ing plans to be there ever since we got home from the St. Louis meeting which I am so thankful now that he did attend. I hope you will have a successful meeting and please convey my heartfelt thanks to all the members for kind sympathy. Sincerely, Erma J. Kern, (Mrs. Carl E. Kern).

Our program chairman Vince Bailey has assembled a very interesting program for us and the first part of this program is a round table discussion. So without any further ado, I am going to turn the program over to Vincent Bailey, Bailey Nurseries.

VINCENT BAILEY: Members, guests, friends, we have a very crowded program so I will not take any of your time. We will go immediately to the round table discussions listed in your program. I feel we are very fortunate to have prominent people for moderators and recorders of these sessions.

[*Editor's Note*: The following round table discussions were held; "Storage of B and B Plant Materials," Arie J. Radder, Moderator, Harvey Gray, Recorder; "Viruses — Their Importance to the Plant Propagator," Professor Donald Cation, Moderator, Zophar P. Warner, Recorder; "How Critical is Timing in Taking Cuttings". Dr. F. O. Lanphear, Moderator, Hans Hess, Recorder. Summaries of the round table discussion were presented and recorded on Friday evening.]

PRESIDENT ROLLER: The next part of our program was to be moderated by Roger Coggeshall but unfortunately he is not able to be here because of illness. However, we have Dr. Robert Mullin of the University of Minnesota who has kindly agreed to take care of that duty.

MODERATOR MULLIN: I know you are all interested in hearing the next speaker. In fact I heard the comment as I entered the room, "When is Mac going to talk?". Our first speaker is Mr. Ian F. Mackay from the Conrad-Pyle Company. He will be speaking to us on the need for research on the Nursery Level.

THE NEED FOR RESEARCH ON THE NURSERY LEVEL

IAN F. MACKAY, *Director of Research*
The Conrad-Pyle Company
West Grove, Pennsylvania

Before getting too deep into this talk perhaps I had better introduce myself. While at one time I was the propagator of a large nursery, for the last 12 years I have not produced a saleable crop of anything and I have had more failures than successes. Yet I am still employed and not by a charity organization. Indeed I might say that my employers have a very high regard for the value of a dollar.

What I have been doing is research on the nursery level. A broader and more embracing job than the name implies. And also a job that is not as common as it should be.

Horticultural reseach is one of the oldest branches of research in existence. Earliest man carried on research every time he tried a new plant or berry for his menu. It must have been a hazardous job and some undoubtedly did not live to carry out any more experiments.

Early man also experimented and found that some plants have healing properties. As a result of which he started a line of research which continues to this day. This attracted the interest of the great intellects of early times and inspired the growing and collecting of plants in an organized manner. Thanks to these intellectuals we have landmarks in the form of writings some of which go back to 300 B.C. These allow us to gauge the progress of research fo the last 2300 years.

I am not going to go back as far as this but I am going back to 1663. Three hundred years ago John Evelyn wrote about seed stratification, seed selection, wounding to promote rooting and the dangers of air pollution. By reading this author's works I had hoped to show how we had progresed over the course of the last 300 years and I was rather put out when I realized that here we are today still talking about the identical subjects.

From Evelyn's time progress in horticulture relied on the stimulation of such organizations as the Royal Society. and also on the great estate owners of England and continental Europe. It became fashionable among these wealthy people to garden on a grand scale and to fill their grounds with collections of all the plants that were available. To further their ambitions some even sent members of their staffs on plant hunting expeditions to all parts of the world. It was on these estates that the finest gardeners that the world has ever known practiced their art.

This was the golden age of discovery in gardening and the commercial nurseryman was not long in getting in on the act. Increased interest on the part of the average man in gardening spurred the demand for plants novel and different. When importations did not fill this need, nurserymen turned to hybridizing and by the mid-19th century they were already meeting with success. This can be judged by the fact that many of our best hybrid Clematis such as Clematis Jackmani were produced at this time and roses hybridized in the same period are still cataloged today.

These newly introduced plants were valuable to the nurseryman for then as now a customer was prepared to pay for the privilege of having something that his neighbor did not. As evidence of this, 100 years ago Lillium Auratum sold for $40.00 a bulb.

In the mid-1800's there were two developments in America which have helped to alter the whole course of horticulture in this country.These were the founding of the land grant colleges in 1855 and of the U.S.D.A. in 1862. While at first their work was concentrated on food crops, towards the end of the last century the colleges started showing an interest in ornamental nursery crops and floriculture. At a later date the U.S.D.A. began working on the same subjects. As a result of the participation of these two institutions we have seen the whole concept of horticultural research change in the last seventy years. It has changed from the amateur methods of experimentation of the last century, to the modern scientific approach that now exists.

Today we have three important sources to which to look for new techniques and materials. The first and foremost of these are the universities and their experimental stations.

The second source of research work is that of the U.S.D.A., both at its Beltsville Research Center and its satellite stations scattered over the country.

The third source of research is that of the allied industries who are interested in filling some specific need of the nurseryman. Profit being their motive they are only interested in research that offers a reasonable return on their investment and this in turn is dependent on the acceptance of the product by the nurseryman. In practice most of the new machinery, materials and chemicals that are made available to us from industry were originally developed for other branches of agriculture. The market we offer is small and certainly not large enough for large corporations to support either research or the manufacture of an exclusive product for our use. In particular the agricultural chemical industry is being faced with increasingly severe regulation of their business where new chemicals are concerned and the development of these is becoming so costly that limited use materials stand little chance of ever reaching the market. This is going to hurt us in the long run.

These are the institutions to whom we look for help in increasing our knowledge of plant life, for better methods of growing and propagating it, and for better materials to assist its growth and to protect it from disease and pests. Never before has more research been carried out of potential value to us commercial growers.

At this point I think we need to ask ourselves two questions:

1. Are we taking full advantage of this work?
2. Are we supporting it and encouraging it?

The answer to both is NO! We are not doing either to nearly the extent that we should and the results of this neglect may become apparent before too long. To see why, I think we need to consider the decreasing influence of the farm vote in the American political scene, for this affects us. Those who question excessive federal participation in this, that and the other, and those whose interest is in cutting federal expenditures may not be so sympathetic to appropriations being made for research to help commercial nurserymen and especially if we only show a half-hearted interest in the work. A further point we want to consider is that the universities in recent years have seen a declining interest on the part of students to take horticulture with the intent of nursery employment. And finally as industry becomes more and more profit conscious and more interested in mass production it is becoming less interested in dealing with a small volume and disorganized trade. This happens at a time when we, too, are more profit conscious and need all the help we can get.

All of this points to a coming decrease in research in ornamental horticulture. In view of this I think our industry should look to the time when it must devote more effort and more of its income to doing its own research. We will have to do this not only in an attempt to increase the efficiency of our production methods but also to make more effort to satisfy the needs of our customers. We will have to supply the home gardener with better plants, that are hardier and better adapted not only to climatic conditions but also to his unintentional neglect and ignorance. We will have to devise ways of making gardening easier for these people for the day is gone when planting a shrub, evergreen or rose was a major earth moving project. In short it is up to us to simplify gardening for our customers and to make it a pleasure and not a backbreaking chore.

In England a good garden is looked upon as a status symbol and this is what I want to see happen in this country. This cannot be done by dozing in complacency while other industries take our customers' leisure time and money away from us. Perhaps I am looking too far ahead so I had better return to the present. There is no question of the need for research on the nursery level in the future but what of it today? Do we need it and what should be its function?

At this time when costs of production are rising faster than the prices of our products and many of us are feeling the so called profit squeeze, and we must lose no opportunity to increase the efficiency of our operations. It is to this end that nursery level research should be principally aimed with its objectives being *to acquire, translate* and *apply the results of academic and industrial research.* If a nursery accomplishes this to the point that it is keeping abreast of current research and as a result is using every uptodate and cost saving technique, it is well on the way to becoming a successful business that will be capable of weathering any storm ahead.

What are the requirements needed to accomplish this? I believe there are two:

1. The need for better communication between outside research and the nursery industry.
2. That nursery management be always aware of the need for constant improvement of its operations.

Communication is the biggest bugbear that has to be faced by the propagator or grower trying to keep abreast of the times. The results of research work and the observations made by individuals are published where? In any one of God knows how many society transactions and journals, government and university bulletins, county agents information sheets and in trade papers. In the case of the nursery industry discoveries made by them are all too often kept in secrecy, either because the originator fears his competition or as is more usually the case because he has no facilities for getting his work acknowledged. This situation is satisfactory neither to the research worker nor the nurseryman. The researcher hopes that the results of his experiments will be put to some use and certainly a progressive nurseryman wants to avail himself of these. But he first has to be aware that the work has been done before he can put it into practice. Lack of communication is the stumbling block in the achievement of this aim.

How can this be overcome? Well if you can afford to employ a full time research employee, he can subscribe to the various types of publications that I have mentioned, but the ordinary grower has neither the time nor the money for this. What he needs is a publication of abstracts on research papers that deal in any manner with commercial horticulture. He needs to know not only what work his own university is doing but also what is being done in other parts of the country. While our business is in Pennsylvania, we receive much information of value from work published in Oregon, California or Ohio just to mention a few. There is no doubt that we still miss many that we would find of value. If we had any where to turn for a single source of information on these papers, our job would be a lot simplier. Abstracts are being produced to some extent by the AAN in their periodically issued Research Review and also by some university extension services, but none of these of which I am aware encompasses a wide enough range. Today's commercial propagator requires a knowledge, albeit limited, of chemistry, plant pathology and plant physiology in addition to his understanding of the various techniques of his trade, and regardless of whether he likes it or not, he has also got to face the problem of selling his product. He needs all the information in these fields that relates to his job and he must not limit his thinking in this to purely horticultural subjects. The only attempt that I am going to make to provide a solution to this problem is to suggest that the Plant Propagators' Society is the best and most logical organization to publish abstracts from current research work. We are a unique society in the breadth of our membership and with the combined knowledge and experience of its members none is better qualified to undertake such a project.

When it comes to publication of the experiments and experiences of members of this Society, I think we may have an easier solution. Actually this subject was covered by Peter Vermeulen two years ago at our annual meeting. He put forward several suggestions for the improvement of communicaton among our members and I hope these are still being considered. It is worth noting that over half of our membership have either not had the opportunity or have not felt inclined to present a paper at any meeting. While obviously not everyone can contribute a paper at every meeting, I think a way needs to be found to allow these silent members to contribute. Could this not be achieved by asking members to contribute not a complete paper but a short summary or abstract to our newsletter, on some feature of experimental work that they have carried out, or of some original technique that they use. From these abstracts our program chairman could draw for complete papers or individuals could write to the originators for more complete information if it is a matter that is of particular interest to them. There is no member of this society who does not have something worthwhile to contribute; otherwise, he would not be a member.

I think that is enough on the subject of communication. Now to turn to the second cause of the failure to translate research to operation. Management and where it fails to manage.

In a speech given the other day the President of the American Nurserymen Association, Sidney Hutton, Jr., made some remarks that I think are worth repeating. I quote, "We are not used to many of the methods, means and aids accepted by other industry as a part of modern management." He went on a little further, "Occasionally, when people in other industry have realized how unsophisticated we are they have jumped to a very erroneous conclusion. They have considered the nurseryman to be a little dumb or a little stupid." And he continued, "We are unsophisticated, Yes; dumb, No. The very fact that we have come as far as we have without the use of these other management tools proves that we cannot be dumb."

There is no question about it, nurserymen are not so dumb but being plant lovers first and businessmen second, too many lack accurate records of production costs. Selling prices are based on a study of the competitor's catalog and if all is well the business remains solvent. However, without an accurate breakdown of the cost of each phase of the production of a plant, the grower has no means of determining where there is a possibility of reducing costs. Without this information the need for research on the nursery level goes unrecognized and techniques are either not adopted or are very slowly adopted. Do we honestly still believe that sweat, the employment of mules and ragged weed chopping hoers are the best way of growing a nursery crop? If they are, then it is only because we as an industry have failed to support horticultural research. Look at any other branch of agri-business and you will see research being applied. Vegetable farmers, cut flower growers and dairy farmers are all more receptive to new ideas and consequently more is done on their behalf. They are all willing to carry out research on their own level to prove that a new idea will or will not work, but not the average nurseryman unless he is first worked over by a very good commercial salesman. You don't believe me? Well how many growers have a really well planned chemical weed control program? How many treat their soil with nematicides without first having the nursery inspector quarantine their crop? Why are we still digging evergreens by hand and shearing them by hand? We certainly would not be if we gave researchers the support they need to invent alternatives and if their inventions were used.

If we look to our brethren in the floriculture industry, we will find that they co-operate very closely indeed with the universities and the U.S.D.A. They recommend where they think research can be of the most use, they maintain close contact when this is being done, and finally they put the results of the work to use. Of course, their prime interest in growing is how many cents they can get per square foot of bench space. Most of us commercial nurserymen are more interested in the beauty of the plants. Now this is no crime and indeed it is an asset. If we are enthusiastic about our product so will be our customers. But we can learn from the floriculturist. We need to follow his example in co-operating with academic research and with applying the results it achieves. But to do this we have to experiment ourselves under our production conditions.

If we are successful in this, our industry will not only be more progressive but it will also appear more attractive to the type of employee we need now and will need even more in the future. This is the space age and few aggressive, ambitious young men want to be associated with an anachonism in industry. To progress we have got to:

1. Acquire
2. Translate
3. Apply

the results of academic research.

To achieve this spells out the need for research on the nursery level.

MODERATOR MULLIN: We will proceed with the next speaker who represents one of three major research areas — the university, the U.S.D.A., and private industry. Our speaker is from the second area, the U.S.D.A. Dr. Marc Cathy will discuss what a propagator should do to pace the development of his plants.

PACING DEVELOPMENT OF WOODY PLANTS

HENRY M. CATHEY[1]

Many growers have already made great advances in accelerating handling of woody plants. Most growers still aim their material towards seasonal sales for plants to be used as foundation plantings for the home, business, or factory. Growers must continue to service the landscape horticulturist but they also must service markets with cuttings and liners of woody plants that have been regulated. Regulated liners will provide plants for decoration inside the home and also can be used as plantings outside the home. Many berried or flowering plants are now on the market that can also serve as decorative house plants.

[1]Horticulturist, Crops Research Division, Agricultural Research Service, U S Department of Agriculture, Beltsville, Maryland

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Through the years, the hydrangea, gardenia, and azalea varieties selected for inside culture have lacked hardiness for garden use. With advances in regulating growth of many woody plants, the propagator again has the opportunity to service a new market area and to produce useful plants in a minimum time. Pacing growth and development of woody plants is possible through procedures already widely practiced by ornamental plant growers.

Regulated culture of woody plants immediately excludes some of the more common practices used by the grower. Trimmings from older plants or cuttings from special blocks of plants growing in the field seldom root and grow uniformly. Most growers take cuttings at a particular time of year and use large cuttings to get flower and fruiting plants the first year of culture. Basic information on ways to regulate the stock plants and cuttings for maximum response and growth control is needed. When the grower learns to make use of the environment, endogenous growth substances, and exogenously-applied growth substances, he then will develop precise growing techniques for servicing the needs of a year-round producing and selling woody plant industry.

Research work on stock plants, cuttings, and procedures to produce the mximum regulation are reported in the *Proceedings* of the Plant Propagators' Society. Identification and reapplication to cuttings of factors and co-factors responsible for rooting will simplify the area of stock plant-cutting production. Regulated growth for continuous cutting production of woody plants should be the aim of any growing procedure.

Part of our research program in the Ornamentals Investigations at Beltsville, Maryland, is concerned with studyig the woody plant liner. Our aim is to provide suitable media, fertilizers, and disease control programs to allow for the regulation and scheduling of production of woody plants — not on a seasonal basis — but on a weekly basis.

Control of Vegetative Growth

Stem Elongation Regulation. Vegetative growth of woody plants is controlled by phytochrome (1) in a dramatically-evident way through extension of short days with low intensity light of various wavelengths, or by interruption of long night periods with a few hours of light of low intensity. The literature concerning photoperiodism in woody plants has been reviewed by Wareing (10), Nitsch (5), and more recently by Romberger (6).

We will consider growth of *Rhododendron* "Roseum elegans", well known hybrid of *R. Catawbiense* Michex., in some detail. Supplemental artificial light during the night promotes vegetative growth of rhododendron. It exhibits many of the control features of herbaceous plants with flowering occurring naturally after 8 or 9 flushes of growth.

Rhododendron plants were grown on 8-hour days with 8-

hour extensions of various types of radiation. The light sources were predominantly far-red (photographic safety light); near equal amounts of red to far-red (incandescent filament light); and predominately red (fluorescent light). The radiant energy from the 3 kinds of lamps was adjusted so that the energy in the red part of the spectrum was the same in all treatments. All 3 light sources promoted stem extension. Incandescent filament lamps gave the maximum elongation of each flush; far-red, second; and red, third.

Waxman reported the usefulness of intermittent light on a range of woody plants in the *Proceedings* of the Plant Propagators' Society. Rather than use continuous light, one can use minimal effective light energy and then allow it to act in darkness until dark reduces its effectiveness. Incandescent light given in cycles of less than 60 minutes for 16 hours delays the onset of short-day dormancy in rhododendron plants (Fig. 1). Light given 10% of a 1-minute or 24 minute cycles was equally effective when the night temperature was maintained at 70° F. At 60° F. night temperature, 1-minute cycles were more effective than 24-minute cycles given for 16 hours; 60-minute cycles cause only moderate delay. The minimal duration of light needed to delay the onset of short-day dormancy is 4 hours of intermittent lighting in the middle of the 16-hour dark period.

Figure 1. Plants of Roseum elegans rhododendron were grown on the natural short days of winter and during the middle of the night incandescent light of 20 ft-c was applied as follows: Left to right, natural days, 4 hrs. from 10 PM to 2 AM, 24 minutes from 11:48 PM to 12:12 AM, and 1 minute every 10 minutes from 10 PM to 2 AM. Treatments continued for 4 months.

The response of plants to intermittent lighting was first studied by Garner and Allard (3) and was developed by Hume (4), Withrow and Withrow (12), and by Waxman (11). The response of plants to repeated stimulation of the phytochrome,, the photo-reversible pigment, is observed in many physiological displays in plants (1). One observes the display in inhibition of short-day dormancy, in promotion of stem elongation of long-day plants, and in the delayed flowering of short-day plants.

Branching Regulation. Continued use of long days causes plants to grow with little development of lateral branches; primarily the plants develop a main stem. The woody plant grower must stop the liner to induce development of lateral branches. One can induce multiple bud break of rhododendron plants by limiting their growth for at least 8 weeks on 8-hour days, exposing the plants to temperatures below 55° F. for 8 weeks, and then returning them to long days (Fig. 2). Stopping the plant by removing the growing point is essential, to build the framework for subsequent development of the plant. Thus, manipulations of daylength and temperature may be too time-con-

Figure 2. Plants of Roseum elegans rhododendron were grown on the natural days from December 1. Plant on left remained on natural days. Center plant grown on natural days with 20 ft-c of incandescent light from 10 PM to 2 AM, soil of plant on right treated with 0.2 gm phosfon and grown on natural days with 20 ft-c of incandescent light from 10 PM to 2 AM. All plants were transferred to 8-hr days, for April and May, and then to a 50°F refrigerator with light for June and July. Plants returned to greenhouse on natural days; plant in flower in late August.

suming for the grower to use in the accelerated culture of woody plants.

Regulated Growth and Flower Initiation. Regulated flowering is desired in the culture of many woody plants. Many cultural practices are employed to manipulate plant size and flowering time; however, these techniques require that the plants receive constant attention to keep them staked. Also dwarfing understocks often contain viruses which shorten the productive life of the plant.

Stuart (7,8,9) discovered that the growth retardants phosfon, Cysocel, and B-Nine caused suppresion of vegetative growth and prompt initiation of flower buds in rhododendrons. These responses did not depend on minimum age or size of plant. Photoperiod and temperatures modified the dosage response and the persistence of the chemicals. Subsequently, the flowering of Camellia, Ilex, Gardenia, Malus, Pyrus, and Prunus was accelerated in response to applications of growth retardants. Current knowledge in the physiology of the growth retardants was reviewed by Cathey in 1964 (2).

The procedure for regulated flowering of rhododendrons as an example is given below and is illustrated in Figure 2.

Pre-treatment. Select uniform plants. Pinch to promote development of 3 lateral shoots. Treat soil (1 part compost, 2 parts peat, 1 part coarse sand) with non-ionic wetting agent at time of repotting (drench soil with 0.1% solution). Pot plants into 5- or 6-inch clay pots.

Lighting. Grow plants on long days (natural days plus incandescent light 20 ft-c) from 10 P.M. to 2 A.M. Continue lighting for 2 months in summer (June, July, or August) and 4 months in winter (November, December, January, February).

Temperature. Maintain a minimum temperature of 65° F. at all times.

Chemical treatment. When growth is starting, treat lots of plants as follows: 1) Soil drench, phosfon 0.2 g/plant, or (2), spray B-Nine 0.25% 3 times at monthly intervals.

Preparation of Solutions:

Phosfon — 0.2 g/pot. Add 1 oz. 10% Phosfon-D liquid in 15 pints water; treat each pot with 1 pint of diluted chemical.

B-Nine — 0.25% spray. Dilute 5% concentrate, 1 part concentrate to 19 parts water.

Post treatment. Flower buds should appear on treated plants 3 to 4 months after treatment with chemicals. Transfer the plants to natural daylengths to allow flower buds to develop.

Cold storage. Store budded plants at temperatures below 55° F. for a minimum of 8-10 weeks to break the dormancy of the flower buds.

Forcing. Return plants to greenhouse for forcing. A variety will require 4 to 8 weeks to force at 65° F.

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CASE HOOGENDOORN: How much phosphon do you use in the pots?

DR. CATHEY: The rates, on the basis of soil and pot size is in the publications. For example, we grow our plants in one part peat, one part sand, and two parts of composted soil. We treat them with a non-ionic wetting agent which is most important in watering rhododendrons. For a 5 inch pot, for a variety such as America or Nova zembla we would use 0.2 gram to 2.5 gram with the dust on the market, the 10% dust. It would be a little less than one teaspoonful per pot. The rates are fairly high. B-9 is a spray, applied at monthly intervals 3 or 4 times. The temperature has to be high enough and grow them on long days. Nova zembla, from my experience, flowers on the fourth or fifth flush. Roseum elegans flowers on about the 9th flush when grown on long days. When you add growth retardants at any age, about the third flush from the time you started treatment, the plant forms a flower bud. So with B-9 you've got to have it working with each of the flushes. It does not seem to persist so every month you must apply a spray.

CASE HOOGENDOORN: Is it not true that with Phosphon you do not have to apply it every month?

DR. CATHEY: Yes, with phosphon you have to apply it only one time. As long as the rhododendron remains in the pot, it will form one flower bud after another.

CASE HOODGENDOORN: Now if you have a treated phosphon plant in a pot and take it out of the pot and plant it in ordinary soil, how long is that phosphon staying with the plant?

DR. CATHEY: If you put it out in well prepared soil and the root system goes right out into the new soil, it will immediately resume growth and show no effect of the growth retardant. But if the root system is not very vigorous, it will continue to show some of the effects. I would not recommend phosphon in nursery beds because of its persistence. I would think it should only be used for potted plants which would later be planted in beds where the phosphon effect would be diluted. For nursery bed culture, I would think only B-9 should be used. B-9 is much more active and you have to be much more careful about dosage to get the proper response.

CASE HOOGENDOORN: Do you use different dosages for holly and for rhododendron?

DR. CATHEY: No, use about the same rate.

ROBERT DEWILDE: If you were to remove the terminal bud from the rhododendron placed under long days, would this effect side branching without the addition of chemicals?

DR. CATHEY: When we pinch we normally get at the most, in my experience, three or four breaks, and normally two may dominate. This is with Roseum elegans. If you use short days, 8 hour days, for 2 months, and then cold, and then long days, you can get eight or ten breaks from the same size plant. But this process takes 4 months. So pinching and taking the two or three, or at the most four breaks, is apparently the only thing to do.

THURSDAY AFTERNOON SESSION

December 3, 1964

The afternoon session convened at 1:15 p.m., David R. Dugan, Dugan Nurseries, Perry, Ohio, moderator.

MODERATOR DUGAN: Our first speaker for this afternoon's program is a man from Chase, Alabama, Mr. Henry Homer Chase who will speak on layering ornamental magnolias.

PROPAGATION OF ORIENTAL MAGNOLIAS BY LAYERING

HENRY H. CHASE

Chase Nursery Company
Chase, Alabama

Layering is the development of roots on a stem while it is still attached to the parent plant. The detached stem, after rooting, becomes a new plant growing on its own roots.

Our method is mound layering, in which the rooting medium is well rotted sawdust instead of soil, and in which the stems remain erect during the rooting process.

We have probably 500 stool plants, the oldest of which are over fifty years old, and we will take an average of about 45 layers from each plant, for an annual production of about 20,000 rooted layers. The oldest plants produce the most stems.

We start our layering in late June or early July, when the stems have obtained a height of about four feet, and a caliper

Fig.1. Making an upward cut into the magnolia stem.

Fig. 2. Sphagnum moss inserted into cut.

of from 3/8″ to 5/8″ or so. Stems as small as 1/4″ can also be rooted successfully, if the operator is very careful and his knife very sharp. The procedure is quite simple. We start by removing the bottom leaves from each stem to a height of about 18 inches to prepare the working area. As low as possible on each stem, but always under a bud eye, we make a tongue cut, about half way through the stem. Into this cut we insert a small wad of sphagnum moss, to hold the wound open, and to provide a carrier for root inducing hormones. We use Hormodin No. 3 for this purpose, thoroughly mixing about 4 tablespoonfuls into a 10 quart pail of well moistened sphagnum moss.

After the wad of hormone treated sphagnum moss is inserted into the cut, we prepare a container for the sawdust by inserting four or more metal stakes into the ground around the parent plant as a temporary support for a strip of ordinary kraft paper. With pinning nails as fasteners, we make a bottomless basket of sorts, resting on the ground, with the top open. Into this basket we pour the well rotted sawdust to a depth of about 18 inches. Soil is then mounded around the paper supported sawdust, and the metal stakes removed to the adjoining plant, leaving soil supporting the paper basket.

It is essential that the sawdust be kept moist during the rest of the growing season. For this purpose we lay a temporary water line, and weekly, or as weather conditions dictate, we water each mound by hand through an ordinary garden hose.

Calluses form within a period of about three weeks, and by early autumn, the stems have become well rooted. In late summer, we prune the tops back to within six or eight inches of the top of the mound, for ease of handling when the new plants are removed.

At planting time, the earth is removed from the mound. The paper has long since rotted away, and the sawdust easily falls away from the rooted stems. The rooted layers are severed from the mother plant with pruning shears, and are ready for transplanting to the field.

We like to do this transplanting in November. The new plants are spaced about 15 to 18 inches apart in 48 inch rows, planted by hand, assisted by a spade. Harvesting starts at the end of the first growing season after transplanting, when the new plants will be from 12 - 18″ through lightly branched 2 - 3′ and useful for mail order or wrapping sizes. At the end of the second growing season, we can start digging them as B&B 2 - 3′ through a few 4 - 5′. After the third year, most of them are well branched 4 - 5′ through 6 - 8′.

We realize that this method is more costly than rooting from cuttings under mist or otherwise, but we feel that the very strong plants we take to the field justifies the extra cost, because of the earlier harvest.

Fig. 3. Layering operation complete.

MODERATOR DUGAN: Our next speaker is Arthur Lieberman, Horticultural Extension specialist from Cornell University who will speak "Observations on Native and Cultivated *Ericaceae* in New York State."

SOME OBSERVATIONS ON NATIVE AND CULTIVATED ERICACEAE IN NEW YORK STATE

ARTHUR S. LIEBERMAN
Cornell University
Ithaca, New York

In the past several years, ericaceous plants have become increasingly popular in landscape plantings on New York State home properties. Here, Rhododendrons, Mountain Laurel, and *Pieris* essentially reach their northern limit of hardiness.

In a survey conducted through the New York State Nursery Notes in 1962 to which 90 nurserymen responded, 80 replies indicated many nurserymen growing Rhododendrons and Azaleas. In New York State, the sale of broadleaf evergreens, many of which are ericaceous plants, increased from 234,000 in 1949 to 615,000 in 1959.

The Literature

A check of the literature shows that studies have been conducted into the taxonomic, ecological and anatomical aspects of ericaceous plants, as well as the applied cultural phases of soils, nutrition, site selection, and propagation. Even the pharmaceutical aspects have been explored.

A list of selected references has been prepared to accompany this discussion today.

Some Hardiness Observations

In the last 9 years of extension travels it has been possible for me to observe, both superficially and in some depth, native stands and cultivated plantings of Ericaceae in New York State, and to arrive at some conclusions — and raise some questions — concerning their requirements and culture. Several persons have shared in either making the observations or interpreting them.

These recent observations in New York State tend to confirm findings of several Cornell staff members in the 1930's concerning rhododendrons and azaleas. They concluded that these plants, so long as hardy types are chosen, do well in areas free of excessive sun and wind, in a mulched, well aerated, well-drained soil. Assuming hardy species are chosen, the emphasis is placed upon factors other than temperature, namely those of site selection and soil preparation.

Soil Preparation

In Cornell extension publications, we emphasize soil structure and texture, as well as available moisture, over pH. It is undoubtedly easier for home gardeners to maintain plantings in acid soils, and observations of native stands indicate that these seem to almost uniformly grow on very acid soils. However, with the advent of chelated iron and of fertilizers with nitrogen in the desired ammonium form, pH become a less formidable factor. Incorporation of peat in the growing medium, regular annual mulching and nutrient applications help maintain conditions in which the plants thrive.

To overcome the problem of soils with poor internal drainage, raised bed plantings are appropriate, and have been used.

Native Stands

In 1960, observations were made at 5 sites of either blueberry, mountain laurel and/or rhododendron in Sullivan County, New York. These Catskill Mountain locations are in USDA's Zone 5A with an average annual minimum temperature of 20° below zero. Soils, topography, associated plants, growth and flowering patterns were studied. It was found that blueberry and mountain laurel were generally growing in more open conditions and in somewhat heavier soils than was the case where *Rhododendron maximum* grew. All sites of the 3 genera had soils with a pH reading no higher than 4.5.

In locations where *Rhododendron maximum* was found growing, both soil aeration and internal drainage were good. At a site by a stream in Upper Ferndale there was decaying organic matter 2 - 4″ deep over a uniform layer of sand 2 feet or more deep. On the top of a bank 10 - 15 feet above a stream, decaying organic material 4 - 6 inches deep was present over a clay loam sub soil. One section of a second site near Camp Chippinaw revealed a 6 - 7 inch depth of organic material over a clay loam sub soil.

On a relatively level bog site beyond coniferous woods blueberry and mountain laurel were found growing. Sphagnum hummocks 6″ deep were present in the bog over a 6″ layer of white clay and a layer of sand underneath the clay.

The Factors of Temperature, Site and Soil

There are a number of old plantings in the coldest parts of New York State (listed as Zone 4 by U.S.D.A.).

One of these is a forty year old site in Essex County, not far from Keene Valley, New York in the Adirondack Mountains. The soil is favorable, a natural mulch is present, and wind protection is afforded by surrounding mountains. *Rhododendron carolinianum, R. maximum, R. catawbiense, R. nudiflorum, Pieris floribunda, Kalmia latifolia,* and a Ghent Azalea (or one of the parent species) are growing well here.

The second is at White Pine Camp of Paul Smith's College, Paul Smith's, New York. Favorable site and soil conditions have created a growth of rhododendrons comparable to that seen in areas in Pennsylvania or farther south. Average annual minimum temperature here is apt to be in the 20 - 30° below zero range, according to the U.S.D.A. map.

Plantings in Poorly Drained Sites

In areas with poorly drained soils, raised bed plantings have been successfully employed, from both the horticultural and landscape design standpoints. The following slides show such raised plantings at Buffalo, Syracuse and Ithaca, New York each having naturally heavy soils with impeded internal drainage. The principle of raised plantings is shown first, with both a bed sloped to the soil surface and one with a retaining wall depicted. In the Buffalo and Ithaca slides the new planting and one several years older are shown.

Chlorosis

Chlorosis is evident where either physical or chemical causes exist.

Where chemical causes are involved, the application of iron, as in the case of the illustrated *Pieris japonica* grown under pot conditions at pH 6.8 should help, if applied at the right time in the growing season. In this case, NPK plus iron sulfate were used at the right, while iron sulfate alone was used in the middle pot. This photo is from an old New Jersey experiment. Chelated iron would more likely be used today.

Should chlorosis occur as a result of physical causes, correcting of the physical factor must be accomplished.

Some Usefully Hardy Ericaceae

Usefully hardy Ericaceae in upstate New York include Rosebay Rhododendron, *Rhododendron maximum,* Carolina Rhododendron, *R. carolinianum,* and some hybrids of it, Catawba Rhododendron, *R. catawbiense,* as well as several "Ironclad" cultivars known to be reliable in Central New York (U.S.D.A. Zone 5) and milder areas, Drooping Leucothoe, *Leucothoe fontanesiana, Kalmia latifolia,* Mountain Laurel, Mountain Andromeda, *Pieris floribunda,* Redvein Enkianthus, *Enkianthus campanulatus,* Tree Andromeda, *Oxydendrum arboreum,* plus a considerable number of deciduous azaleas. The latter include Pinxerbloom, *Rhododendron nudiflorum,* Roseshell Azalea, *R. roseum,* Pinkshell Azalea, *R. vaseyi,* and Flame Azalea, *R. calendulaceum,* Sweet Azalea, *R. arborescens,* and Swamp Azalea. *R. viscosum.* A type related to Flame Azalea, the Cumberland Azalea, *R. bakeri,* has been grown successfully in Ithaca for many years and deserves more attention from plant propagators looking for a late-flowering, cold-hardy plant.

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MODERATOR DUGAN: Our next speaker is a seed technologist at the New York State Agricultural Experiment Station and has operated an experimental nursery for testing seed quality and sources for the past twenty years. Mr. C. E. Heit.

THE IMPORTANCE OF QUALITY, GERMINATIVE CHARACTERISTICS AND SOURCE FOR SUCCESSFUL SEED PROPAGATION AND PLANT PRODUCTION

C. E. HEIT, *Department Seed Investigations*
N. Y. State Agricultural Experiment Station
Geneva, New York

The importance of seed quality and germinative characteristics can not be stressed too strongly if the nurseryman or plant propagator desires the most success in his plant production program. For many years nurseryman thought that tree seed could not be tested accurately in the laboratory for germination as other kinds of seeds. Some seed dealers and collectors have also clung to this belief too long and have even passed such information to the seed buyer through their catalogues, correspondence or conversations.

To-day the seed laboratory which is properly equipped with modern, automatic light germinators and manned with experienced, ingenious seed analysts can test any kind of tree and shrub seed, no matter how dormant or how difficult they are to germinate. Our New York laboratory tests hundreds of tree and shrub seed yearly now on a service basis for nurserymen, seed dealers, collectors and private planters. Our seed testing service is maintained for residents of New York State but we also test tree seed for persons from other States especially when

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THE IMPORTANCE OF QUALITY, GERMINATIVE CHARACTERISTICS AND SOURCE FOR SUCCESSFUL SEED PROPAGATION AND PLANT PRODUCTION

C. E. HEIT, *Department Seed Investigations*
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The importance of seed quality and germinative characteristics can not be stressed too strongly if the nurseryman or plant propagator desires the most success in his plant production program. For many years nurseryman thought that tree seed could not be tested accurately in the laboratory for germination as other kinds of seeds. Some seed dealers and collectors have also clung to this belief too long and have even passed such information to the seed buyer through their catalogues, correspondence or conversations.

To-day the seed laboratory which is properly equipped with modern, automatic light germinators and manned with experienced, ingenious seed analysts can test any kind of tree and shrub seed, no matter how dormant or how difficult they are to germinate. Our New York laboratory tests hundreds of tree and shrub seed yearly now on a service basis for nurserymen, seed dealers, collectors and private planters. Our seed testing service is maintained for residents of New York State but we also test tree seed for persons from other States especially when they do not have proper testing facilities in their respective States.

Most coniferous tree seed can be tested within 10-30 days. With modern automatic artificial light germinators as exhibited in Figure #1 most pines, spruces, firs, and cedars can be tested promptly without any stratification or prechilling treatment. Both artificial light and alternating temperatures stimulate many of these dormant seed to germinate rapidly. Many hardwood and shrub species can also be tested for germination in the laboratory without special treatment such as the elms, spring seeded maples, catalpa, black locust, common lilac and tree of heaven.

Extremely dormant seed such as apple, peach, cherry, white ash, bittersweet, barberry, basswood, redbud, and certain conifer

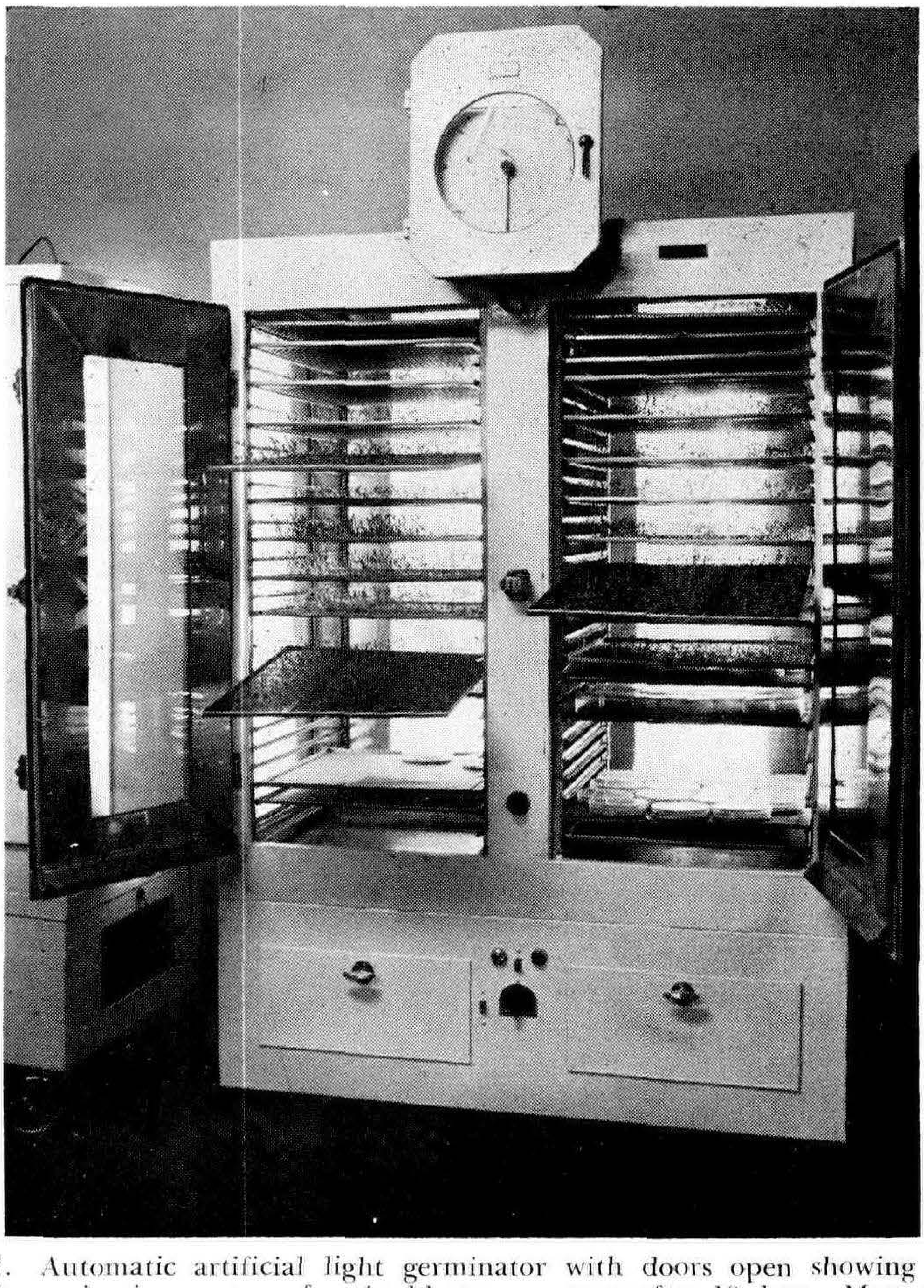

Figure 1. Automatic artificial light germinator with doors open showing conifer seed germinating on top of moist blotters on trays after 10 days. Most of these pines and spruces have completed their germination.

species can be tested by the embryo excision method within 5 to 20 days. The embryos are removed and placed in dishes under optimum temperature and light conditions in large dishes. These excised embryos will show varying degrees and different types of growth and behavior. The performance of peach embryos of varying germination and vitality is shown in Figure #2. Staining tests with chemicals such as tetrazolium chloride can be used for detecting approximate planting value with those extreme dormant seed where embryos can not be removed readily. Thus the seed analyst can determine actual planting value of all tree and shrub seed within a reasonable length of time. No propagator or nurseryman should sow any seed lot without learning the germination percentage or its approximate tree planting value.

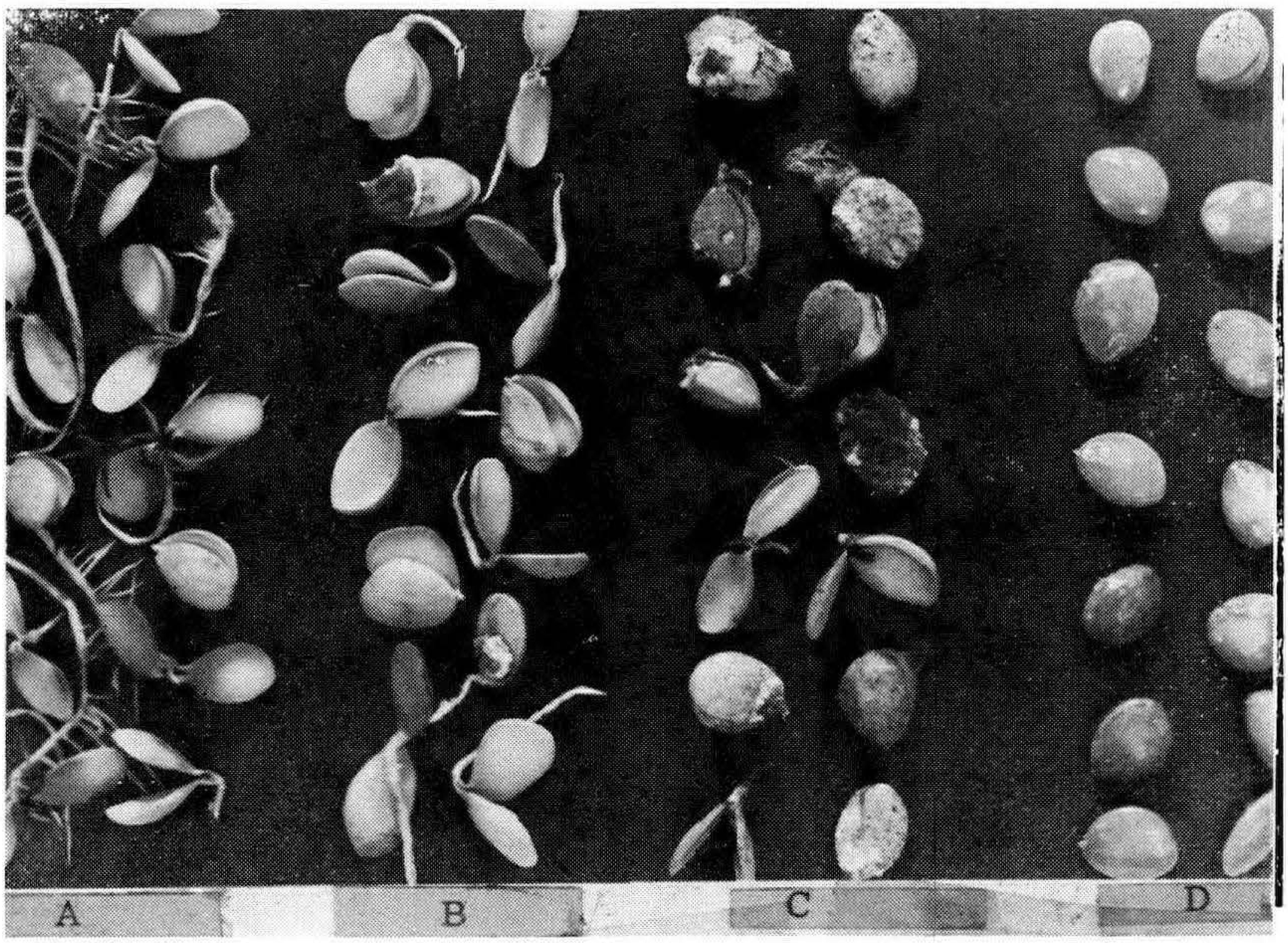

Figure 2. Embryo excision method for testing 4 peach stocks showing comparative strength and planting value. A-strong seed, vigorous growth; B-good reliable seed, fair vigor; C-old seed, weak doubtful value; D-dead seed, no activity. Actual germination of these stocks when empty and bad seed were taken into consideration were 80%, 52%, 18% and 0% respectively.

At present we have standard testing procedures for testing over 100 tree and shrub species which were adopted in June 1964 at the annual meeting of the Association of Official Seed Analysts held in Rochester, N.Y. These rules for testing tree and shrub seed will become effective in July 1965. Each official seed laboratory in your respective states will have these methods to follow when you submit samples to them for testing purposes. A memo summary of "Thirty Years Testing of Tree and Shrub Seed" compiled by the writer may be received upon request. It also lists certain other reprints on seed source studies which are available upon request.

There are two factors which affect seed quality as it is purchased or sown in the nursery, namely purity and germination. The best seed must be properly cleaned, free from inert matter, chaff, stems, cone scales, weeds and other crop seed. Your tree seed must be also true to name or labeling. Another reason for submitting your seed to a laboratory for a test is to check proper labeling. Many tree seed can be identified by laboratory seed germinative characteristics and response. This information will detect mislabeled seeds and protect the user from planting the wrong kind of seed. In the last few years our laboratory has found the following species misnamed as to kind when submitted to us for testing.

1. Black Hills Spruce	Found to be:	Colorado Blue Spruce
2. Balkan Pine	"	Austrian Pine
3. Chinese Pine	"	Japanese Red Pine
4. Jack Pine	"	Shortleaf Pine
5. Japanese Black Pine	"	Japanese Red Pine
6. Scotch Pine	"	Aleppo Pine
7. Scotch Pine	"	Monterey Pine
8. Douglas Fir (Blue from Colorado)	"	Caesia or viridis Douglas Fir or Montana or British Columbia
9. Coral Berry	"	Honysuckle
10. White Mulberry	"	Lonicera Species

HOLD DEALER RESPONSIBLE

The seed dealer or seed collector should be held responsible for the quality of seed he sells. Each propagator should request germination percentage and complete labeling as to source information when purchasing seed from any dealer. Too many nurserymen have purchased tree seed blindly in the past, paid for the seeds, planted them in the nursery with partial or total failures because no germination tests were made prior to sowing and old, weak or dead seed was sold to them.

New York State has provisions in its seed law to protect the buyer of tree seeds, as it does for all other kinds of seeds. There are a few other states which have tree and shrub seed provisions in their laws, namely Georgia, Massachusetts, Pennsylvania and Michigan. Maryland and other States are taking steps to do likewise. It appears advisable and necessary for more States to enact labeling laws so that nurserymen will be protected in purchasing tree seed of good quality and true to name. The basic requirements of these labeling laws are:

1. Name and address of vendor
2. Kind of seed and variety
3. The percentage by weight of pure seeds

4. The percentage of germination
5. Year of collection
6. The specific locality; (U.S. - state and county or nearest political unit in case of foreign countries) in which seeds were collected.

Of course certified tree seed is the final answer and ultimate goal for highest quality tree seed. New York has provisions in its seed law for certification of tree seed and has adopted standards for five conifer species. All nurserymen should promote the establishment of certified tree seed standards in their respective areas.

NEED FOR BETTER TREE SEED CONTROL

Did you know that old, weak, dead and even misnamed tree seed can be shipped into the U.S. to-day? We need some type of Federal Control on imports. Specific cases of dead, misnamed seed involving transactions of several hundred dollars being allowed to enter this country were shown on slides. Seed dealers and private buyers have not protection at present against such situations. Some organizations are promoting the amendment of the Federal Seed Act to correct this situation. Your Society might wish to cooperate with them.

Too much weak, unfit, dead tree seed is being sold in the U.S. to both small and large growers and your Society has an opportunity to improve the situation both individually and as an organization. Our New York laboratory has tested tree seed samples nearly every year which were purchased by State inspectors from various U.S. seed dealers. In 1960, 99 samples were purchased from 9 different tree seed dealers. Two dealers has this record, 7 of 20 samples were found unfit or dead; 5 of 10 samples unfit, dead or mislabeled. A total of 15% of samples received by mail were found to be unfit.

Our tests from samples purchased by State Inspctors in 1964 show little if any improvement. Samples were purchased from 10 - 12 seedsmen or dealers and one or more samples of Austrian pine, Japanese black pine, Swiss stone pine, Norway spruce, White spruce, Engelmann spruce, Black Hills spruce, Sitka spruce, Red spruce, Cryptomeria, Orange, Ginkgo, Chinese elm, Oriental arborvitae and others were found to be unfit or worthless for planting purposes. Dealers who sold this dead and unfit sed were located as follows: 4 in California, 3 in Pennsylvania, one each in Massachusetts and Michigan. Several samples were found to be mislabeled as to kind. One group of 25 inspection samples from U.S. dealers showed 10 lots either dead or so low in germination to be unfit for planting and 4 of this group were found to be mislabeled or misrepresented as to species. The quality of tree seed being sold in the future to nurserymen can be improved by individual and united action by our Society. We have presented the facts as they exist to-day. We do not wish to infer that all tree seed being sold is low quality, much tree seed being sold to-day is good to excellent quality.

Some dealers are very careful to distribute only the best quality seed obtainable.

GERMINATIVE CHARACTERISTICS

For success in growing excellent field stands of seedlings. both total germination percentage and vitality of each seed stock is important. Laboratory tests will reveal both of these characteristics. Old seeds of weakened vitality are readily distinguished from strong, healthy seeds in a performance test. These slow germinating, weak, abnormal seedlings have no nursery field value. Extraction injuries and other mechanical seed injuries can be detected in laboratory tests. The grower must beware about sowing old, weakened or injured seed as these weak seedlings do not withstand the rigors of unfavorable field conditions as compared to strong, vigorous seed.

Varying degrees of dormancy can be measured by laboratory tests and the propagator must know the exact dormant nature of each seed kind and variety to have complete success. Some seed need fall sowing or special treatment for maximum germination. Others should not be fall sown as they might pregerminate and be killed during the winter. The most dormant conifer species such as Balkan pine, White pine, most of the firs, Japanese larch and hemlock should be fall sown for optimum

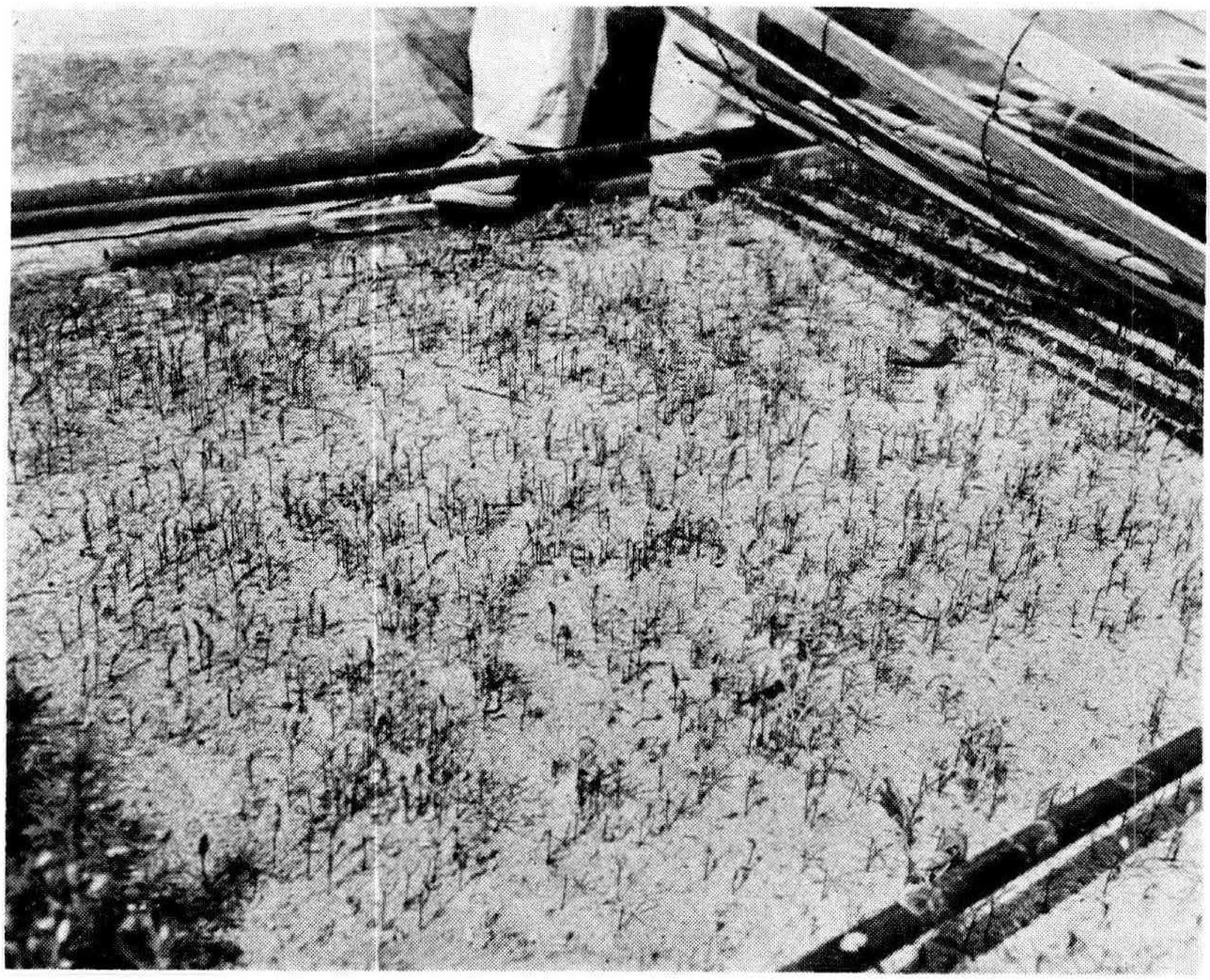

Figure 3. Early spring seedbed germination of fall sown Concolor fir seed. Many dormant conifer species should be fall sown for a most successful field stand and maximum growth the first year.

maximum germination in the spring. Note excellent germination in very early spring of fall sown concolor fir seed in Figure #3.. Fall sown seed of these dormant species will insure complete, maximum germination of all viable seed the following spring, it will insure rapid growth and establishment of the seedlings before damping off conditions become critical and it will result in larger, more vigorous seedlings by the end of the first year. The writer has grown 2 year seedlings from fall sown seed as large as 3 year seedlings from spring sown seed with the same species. Small propagators who grow a few conifer seedings might be interested in securing a reprint of a recent article published by the writer for the small nurseryman entitled "Tips on growing healthy, vigorous conifer seedlings and transplants" which can be secured upon request.

CONTROL SEEDBED DENSITY

Seedbed density must be controlled in order to produce the most healthy, vigorous seedlings and transplants. By knowing the germination percentage and the number of seeds per pound or ounce, the seedling rate can be regulated so as to give optimum seedbed density. This will result in fewer failures and over-crowded seedbeds both of which occur without careful attention to these two factors. A good example of careful attention and accurate calculation of these two factors resulted in op-

Figure 4. Regulation of seedbed density in 1-0 Mugho pine seedlings having known germination percentage of the seed and number of seed per pound before sowing seedbeds. Both these factors must be considered so as to secure ideal density for maximum head development in 2-0 seedlings.

timum seedbed density in 1 year Mugo pine seedlings as shown in Figure #4. These seedlings are not too dense for maximum growth as to allow the buds to break and develop a good head as 2-0 stock and eventually a lower branching, more spreading Mugho pine field grown specimen.

The ideal seedbed density will vary depending on the species, length of time left in the seedbeds and possible use of seedlings. Most nurserymen sow their seeds too thickly as the writer has observed with evergreen seedlings growing as high as 150-300 per square foot. These seedlings are so "spindly," similar to "hair on a dog" and they have no value as they never will recover the transplanting shock so as to develop into sturdy, healthy plants. A well-balanced seedling should be the ultimate goal of every propagator ,that is proper root-top ratio and this characteristic can only be obtained by proper regulation of seedbed density. The writer has grown strong, healthy 1 year Scotch pine seedlings 2 - 4 inches in height at a density of 100 per square foot and transplanted them with excellent results. However, for good sturdy 2 year Scotch pine seedlings this density must be reduced to 45-60 per square foot and for good 3 year seedlings this figure must be reduced to 25-30 per square foot. Firs and spruces may be grown at a little higher density and hardwood species usually must be grown at a lower density for best results.

The seed per pound or ounce must be determined for each seed lot and used in calculated sowing rates along with germination percentage. Average seed per pound rates published by species in catalogues or textbooks should not be used because of extreme variation with individual seed lots within the same species. Seeds per pound will vary within a species due to many factors, such as seed source, age of tree, cone size, condition of tree, percent of empty seed present and many other factors. For example, Scotch pine seed per pound will vary from around 32,000 in some Spanish sources to as high as 104,000 in the North Baltic sources of Finland or over 3 times as many. Similar seed count variations exist in other species, although they may not be as great. Thus never neglect the seed per pound figure for the seed lot you are presently sowing.

IMPORTANCE OF SEED SOURCE

The writer has conducted seed source studies on many species during the last 20 years such as Austrian pine, Mugho pine, Scotch pine, Colorado blue spruce, Engelman spruce, Norway spruce, Concolor fir, Douglas fir and others, both in the laboratory and in the nursery. Variation in seed germination in the laboratory from different geographical sources has intrigued the writer immensely and certain species and strains can be identified by their germinative characteristics. Species showing variation in germinative response due to geographical location have been Douglas fir, Ponderosa pine, Concolor fir, Lodgepole pine, Scotch pine, White pine and possibly others. Seed sources of some of these species vary in rate of growth, winter hardiness, type of development, needle length and color in both summer and off-coloring or adverse yellowing in the winter. The propagator must select the optimum seed source for the intended use of his planting stock, for the characteristics needed for its eventual planting site or for his personal and customer preference for the ideal type of each species. These facts must be determined before selecting the correct seed source and the propagator must have learned the characteristics of the many sources available before he purchases his seed for sowing in the nursey.

In Mugho pine one must be certain to secure seeds from the true dwarf, compact trees of the high Tyrol Mountains of Central Europe. Open market seeds without authentic certification have been collected from fast growing rangy mountain pines found on the sand dunes along Denmark and Germany.

SCOTCH PINE SOURCE STUDIES

Detailed studies covering 20 years or more on over 200 known seed sources of Scotch pine can not be presented here. Memos or reprints are available upon request. Studies have shown that all Nurserymen, Christmas Tree Growers and Propagators should learn the specific characteristics of various geographical sources. Observations have been compiled on seed sources from Austria, Belgium, France, England, Germany, Greece, Italy, Norway, Poland, Scotland, Spain, Sweden, Switzerland, Turkey, Yugoslavia and many growers strains from the U.S. Growth habits, needle and branch characteristics and winter coloration have varied tremendously in 1 and 2 year seedlings and in 3 and 4 year transplants. Various seed source series have been tested in nursery rows year after year as shown in Figure #5 with comparative results recorded. Four year old transplants from different sources growing side by side have varied in total height from 1 to 3 feet, in needle length from 2 to 4 inches and in winter coloration from golden yellow to blue-green. What kind of a Scotch pine do you wish to grow for yourself or your customers? What is going to be the use of your planting stock? Do you want a slow growing pine, or a fast growing tree? Do you want a "golden" Scotch pine or a green Christmas Tree? Do you want a short needle, medium length needle or a long needled source? It is more important that you know the source you are sowing.

In general summary we might state these facts.

1. Sources from a single country have been found to vary widely, especially as to growth rate and needle length.
2. All sources tested from five Spanish provinces namely Burgos, Cuenca, Guadalajara, Guadarrama and Soria, at two or more elevations, have performed fairly uniformly with slight variations in rate of growth and winter coloration. These sources have shown short to medium length needle, slow to medium growth rate and excellent winter color.

Figure 5. A planting of Scotch Pine 3 and 4 year old transplants numbering 50 different seed sources being tested side by side for growth rate, branch angle, needle length, bud formation and winter needle coloration. Note extreme variations in growth rate and needle length.

3. French sources have shown wide variation in growth rate but usually good winter color and short to medium length needle.
4. England and Scotland sources have shown good needle color with mostly medium length needle and medium growth rate. Secondary height growth sometimes has developed in these sources.
5. Sources from Greece and Turkey have not been tested as long as many others but have shown most encouraging results and most favorable Christmas tree characteristics to date, especially when all factors are taken into consideration. Turkish strains have had to date excellent green color and Greece sources have shown particularly excellent general form as transplants.
6. Many foreign sources have shown moderate to severe winter needle yellowing or extreme rapid growth and long needle development. In this general category have been sources from Austria, Belgium, Northern Germany, Poland, Italy, Switzerland, Norway, Sweden and Yugoslavia.
7. There is no correlation between rate of growth and length of needle as far as winter coloration or yellowing is concerned. The slow growing Highland French strains and the Sweden sources have shown nearly identical rates of growth and needle length yet they were at the two extremes of blue-green to golden yellow as to winter coloration.

DOUGLAS FIR SOURCE STUDIES

We know of no other coniferous tree in which seed source of your planting stock is so important or critical. The seed of this species is collected from far north in British Columbia, Canada to as far south as Northern Mexico. It is also distributed East and West from the Eastern base of the Rocky Mountains in Montana and Colorado to the Pacific Coastal area in Washington and Oregon. There are three recognized strains or races of this fir, namely *viridis, caesia* and *glauca* and geographical mixtures of them.

Several factors must be considered in selecting seed for production of seedlings, transplants, or finished landscape planting stock. Do you wish a fast growing douglas fir or a slower, more compact type of growth? Do you wish uniform green foliage, a grey green type, a blue grey foliage or the most uniform bluish foliage? You no doubt wish a winter hardy tree but many sources are not winter hardy in the Northern U.S. and our Northeast region. How about length of needle or type of needle development? Have you grown different sources in your nursery of known origin to learn which characteristics you, your landscape buyers or private customers perfer? We suggest you do this or at least learn the characteristic performances of the various geographical sources. Enough information is now available on over 100 different seed sources so that if a propagator knows the color, type of tree development and growth rate desired, several sources can be recommended for his needs.

Findings and observations on a 15 year study of Douglas fir seed sources can not be presented here but a memo summary is available upon request. New sources are under test at the present time. Many of the field failures with this species in past years can be traced directly to the wrong seed source. Most of the West Coast *viridis* strains are not winter hardy in the North Central or Northeastern U.S. Some of the inland *viridis* or *caesia* strains from the Wyoming, Idaho, Montana area are terrifically slow growing and not suitable at all for Christmas tree production or for other uses. However, these sources might be ideal for certain ornamental uses, tub culture or foundation planting. Other inland *viridis* and *caesia* sources have been found to be winter hardy, fast growing and excellent for Christmas Tree planting.

The blue *glauca* sources from the large Rocky Mountain region in British Columbia to Southern Arizona and New Mexico were all found to be winter hardy but varied in rate of growth, needle color and other characteristics as shown in Figure #6. These two sources shown here have both produced excellent plant specimens and yet note the difference in growth rate, a typical performance year after year. Other two year old seedlings from various sources have varied in height growth from 2 - 3 inches to as much as 12-18 inches and from a uniform blue to blue grey to uniform green in needle coloration and from 100% winter killed to 100% winter hardy. The nurseryman or grower must order more than "just douglas fir seed" to have best success with this species.

Briefly, we can summarize by stating that in order to be most succesful in seed propagation and plant production all propagators, both large or small, must sow tested seed of known, strong germination percentage, true to name as labeled, and of known, authentic seed source to fulfill the requirements for the intended use or purpose for which the stock is to be grown.

Figure 6. Two Douglas Fir seed sources as 2 year seedlings showing extreme variation in height growth. Foreground — Manti-Lasal Forest, Utah 9,000′ elevation 3-6 inches. Background — Coconino National Forest, Arizona, 7,000′ elevation 10-16 inches. Several sources from Montana and Wyoming were slower growing than the Manti-Lasal source.

MODERATOR DUGAN: Our next speaker is Dr. Pridham from the faculty of Cornell University, Department of Floriculture and Ornamental Horticulture.

PROPAGATION OF AMERICAN ELM FROM CUTTINGS

A. M. S. PRIDHAM
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Ithaca, New York

Interest in propagating strains of disease resistant American Elm is evident in one of the first papers in recent years dealing with vegetative means of propagating *Ulmus americana*. Doctor T. W. Bretz (2), 1949, used leaf bud cuttings from 8 year old trees of 17 resistant selections. Cuttings were taken in May, treated with N.A.A. rooted to 60% in 6 weeks. Some rooting took place in all 17 strains as well as with *U. pumila, U. Thomasii,* and *U. fulva,* but not with Buisman Elm.

W. L. Dorman and M. A. McKenzie (4) treated new June shoots 4 to 6″ in length with I.B.A. 50 ppm. These rooted 53% (untreated 34%) while root cuttings were useful in 97.5% of cuttings whose proximal end was exposed. Stem cuttings of *U. pumila, U. parvifolia* and *U. japonica* rooted from June cuttings. Buisman Elm failed to respond.

Beginning in 1959 a project of the British Forestry Commission, "Propagation of Elms and Poplars" was reported in their yearbook by J. Jobling (6-11) and has continued through the 1963 report (10). The authors (11) report propagating 620 plants from 24 clones with an average rooting of 57% and for easily rooted clones 80%. Sturdy one year wood as 5″ cuttings was treateed with I.B.A. 1000ppm in talc. The soft wood cuttings were inserted under mist within 2 hours of removal from young wood from young trees preferably terminal cuttings. Storage of cutting wood at 35° - 37° F. for as long as 16 days to 90 days improved survival in the cutting bed and later in lining out when 69% survived. Rooting over 60% was rated good and below 30% poor. *Ulmus hollandica* var. hollandica and other varieties were successfully propagated including *U. glabra, U. procera,* and *U. carpinifolia* but not *U. americana.*

Recent work with American elm by Ouellet (12) in Canada is based on young cutting wood taken in June until late July treated with I.B.A. 50 ppm for 24 hours using coarse sand, humid air at 70° F. - 75° F. and illuminated by 1200-2000 foot candles. A maximum of 80% rooting occurred in young one year wood but 20% in cuttings of older (5 year) wood. Cuttings made in August rooted poorly while other species rooted under the conditions noted and include *U. pumila, U. japonica, U. hollandica,* and Buisman (19%).

In studies at Cornell both root cuttings and stem cuttings have been used with results essentially as noted above. Procedures used in 1964 included collection of 1964 wood and immediate immersion in cool water followed by enclosure in polyethylene bags then storage in cool shaded spot for up to an hour or two, later stock piling in refrigerators at 35° F. until they could be prepared for sticking.

Cuttings were removed and stuck in perlite vermiculite 1:1 mix in 4 x 8" Market Pac trays, 10 per tray. The cuttings were dipped stem end in N.A.A. 1000 ppm solution made by dissolving the acid in a tablespoonful of carbowax 1400* and bringing to volume with warm distilled water. Treatment was by dipping and holding in the solution for 2 to 4 seconds.

Trays of cuttings were placed under constant mist from Florida nozzels for 24 hours then to intermittent mist. Rooting took place in six weeks and the cuttings moved from the pac to individual 3" pots of peat or plastic and returned to the mist. Weekly foliar feeding was used during the propagation and was based on 1 gram N per pac per week.

Fertilizer was used during the 6 weeks rooting period and continued after potting up in larger containers, usually gallon size or #10 size plastic plots.

Cuttings were left in the Market Pac till roots were obvious along the base of the pac both inside and out. American Elms usually produce 3 to 5 roots of which 1 or more tends to elongate to 8" and more with relatively sparce branching. Propagating in 2-3" peat pots or cylinders could be an advantage in carrying cuttings through to field planting stage in one season.

Rooting to the order of 50% and better held for cuttings taken in May and June but fell off to occasional rooting from July and August cuttings in which outer bark was no longer green but light brown. Winter root cuttings were successful (25%) but poor in June.

On the basis of present evidence propagation of American Elm clones of disease resistant type may be propagated from soft wood cuttings during early growth beginning when first leaves approach mature leaf area for the clone, and continuing through a period of a month or more. Stock piling of soft wood cuttings may be done and cuttings placed in individual containers of light weight media with foliar feeding during propagation so that well rooted liners of 6" to 12" stem can be fall planted under appropriate conditions.

One method of propagation reported in Agricultural Research (1) for poplar may have significance in propagation of American Elm. The method is to select sprouts from the base of stumps. The report indicates that early spring sprout cuttings of poplar rooted 80% to 100% in 3 to 4 weeks and grew 5 to 5½ foot in two months. Limb sprouts of elm taken in 1964 at Ithaca rooted as did soft wood cuttings in general but basal shoots from the stump or from cutting roots near the stump to stimulate shoots was not reported. Jobling reported stooling for producing of cutting wood. Wright (15) succeeded in producing elm seed on cut branches.

*Product of Union Carbide Co.

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THE USE OF ANTI-DESICCANTS IN ESTABLISHING LINERS

K. W. REISCH
ELTON M. SMITH AND L. C. CHADWICK
The Ohio Agricultural Experiment Station
Wooster, Ohio

Transpiration, or water loss from various plant parts, is a natural process which can, under certain conditions, result in damage to or death of plants. Rapidly transpiring plants often lose water to the extent that leaf cells lose turgor and wilting results. If water loss exceeds absorption beyond the extent of recovery, death from dehydration will eventually occur. Even a moderate loss of turgidity causes premature closure of stomates which interfers with photosynthesis and other metabolic processes. Water loss can become very critical when roots are damaged or removed as in bare-root transplanting, and are not sufficient to compensate for the water lost in transpiration.

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The objective of this study was to determine the feasibility of using specific anti-desiccants in reducing water loss and increasing survival of transplanted bare-root plants.

Emerson and Hildreth (2), in 1933, found that corn oil and sulfonated linseed oil reduced transpiration of Austrian Pine seedlings. Thornton (6), in the same year, reported better resuls in transplanting bare-root evergreens when the root systems were treated with paraffin emulsions. In 1935 Chadwick (1) reported that emulsified paraffin and vegetable wax reduced transpiration, and as a result, transplanting of woody plants may be aided. In 1937, Miller et al (5) found that paraffin aided survival of summer transplanted maples, elms, lilacs, and conifer seedlings.

In recent years the anti-desiccants appearing on the market have primarily consisted of latex, plastics, and various types of resins. As with the waxes, paraffins, and oils, much research has centered around increasing survival of transplanted plants.

Working with a vinyl latex, Jones and Richey (4) reduced desiccation during the first two days after setting out tomato plants. Gartner, O'Rourke, and Hammer (3), tested a vinyl latex on transplanting a wide variety of ornamental plants and reported the following: 1) both bare-root and balled and burlapped conifers responded favorably in June and July; 2) survival of most deciduous trees under study was improved; 3) the cessation of growth which normally takes place in most transplanted plants, was often prolonged as a result of treatment.

The complete research project related to winter protection, transplanting, and transpiration rates and this paper covers the latter two aspects.

Transplanting

The materials used in this study were FOLI-GARD and RUTEX, acrylic copolymers formulated by the U.B.S. Chemical Company, Cambridge, Mass., and WILT-PRUF, a vinyl latex formulated by Nursery Specialty Products, Inc., New York, New York. These anti-desiccants were diluted according to the manufacturers instructions and applied with a small hand pump sprayer.

Cotoneaster divaricata was selected as the test plant for the transplanting phase since it has an open, sparse root system which leads to some transplanting difficulty.

The plants were transplanted from nursery rows at the Berryhill Nursery Co., Springfield, Ohio to The Ohio State University nursery at the following times, either bare-root or balled and burlapped, as indicated.

1962

October — bare-root, 24-30 inches in height
November — bare-root, 24-30 inches in height

1963

*June — bare-root, 15-18 inches in height
July — balled and burlapped, 18-24 inches in height

August — balled and burlapped, 24-30 inches in height
October — bare-root, 30-36 inches in height
October — balled and burlapped, 30-36 inches in height
* Winter injury caused reduction in plant height

The Foli-Gard and Wilt-Pruf treatments were applied to both leaf surfaces before digging and the Rutex applied to the roots (where indicated) immediately after digging. Each treatment date included 90 bare-root or 45 balled and burlapped plants. Each anti-desiccant treatment was applied to groups of three plants and replicated five times. Bare-root treatments were as follows:

1. Foli-Gard on foliage
2. Wilt-Pruf on foliage
3. Rutex on roots
4. Foli-Gard on foliage and Rutex on roots
5. Wilt-Pruf on foliage and Rutex on roots
6. Untreated

Since the plants moved balled and burlapped were without exposed roots, only treatments 1, 2, and 6 were used.

Results

Survival varied with both time and treatment and the following observations were made on results from the various transplanting dates.

October 18, 1962 — *Bare-root*

As indicated in Table 1, Foli-Gard and Foli-Gard plus Rutex reduced the extent of branch die-back and the number of branches with dieback.

Those plants treated with Wilt-Pruf and Wilt-Pruf plus Rutex had more dieback than the untreated plants. This could be due to the fact that leaves on these plants remained attached from 7 to 10 days longer which could have resulted in greater water loss.

Table 1. The effect of anti-desiccants on *Cotoneaster divaricata,* 24 to 30 inches in height, transplanted bare-root Oct. 18, 1962.

A. Measurements of the average dieback per plant and the number of branches with dieback on July 31, 1963.

Anti-desiccant	Average die-back per plant in inches	Average number of branches with dieback
Foli-Gard + Rutex	93.8	14.1
Foli-Gard	96.4	15.8
Rutex	181.9	23.6
Untreated	184.9	21.6
Wilt-Pruf	217.0	18.1
Wilt-Pruf + Rutex	220.0	31.2

B. Observations of the general condition of the same plants on June 28, 1964

Anti-desiccant	Condition*			
	Good	Fair	Poor	Dead
Foli-Gard	15	0	0	0
Foli-Gard + Rutex	13	1	0	1
Rutex	10	1	0	4
Untreated	10	0	1	4
Wilt-Pruf + Rutex	10	3	0	2
Wilt-Pruf	8	1	0	6

*The values indicate the relative condition of the plants as follows..
Good — Over 40" in height, vigorous appearance
Fair — 25-40" in height, not as vigorous
Poor — Less than 25" in height, weak in appearance

November 19, 1962 — *Bare-root transplanting*

There was no advantage in the use of anti-desiccants. Rutex alone and Rutex with the other materials caused increased dieback. Eighteen months after treatment all plants appeared to be of equal good quality.

June 7, 1963 — *Bare-root transplanting*

All leaves turned brown after transplanting and plants had considerable dieback; however, on the basis of regrowth. Foli-Gard was superior to other treatments, whereas plants treated with Wilt-Pruf plus Rutex were in poorer condition than the untreated plants. This pattern was still evident 12 months later.

August 28, 1963 — *Bare-root transplanting*

All leaves turned brown and dropped and all plants died to near ground level regardless of treatment. Regrowth the following June, 1964 was approximatetly 50 percent better on all treated plants (excepting Rutex alone) than on those untreated.

October 10, 1963 — *Bare-root transplanting*

All anti-desiccant treatments were beneficial in this planting. Rutex alone was again the least effective.

July 16, 1963 — *Balled and burlapped transplanting*

The plants treated with anti-desiccants were of equal quality to those untreated.

August 28, 1963 — *Balled and burlapped transplanting*

The use of Foli-Gard resulted in plants of superior quality; however, survival was good in both treated and untreated plots.

October 10, 1963 — *Balled and Burlapped transplanting*

Both anti-desiccant treatments were superior to no treatment as indicated in Table 2, below.

Table 2. The effect of anti-desiccants on Cotoneaster divaricata, 30-36 inches in height transplanted balled and burlapped October 10, 1963 Observations of the general condition of the plants were recorded June 28, 1964.

Anti-desiccant	Condition*		
	Good	Fair	Dead
Wilt-Pruf	15	0	0
Foli-Gard	14	0	1
Untreated	5	1	9

*The condition of the plants was judged as follows: Good — Complet eleaf coverage to branch tips Fair — Partial leaf coverage with some die-back of branches

In summary, the success of transplanting Cotoneaster divaricata decreased in the following order.

Bare-root transplanting without anti-desiccants with plant in a leafless condition

Balled and burlapped transplanting with anti-desiccants

Bare-root transplanting with anti-desiccants in autumn with leaves on the plants

Foli-Gard was more effective than Wilt-Pruf in increasing transplanting survival and there was no advantage with the use of Rutex on the roots.

II. *Effect of Anti-Desiccants on Transpiration*

Plants of *Weigela 'Vaniceck'* and *Euonymus fortunei 'Coloratus'* were used in laboratory research designed to study the effects of Rutex and Foli-Gard on transpiration rate.

The plants were grown in solution and the rate of transpiration measured by use of a potometer, under the following conditions and combination of conditions.

Temperature — 90°F, 70°F, 40°F

Wind Velocity — 0, 5, 13 M.P.H

Foli-Gard and Wilt-Pruf Applications —

Upper, lower, both leaf surfaces

Light intensity and humidity were maintained at constant levels.

Results

1. Foli-Gard reduced water vapor loss an average of 35 percent whereas Wilt-Pruf reduced it an average of 24 percent.
2. Transpiration was reduced 10 percent when anti-desiccants were applied to the upper side of the leaf and by 30 to 40 percent when applied to the lower surface.
3. An increase in wind velocity over the leaf surface from 0 to 13 m.p.h. had no effect on the transpiration rate when Foli-Gard was used, however, the rate increased with increased velocity on plants treated with Wilt-Pruf. Two possible reasons explaining the reduced effectiveness of Wilt-Pruf are that it tended to form droplets resulting in uneven coverage and became brittle and cracked when the leaves moved in the air stream.

4. Anti-desiccant treatment decreased transpiration to a relatively constant level all 3 temperatures.

III. *Effect of Guard Cell Movement on Anti-desiccant Film*

The natural opening and closing of stomates, affects the rate of transpiration and this study was under taken to determine the effect of guard cell movement on anti-desiccant film. *Tradescantia fluminensis variegata* was selected as the test plant since the leaves have few and large stomates which can be readily observed with a microscope.

To obtain an impression of the stomates, a combination of silicone rubber and a catalyst was applied to the leaf, allowed to dry, and then peeled off. An impression was made from this with cellulose acetate and acetone which, upon drying, was clear and could be viewed under a microscope.

Results

Neither Wilt-Pruf or Foli-Gard caused guard cells to close nor did they prevent them from closing.

The anti-desiccant film was affected by the movement of the guard cells in the following manner.

FOLI-GARD

Time after treatment

1 day — Slight cracking in stomatal aperture of some stomates

3 days — Definite opening in stomatal aperture of many stomates

7 days — Same as 3 days with no additional cracking.

WILT-PRUF

1 day — Pronounced cracking of stomatal apera-

3 days — Cracking evident around many guard cells, and some pieces of film missing

7 days — Areas of film missing, considerable cracking evident.

Summary:

Anti-desiccants will improve survival of deciduous plants when moved in full leaf either bare-root or balled and burlapped. In this study no advantage was found with use of anti-desiccants when plants were transplanted in a leafless state.

In laboratory studies Foli-Gard reduced the rate of transpiration to a greater degree than Wilt-Pruf which is probably the reason that Foli-Gard was more effective than Wilt-Pruf in increasing the survival of transplanted Cotoneaster divaricata. This supposition was further substantiated by other research which indicated that Foli-Gard formed a continuous film over the leaf surface for a longer period of time than Wilt-Pruf.

Although not a panacea for transplanting deciduous plants in full leaf, the use of anti-desiccants will aid in re-establishment and improved survival even though the period of effectiveness may exist for only a few days.

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MODERATOR DUGAN: We are now ready for the question period.

ROLAND DEWILDE: I would like ask Dr. Pridham why he stored the elm cuttings in the refrigerator before sticking them?

DR. PRIDHAM: The reason was that we were taking cuttings from over a hundred trees and it was easier to gather and store them and then stick the whole lot in one operation. We kept the cuttings at 35° F. in polyethylene bags for about a month's time. However, I do believe that we did get some benefit from hardening the cuttings during storage and this is procedure used in England by Jobling.

DR. HESS: I would like to ask Mr. Heit if he has used tetrazolium chloride test to determine seed viability and if he would recommend it as a test for ornamental seeds?

MR. HEIT: Yes we have used it in emergency situations but from our experience a normal germination test is more reliable. This is because with weakened or damaged seed you might get false results. However, I know some laboratories, some foresters, and some nurserymen are using it with fairly good results. It is a difficult test to evaluate unless you have had a lot of experience.

PETER VERMEULEN: Dr. Heit, have you had any experience of seed from witchs' brooms?

DR. HEIT: No.

JOHN RAVENSTEIN: I want to ask Henry Homer Chase if the root system on his magnolia develop only on one side or is it all around the stem? Why do you make the cut only on one side?

HENRY H. CHASE: Yes, after transplanting that root system is going to surround the entire stem. It is quick and easy to make the cut only on one side.

JOHN RAVENSTEIN: You said that you cut the plants off in November. In the dormant season you have a plant completely cut off?

HENRY H. CHASE: Yes, there is nothing there except the adventitious buds which will come next spring to produce the forty-five to fifty stems we use.

RALPH SHUGART: I would like to ask Mr. Heit what seed bed density he used for pine?

MR. HEIT: This depends upon how long you are going to leave the seedlings in the bed. If you transplant them after the first year, you can grow up to 100 per square foot. If you are going to grow 2 year seedlings, we cut it down to fifty to sixty per square foot. If you are going to grow three year seedlings, cut the number down to 30 or 40 per square foot.

MR. LOWENFELS: I don't want to start another argument here, but on this anti-desiccant business, Dr. Snyder gave a talk to the Holly Society and between these two talks I don't know whether to use them or not because Dr. Snyder says the materials wore off.

DR. REISCH: It does wear off in about three to seven days.

MR. LOWENFELS: So what is the benefit of using it in the field if it is going to wear off?

DR. REISCH: That's a good question.

WILLIAM FLEMER *III*: I would like to ask Dr. Pridham if he found clonal differences in rooting the different elm cuttings or did they all root relatively uniformly?

DR. PRIDHAM: I think that everybody who plays with elms, runs into a few trees that don't want to root. However, we did get at least twenty percent rooting of all the varieties we took this past summer.

MODERATOR DUGAN: Our next subject is the no tillage method of propagation and production which is just about as controversial as you can get. Many of us had the pleasure of seeing this operation last December and we know that the plants do grow. Today we will have the opportunity to hear how it is done. Hugh Steavenson.

MULCH CULTURE OR "NO-TILLAGE" METHOD OF PROPAGATION AND PRODUCTION

HUGH STEAVENSON
Forrest Keeling Nursery
Elsberry, Missouri

Those of you who have visited our nursery in Northeast Misouri know we are situated in quite hilly terrain overlooking the Mississippi River bottoms. Our primary production over the years has been seedlings, but in the past decade or so our production has included material as large as specimen (caliper) shade trees and container stock. We grow a long list of tree and shrub seedlings as well as a variety of evergreens and other stock; so my comments on mulch or "no-tillage" culture are not restricted to just a few items.

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For years I was convinced that seedlings and transplants could be most economically and feasibly produced on the light, nearly level alluvial soils that occur where creeks empty upon the bottom ground. For over a century these creeks deposited an out-wash eroded from the nearby hills. While these "made" soils are indeed suitable for most nursery crops, it took years of observation to demonstrate any species or variety would perform as well on our hills and many items would do much better. Furthermore, air drainage was far superior on our ridges and hillsides and seeding, planting and harvesting could proceed when the bottom grounds were too muddy to touch. Our hills did lack adequate water for irrigation and it took a decade of constructing reserviors and diversion terraces to solve the water problem. These hills adjacent to the river are covered with a loessal mantle, long recognized as a horticultural soil, but at the same time a very erosive one. To produce nursery crops and still keep the soil in place requires comprehensive soil conserving practices, including terraces, contour planting, sod rotation, cover crops and strip cropping. Not the least benefit of our mulch or "no-tillage" culture is the fact that it is a key practice in erosion control.

Mulch culture is an intensive practice. That is, it is not cheap and demands a high production per acre. I think most nurserymen would agree that nursery crops in general, which represent a lot more value per acre than most agricultural crops, demand the best soils available, brought to a high state of fertility and physical condition. This is especially true with a system of mulch culture.

Our program is to bring land ultimately scheduled for nursery cropping to a workable grade by bulldozing and land leveling. This does mess up the top soil somewhat, but with loessal soils this is not too serious. Next limestone is applied, usually dolomitic as our soils are generally deficient in magnesium. When this is plowed down, rock phosphate is applied if the need of phosphate is indicated. Then the land is planted to a perennial sod crop, usually alfalfa and brome grass or an alfalfa-fescue mixture. The grass is fertilized as indicated by soil tests and rotationally grazed. Mixed fertilizer is applied semi-annually to maintain the forage at optimum productivity. Growth is clipped as needed and all clippings are left on the ground — no hay crops are removed.

Actually, all this really costs nothing. I can tell you there isn't much money in raising beef cattle these days, but the fact remains that ordinary pastures produce about 100 lbs. of beef per acre while a good fertilizer-management program will quadruple this yield. By bulk spreading we can apply 600 lbs. of fertilizer (usually 22-11-11) for $21.60 per acre and produce an extra 300 lbs. of beef worth at least $60 even on today's weak market.

During the build-up period — we like to leave the ground in sod for at least three years — weed control is of great importance. Clipping will control tall growing weeds. A heavy luxuriant sod will crowd out most other weeds. I suspect it might be smart to leave legumes out of the grass mixture. This would permit spraying with 2-4-D, or other herbicides. Even for pasture it is probably more economical to grow straight grass and get nitrogen out of the bag.

A heavy sod is difficult to work into nursery beds. We like to go through one year of annual green manures before finally fitting the soil for nursery planting. If the sod is broken in the fall, rye or annual brome grass is seeded. This is turned under in late spring and followed with a couple of stands of thickly-drilled corn. Each green manure crop is generously fertilized and plowed or disced down before weed seeds mature. Corn is said to return more organic matter to the soil than legumes, such as soybeans. And corn lends itself better to weed control practices, i.e., herbicidal spraying.

So much for soil preparation. The soil should now be at an optimum level of fertility, with a low weed seed population, and in an excellent physical condition. Organic matter level will be near the peak that can be secured by agronomic practices, about 2½ or 3% at our latitude.

In our "mulch bed" culture, a sawdust mulch is applied immediately after sowing in the case of seed beds. Where the beds are planted with "liners," mulching may be delayed for 10 days or so in order to smother the first crop of weed seedlings.

I am sure there are better mulches than sawdust. The plant nutrient content of sawdust is very low, about one-half that of straw or one-eighth that of alfalfa hay. We have used ground corncobs extensively. They are excellent but grinding is tougher than you think. The processed sugar cane mulch the fellows in Rhode Island use looks beautiful. Sawdust does have the lovely quality of being cheap. Our only cost is hauling a few miles and spreading. Two inches, our average application, comes to about 135 yards per acre. With 30 or 40 acres to mulch, you can see that the sheer physical job of hauling and spreading is no little chore.

The influences and benefits of mulching are well known and scarcely need enumerating. An open, porous mulch insulates the soil surface against summer's heat and winter's cold. It induces better penetration for rain or irrigation water. It conserves soil moisture and reduces surface evaporation and may thereby appreciably reduce irrigation requirements. It acts as an erosion buffer. We observe noticeable improvement in soil tilth, structure and mellowness under mulch as against usual tillage, and can assume that soil aeration, or gas exchange, is markedly benefited by mulching in contrast to soil compaction resulting from repeated tillage.

We observe that a lace-work of feeder roots will proliferate right at the soil surface under a good mulch while these surface roots are generally destroyed by tillage.

Mulching can pay for itself in weed control. The proper thickness can smother many weed seedlings while permitting the nursery crop seedlings to germinate and emerge without difficulty. It would be misleading to suggest that mulching can solve the weed problem; but it can supplement and abet other control measures. Indeed, the advent of chemical herbicides has made mulch culture for field stock much more practicable.

Several years ago, and for a period of years, we used goslings as weeders. As selective herbicides came into the picture, we "retired" our goose herd. This is not a paper on chemical weed control, but I will mention we favor some of the less "hot" materials, such as Dacthal and Casoron for first-year linings and seedlings. Chloro IPC does an outstanding job on winter and spring weeds while Simazin is excellent for summer weeds (or weeds any time) and does give long season control. Nevertheless, we see just enough evidence of growth retardation and injury in various situations and with a number of varieties that our trend has been to lighter applications of the chemicals and greater dependence on the milder types, such as Dacthal.

Our fellows, Bob Suddarth and Wayne Lovelace, have been testing a number of herbicides for direct application to the sawdust mulch immediately after seeding. We are now using Dacthal in this manner as a standard production practice, and as a follow-up treatment after seedlings have germinated. To me, this is treading on pretty thin ice, but so far results looks good.

With seedlings, the greatest benefit of mulch culture is securing a stand. Many seedling growers, such as those in the western prairies, have sandy loams that permit them to secure good stands with a number of tree and shrub species when seed is drilled or planted in rows. This is not true with our clay loams. We need a loose, friable mulch over the seed to secure satisfactory emergence, particularly with the lighter seeds. (Incidentally, I note that growers in east Tennessee and northern Alabama use a rotted sawdust or peat covering over seeds sown in drill rows or shallow furrows; the beneficial effect on seedling emergence is similar to that we achieve with mulch beds.)

We prepare raised beds (4 ft. wide, 6 ft. center to center) mechanically with no handwork whatsoever. Beds are finished with a narrow guage corrugated roller (Brillion) and the seed broadcast on the bed surface. The seed is rolled in with the same corrugated roller. Now sawdust is applied with a manure spreader. By making several "passes" the desired depth and a good uniformity of covering is achieved.

The same covering procedure is used in mulching transplants or field lined stock.

One pernicious problem with seed beds is the blowing off of the sawdust covering.

Recently we have discovered that the light netting (Erosionet) used for highway grass seedlings and the like, does an excellent job of holding down our sawdust seed bed covering.

It can be removed as the seedlings germinate and stored for re-use. Wind is still a problem, however. Last spring we suffered heavy seedling losses just as many seedlings were emerging in early May. Netting had been removed when severe winds in a single day actually blew the sawdust covering and seedlings out of exposed beds, or driving particles of dust sheared off seedlings. We are now planting shrub windbreaks to mitigate this hazard.

Obviously, mulch culture is economically practicable only under intensive cropping. Seed beds are by their very nature "intensive." The same is true with transplants. Beyond seedbeds and transplants, much of our mulched acreage is devoted to what we refer to as "15 in. spaced sttock." Here we use the identical 4 ft. beds as for seedlings and transplants, but stock is set in rows 15″ apart with plants spaced 15″ apart — about 15,000 per acre. This high population justifies such intensive practices as mulching, heavy fertilization and irrigation. Under this system we produce small-size B&B evergreens and some of the more dwarf shrubs and the like.

In passing, the well-known nitrogen-starvation effect of sawdust (and other raw organic substances) should be mentioned. Something like 2 lbs. of nitrogen per 100 sq. ft. of surface for every inch of sawdust applied is necessary to compensate for nitrogen tied up by soil organisms as they break down the sawdust. This amounts to almost 1,000 lbs. of N per acre for each inch of sawdust. We would never apply this much N at one time for fear of crop injury. (In fact, we have decimated seedling stands with a dressing of ammonium nitrate when the fertilizer particles clung to the foliage). We prefer to use a mixed, high-nitrogen fertilizer and make repeated application as soil tests and crop growth indicate. Indeed, rapid break-down of the sawdust mulch is *not* desired. All that is necessary is to maintain a good nutrient level for the nursery crop and the sawdust break-down will pretty well take care of itself.

Now we have used this sawdust mulch culture for 23 years, we are convinced that soils constantly improve with this system. Where such land has gone back to farm crops, yields have been remarkable. Indeed, once into the system it is doubtful that further rotation with sod crops or other green manures is necessary, except possibly for disease control.

But I should hasten to say that all authorities do not agree with our experience. Warren Baldsiefen, New Jersey grower of rhododendrons and azaleas writes:

> "The commercial use of sawdust, which has resulted from accessibility and low cost and the ease of application, has, from my observations of its use from Oregon to New Jersey, resulted in many failures. In commercial growing a crop is removed from an area every few years either to be re-spaced or to be sold. And it is here that the trouble begins, for when these plants are

lifted some mulch, left from digging, falls into the hole and the sawdust becomes an ingredient of the soil. Perhaps meticulous care might prevent this but I have never seen it so, and in every instance where plants were removed, sawdust, only partially decomposed, was mixed with the soil and the next plants placed there had to compete with it for nitrogen. Many sorts of woods (as sawdust) take a dozen years or more to break down and in this time several crops of rhododendrons can be taken from a given area. Each time more sawdust enters the soil and each time the supplemental nitrogen feeding becomes more grotesquely complicated. I have seen it bcome so hopelessly disastrous that, as a consequence, fields were left fallow for years.

"The theory that periodic feeding will eliminate this fault is weak. If in the late summer, with leaves showing deficiency symptoms, we could ascertain with any degree of accuracy precisely how much nitrogen is needed, a safe application might be made. However, this is impossible, for we have sawdust both as mulch and as soil amendment in various stages of decay, possibly complicated by several different kinds of wood. To try to supply the proper amount of nitrogen without overstimulating the plant at such a critical time just before cold weather is, in my opinion, next to impossible. In sections which are subject to extremes of climate in both summer and winter, any measures which alter the plant's natural metabolism, even slightly, can be fatal at these sustained periods of high or low temperatures. I have also seen the quick death of plants from the effect of sawdust in the soil. In other instances, growth was retarded for a year before returning to normal."

Not being a rhododendron grower I would not care to challenge Mr. Baldsiefen. I do know some of the prettiest rhodies I have ever seen grown by Cottage Gardens of Eureka, California in containers in a wood shaving medium. At Semmes, this fall, I saw acres of superb azaleas grown in deep beds of virtually straight pine shavings. Mr. Baldsiefen's comments do point up the problem of nutritional balance in the use of a mulch, especially a sawdust mulch. But in our experience it is not a formidable one. Jack Hill, in discussing the problem of growth stimulation in late fall and subsequent winter injury, has stressed that this condition never need exist if *an optimum nutritional level is maintained throughout the growing season.* I am inclined to believe this the key to the whole problem.

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Available from: Superintendent of Documents, U.S. Government Printing Office, Washington 25, D. C. 15c

MODERATOR DUGAN: Our next subject is the grafting of junipers by Mr. Andrew Klapis, Jr. of Raytown, Missouri.

GRAFTING JUNIPERS

ANDREW J. KLAPIS, JR.
Raytown, Missouri

Originally this material on pot grafting of Junipers was to be centered around the Bard-Parker surgical knife and its use as a grafting knife. Since my original training in the business world was in the pharmaceutical industry as a medical detailer, I couldn't see why a modified Bard-Parker knife wouldn't be an ideal grafting knife. I had a dentist friend who obtained the first two handles for me and a varied supply of blades. These two original knives proved to be too fragile for some of the heavier scions and understock and about four years ago I found the heavier handle which you see displayed on the tables. The knife handles and blades can be purchased at any good surgical supply house. The #6 Bard-Parker handle is the heavy grade, and blades numbering #20 through #24 are the series which fit the #6 handle. The price is about $3.00 each for the handle and $1.50 per dozen for the blades. We have found these satisfactory even for Blue Spruce and other heavy understock. In our experience, the blades retain their keen edges for about 200 grafts, and then they need to be changed.

Probably the first consideration in a discussion concerning Juniper Grafts is one of what understock to use. At Raytown Nursery for the past several years we have used both Hetzi Juniper and J. Virginiana with the heavier burden going to Hetezi — when we can get enough. The Hetzi understock we try to keep supplied from our own propagation. These cuttings are taken in the winter from the first killing frost on. We use fruit boxes as flats and horticultural perlite as the rooting medium. This gives us about 6 inch depth to the rooting medium, and we take cuttings of approximately 12 inch length. The ideal diameter of understock is somewhat smaller in our thinking than is held by many others. We graft on understock from 3/8" on down, but we feel the ideal is 1/4" down to 3-32". We have proven to our own satisfaction and the satisfaction of our customers that these lighter understock and scions *in our operation* exhibit greater vitality and a much better survival percentage than when heavier understock is used.

The hormone used for these J. Hetzi cuttings is Indole butyric acid in talc in the strength of 20 mg/gm. We put 150 cuttings to each box and the boxes are placed in a small fiberglass greenhouse which is heated by a small gas furnace circulating hot air through downspout piping under and over the bench.

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The thermometer is kept at 65°. Last winter we stuck about 7000 cuttings. These were potted off into square plastic rose pots 2½" and plunged in sand in cold frames. They grew throughout the summer, were fed two or three times with liquid fertilizer and shaded when necessary. About November 1st we brought the J. Hetzi understock into the greenhouse on a warm bench, and when root growth is reactivated, grafting can begin — usually about December 1st. Our Virginiana understock is purchased from one of the seedling growers in our area. Specifically, Forrest Keeling in Elberry, Mo., Skinner in Topeka, Kans., and Plumfield in Freemont, Nebraska have been our sources. About November 15 when we receive the J. Virginana understock, it is potted in 2½" square rose pots and stored on a warm bench to reactivate root growth. When the white indicator tips of roots show up, grafting can be started.

Our grafting case is a variation from the normal set up, too. We use an ordinary greenhouse bench 6 ft. wide and 45 ft. long. This is of redwood construction with bottom heat and is cleaned thoroughly and then treated with Morton's Soil Drench "C" before the case is set up. Next a skeleton framework 16 inches high is built along each side of the bench, and this is covered with a double layer of polyethylene. Drawn tightly over the center of the bench for its entire length is a heavy guage wire. This wire is 3 ft. from the floor of the bench. Sheets of 4 mil. polyethylene film are draped over the wire in a tent-like fashion so that they hang down to the lower edge of the bench on either side. This gives a wall-tent effect over the whole bench. The individual sheets of plastic are 8-10 ft. long and overlap 18" to reduce moisture loss to a minimum. Finally, a skirt of polyethylene is suspended from the edge of the bench to the greenhouse floor, thus trapping the heat under the bench and keeping it more constant. The floor of the bench is next covered with clean, new polyethylene and stapled in place. Now we fill the bench with sphagnum peat preferably the longer fibered German type. This is wet down and tossed and then re-wet several times until water can be squeezed out. We feel it is important to make sure that the peat is uniformly wet.

We graft a good many varieties of upright juniper. This includes J. v. Canaerti, J. v. glauca, J. v. burki, J. v. Hill's Dundee, J. v. glauca improved, J. v. globosa, etc. Juniperus chinensis keteleeri and several of the scopulorum varieties such as J. s. Welchii, alba and Sutherland complete the list of grafts we make. Occasionally we do small amounts of hard to obtain spreader type of juniper by grafting, but this is a small quantity proposition for our own landscaping use.

The greatest demand for grafts in our area as to variety has been for J. v. Canaerti and Keteleeri — with Keteleeri slowly creeping up on Canaerti over the past two or three years. Kets are very versatile and will stand more abuse and adverse circumstances than any of the other upright junipers.

In collecting scions, we try to use local sources either from our own nursery or other local nurseries' trees. We believe along with many others that fresh scions are very important to good vital pot grafts. The scions collected are from 12 to 16 inches in length and will range from 1/8" to 3/8" in diameter at the base. Even within our own nursery there is a difference of opinion on the length and taper of the base of the scion. Suffice it to say that the length of the base-taper to the scion is about 1¼" and we tend to keep the taper rather thick; though the diameter of the understock governs, how heavy the base-taper of the scion can be.

After the side-cut is made in the understock, and the tapered scion is inserted; the graft is secured by a rubber budding strip and placed in a flat. When each flat is filled, the grafts are taken to the grafting cse and placed upright on the bottom of the bench. Here is where the thin-walled plastic square pots show their worth. We are able to put almost half again as many grafts into the case than we could when we used clay pots. There doesn't seem to be any detrimental effect on the root system, callus activity, etc., in the use of plastic pots. It saves time in storing, handling and shipping. In our hands we have had fine success using the plastic pots. The pots are placed side by side across the 6 ft. width of the bench and then the wet peat is pulled up around the graft union so that the rubber bud strips are covered. The polyethylene tent-like cover allows easy access for putting grafts in or for spraying or ventilation. In six to eight weeks the grafts are callused and can be taken out of the case. The understock is cut off at the graft union and the pot grafts are taken to a cooler greenhouse for hardening off. This is usually the latter part of February, possibly into March. By mid April, the pot grafts are ready for pick-up or delivery.

In our experience, we feel that pot grafts should be potted off into larger pots during Spring or Summer, or be plunged into beds or cold-frames until the following late Winter or early Spring. Some of our customers feel that this increases the survival rate considerably. What has been outlined here is rather basic to the grafting of upright junipers. I hope there may have been some innovations of value in our use of the Bard-Parker knife and the grafting case for some of you. In our hands at Raytown Nursery, we have had good success with this method.

MODERATOR DUGAN: Next we will have a paper by Dr. E. T. Anderson of the University of Minnesota.

STOCK — SCION RELATIONSHIPS*

E. T. ANDERSEN
University of Minnesota
St. Paul, Minnesota

General interest among fruit growers in the whole field of stock - scion effects is very high. Cognizant of this interest the Dwarf Fruit Tree Association of America sponsored two group tours of the European fruit growing industry this summer. I had the good fortune to be a member of one of these groups and visited both research institutions and private growers in some of Europes most concentrated fruit areas. A very great deal has already been written about clonal rootstocks and different scion varieties and their relation to one another. I will therefore attempt to limit my comments to some of the stock - scion effects we encountered, that, though certainly not new, are receiving considerable attention at the present time in Europe.

Our group was mainly concerned with apples and consequently most of my observations will be on apples. This is not unfortunate because no other plant has undergone so much intensive study or been developed to such a high degree of refinement in its use of stock - scion combinations. No doubt much of what has been found to be true for apples will also prove true in other woody plants.

Almost throughout western Europe growers are either already using clonal rootstocks for apples or are in the process of changing to them. It seems that all countries have recognized the advantages of these stocks.

My comments here will be brief because interaction effects on tree size, early cropping, yields, etc. will vary from area to area and only experience in the area can provide definite answers. In general three reasons appeared primary in the shift to clonal rootstocks:

(1) The desire for early fruiting in the orchard
(2) The possibility of heavy yields annually, starting only a few years after planting, and
(3) The need for small controlable trees.

A fourth factor must be considered along with these as it is closely related to all three and that is uniformity, without which, of course none of the advantages could be realized. We learned that it was recognition of the lack of uniformity among trees on seedling roots that prompted Wellington and Hatton, the first and second directors of the East Malling Research Station to investigate rootstocks. Their primary concern was to obtain uniform material with which to conduct research on other cultural problems. As you know their work and that of men who followed them at East Malling have made that station the main centre of research and information in this field; research which has provided the foundation on which this revoluntionary development in the fruit industry has been built.

*Paper No 1212 Miscellaneous Journal Series, Minnesota Agricultural Experiment Station, University of Minnesota.

But this development has brought many problems and accentuated others. Prominent among these and no doubt related to several others is the problem of viruses present in the stock variety, the scion variety, or both. Only a few of the viruses that infect these tree fruits produce obvious symptoms. Many of them are virtually symptomless excepting on a few varieties or certain unrelated indicator plants. For example, Cropley (1) states that many of the rootstock varieties including some of the clones of M II, M III, M IV, M VII, M IX, MM 106, and MM 109 carry the chlorotic leaf spot virus which can be transmitted to an apple chlorotic leaf spot indicator clone R 12740-7A. These rootstocks do not express the symptoms of chlorotic leaf spot. Many of the apple rootstocks and most commercial apple varieties also contain viruses which cause stem pitting in Virginia crab and decline in another indicator called Spy 227. According to Posnette and Cropley (3) he virus "star crack" may render Cox's Orange almost entirely nonproductive yet have virtually no effect on Sunset or Lord Lambourne.

It is known to affect Golden Delicious as well. Rubbery wood virus may seriously affect the vigor of Lord Lambourne and yet have little effect on Sunset or Cox's Orange. If "mosaic" virus and "rubbery wood" are present at the same time the effects on Cox's Orange were severe. The significance of these findings point up the importance not only of the effect that viruses present in the rootstock may have on the scion variety but, conversely, also the effect that viruses in the scion may have on the rootstock. The virus problem, complicated by the many rootstocks each a possible carrier of several and different viruses and many scion varieties also carriers of viruses, is one of great complexity. No doubt many of the conditions that at one time were considered incompatibilities are the result of virus infections. Well known is the fact that many of our apple varieties are entirely infected with the stem-pitting virus. Though symptomless in these varieties it causes stem pitting on Virginia crab and stunting of trees where Virginia crab is used as an interstock.

Mr. A. P. Preston, in charge of rootstock studies at East Malling commented that because of the virus situation much of the work relating to stock and scion will be repeated to determine whether viruses may have been responsible for the results.

In England they have organized a "Mother Tree Scheme" at the East Malling Station to provide the cleanest possible propagation material to nurserymen (2). Most of the apple rootstocks have been virus tested on indicator plants and only the cleanest ones are being used. Of these M. VIIa has come into our trade here. These are free of some viruses including mosaic, rubbery wood and chat fruit but most contain chlorotic leaf spot and stem-pitting viruses.

The English are using heat treatment to free tree fruit clones of viruses. Small active plants are exposed to 98° F. for 3 weeks. The small shoot tip is then grafted to a clean seedling tree and tested for virus. Clean shoots are then propagated for use.

France has also implemented a certification and indexing program to provide reliable propagation materials to nurserymen and growers.

Concerning incompatibilities other then those due to viruses, Dr. Jaques Huet of the Fruits Research Station at Angers, France made an interesting observation. Such incompatibilities are found to be accentuated by warm climatic conditions. For example, peach on Myrobalan plum is very poor in southern France (where peaches are important) but fairly good in the north where it is cooler. In south east England if an interstock such as Brompton is used the tree is quite satisfactory. This is not so in southern France. It seems to me that even these relationships could be virus effects.

Another significant relationship pertains to the juvenility of tree fruit seedlings. Long periods of vegetable growth before flowering plague the fruit breeder. At East Malling this long juvenile period is greatly shortened by grafting wood of the young seedling to an extremely precocious clonal rootstock designated 3431. Young trees planted in 1962 are all fruiting in 1964. If left to grow as seedlings on their own roots many would require 10 to 12 years to fruit. The advantages of this to the breeder are obviously quite remarkable.

In conclusion I will refer briefly to some of the principle rootstocks in use in the countries we visited. In France nearly all new apple plantings are on M IX with a few on M II. Most apples are grown in closely planted hedge rows and trees on M IX were amazingly vigorous. In the famous Po Valley fruit area of Italy most apples are on seedling roots but many new plantings are on M IX. Harvesting the tall trees growing on the rich soils of this valley is beginning to be a problem.

In Holland nearly all new plantings were on M IX or M II; also in hedge rows but pruned to the spindle bush type and not as narrow as the hedges in France. In England M II is most popular. It has better anchorage and less tendency to sucker than M VII. Malling IX is too low in vigor and requires too much coddling. The new M. 26 is very popular and being used a great deal in new plantings. It does not sucker and is intermediate in size between M. IX and VII. It can be propagated economically by hard wood stem cuttings. The English system of culture is mainly of small trees pruned much like a modified leader. They recommend staking while trees are young. Sweden uses mostly their own rootstock, Alnarp II. Though not dwarfing this rootstock produces precocious trees and is easy to control by pruning under Swedish conditions.

The foregoing brief review is sufficient to point up the fact that each country and area has its own peculiar conditions that will dictate the selection of rootstck - scion combinations. Testing carried out in one area can provide leads but cannot provide reliable answers. Reliable answers can come only after very extensive trials over a fairly long period of time.

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1. Cropley, R. The association of sap — transmissible virus with apple chlorotic leaf spot. Plant Disease Reporter 47:165-167, 1963.
2. Posnette, A. F. The mother tree scheme. Ann. Rep. of the East Malling Res. Sta for 1961. pp. 125-127. 1962.
3. Posnette, A. F. and R. Cropley. The effect of virus infection on the growth and crop of apple, pear and plum trees. Phytop. Medit. II.

MODERATOR DUGAN: Our final speaker this afternoon is Mr. Robert DeWilde who will talk about production and breeding of lilacs.

PRODUCTION AND BREEDING OF LILACS

ROBERT C. DEWILDE
Perkins - deWilde Nurseries, Inc.
Shiloh, New Jersey

INTRODUCTION

The common lilac *Syringa vulgaris* has been grown in gardens of the world for centuries. The first botanical description was written by a French naturalist in the year 1554. During the seventeenth century, English gardens were enriched with this shrub from seed collected in the lilac's native habitat of Rumania, Bulgaria, and Greece. The lilac was one of the first ornamentals brought to America by the early settlers. The beauty of lilacs has been expressed in poems and songs and is strongly associated with home, family, and memories of spring. There is little doubt that nurserymen can find the production of lilacs and the introduction of superior varieties quite rewarding.

PRODUCTION

Lilacs may be propagated in any of five general methods: seed, cuttings, layers, budding, and grafting. When considering the method of production for lilacs or any plant, the commercial objective is to produce the largest percentage of quality salable plants, true to name, in the shortest period of time. One important prerequisite for quality lilacs is that the salable plants be actively supported by their own root system.

Beginning then with seeds, the varieties of *S. vulgaris* will not reproduce the seed parent true to name since they hybridize rather freely. Only the true species grown in isolation can be relied upon to reproduce the parent plant.

Layering of stock plants can be done in late autumn. The time required to root the layered branch is approximately eighteen months. Two additional years are generally required for development of the severed layer into a saleable plant. The tremendous number of stock plants necessary for even a small comreliable answers. Reliable answers can come only after very extensive trials over a fairly long period of time.

LITERATURE CITED

1. Cropley, R. The association of sap — transmissible virus with apple chlorotic leaf spot. Plant Disease Reporter 47:165-167, 1963.
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Layering of stock plants can be done in late autumn. The time required to root the layered branch is approximately eighteen months. Two additional years are generally required for development of the severed layer into a saleable plant. The tremendous number of stock plants necessary for even a small commercial operation usually relegates this method to amateur interest.

Production of lilacs from cuttings can be accomplished by taking very young soft growth when the newly developed shoots are no more than four inches in length. A sharp knife is used to sever the soft cutting at the point where the new wood emerges from the old. Cuttings should be collected in a polyethylene bag to prevent moisture loss. As with all soft cuttings the time between taking the cutting and its insertion in the bench should be as short as possible. With the use of a fog or intermittent mist system, rooting of good percentage should occur in three to six weeks. Rooted plants are potted, hardened off, and planted in field rows the following spring. This method of production is satisfactory in most respects, but we have found some limitations. Exact timing is required to obtain the very soft cuttings since the rooting percentage falls off rapidly as the new shoot matures. Varietal differences in the time of shoot emergence, rate of growth, and even slight variations in stock plant location require that a constant daily vigilance be maintained over a three week period to obtain the required amount of cuttings. Our propagation requirement was for the production of over a hundred thousand lilacs consisting of about thirty standard varieties and test trials for a number of new introductions. This presented a monumental task since other plant material must also be collected for soft wood propagation at this time of year. Finally, the production time required is four to five years from the time of taking the cutting until the majority of the plants are eighteen inches or better.

Budding of lilacs is carried out in late summer. The understocks most commonly used are seedlings of *S. vulgaris* and oval-leafed privet, *Ligustrum ovalifolium*. Seedlings of *S. vulgaris* provide the most compatible stock, but there is no doubt that the identification problem involved with the "suckering nuisance" of the common lilac has caused most American nurserymen to use privet. Generally the standard "T"-bud method is used. The bud is placed at the lowest point on the stem of the privet, usually several inches below the normal cultivated soil level. The privet top is cut off the following spring. The bud takes its strength from the understock and may grow as much as four feet in one year. By using two or four buds "salable" plants can be produced in one year. The budded lilac has no roots of its own and since privet is not a truly compatible root stock, a natural deterioration begins as antagonism between stock and scion occurs. Unless the budded lilac can be made to produce its own roots the plant will be short lived. Success depends upon deep planting of the lilac stem and subsequent development of adventitious roots along the stem. It is my hypothesis that initiation of the rooting process occurs only when low oxygen conditions within the phloem parenchyma of the lilac stem induce tbe production of auxin. Auxin initiates growth activity, and if the proper chemical "cofactors" are present in the stem, root meristems and adventitious roots are formed. The swollen below ground portion of the stem which is often typical of budded lilacs is an example of auxin induced growth where the "cofactors" in the stem are lacking, or are acting as inhibitors to root formation. When the lilac is planted deep enough to provide the low oxygen requirement to initiate the rooting process of the stem, a logical question is: What have we done to the oxygen requirements of the privet roots? Roots require oxygen for their respiratory activities. Without oxygen, stored sugars in the roots cannot be utilized to provide the energy necessary for root growth and the uptake of essential elements from the soil. When the roots are poorly aerated growth of the plant is usually restricted. At best, the time required for the production of sufficient adventitious roots to support the lilac plant is two years. During this period adverse conditions often cause death. The percentage of budded lilacs which fail to obtain their own roots will naturally vary with the variety, soil type, and general treatment given the plants by the nurserymen and the buyer. It is my opinion that a majority of budded lilacs do not perform well in amateur gardens and that the number that fail to produce their own roots and subsequently are short lived is much greater than nurserymen are willing to believe. Budding does serve a useful purpose on our nursery for rapidly increasing the required wood of new or desirable varieties for our grafting operation.

Gafting is accomplished by uniting three to four inch length lilac scions onto privet understocks. An important feature of the grafting operation is that the work is done in January when the nursery schedule is generally light. We at Perkins-deWilde Nurseries use this method of propagation. A detailed examination of our production program follows.

If we pick up the cycle for the production of privet understock at this time of year, we will find the one-year-old privet plants tied in bundles healed in sphagnum moss in a cold cellar. During the month of December, when weather conditions are adverse and inside work is required for steady employees, the privet is graded and understocks of pencil thickness with good root systems are selected for grafting. The privet tops are cut off and the branches are saved for making hard wood cuttings. The privet is cleaned of all roots except those at the basal portion. The basal roots are trimmed back to two inches and the heavy roots are removed. The root stock consisting of basal roots and a five inch stem is examined for "eyes" or "buds" which might give rise to suckers at a later date. The stem is disbudded of these "eyes," thus greatly reducing the possibility of suckering. Understocks are tied in bundles of twenty-five, dipped in a fungicide solution, packed in boxes of sphagnum moss, and stored in a cold cellar until required for grafting. The privet tops are sorted and the strong wood is selected for hard wood cuttings. A cutting seven inches in length is made and all but the top two or three sets of buds are removed. The disbudding is necessary to produce an understock that will be free from excessive side branching at the point where the graft will be made the following year. The cuttings are tied in bundles of fifty, dipped in a fungicide solution, packed in boxes of sphagnum moss, and stored in a cold cellar until early spring. In the spring the ground is prepared; a narrow trench about five inches deep is made and the cuttings are stuck about two inches apart on the row and in field rows three feet apart. The cuttings root in the field and grow through the summer until late fall. In November the rows of privet are mechanically root pruned, the plants are lifted bare root, tied in bundles, and placed in a cold cellar, thus completing the cycle for the production of understock.

Lilac scions are gathered from stock plants as needed for grafting during the month of January. Scions may be pre-cut and stored in a cold cellar. Storage is easily accomplished by wrapping the scions in "no-rot" burlap, dipping them in a fungicide solution, and placing the bundles in moist sphagnum moss.

The mechanics of making the side graft which we use are fairly easy, although practice is required to develop efficiency movement and ease of hand. The grafting knife must be drawn straight across and parallel to the privet stem, insuring a flat, level, and straight cut. When the same type of cut is made on the lilac scion, the stock and scion are easily united, providing even cambium contact on at least one side of the graft. A rubber grafting strip is used to hold the union in place. Waxing the graft union may be beneficial, but our percentage of successful grafts has not reflected this and the waxing operation has been eliminated.

The finished graft is planted directly into a cold frame type greenhouse where the temperature remains cool, but is kept above the freezing point. The soil into which the graft is planted is an ordinary mixture of sand, soil, and peat with fertilizer added and the pH adjusted to 6.5. The graft is planted below the graft union so that only the top buds of the lilac scion are visible. Callus tissue is rapidly formed on the graft union and also at the base of the lilac scion.

During the month of October the lilacs are dug from the cold frame and planted in field rows. At planting time ninety percent of the grafts will have started to produce adventitious roots from the callus tissue formed at the base of the lilac scion. In October one year later the privet nurse stock will have deteriorated and in most cases the lilac will be supported entirely by its own roots. At this time the lilac stem is cut back to two inches above the ground. The following spring strong shoots break from the base of the stem. In the fall, a little less than three years after grafting, eighty percent of the plants should be in well branched grades of eighteen to twenty-four inches and two to three feet. The privet stock which has fulfilled its purpose as a temporary nurse stock will have completely died away, resulting in quality salable lilacs actively supported by their own root system.

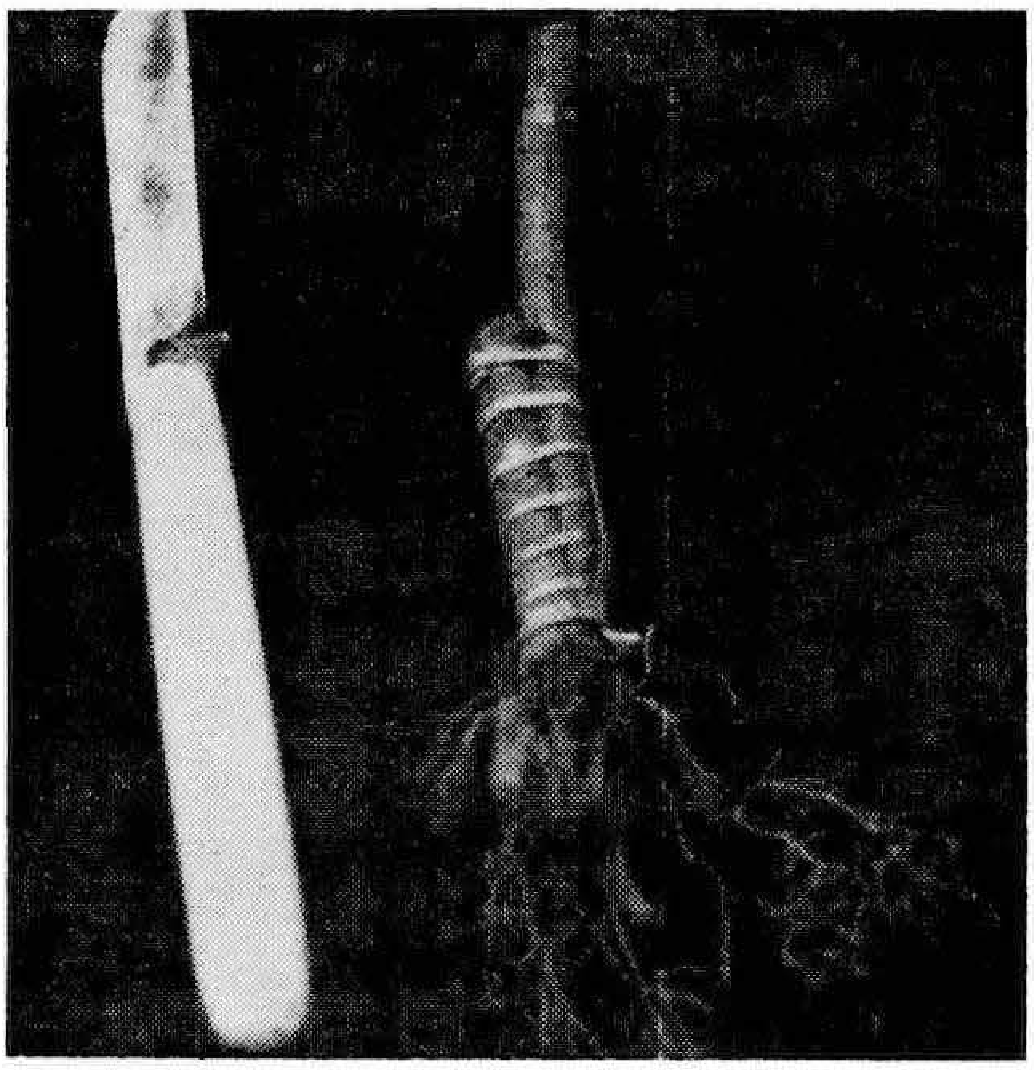

Figure 1. A newly made graft.

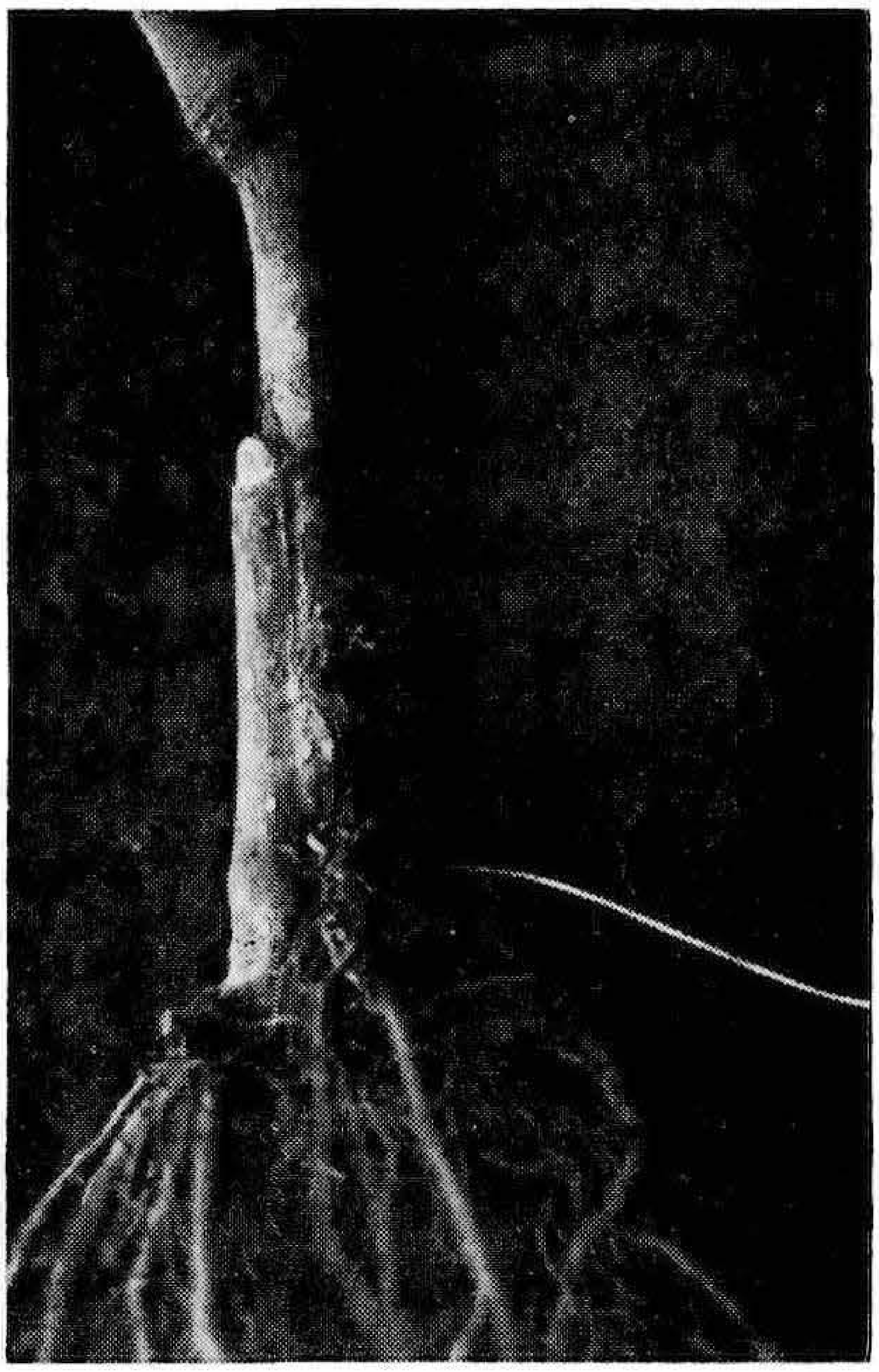

Figure 2. Graft after union formation and growth.

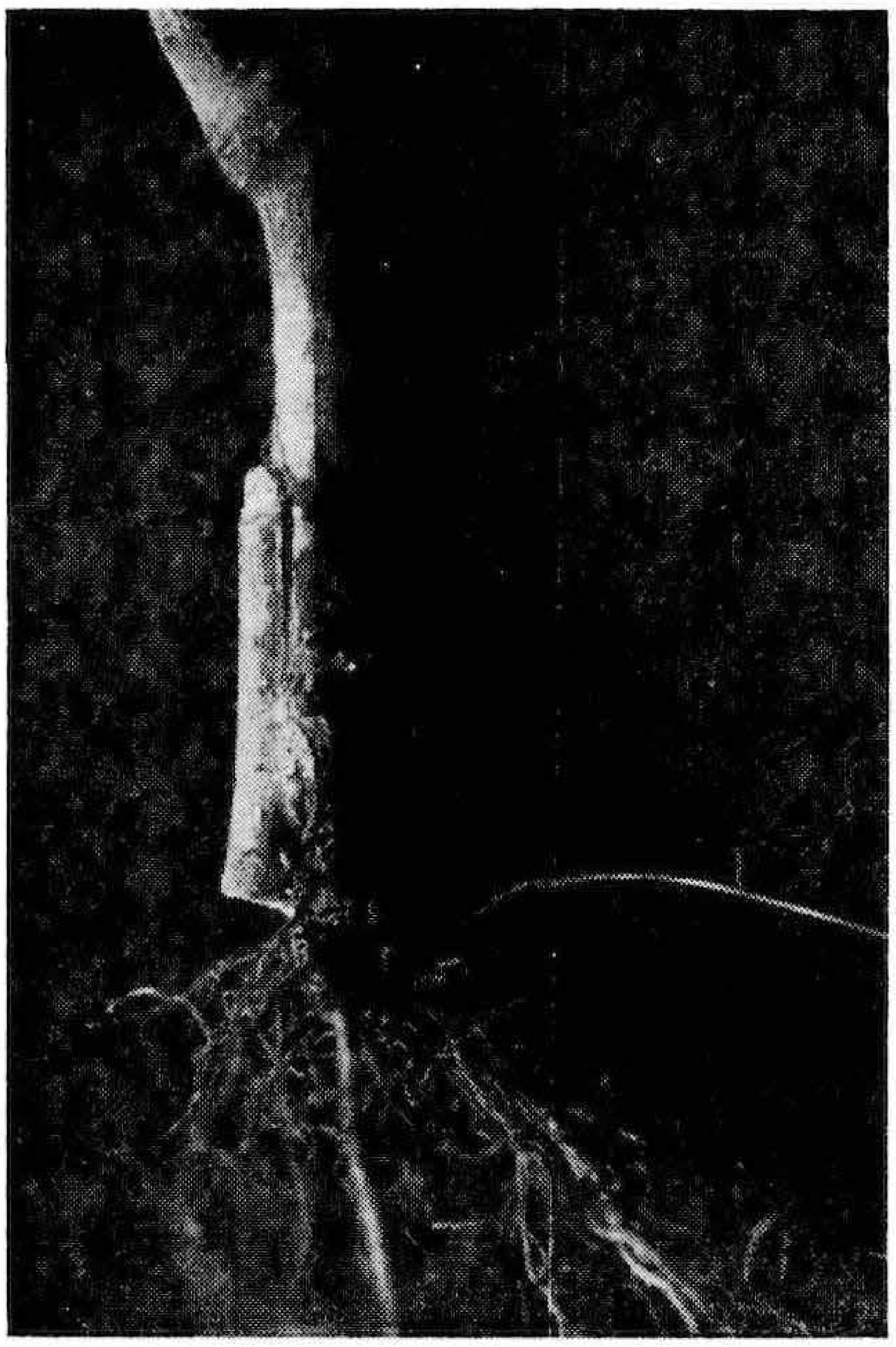

Figure 3. Understock root system removed.

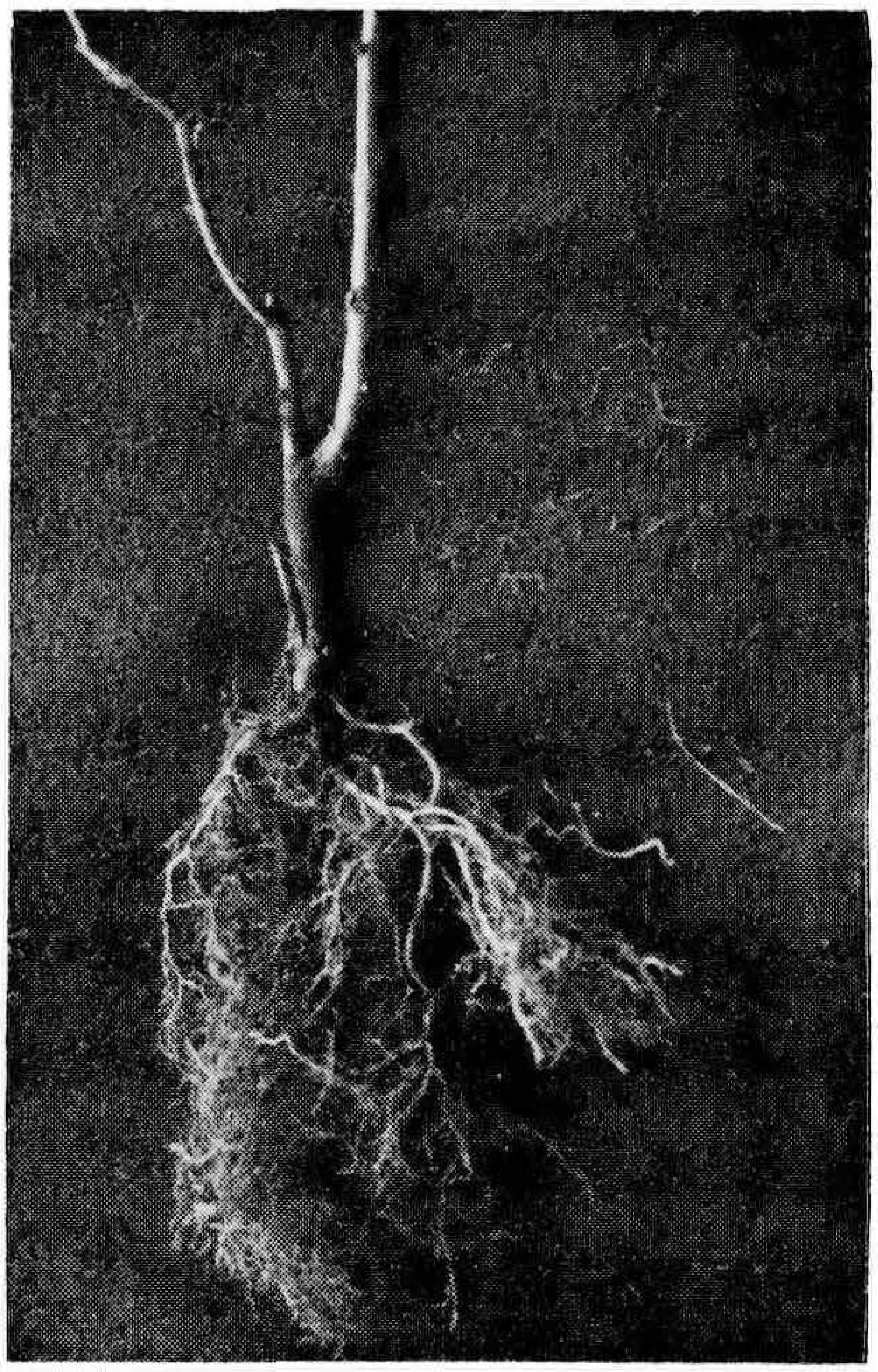

Figure 4. Scion on own roots with only a remnant of understock.

BREEDING OF LILACS

In America there have been two general types of lilac breeding: the first of which comprises straight selection of progenies raised from open pollinated seed, or from more or less random crossing of good varieties with the object of looking for a "winner." It is easy to disparage this technique, but it has given us a large number of our present day lilac varieties. The second method of breeding is possibe only after the first has produced a range of varieties reasonably suited to local conditions. It comprises a more positive approach of choosing the best of the available varieties to work with, finding out their faults and deliberately building the required characteristics into them or into similar varieties. Although there is a great challenge to develop new hybrid groups through species crosses, it was decided to direct the main effort of our breeding program to the established *S. vulgaris* group with the hope of obtaining improvement in the following areas: extension of the season of bloom; selection of compact and shapely growth habits with consideration for possible dwarf varieties; obtain mildew resistance; increase flower substance to withstand spring rains; obtain clearer and darker colors particularly pinker pinks and redder reds; increase the size of flower spikes with emphasis on the double flowered varieties; obtain flowers with less color fade; and finally to increase the desirable lilac fragrance. Naturally, there is always a hope for a new color break or other novelty features that will provide a new breeding line. With the help of Dr. John C. Wister of the Arthur Hoyt Scott Horticulture Foundation of Swarthmore College and Mr. Alfred Fordham of the Arnold Arboretum, over two hundred and fifty different named lilacs were obtained. This collection was comprised of *S. vulgaris* varieties, their hybrids. and a representative species group with their known hybrids. With the help of Dr. Wister these lilacs were reviewed for their particular characteristics. After gathering as much information as possible, a breeding program was started in the spring of 1959.

The mechanics of making the crosses are relatively simple although tedious. The flowers of the desired female or seed parent are emasculated and the petals are removed before the flower opens. Pollen of the male parent is usually collected from dehiscing anthers in the field early in the morning. Pollen is easily collected and stored in vials for use when the blooming times of the varieties do not overlap. Unfortunately, numerous pollinations of the same cross are necessary to obtain a number of progeny since the maximum number of seeds obtained from any single pollination is two. One or more flower spikes on the seed parent are selected for each cross. Since the individual florets mature first at the top of the spike, these open flowers are cut off together with the lesser developed buds at the base of the spike. As high as fifty flower buds can then be emasculated for pollination from the center of the flower spike.

In order to prevent contamination from foreign pollen a polyethylene bag is placed over the flower spike of the completed cross. Each cross is tagged and recorded with regard to location of the plant and the location of the cross on the plant. When the blooming season is over the protective bags are removed. In the latter part of September the seeds are collected and stratified for eight to ten weeks. The seeds are sown in flats containing an ordinary soil mixture and a top layer of sphagnum moss. The germinated seedlings are transferred to pots and placed in a cold frame. The following fall the seedlings are planted in nursery rows. The crosses made in the spring of 1959 flowered abundantly for the first time in the spring of 1963. Selections from the program were made for further testing. Although there are numerous excellent varieties in the *S. vulgaris* group, it is believed that selective breeding will provide varieties of superior merit.

MODERATOR DUGAN: As the day draws to a close I want to take this opportunity to thank you. You've been a good group. You've asked questions at the right time and you kept your mouths shut the rest of the time. We have come out on time and I want to thank our speakers. They have done a terrific job of presenting their material, stimulating us to go home and cut a bigger swath in the propagating business.

John Roller has a few announcements.

PRESIDENT ROLLER: I would like to make appointments to the following committees. To the resolutions committee, Dick Fillmore, Chairman, Clarence Barbre, and Arie Radder. To the auditing committee, Mr. W. E. Cunningham, and James Ilgenfitz. To the students award committee, Mr. William Flemmer, III.

FRIDAY MORNING SESSION

December 4, 1964

The session convened at 9:00 a.m. in the Ballroom, Manager Hotel. Mr. Leslie R. Bork, Jr., moderator.

MODERATOR BORK, JR.: Our first speaker this morning is Mr. Al Fordham of the Arnold Arboretum who will talk with us about abnormal conifers from native populations and also White Pine Witches' broom seedlings.

ABNORMAL CONIFERS FROM NATIVE POPULATIONS IN MASSACHUSETTS

ALFRED J. FORDHAM
Arnold Arboretum
Jamaica Plain, Massachusetts

This series of slides will show some abnormal conifers which originated spontaneously in Massachusetts.

Within fifty yards of this solitary fifty-foot tall Canadian hemlock, nine slow-growing forms similar in character, were discovered. No other probable parent tree or the remains of one that might have fallen, could be found within a distance of one quarter of a mile. Each abnormal plant was characterized by a single trunk, short branched habit of growth, and small needles darker than usual in color. Although the plants ranged in size from three to five feet tall, they could well be of a like age estimated at about thirty-five years. The parent tree was searched carefully for a witches' broom or the remnants of one, with the thought that seeds producing the varians might have originated in this way. However, no evidence of a broom could be detected.

Canadian hemlock has produced a multitude of slow-growing genetic forms. As an indication of this abundance the Arnold Arboretum in recent years, has received plants or propagating material of 73 abnormal hemlocks almost all of which were discovered in natural habitats. Any dwarf or slow-growing variant located in the woods is at a competitive disadvantage for it would tend to be shaded out by other woodland plants. Canadian hemlock, however, has the ability to survive in shade, so that slow-growing forms persist where dwarf forms of other subjects might fail.

This eight foot tall, oddly shaped Canadian hemlock looks as though it is a tree which has lost its leader. This is not the case, for in the same area there are another 18 or 20 plants about half this size with the same dark foliage color and peculiar shape. I searched the area for an abnormal parent plant which might be casting seeds but found none. The only hemlock nearby, of adult size, was about 100 yards away and of normal appearance. However, it is quite probable seeds which gave rise to these oddities were shed by that tree.

The loosely formed weeping hemlock shown in this slide is located beside a country road. It is distinctly pendulous, but not nearly so impressive in this character as Sargent hemlock or numerous other weeping hemlocks now known in cultivation.

This prostrate form found at the edge of a pasture is growing under very poor conditions. In character it is somewhat like 'Cole's Prostrate.' It has been propagated and in a few years we will know how it will perform when provided with better growing conditions.

A number of white pines, differing from the normal, have appeared in the woods. This particular one is about 4 feet tall and unusual because of its contorted branches.

This white pine, apparently a slow-grower, has better than usual foliage color. When propagated it may well produce a good ornamental dwarf.

The white pine now shown could, when propagated, make a good upright plant for the angle of branching, as seen near the top, is quite tight. *P. strobus fastigiata* when young has a narrow upright shape but it broadens with age. This specimen at the Arnold Arboretum was grafted nearly 70 years ago in 1897 and through the years has widened to this extent.

This small white pine has a multibranched framework which indicates that it will be a slow growing bush type rather than a normal tree. It was found together with many others in the vicinity of a fruiting witches' broom.

This small *Juniperus communis* found in a pasture, is a very slow growing hemispherical mound about 12 inches high by 22 inches in diameter, with a framework which shows it to be quite old. Cuttings have been rooted and it will be under observation to see if the slow growth and mound shape persist in cultivation.

A second *Juniperus communis*, one of many taking over an abandoned pasture, shows an odd growth habit and yellow coloraion. We plan to propagate it and add it to the Arboretum collection.

WHITE PINE WITCHES' — BROOM SEEDLINGS

ALFRED J. FORDHAM
Arnold Arboretum
Jamaica Plain, Massachusetts

Last year at the St. Louis Meeting, I presented a series of slides depicting this white pine witches'-broom which grows in the Berkshire Hills of western Massachusetts. It has fruited and shed seeds for many years. Within its dispersal area over 200 genetically dwarf forms were found. In the intervening year some of its seeds have been germinated thereby providing an opportunity to observe the behavior of its progeny. The next slide shows the small twig and cone characteristics of the broom when compared with those of normal pine. These cones

The loosely formed weeping hemlock shown in this slide is located beside a country road. It is distinctly pendulous, but not nearly so impressive in this character as Sargent hemlock or numerous other weeping hemlocks now known in cultivation.

This prostrate form found at the edge of a pasture is growing under very poor conditions. In character it is somewhat like 'Cole's Prostrate.' It has been propagated and in a few years we will know how it will perform when provided with better growing conditions.

A number of white pines, differing from the normal, have appeared in the woods. This particular one is about 4 feet tall and unusual because of its contorted branches.

This white pine, apparently a slow-grower, has better than usual foliage color. When propagated it may well produce a good ornamental dwarf.

The white pine now shown could, when propagated, make a good upright plant for the angle of branching, as seen near the top, is quite tight. *P. strobus fastigiata* when young has a narrow upright shape but it broadens with age. This specimen at the Arnold Arboretum was grafted nearly 70 years ago in 1897 and through the years has widened to this extent.

This small white pine has a multibranched framework which indicates that it will be a slow growing bush type rather than a normal tree. It was found together with many others in the vicinity of a fruiting witches' broom.

This small *Juniperus communis* found in a pasture, is a very slow growing hemispherical mound about 12 inches high by 22 inches in diameter, with a framework which shows it to be quite old. Cuttings have been rooted and it will be under observation to see if the slow growth and mound shape persist in cultivation.

A second *Juniperus communis*, one of many taking over an abandoned pasture, shows an odd growth habit and yellow coloraion. We plan to propagate it and add it to the Arboretum collection.

WHITE PINE WITCHES' — BROOM SEEDLINGS

ALFRED J. FORDHAM
Arnold Arboretum
Jamaica Plain, Massachusetts

Last year at the St. Louis Meeting, I presented a series of slides depicting this white pine witches'-broom which grows in the Berkshire Hills of western Massachusetts. It has fruited and shed seeds for many years. Within its dispersal area over 200 genetically dwarf forms were found. In the intervening year some of its seeds have been germinated thereby providing an opportunity to observe the behavior of its progeny. The next slide shows the small twig and cone characteristics of the broom when compared with those of normal pine. These cones when compared with those taken from a normal tree show the variety of subnormal sizes which it produced.

Far fewer viable seeds were produced than would be expected in normal cones for many were abortive. However, 154 were acquired from the limited number of cones available.

On September 20, 1963 the seeds were separated into two lots and started on a stratification period of three months at 40 degrees. The first lot contained 135 seeds while the second, consisting of 19 miniature seeds was handled separately to see whether or not size would affect the outcome.

On the 20th of December both lots were sown and by January 3rd a general germination had taken place. Seventy-five seedlings developed from lot #1 while in lot #2 only five seedlings appeared. On the 27th of January they were potted and placed on long days using Dr. Sidney Waxman's recommendation of a 30 second light interval every fifteen minutes throughout the night. This worked well and the seedlings in eleven months were comparable with plants grown for three years in the conventional way. Under this program the normal pine seedlings produced one apical growth after another in contrast to the abnormal forms which were then easily segregated.

Differences in the seedlings became apparent by April 22 so the first photographs were taken. Some had gone past the cotyledon stage while those smaller and weaker found it an effort to shed their seed caps. Some cotyledons were greatly distorted while others formed a tightly clenched ball.

A set of slides made in July show the development to this point. Some of those considered to be dwarf have developed adult leaf bundles, while none of those thought to be normal have yet done so.

In September and October the compact character of the abnormals became more defined with many buds breaking in the region of the cotyledons but producing only very short growth. The latest photographs taken in early November, show a new set of branches developing. Last week, November 27, some dwarf seedlings had advanced to a point where 22 branches were evident on 2 inch plants.

Mr. Albert G. Johnson, University of Minnesota, who has been working with witches'-brooms, sent us seeds of *Pinus banksiana* collected from a broom near Gordon, Wisconsin. They were sown on the 21st of February and by the 4th of March had produced general germination. Those dwarf in nature could be quickly separated as they responded to long days better than did the white pines. However, they produced a whorl of stubby branches at each growth flush in contrast to the white pines where branching occurred mostly in the cotyledon area.

This witches'-broom was located along a country roadside in Foxboro, Massachusetts. In late May, when white pine blossoms in Massachusetts, a trip was made to see if it flowered and to observe their sex. Widening of the road was in progress and as the broom was in the path of construction it was collected.

In characteristics it is quite different from the rest of the tree. The leaves which were borne on abnormally short and thick shoots measured from seven-eighths to one inch in length while on the same branch the normal leaves measured from 2½ to 3¼ inches.

This series of photographs will show where the abnormal development began. The broom shows nine flushes of growth which would indicate it to be nine years old. The normal whorl of six branches as seen on the right would have started development ten years ago. The following year another six branches developed and one of these gave rize to the broom. Five of these were located beneath the broom in a position where they were too densely shaded to survive but the terminal shoot had enough light to continue as a spindling growth.

A close-up of the joint at which this occurred. The smaller branch with its small leaf surface has developed to about pencil thickness while the broom with its relatively vast leaf surface has caused the entire branch to thicken. Here we see the broom as it was positioned on the tree.

In the Arnold Arboretum we have a broom on *Pinus rigida*. This picture shows an example of its cones. The two large ones in the center were taken from the main part of the tree while those on the sides were collected from the witches'-broom. Although the cones and seeds from the broom were a great deal smaller than usual the seedlings showed no abnormality.

This broom is located in a cemetery in Millis, Massachusetts. In late May while checking it for flowers, a colorful mass was noticed at its base. Upon investigation with binoculars it proved to be the most patriotic crows nest ever seen as it was composed of American flags stolen from the graves of veterans. Within fifty yards of the tree all flags had been ripped from their staffs and worked into the construction of the nest. A telephoto shot taken on a rainy day shows the broom structure together with the jazzy crows nest positioned to take advantage of the brooms' density. Tattered remnants such as these littered the ground under the broom bearing tree.

Two members of the Society, Sid Waxman our secretary, and Radcliffe Pike from the University of New Hampshire, are shown with a white pine broom collected in Grafton, New Hampshire during a seed collecting trip last September. This also provides an example of witches'-broom develpment from a single lateral bud.

MODERATOR BORK, JR.: The second speaker is Dr. Wesley Hackett from the University of California who will speak to us on growth phases in relation to plant propagation.

GROWTH PHASES IN RELATION TO PLANT PROPAGATION

Wesley P. Hackett
Department of Agicultural Sciences
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The physiology or internal functioning of plants changes as they progress from seedlings to maturity. These internal, physiological changes are sometimes manifested by a series of marked changes in morphological characters and rate of growth. Examples of morphological characters which change with maturation are leaf shape and arrangement, stem and leaf coloration, habit of growth and degree of thorniness. English ivy (*Hedera helix*) is a good example of a plant which exhibits marked changes in morphology with maturation. As a seedling and for many years thereafter, it is a vine with lobed leaves, reddish stem, dorsa-ventral leaf arrangement, and aerial roots. Mature ivy plants are woody shrubs with entire oval leaves, green stems, spiral leaf arrangement and no aerial roots. In other plants, however, the morphological differences may be so slight and gradual that they are not apparent to the casual observer. Another indicator of physiological change with maturity is the greater tendency of cuttings taken from young seedling plants to initiate adventitious roots than those taken from older plants. This has been shown for many species including apple (10), pine, spruce, maple, ash, oak (25), hemlock (4) acacia (23), and many others. Still another indicator of physiological change with maturity is the fact that seedlings go through a period of growth and development during which they *will not* flower and form reproductive structures even when known environmental requirements for flowering such as photo period or low temperature are fulfilled. Ultimately, however, these plants mature and acquire the ability to flower.

The immature condition as manifested by the physiological and morphological characteristics associated with young seedling plants is referred to as juvenility (11) and plants or parts of plants with these characteristics are said to be in the juvenile phase of growth. Plants or parts of plants with mature characteristics such as the ability to flower are said to be in the adult or mature phase of growth.

Growth phases are of interest to plant propagators, growers, and breeders for the following reasons:

1. First, ease of adventitious root formation is associated with juvenility and therefore plant propagators would like to prolong or reestablish the juvenile phase to take advantage of this characteristic.
2. Secondly, plants in the juvenile phase can not be induced to flower and therefore plant breeders and growers would like to be able to shorten the juvenile phase to obtain early early flowering and fruiting.

Because of the importance of growth phases to most people who grow plants, it is worthwhile to review what is known about growth phases and see how this information can be applied to plant propagation and production.

Over the years since about 1900 considerable information has been gathered concerning growth phases. Observations show that the duration of the juvenile phase and accompanying characteristics is variable and may be only a few days or weeks in some plants, whereas in others, such as *Hedera helix*, it may persist for years. The change from the juvenile phase to the adult phase may be rather gradual so that there are different degrees of juvenility. This is true for both rooting ability and morphological characters, as indicated by transitional leaf shapes and transitional degrees of rooting ability. It can also be said that the various juvenile characteristics are lost at different rates. For example, juvenile leaf morphology may disappear faster than ease of rooting. Thimann and Delisle found this to be true in white pine where the change-over to secondary needles is completed in the second year while the ability to root from cuttings shows a gradient lasting five or six years. So there seem to be gradients of juvenility and the gradients may not be the same for all characters.

It is interesting and of practical importance to note that the bases of many plants retain a certain degree of juvenility or the ability to produce juvenile shoots even when they are quite old (24). This is reflected in the fact that cuttings taken from the lower portions of a plant sometimes root better than those taken from the upper part (13). This is also the reason that cuttings taken from hedges and suckers or root sprouts may root easier than cuttings taken from the upper parts of intact plants.

One of the most striking features of growth phases is that in many cases both the juvenile and the adult state are transmitted by vegetative methods of propagation such as cuttage or graftage. Vegetatively propagated offspring from the juvenile phase continue their normal sequence of maturation and finally flower. Vegetative propagations from adult shoots continue to grow as adult for indefinite periods of time. Frost (9) has shown this to be true for buds of *Citrus* where plants grown from buds taken from the base and inner portion of a seed-grown tree are thorny, while plants which developed from buds taken from the peripheral portion are likely to be nearly thornless and will flower and bear fruit earlier.

It is also known that environmental factors influence the rate of maturation. This is, the duration of the juvenile phase is not fixed and can be prolonged or shortened to some degree. These influences of environment on rate of maturation are indirect evidence that juvenile characteristics are associated with physiological age or condition rather than chronological or time age. Hess (14) has presented direct evidence to show that juvenile and adult forms of *Hedera helix* are physiologically different as indicated by differences in amounts of rooting cofactors.

As mentioned above environmental factors affect the rate of maturation and may even cause reversions from adult to a more juvenile condition. It has been shown with some herbaceous plants (3, 15) that high light intensity reduces the length of the juvenile phase and stimulates earlier flowering. With geranium seedlings (2) it is known that higher daytime temperatures up to about 75° or 80° F. coupled with high light intensity will reduce the time from sowing to maturity. The juvenile phase of rhododendron (6), camellia, pine and birch (17) seedlings have been reduced by growing them under long photo-periods in a glass house. The common effect of this treatment was to produce a larger plant in a given period of time. In each case the time to first flowering was reduced.

Low light intensity or shading has the opposite effect of high light intensity and prolongs the juvenile phase in beech trees (22) and some herbaceous plants. Etiolation (the development of plants or plant parts in the absence of light) has a great stimulatory effect on root initiation and in our laboratory we have recently shown that etiolation causes a reversion from adult to juvenile morphological characteristics in *Hedera helix*. It has also been shown that growth under glass (as in a glasshouse) prolongs the juvenile characteristics of *Acacia melanoxylon* (23). This could be due to a combination of factors including light intensity and light quality (glass screens out portions of the ultraviolet light).

High temperatures (especially night temperatures) are known to prolong the juvenile phase or cause reversions from the adult to juvenile phase in raspberry shoots and some herbaceous plants (7, 16, 18). For the water fern *Marsilea*, a deficiency of either organic nutrients such as carbohydrates or inorganic nutrients such as nitrogen prolongs the juvenile leaf form and induces reversions on adult plants (1). This relationship of low nutrient levels to juvenility has also been shown for the South American rubber tree. Finally, it has been observed that application gibberellic acid, a plant growth substance, to adult *Hedera* plants will induce a reversion to the juvenile type growth, if minimum temperatures are 60° F. or above (12, 20).

Some of the knowledge which we have concerning growth phases can be applied through commercial techniques and practices. The use of hedges and root sprouts as a source of cuttings which are easier to root is based on the knowledge that juvenility is retained in the base of trees even when they are quite old. The stool or mound layering technique which is used for the propagation of Malling apple stocks, currants, and gooseberries is at least partially based on this information. In graftage and cuttage propagation of plants it is important to remember that both the juvenile and the adult phases are transmitted by vegetative propagation. This means that scion wood and cuttings should be taken from adult shoots which have flowered if rapid flowering and fruiting are desired on the new plants. The knowledge that the length of the juvenile phase of some herbaceous and woody plants can be shortened by environmental factors which increase the rate of growth is being used by plant breeders to speed up flowering. Commercial growers also utilize this knowledge when they time their planting dates to take advantage of environmental conditions most favorable for the growth of their crop.

It should also be mentioned that many techniques have been used to produce earlier flowering of vegetatively propagated clonal varieties. These techniques include grafting on dwarfing stocks, girdling or ringing of trunks or branches, bark inversion on trunks or branches, and tying a knot in the stem. Sax (21) indicates that these techniques probably do not promote earlier flowering juvenile seedlings.

At the present time we really have very little control over growth phases and our desire to prolong or shorten the juvenile phase can be accomplished only in a very limited way with a limited number of species. It is encouraging to note that environment can be utilized in a few cases to modify the rate of maturation and to cause reversions from adult to the juvenile phase. Perhaps with more information the use of environment to control growth phases could be widened. The fact that adult *Hedera* can be rejuvenated by grafting onto juvenile plants (5) or by growing in the same solution culture with juvenile plants (8) indicates that translocatable chemical substances may be involved in controlling growth phases. Robbins (19) has suggested that it may some day be possible to isolate and identify substances from the juvenile stage which when introduced into the adult would cause it to become juvenile.

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MODERATOR BORK: Our next speaker is from the Department of Entomology, Cornell University. Dr. John Weidhaas.

OBTAINING EFFECTIVE DILUTIONS OF INSECTICIDES WITHIN PROPAGATING STOCK

DR. JOHN A. WEIDHAAS, JR.
Department of Entomology
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This paper is essentially a review of research and a progress report on systemic insecticides as they may be used on woody ornamental plants. The wording in the title was chosen to emphasize the complex nature of systemics in relation to conventional contact insecticides which are simply diluted to the proper degree and applied externally on plants. My objective here is to discuss the nature of systemic insecticides as they are used on trees and shrubs, the knowledge gained to date, and the research needs of the future if systemics are to become useful tools of the plant propagator.

A systemic insecticide was defined by Bennett in 1949 as a substance which is absorbed and translocated to other parts of the plant rendering it insecticidal. Such a definition does not include chemicals which are simply absorbed into the plant, but not translocated. Some insecticide compounds are soluble in plant lipoids and, therefore, are absorbed into plant tissue (Gunther and Blinn, 1956).

The concept of systemic insecticides has been known for centuries. Yet practical use of this method is quite recent.

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The concept of systemic insecticides has been known for centuries. Yet practical use of this method is quite recent.

Selenium, used considerably in earlier greenhouse pest control, was the first systemic to be studied by entomologists (Hurd-Karrer and Poos, 1936). The first modern organic systemic was reported in 1947 by Schrader in England. In relation to all of our modern synthetic pesticides, systemics are not really so new since DDT became available commercially in 1945 only two years before the first systemic. Dieldrin and lindane were developed also in the late forties. As I shall attempt to point out later, it is much more difficult to achieve an effective dilution of an insecticide within a living, biologically complex plant than to simply apply a known dilution on its surface.

There are 4 major routes through which a plant system can be rendered insecticidal: the seeds, the roots, the leaves, and the bark. Seed treatment does not seem to be generally applicable to woody ornamentals. Treating leaves is not greatly different from conventional spraying. It does, however, provide a relatively simple method of application. Several approaches have been tried in treating the bark; by painting, by bark implant, and also by injection into the xylem. Root treatment is achieved by treating the soil and allowing root uptake as in the absorption of nutrients.

There are six major advantages in using a systemic type compound for insect control. First, it is possible to kill hidden insects such as aphids in curled leaves, or on roots; mites and insects in buds, galls, or bark; and eggs or very young insects in leaves. Second, the selectivity in killing plant feeders favors beneficial insects such as predators. Third, coverage of rapidly growing plant parts is possible in contrast to residual sprays which only cover existing shoots and leaves. Coverage is also possible on very dense and low growing plants which are hard to treat with spray equipment. An effective systemic would be taken up by the plant into all parts as they grow. Fourth, extended control should be provided, perhaps for an entire season, since roots continue to grow into systemic-treated soil. Fifth, the plants could be treated at a much more convenient time for the propagator and act as a fully effective preventive treatment. This would eliminate the need for emergency spraying or fumigating measures when other jobs must be attended to. Sixth, less total toxicant, less costly equipment, and less labor should be necessary for an insect control program.

Rather than discuss disadvantages as such, I should like to review some of the work which has been done to show the complexities and problems associated with the use of systemics.

First, what do we know about the relative toxicity to the operator? The values for LD-50 in Table I illustrate that most systemics are very highly toxic. The LD-50 is a standard reference which indicates the oral or dermal dosage in milligrams per kilogram of body weight which will cause 50% mortality in an exposed population of laboratory test animals. The conventional contact insecticides malathion, DDT, and lindane are included for comparison. With the most poisonous systemics, plants should not be handled within 5 days of treatment and full protective measures must be carried out without exception. Most growers are not sufficiently aware of the potential hazards of these chemicals.

Table I — Summary of Relative Toxicities for Systemic Insecticides Registered for Use on Ornamental Plants.

	LD-50		
	Oral	Dermal	Method of Application
demeton (Systox)	2-6	8-14	full coverage spray, soil drench
dimethoate (Cygon)	250	1000+	full coverage spray
Di-Syston	10-12	20	soil broadcast with granules
Meta-Systox-R	65-80	250	full coverage spray
phorate (Thimet)	1-2	2-6	soil drench
phosphamidon	16	267	full coverage spray
	Non-Systemic References		
malathion	1375	4000	full coverage spray
DDT	250	2510	full coverage spray
lindane	97	900	full coverage spray

The phytotoxicity of systemics was recognized early. The dosage necessary to kill insects feeding on the plant is very close to that which is toxic to plant cells, particularly the foliage. English and Hartstirn (1962) found that Bidrin injected into elm trees caused no injury at 0.5 and 1.0 ml. per inch of trunk diameter, slight injury at 2.0 ml., and severe damage resulting in defoliation from 4.0 and 8.0 ml. Norris in elm bark beetle control studies in Wisconsin has developed a very detailed crown class chart for elm trees to insure the exact dosage of Bidrin implanted in each tree. For systemics in general it is critical that exact dosages be applied. However, injury to plants has been least pronounced in soil treatments, and greatest with implants or injections.

In spite of about 15 years of investigation, systemics have had limited uses in insect control. Of some 26 systemic compounds studied, only 5 or 6 are available for commercial use. The registered uses are limited mostly to aphids, leafhoppers, leafminers, and mites. Table II summarizes the current uses suggested for growers in New York State.

Table II — Recommended Uses for Systemic Insecticides on Woody Plants in New York.

dimethoate (Cygon) 43% EC 1 pt./100 gals. water — SPRAY birch leafminer, fletcher scale on taxus, fiorinia hemlock scale, honey locust mite, pine needle scale

Di-Syston 10% Gran. 1 - 2 lbs./Acre or 4 oz./inch trunk diam.—SOIL
aphids, birch leafminer, lacebugs, leafhoppers, mites

Meta-Systox-R 25% EC 1½ pts./100 gals. water — SPRAY
5% Gran. ½-5 lbs./inch trunk diam. — SOIL
aphids, birch leafminer, holly leafminer, leafhoppers, mites

phorate (*Thimet*) 10% Gran. 60 lbs./Acre or 3 oz. inch of trunk —SOIL
birch leafminer, holly leafminer, boxwood leafminer

phosphamidon 49% Spray Conc. ½-1 pt./100 gals. — SPRAY
Aphids, arborvitae leafminer, birch, elm, hawthorn, and oak leafminer, some leaf-feeding caterpillars

demeton (Systox replaced by Meta-Systox-R
Bidrin not registered for use in New York

Systemic chemicals in themselves are variable in mode of action (Ripper, 1952). Selenium is a stable material in that it remains in elemental form when translocated in the plant. Some systemics are endolytic; that is, gradually broken down to non-toxic forms when inside the plant. Older materials such as schradan and Pestox are in this category. Some systemics are endometatoxic, that is, metabolized into other or more toxic compounds once inside the plant. Bennett (1957) pointed out that the plant, instead of being a passive spray target, becomes an active physiological and biochemical participant in the application of the insecticide.

In a symposium in 1953, Wedding discussed the plant physiological aspects of using systemic insecticides. To be effective the insecticide must pass through the plant cuticle, cell wall, and plasma membrane. For non-polar organic compounds such as the systemics discussed here, absorption may be possible through the cuticle directly. It has been thought more commonly that penetration is generally through stomata. To be effective the compound must also penetrate cell walls and the plasma membrane which has the property of selective permeability. Once inside the cells, a systemic insecticide must be translocated throughout the plant. It is apparent that bark treatments would be most effective for materials moving in the phloem, whereas xylem implants or root uptake would result in movement through the xylem. Such movement is influenced by a number of factors such as temperature, carbohydrate storage, soil moisture, light intensity, and others. Wedding (1953), through the use of radioactive tracers, studied the movement of OMPA and Systox in beans and rooted lemon cuttings respectively. OMPA tended to accumulate more rapidly in young leaf and stem tissues. Systox applied in a band around the stem moved both up and down the stem from the point of application. The rate of movement varied from 2.5 cm. per hour down to 10 cm. upward. It was also noted that a diurnal effect occurred both in the direction and rate of movement. In studies with phosphamidon on hemlock, Randall and Jackson (1963) showed uptake from the foliage as well as cut stems, and movement both downward and upward in hemlock shoots. Some fumigating effect was also demonstrated. Work by Wallner and Weidhaas (St. John et al, 1964) with hemlock showed that dimethoate (Cygon) tended to move most rapidly into new shoots. Table III shows that the upper half of hemlock trees receiving soil treatments had a higher residue analysis of dimethoate than the lower. This was supported by scale control observations, since crawlers moving to new growth were killed as they fed on new needles (Wallner, 1962). Foliar sprays have been more effective with dimethoate as is apparent in Table III. Comparing that foliar residue analysis with that in Table IV it can be seen that heavy rain after treatment in 1963 resulted in less foliage residue, since no rain occurred for 2 or 3 weeks in the 1962 tests.

Table III — Residues in ppm of Dimethoate in Foliage of Hemlock*

1962 Treatment	Micrograms per gram of foliage 2 Weeks	5 Weeks	8 Weeks	11 Weeks
Foliar 1 pt./100	11.5	3.3	1.6	0.1
Drench 8 lb./Acre Upper ½	2.9	. .	. .	0.3
Drench 8 lb./Acre Lower ½	0.6	. .	. .	0.3
Drench 4 lb./Acre Upper ½	0.4	. .	. .	0.1
Drench 4 lb./Acre Lower ½	0.2	. .	. .	0.4
Untreated	.01	. .	. .	0.0

*St. John et al (1964)

Table IV — Residues in ppm of Dimethoate in Foliage of Hemlock.

1963 Treatment	Micrograms per gram of foliage 0 Weeks	2 Weeks	5 Weeks	8 Weeks
Foliar	24.0	4.0	0.8	0.0

The effect of rainfall calls attention to the importance of environmental factors on the effectiveness of systemic insecticides. The type of soil, soil moisture, availability of nutrients, soil cover, type of plant, and growing conditions must be taken into consideration if systemics are to be used successfully.

As a final point, it should be emphasized that many field experiments have been conducted with systemic insecticides for control of pests on ornamentals. To cite only a few, Schread (1956) in Connecticut has carried on numerous tests. Streu (1964) in New Jersey found that systemic controlled aphids on Easter lilies throughout the entire period of forcing. Donley

(1964) in Ohio obtained season-long control of mimosa webworm on honey locust with Di-Syston and phorate. Treece and Matthysse (1959) published the results of numerous field trials with systemics on nursery insects. In most of these field investigations results were not conclusive or clear-cut. Systemics did not seem to give the good results which had been anticipated. It now appears obvious that there are many physiological and biochemical complexities influencing systemic uptake, translocation, and detoxification. Detailed basic studies are necessary to determine the physical, chemical, and biological phenomena which occur in treated trees and shrubs. Undoubtedly, this will be achieved only through team effort by entomologists, plant physiologists, and biochemists. It is well recognized that plant physiologists themselves are still struggling to unravel the many theories of how water and nutrients are absorbed, translocated, and utilized by plants. All of these perplexing problems become the entomologist's problems when he tries to understand the mechanism of treating woody plants internally with complex organic chemicals.

In conclusion, systemic insecticides are known to be effective for certain limited uses in insect control on trees and shrubs. They need a great deal of investigation, particularly the basic approach to understanding the mechanism of absorption, translocation, mode of insecticidal action, and detoxification in the plant. Considerable research is being conducted in several countries on systemics, but we can anticipate that progress will be relatively slow. Increased cooperation will be essential between entomologists and plant physiologists.

In this paper I have attempted to highlight the principles and problems involved in systemic insecticides rather than simply review how they can be used. Hopefully this will provide you with a little better appreciaion of the research job which needs to be done and an understanding of the general nature of insect control with systemic insecticides.

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MODERATOR BORK: Now we had a little time for some questions.

DR. REISCH: I would like to ask Dr. Weidhaas if there is any oral toxicity involved, considering dilution in the foliage, from the use of systemic insecticides?

DR. WEIDHAAS: I am sure this question will get a lot more attention in the future. We do not have specific answers for that question, but as far as we know the normal exposure to the leaves of treated plants does not seem to be a problem. However, I think until we obtain more information, it would pay to avoid use of these materials in places where they will be exposed to the public.

DR. REISCH: The only reason that I ask this question is that the systemics are being used on home grounds and we receive calls at the University relating to children eating fruit or foliage, not specifically on treated plants but as a normal problem.

DR. WEIDHAAS: I feel that there is a safety factor here where the systemic materials are diluted. The eating is not habitual or a normal diet. It is an occassional situation and I don't think it is a great hazard.

MR. LESLIE HANCOCK: Is there any hope of systemic treatment of elms, particularly the large, old trees.

DR. WEIDHAAS: The state of Wisconsin has been doing the greatest amount of work on dutch elm disease control through bark beetle control. They have treated from 9 to 11 thousand trees in Milwaukee successfully. However, the chemical is not yet registered for use commercially. It is being used only on an experimental basis. It does not seem that it will be available next year, but perhaps the year afterwards.

VOICE: Dr. Weidhaas, I would like to ask a question about the treatment of plants with systox. Do you find in a group of plants that have been uniformly treated that a few plants still are infested?

DR. WEIDHAAS: I'm not sure I can give you an answer to that question. I think that when this does occur it may be due to differences in uptake by various parts of the plant. We find this in the case of elm trees which are forked very low and we inject the trees in the trunk. This material only went up one side of the tree and did not spread around. I don't know whether the same would apply to the roots when part of the roots are injured and therefore the concentration of the systemics may not be high enough in some parts of the plant and therefore the insects would be able to survive.

HANS HESS: Are there any results which indicate control of nematodes on the roots by the systemics?

DR. WEIDHAAS: There was a paper from New Jersey at the Eastern Branch meeting of the Entomological Society in October in Baltimore. He obtained excellent control of nematodes on azaleas but, I'll have to check my notes for the chemical.

ROLAND DEWILDE: I think Di-Syston was the one which was most effective.

PETER VERMEULEN: I would like to ask Al Fordham if the witches' broom plants retain their character or can we expect a reversion to the normal type?

[*Editor's note*: Al Fordham was not present when the question was asked.]

DICK VANDERBILT: Certain plants have a natural resistance to, say leaf minor. Is this resistance due to insecticides already present naturally or are they distasteful to the insects, or is this assumption true at all?

DR. WEIDHAAS: I think when we get done solving the nurseryman's immediate problems, we can take a look at some of these very interesting problems, but I don't have any information on this what so ever. I think this is an area that needs additional work.

DR. HESS: There are large varietal differences between plants and their susceptibility to insects. For example in water melons there is chemical which attracts cucumber beetles. You can cut open a melon which contains the attractant and in a few hours he melon is completely covered with beetles. A variety which does not contain the attractant has only a few bettles on it. The point is that varieties of the same species can contain different substances which may attract or be repulsive to insects.

DR. WEIDHAAS: Yes, there are as great number of very interesting examples where insects will avoid an individual plant and are attracted to another. For example, we know of two pink oaks in Buffalo standing side by side. One is completely covered with oak gall, the other without a single gall on it.

ROLAND DEWILDE: I would like to ask Dr. Weidhaas if the insects develop a resistance to systemic insecticides? We have run into this problem with a number of insecticides, particularly the phosphates. If you use them for 2 or 3 years, it doesn't kill the particular strain of mites any more.

DR. WEIDHAAS: No matter how chemicals are introduced into a plant the end result is a toxic effect upon the insect. So we can expect the similar problems of insect resistance. In the greenhouse a problem has developed with mite resistance to systemics.

MODERATOR BORK: The next paper will be by Dr. Harold Pellet of the University of Nebraska.

COLLECTION, PROPAGATION AND EVALUATION OF WOODY PLANT MATERIALS FOR HIGHWAY IMPROVEMENT IN NEBRASKA

HAROLD PELLETT
University of Nebraska
Lincoln, Nebraska

The Roadside Improvement section of the Nebraska Department of Roads was reactivated in 1961 and since then has been quite active in landscape plantings along our developing Interstate 80. At present, 70 miles of interstate right of way have been landscaped and 150 miles have been seeded to grass mixtures. The average costs of the landscape plantings are approximately $14,000 per mile and $11,000 per major interchange in urban areas, and $1,000 per mile and $7,500 per interchange in rural areas.

The rest area facilities being developed by our roads department are very modern. These facilities contain sheltered picnic tables and a heated information rest room building with flush toilets. In the Platte river valley, the water table is just a few feet below the surface and in this area the road base is constructed by pumping sand to the area. This process leaves a string of sand pit lakes along the interstate route. Many of the rest areas in the Platte Valley are being established to include one of these lakes in the area. This gives a beautiful setting to these rest areas and makes it very attractive to tourists to stop and relax for a few minutes. At present, the rest area facilities being developed by our Department of Roads are not equalled by any other state. We in Nebraska are quite proud of the progress being made by our Department of Roads in landscaping, and feel that we'll have one of the most scenic interstate routes in the country.

This spring, two research projects were set up between our Department of Roads and the University. Dr. Al Dudeck is working on one of these projects dealing with the establishment of turf grasses and erosion control.

The research project that I am working on is titled and can be described as "Collection, propagation, culture and evaluation of plant materials for roadside improvement." The program was initiated in March of this year. This year's activities have dealt primarily with the 1st two categories of the project (collection and propagation) of plant materials. About 175 species of woody plants were obtained from various nurseries this spring and planted at our University Agricultural Field Laboratory. Since that time, we have collected and propagated materials from the University of Minnesota's arboretum and from the wild in arid and mountainous regions of Colorado, Utah, and Arizona. We hope some of these latter materials might prove satisfactory for plantings in the western part of Nebraska where the annual rainfall is low (about 15-19"). These summer collections have given us about 100 additional species to evaluate.

The latter two categories of the project, culture and evaluation of plant materials, will be initiated into the program in the coming year. The chief obstacles of establishing woody plants encountered by the roadside improvement section of our highway department are caused by two prime factors. These are drought and "mower blight." A study of various mulch materials is being established this fall and next spring. The various mulch materials will be evaluated for ability to conserve moisture and for weed control. Weed control is important in that weeds compete with the desired trees and shrubs for moisture and also make it difficult for maintenance personnel to see the trees while mowing. Mulch materials that eliminate weeds for a small area around each tree will therefore also cut down on mower damage.

The 4th category of the study, evaluation of plant materials, will be a long range objective in that several seasons are necessary to adequately test the plants for various climatic conditions. The climatic conditions within Nebraska vary considerably. The route along the Interstate can be divided roughly into 3 areas. The eastern section gets a fairly good annual rainfall averaging about 26 - 30". The central portion extends through the Platte River Valley and has a much lower rainfall. However, the watertable in this area is only a few feet below the surface so the problem involves maintaining woody plants the first couple of years until the roots can reach the watertable. The western area is quite arid and will be much more difficult to establish and grow plant materials. Because of this wide variation in climate, the plant materials will need to be evaluated in several areas to give us a true picture of their performances.

A few colored slides were shown of plants collected in the Rockies of Colorado and in Utah. This collection trip was in cooperation with the USDA North Central Region Native Plant Exploration Project. The 1st picture was of a species of *Potentilla* collected in the rockies of Northern Colorado and also west of Cheyenne, Wyoming as a possible ground cover plant. It grows in dry, rocky sites and spreads by rhizomes. *Lonicera involucrata* may be a desirable small growing plant for landscaping. It reaches a height of 3 - 4' and grows native in higher altitudes in the Rockies. It is also native in much of Minnesota. The Elderberries are possible highway ornamentals as they are quite rugged. *Shepherdia rotundifolia* will make an excellent landscape plant if it can be grown under our climates. It makes a very compact growth habit to a height of four feet and is supposed to be evergreen. It grows in very poor soil in arid climates of southern Utah. The native *Amelanchier* of Utah is also of interest to us for our dryer areas. Another possibility of a small tree for extremely dry areas is the one leaf ash *Fraxineus anomala.*

Fallugia paradoxa or Apache Plum has been reported doing quite well at Manitoba and is quite ornamental. Many of the Mountain Mahogany species, *Cercocarpus,* are of excellent ornamental qualities. *Pursha tridentala* is of extreme interest to us an ornamental and as a possible ground cover plant for highway slopes. Clones were observed with a diameter of 20 feet. The plant is found native from Wyoming down through Utah and Arizona. Clones of *Cornus stotonifera* were collected north of Zion National Park with a very low habit of growth and a diameter of 20 feet across the clump. The height was about 3 feet. *Peraphyllum* or squaw apple is another plant with excellent aesthetic qualities. It has a spreading growth habit and reaches a height of five to six feet.

MODERATOR BORK: Thank you very much, Dr. Pellett. Continuing right along with the program, the next paper will be given by Mr. Wolfgang Matzke, from the Burwell Nurseries, Columbus, Ohio.

THE RUTHNER TOWER GREENHOUSE

WOLFGANG MATZKE
Burwell's Inc.
Columbus, Ohio

Within the short 15 minutes allowed for my paper, I can only present a brief outline of a very interesting new concept of plant growing. This concept was not originated by a nurseryman, but by an industrial engineer who derived the idea of continuous plant production from his experience with the operation of machines and control instruments in the steel and metal industry.

All industrial production of any importance uses automatically controlled conveyor systems. The raw materials are continously fed in on one side and the finished product emerges by the time all the programed stages have been completed. Furthermore in industrial production every phase must be clearly comprehensive and the progress within a given time must be planned and controlled.

Mr. Ruthner, the Austrian engineer and inventor of the Tower Greenhouse (TGH), developed the idea of setting the plants on a space-filling conveyor system and pass through a number of chambers each providing for a different — but constant — set of environmental factors, according to the growth stage of the plants. In such a way, he envisions the possibility of a *continuous crop production* which will eventually lead to a completely controlled environment and make the grower independent of his geographical location and the change of seasons.

Such an industrial plant for crop production could then turn out, let us say 10,000 heads of lettuce every day once the whole of a small tree for extremely dry areas is the one leaf ash *Fraxineus anomala.*

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Such an industrial plant for crop production could then turn out, let us say 10,000 heads of lettuce every day once the whole set up would have gone into operation by setting a specified number of seeds or young plants on the conveyor every day. A big industrial concern in Western Germany is now pushing this project and several European food chains have been very interested in the establishment of such a continuously operating plant production.

So far, only the first units of such industrial installations have been constructed. These units are todays Tower Greenhouses, six of which have already been erected in Austria and Germany and several more will be installed within the next couple of months.

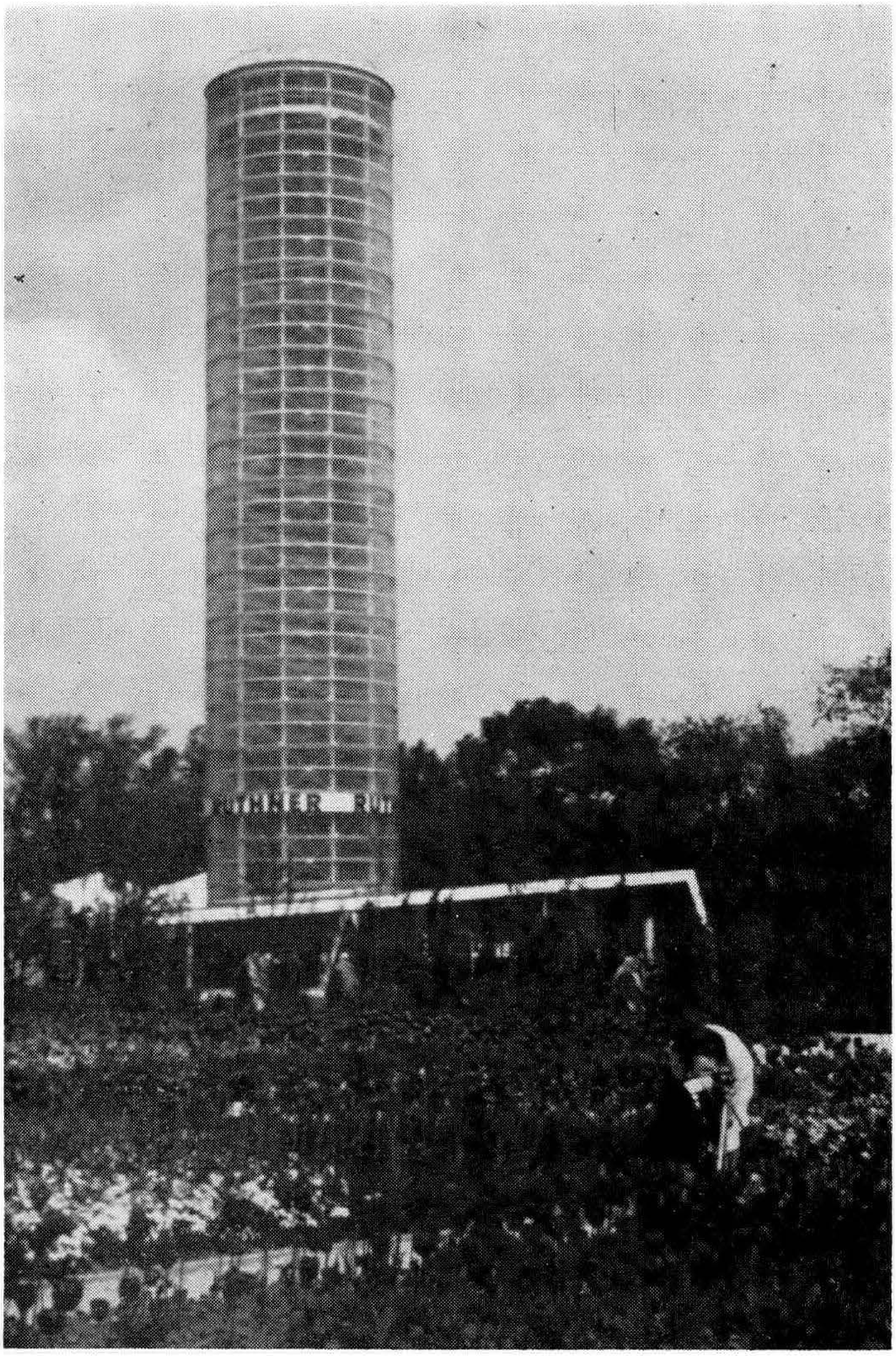

Figure 1. Ruther Tower Greenhouse, Vienna, Austria.

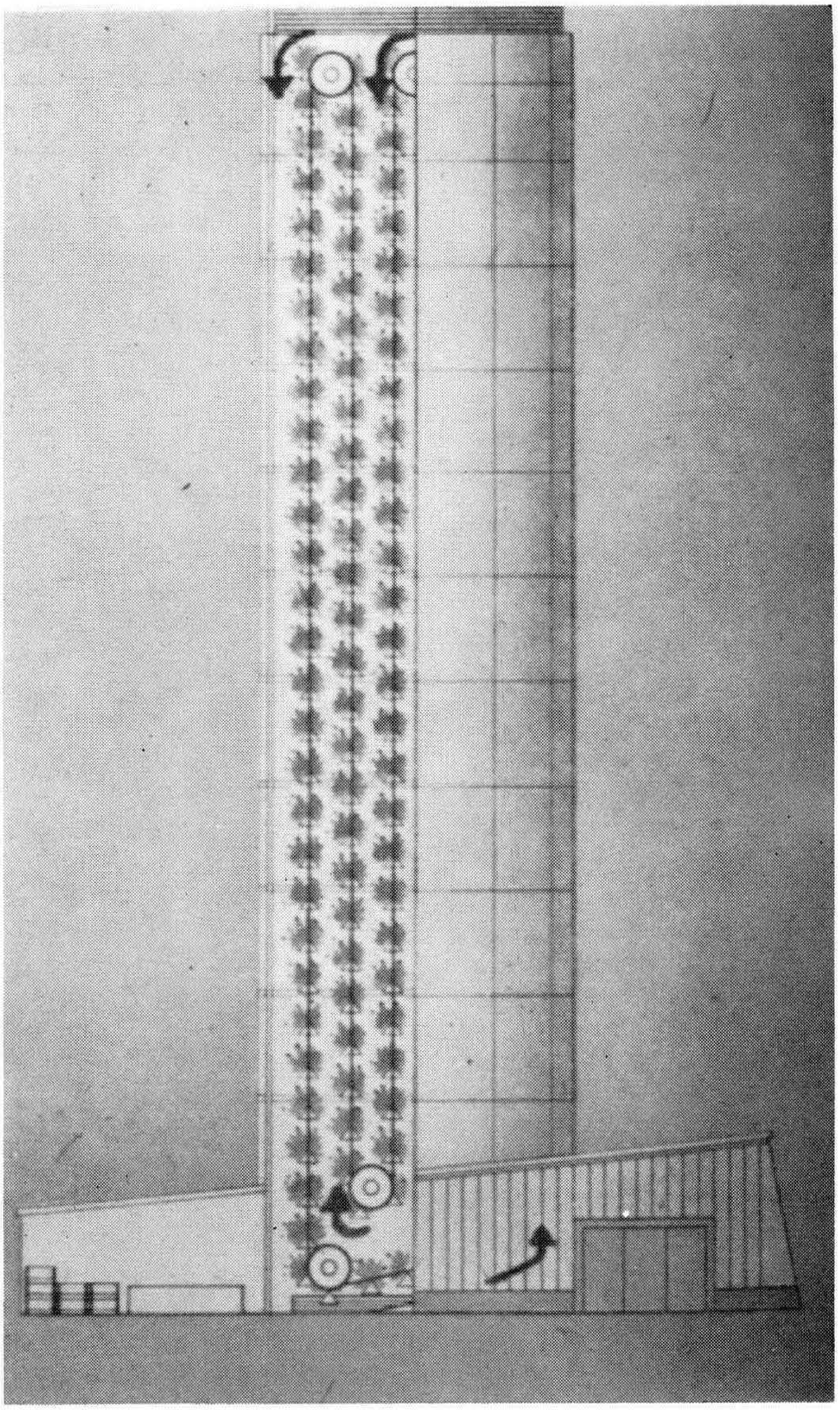

Figure 2. Diagram of a Ruther Tower Greenhouse.

I shall now explain some of the technical details by means of a few color slides and a short 8 mm movie:

Slide #1. This TGH was one of the main attractions at the 1964 International Horticultural Exhibition in Vienna, Austria. It is a 130 ft. high galvanized steel construction covered with corrugated polyester (plastic) material. Though it covers an area of only 250 sq. ft. it provides for an actual cultivating area equal to 15,000 sq. ft. of bench space (or the equivalent of a greenhouse of approximately 50 ft. x 400 ft.).

Slide #2. The individual plants in either posts or flats are placed on shelves that are attached — one above another — to a conveyor belt system. By means of a small electric motor the plants are kept in a slow continuous vertical up and down motion as indicated by the arrows. This motion provides for three important things: (1) a very high space utilization, (2) a favorable environment for plant growth, since no single plant will remain under unfavorable light or temperature conditions for any length of time, and (3) on ideal set-up for a full automation of crop management as illustrated. *e.p.* by the water tank at the bottom of the TGH. The pots can be immersed and thus watered or fertilized by simply lowering or raising the water table.

Slide #3. The first TGH — shown in the foreground of this slde — was put into operation in May 1963. It is a 33 ft. high vertical greenhouse, covering an area of about 700 sq. ft. (*e.p.* comparable to a 20 by 40 ft. greenhouse). One can recognize the plants in their flats on the plant carrier (shelves). By opening the *vents* on top of the TGH a very efficient ventilation is achieved, because of the chimney effect due to the height of the tower.

Slide #4. With a misting line installed in a TGH, one mist nozzle can take care of many more plants than over a flat surface, because the flats pass by under the nozzle at regular intervals.

Slide #5. The results obtained in the first TGH were so encouraging that a second larger one was erected six months

Figure 3. Automatic watering in Ruther Tower Greenhouse.

later at the same location of a small vocational horticultural school in Langenlois, near Vienna, Austria. TGH II has a height of 60 ft. and is covered with corrugated polyester material. It covers approximately 160 sq. ft. and provides for a growing area of up to 3,500 sq. ft. (equals a 40 by 100 ft. regular greenhouse). Let's have a look inside:

Slide #6: Here is a crop of geraniums in plastic pots sitting in special racks on the plant carriers. As the plants move downwards to he bottom of the TGH they can be automatically watered by simply immersing the pots momentarily in a water tank.

Slide #7. Shows pots above water tank in more detail.

Movie:

Section 1. Shows the first TGH, erected 1963 in Langenlois, Austria, further a variety of vegetable and ornamental crops rotating in TGH II.

Section 2. Propagation of a batch of 50,000 carnation cuttings and of woody ornamentals in the TGH of a commercial nursery in Vienna, Austria.

Section 3. Ruthner — TGH at the International Horticulture Exposition in Vienna, Austria.

Summary

The idea of setting plants on a conveyor belt system and rotating them through space opens a completely new outlook towards plant production. Eventually, such a set-up may be operated above ground or underground under a completely controlled set of environmental factors. It offers possibilities for a mass production of food crops to supply both our modern super markets and the starving nations in underdeveloped areas of this world. Undoubtedly, the invention of the TGH will show the way to new discoveries in plant growing.

So far, the TGH has proven its suitability mainly for plant propagation, for growing bedding and groundcover plants and for the production of certain vegetable crops. Though the vertical greenhouse, at the present time, is not yet a foolproof device for plant growing it can definitely help the experienced grower to perform his work more efficiently and it has been stimulating to the imagination of many florists, nurserymen, and garden store operators.

MODERATOR BORK: Next we will have Dr. Harold Tukey, Jr. and Mr. G. L. Good talk to us about leaching of cuttings under mist. Dr. Tukey will talk first.

LEACHING OF NUTRIENTS FROM CUTTINGS UNDER MIST*

G. L. GOOD AND H. B. TUKEY, JR.
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Introduction

Mist propagation is not a strange term to the International Plant Propagators' Society. In the past 25 years the development of mist has enabled the propagator to root softwood, semi-hardwood, and many other difficult to root cuttings of various plant species. By spraying water into the air and maintaining a film on the cuttings themselves, transpiration is reduced. In this way, the turgidity of the cutting is maintained which is essential for root formation. But by allowing water to come in contact with the surface of the cuttings, leaching of organic and inorganic nutrients from within the plant tissue can occur.

Leaching of metabolites from intact plants has long been recognized. A great diversity of organic and inorganic materials can be leached from a wide range of plant species, and these losses are influenced by many factors (Tukey 1962). Many workers have published evidence that the mineral nutrient content of cuttings was lowered due to the leaching effects of mist during the rooting period (see Tukey, 1962). Sharpe (1955) showed that softwood cuttings of peach, grape, and blueberry all lost considerable amounts of nitrogen, phosphorus, and potassium and these losses were dependent upon the amount of mist used. Symptoms characteristic of nutrient deficiencies have been developed in cuttings under mist, suggesting that nutrients can be leached (Sweet and Carlson, 1955).

This paper is a survey of the leachability of several plant species propagated by cuttings under mist, as influenced by the maturity of the cuttings.

Materials and Methods

The plant material used in the study included herbaceous cuttings of *Chrysanthemum morifolium, Coleus blumei, Dianthus,* and *Euphorbia pulcherrima*, and woody cuttings of *Euonymus alatus, Euonymus fortunei* 'Vegetus,' *Ligustrum ibolium, Lonicera tatarica, Ribes alpinum, Pyracantha coccinea* 'Lalandii,' and *Forsythia intermedia.*

Forty uniform cuttings of each species were selected either in June or in September. Twenty cuttings were immediately dried, weighed, and analyzed in the laboratory for nitrogen, phosphorus, potassium, calcium, and magnesium, and in the case of *Chrysanthemum morifolium,* for soluble carbohydrates. Another twenty cuttings were placed in clean quartz sand under a distilled water mist until they were rooted, and then they were dried, weighed, and analyzed.

*The financial support of U. S Atomic Energy Commission Contract AT (30-1)-2598 is gratefully acknowledged.

Results

Many workers have reported losses by leaching as a per cent of the dry weight of the cuttings (Tukey, 1962). This is valid only if there is little or no growth during the rooting period. In these experiments (Table 1), it was noted that herbaceous and softwood cuttings taken in June did grow during the rooting period. For example, the dry weight of *Chrysanthemum morifolium* increased almost 3 times the original weight during the rooting period, while *Ribes alpinum* and *Euonymus alatus* had an increase of 50 per cent. Thus, to be more precise, leaching losses from cuttings growing during the misting period should be expressed as the total amount of nutrient leached.

On this basis, the nutrient contents of *Chrysanthemum morifolium, Ribes alpinum,* and *Euonymus alatus,* both before and after rooting are presented in Table 1. The total amount of the nutrients remained essentially unchanged during the rooting period for both *Chrysanthemum* and *Ribes* and differed only slightly for *Euonymus.* This indicates that little if any of the nutrients were leached by the mist, with the exception of potassium from *Euonymus.*

Table I. Nutrient Content and Dry Weight of Softwood Cuttings Propagated Under Intermittent Mist.

Species	Dry weight*	N	P	K	Ca	Mg
		Nutrient Content				
	(g/cutting)	(mg / cutting)				
Chrysanthemum morifolium						
Before Rooting	.70	25.3	4.1	25.4	8.4	3.1
After Rooting	1.97	25.8	4.8	28.2	9.8	1.3
Ribes alpinum						
Before Rooting	.67	15.6	1.9	10.9	9.7	1.2
After Rooting	1.08	16.8	1.6	8.6	8.6	1.6
Euonymous alatus						
Before Rooting	1.00	23.1	2.5	9.3	53.0	3.2
After Rooting	1.49	21.6	1.8	1.3	49.0	2.7

*Increase in weight during rooting due to carbohydrate increase.

It has also been reported that organic as well as the inorganic nutrients can be leached from plant tissues (Tukey, 1962). Accordingly, chrysanthemum cuttings were analyzed for the total soluble carbohydrates both before and after they were rooted under mist. The results showed that the cuttings contained 191 milligrams of soluble carbohydrate per cutting before they were rooted and 830 milligrams after they were rooted, more than a four-fold increase during the rooting period. However, an analysis of the leachate from these cuttings showed that only 0.1 milligram of soluble carbohydrate was leached from these cuttings.

From these data it can be seen that cuttings which are young and actively growing do not lose appreciable quantities of metabolites through the leaching action of mist. This is in accord with research with intact plants in which very young leaves of plants are often relatively difficult to leach (Tukey, 1962).

It was also reported that leaching of nutrients increased as leaves became older, suggesting that cuttings of mature wood might be more susceptible to leaching than would cuttings of immature wood.

The results of this study are presented in Table 2. Cuttings of *Pyracantha coccinea* 'Lalandii' and *Euonymus fortunei* 'vegetus' did not lose appreciable amounts of nutrients by leaching. However, these two species were not dormant, but rather were still growing in a greenwood condition and they responded to mist just as did those cuttings which were taken in the spring. However, the results for hardwood cuttings of *Forsythia intermedia* and *Ribes alpinum* showed a different picture. The nutrient content of these cuttings after rooting was considerably less than before rooting, due to leaching.

Table 2. Nutrient Content of Semi-hardwood and Hardwood Cuttings Propagated Under Intermittent Mist.

Species	Nutrient Content N	P	K	Ca	Mg
	(mg / cutting)				
Pyracantha coccinea 'Lalandii'					
Before Rooting	14.2	0.9	8.2	12.2	1.6
After Rooting	14.4	0.9	7.5	8.9	1.8
Euonymous fortunei 'vegetus'					
Before Rooting	29.0	4.1	12.6	63.5	4.1
After Rooting	26.9	3.3	12.1	62.8	5.4
Forsythia intermedia					
Before Rooting	21.5	2.6	13.0	16.7	3.8
After Rooting	20.9	1.6	9.9	11.4	0.9
Ribes alpinum					
Before Rooting	13.6	2.7	10.5	12.4	1.6
After Rooting	11.7	1.8	6.6	8.3	1.7

Table 3. Leaching of Nutrients from *Ribes alpinum* Cuttings Propagated Under Intermittent Mist as Influenced by the Maturity of the Cuttings.

Cutting Maturity	Nutrient Content N	P	K	Ca	Mg
	mg / cutting)				
Softwood					
Before Rooting	15.6	1.9	10.9	9.7	1.2
After Rooting	16.8	1.6	8.6	9.4	1.6
Nutrient Leaching	-	-	2.3	-	-
Hardwood					
Before Rooting	13.6	2.7	10.5	12.4	1.6
After Rooting	11.7	1.8	6.6	8.3	1.7
Nutrient Leaching	1.9	0.9	3.9	4.1	-

A more direct comparison of the influence of cutting maturity on leaching is given in Table 3, which compares losses by leaching from cuttings taken in June with cuttings taken in September. Softwood *Ribes alpinum* cuttings retained their nutrients, with the exception of potassium, whereas hardwood cuttings had a considerable portion of the nutrient content leached by the mist.

Discussion

The results of these experiments demonstrate that loss of nutrients by leaching from cuttings is influenced by the maturity of the cuttings. Mature hardwood cuttings were much more susceptible to leaching than were the rapidly growing softwood and greenwood cuttings. It is interesting to speculate that this may be another factor in explaining why softwood cuttings do so remarkably well under mist as compared with hardwood cuttings.

It has been reported that nutrient deficiency symptoms develop in some plants propagated under mist. In the case of the hardwood cuttings, this could be due to leaching from the cuttings. However, in the case of herbaceous cuttings, the nutrients in the cuttings were diluted by the large increase in growth during the rooting period. Additional nutrients are not available to the cuttings and thus deficiency symptoms develop in the new growth.

These results suggest that applications of nutrients through the mist during the rooting period would be of benefit to the cuttings, as shown by Boodley and Morton (1962). Nutrient mist would replace nutrients which were leached and would supply nutrients for new growth during rooting.

Summary

Young, vigorously growing cuttings propagated under mist did not lose considerable amounts of nutrients by leaching. The mineral deficiencies observed in the plants were apparently caused by a dilution of the original nutrients by additional carbohydrates as a result of growth. More mature cuttings which were not growing during the rooting period lost considerable amounts of nutrients to the leaching action of the mist. Mineral deficiencies which developed in these cuttings were apparently due to losses of nutrients by leaching. It would appear that nutrients added to the cuttings through the mist would be of benefit to both herbaceous and softwood as well as hardwood cuttings.

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MODERATOR BORK: I will now turn the program over to President Roller.

PRESIDENT ROLLER: Dr. Waxman has an announcement.

DR. WAXMAN: I would like to remind you all that tonight is the question box. The question box is on the registration desk.

ROY NORDINE: The annual dinner meeting for the Botanical Gardens, arboretum, and university people will be held tonight. We will meet in the lobby at 5:45.

FRIDAY AFTERNOON SESSION

December 4, 1964

The session convened at 1:15 p.m. in the Ballroom, Manger Hotel. Mr. Ralph Shugert, moderator.

SPEAKER - EXHIBITOR SYMPOSIUM

MODERATOR SHUGERT: The first speaker this afternoon is Professor Joseph C. McDaniel from the University of Illinois.

A LOOK AT SOME HACKBERRIES

JOSEPH C. McDANIEL
Department of Horticulture
University of Illinois
Urbana, Illinois

While hackberries have been relegated to a place of little importance by most recent writers on ornamental trees, I believe it is time that propagators gave a fresh look at some of the things available in the genus *Celtis*.

I have been doing this, particularly in east central Illinois, since the elm diseases took practically all our native *Ulmus* off the local streets. We can see now a great many old and younger hackberries, which offer much as hardy, adaptable shade trees for yards, streets and roadsides. Many of them, in my opinion, give a better year-round effect than *Ulmus americana,* and some clones are very elm-like in general habit. These include some *C. occidentalis* which are but slightly affected by the hackberry witches'-broom disease. *C. laevigata,* native in southern and extreme western Illinois is another species of promise, almost never disfigured by witches'-broom. Besides these two, I shall mention some other species with ornamental potentialities for eastern and southern North America.

Celtis appears to be easily the largest woody genus in the *Ulmaceae.* Rehder's Manual of Cultivated Trees and Shrubs discusses seven genera in this family, only *Ulmus* and *Celtis* with more than five species each. *Ulmus,* with a world-wide distribution of about 18 species, has had the major share of horticultural attention. But *Celtis* has around 70 species, north temperate, tropical, and some even south-temperate. A few each from North America and temperate east Asia seem most worthy of our attention as ornamental trees in the 1960's.

Let's look at native and introduced trees of *C. occidentalis* in central Illinois before moving on to one of its varieties, and then to other species.

The most northern and one of the most widespread species of *Celtis* in our region is *Celtis occidentalis,* with its variant forms. The eastern Illinois trees that I am showing in the slides are generally of the variety that most of the botanists twenty to fifty years ago (including Rehder and Sargent) would have called *C. occidentalis* var. *crassifolia* Gray. But in Gray's Manual of Botany (8th ed. 1950) by M. L. Fernald, the so-called *crassifolia* is made synonymous with the type, *C. occidentalis* L. The other two varieties treated by Fernald have thinner, smoother leaves than the type, and one of them var. *pumila* (Pursh) Gray, is frequently only a shrub. The other, var. *canina* (Raf.) Sarg., may be a shrub, or sometimes as tall (30 M.) as the type.

Fernald, along with other taxonomists, mentions the difficulty of separating species and botanical varieties in *Celtis*. He writes, "The N. Amer. species and varieties too often seem . . . confluent. Fully mature fruit is important for identification." Under *C. occidentalis*: "Exceedingly variable, passing freely from one var. to another and suspected of hybridizing" with two other American species. "The best marked varieties" in Fernald's classification, include typical *C. occidentalis* (or *crassifolia* of other authors) with generally larger, scabrous, gradually acuminate leaves, nearly spherical orange-red to fuscous drupes, with shorter pedicels (0.3 to 1.5 cm.) compared to those of vars. *pumila* and *carnina* var. *pumila* and var. *canina* both have larger pedicels (0.8 to 3.5 cm.), smooth, more or less membranaceous leaves. They are differentiated from each other principally by their leaves, which in var. *pumila* are conspicuously inequilateral and averaging more than half as broad as they are long, those on fruiting branchlets 3 - 9 cm. broad at base, while those of var. *canina* are more nearly equal-sides, with ovate-lanceolate blades averaging less broad and running on fruiting branchlets 1.5 to 9 cm. broad at base. On all varieties, leaf dimensions on non-fruiting shoots, and especially on young trees, may considerably exceed Fernald's average for the species of 8 by 4.5 cm. Fernald says the stature of the species is "greatly varying in response to habitat." Without denying the environmental influence, I'd say also, "Look for genetic variability, and propagate from trees that have made good specimens in the kind of habitat your stock is to be planted in."

In recent years, some hackberries have been planted on our campus and on streets of new subdivisions in Urbana. Unfortunately for the landscape, these were not of the local race of typical *C. occidentalis* native around Urbana. They more agree with var. *canina*, and if I had only these recently planted trees to judge hackberries by, I'd tend to agree with Dr. Donald Wyman that they have "nothing especially to recommend their use where better and more attractive trees are available." (Trees for American Gardens, p. 151.) Better hackberries were available around Urbana, but the planters went farther and fared worse.

Here's one of the var. *canina* trees that I have watched for several years, at the Urbana Junior High School. The following picture, taken just across the street on the same October day, shows a typical vigorous seedling of the Urbana race of *C. occidentalis.* Next, a few views of planted trees, also probably var. *canina,* on the University campus. Some of them may turn out better than the one by the Junior High, but not as good as the old local seedling next shown in the foreground.

Several of the older, local race trees of *C. occidentalis* around Urbana and Champaign look good enough to be considered for clonal propagation. In view of the miscellaneous material now grown as nursery seedlings, and the inferiority of many of them, I believe that the nurseryman who wants to offer a superior hackberry will eventually take up clonal propagation. Here is one of my candidates for grafting: a tree in Urbana that has the aspect in general of a good type of American elm. Note its pendulous secondary branches. This one and many of our other older hackberry trees in Champaign County and near there are almost free of the disfigurement due to the hackberry witches'-broom condition.

Celtis laevigata Willd. is another species native in the southern half or more of Illinois, but not the Urbana area. It is the prevailing *Celtis* in the lower Wabash Valley, and southward to the Florida Keys, Bermuda, and Nuevo Leon, Mexico, north to Oklahoma, southeast Kansas, Missouri (above St. Louis) and to the coast of Virginia in the eastern states. (Its synonym is *C. mississippiensis* Bosc.) Here are some views of specimens in Cairo, Illinois and in eastern Missouri, taken in the first week of October. Then two trees planted in Decatur and Urbana, Illinois, in Zone 5, where Wyman rates it hardy. Wyman includes this one American species among his recommended hackberries, "because it is a widely found native tree, very resistant to the witches'-broom disease . . . and widely used as a street tree in the South." It has, I think, an interesting trunk, with its irregular corky protrusions in the bark.

One view shows the good union of a graft I made, of *C. laevigata* on *C. occidentalis* at Urbana. *C. laevigata* is also a variable species as to form, and we could select more weeping or irregular, or more upright and dense-headed clones for propagation. Far-southern sources of it may lack hardiness with us in Zone 5.

Propagators who want to try grafted hackberries might use seedling stocks of *C. occidentalis* or whichever species is available and hardy in the nursery area. Another combination I found compatible fifteen years ago at Nashville, Tennessee, was *C. sinensis* on stocks of *C. laevigata.* The latter is one of the commonest of all trees in Nashville. I used chip buds in late summer. According to Hortus Second, *Celtis* may also be propagated by cuttings in the fall. I have not seen it tried with summer mist methods, though Hartmann and Kester (in Plant Propagation, 1959 say both *C. occidentalis* and *C. laevigata* can be started by cuttings.

Some botanical varieties of *C. laevigata* include var. *Smallii* (Beadle) Sarg., common in its eastern range and different principally in retaining leaf serrations on the mature tree. From southwestern Missouri to New Mexico, a bushy tree or shrub form is var. *texana* Sarg. Some recent authors include a farther western var. *reticulata*, the netleaf hackberry, ranging from western Texas and possibly Washington state to southern California. (Rehder and Sargent called it *C. reticulata* Torr.) It has been recommended as a desirable native small tree species for southern Arizona landscape use. Steve Fazio, member of the Western region of the Society, and acting head of the Department of Horticulture at University of Arizona, sent me the views I show of desert hackberry in the Tucson area.

Some of the exotic species of hackberry have been cultivated at least to a limited extent in Georgia and California, and in arboreta elsewhere in the U.S. These include *C. simensis* Pers., now well naturalized at Davis, California, and *C. australis* L., the European hackberry, listed by Hortus Second as being grown in southern California. (Fazio does not know of any in southern Arizona plantings.) These probably are both more tender than the midwestern forms of *C. laevigata.*

Here in one of the Rochester parks, I've seen and liked *C. Bungeana* Bl., native to China and Korea. It would be my first choice of foreign hackberries to try in Zones 5 and 6 of the eastern states and Ontario. Wyman in his book, Trees for American Gardens, writes, "In general this species performs the best of those in the Arnold Arboretum . . . it is as yet unavailable from commercial sources." He also recommends another Asiatic species, *C. jessoensis* Koidz. from China and Japan. *C. jessoensis,* he says, is "possibly of value as a substitute for the American elm."

MODERATOR SHUGERT: Thank you very much. It certainly was well done. Our next speaker, speaking on *Crataegus* root stock studies at the Morden Experimental farm, a gentleman we are very proud and pleased to hear this afternoon, is W. A. Cumming who is the head of the Ornamental Section of the Canadian Department of Agriculture from Morden Manitoba.

CRATAEGUS ROOTSTOCK STUDIES

W. A. CUMMING
Experimental Farm, Research Branch
Canada Department of Agriculture
Morden, Manitoba

In 1949 we introduced Toba hawthorn which was the result of a cross between *Crataegus oxyacantha* 'Paul's' Scarlet' and the native species *Crataegus succulenta.* This new cultivar gained recognition quickly in those areas where nurserymen were already propagating hawthorn cultivars and had a reasonably satisfactory rootstock available. On the Canadian prairies, from whence it was introduced, its performance was disappointcipally in retaining leaf serrations on the mature tree. From southwestern Missouri to New Mexico, a bushy tree or shrub form is var. *texana* Sarg. Some recent authors include a farther western var. *reticulata*, the netleaf hackberry, ranging from western Texas and possibly Washington state to southern California. (Rehder and Sargent called it *C. reticulata* Torr.) It has been recommended as a desirable native small tree species for southern Arizona landscape use. Steve Fazio, member of the Western region of the Society, and acting head of the Department of Horticulture at University of Arizona, sent me the views I show of desert hackberry in the Tucson area.

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In the spring of 1955 we happened to have a surplus of seedlings of *C. arnoldiana.* Two hundred and thirty of these were lined out and budded in August of that year to 27 different species including *C. mordenensis* 'Toba'. The catch was only 60% but it was evident that seedlings of Arnold hawthorn were widely compatible. Two plants of each species on this stock were transplanted into permanent positions in the arboretum without a single loss to date. Previous experience had established that *C. arnoldiana* was hardy on the Canadian prairies and we proceeded to recommend it as a rootstock until such time as further tests could be made.

In the autumn of 1958 we collected seed from 23 different species growing at Morden. These seeds were cleaned immediately, air dried and placed in cool storage (40 degrees F.) until planted in late July 1959. Immediately before planting, portions of each seed lot were scarified in concentrated sulphuric acid (commercial) for 1 and 2 hours. Germination results for the nine species selected for rootstock studies plus those for our native *C. succulenta* are recorded in Table I following:

Table I *Seed Germination Results*

Species	No Treatment		H_2SO_4 for one hour		H_2SO_4 for two hours		% sdlgs dug based on No seeds planted	% survival transplanted seedlings
	Days	%	Days	%	Days	%		
C. mollis	291	28	291	28	291	31	23	95
C. arnodiana	291	22	291	30	291	30	25	98
C. sanguinea	294	20	294	33	294	29	17	91
C. rivularis	297	16	297	32	297	39	24	95
C. caesia	297	0	297	15	297	12	7	82
	682	10	—	—	—	—	—	—
C. wendilandi	297	8	297	22	297	36	15	90
	679	2	—	—	—	—	—	—
C. strigosa	293	16	293	18	293	18	17	86
	679	12	679	2	—	—	—	—
C. chrysocarpa	297	2	297	24	297	27	16	97
	679	2	—	—	—	—	—	—
C. punctata	293	24	293	45	293	42	33	93
C. succulenta	294	0	294	8	294	16	6	79
	679	12	679	5	—	—	—	—

It is not my intention to discuss, in this paper, the many difficulties involved in germination of the seeds of the genus *Crataegus.* Although germination percentages in this particular year and presented in Table I are lower than usual, they serve to point out the procedure we have worked out for handling hawthorn seeds under our climatic conditions. A short summary of our experimental results with the seed of *Crataegus spp.* appears on page 12 of our bulletin entitled "Propagation Studies in Fruits and Ornamentals at the Morden Experimental Farm" published in June, 1964. Our recommendations are as follows: "In the best treatment for *Crataegus*, seed is dried, stored at 40° F. over winter, scarified with acid for 30 minutes and sown in June. Seed sown in late summer benefits by a longer scarification treatment in acid, up to 2 hours."

The seedlings in this particular test were dug in the spring of 1962, at which time most of them were two years old. Notes were taken on their root formation and uniformity in size and nine species were selected for lining out for the actual budding tests. Seedlings of *C. succulenta* were eliminated because of their poor root system and their suckering habit, the others were eliminated either because of poor seed germination or unevenness in growth. Table II records the budding results.

Table II *Budding Results*

Seedling Rootstock	% of Surviving Sdlgs Budded in 1962	% Yield of Budded number budded) Plants (based on 1963	1964	Ave Height of Budded Plants (inches) 1963	1964	Ave diameter Budded Plants (sixteenths of an inch)
C. mollis	96	88	88	42	73	13
C. arnoldiana	96	74	70	40	65	14
C. sanguinea	83	83	78	34	71	12
C. rivularis	88	93	86	34	61	12
C. caesia	89	81	56	34	71	14
C. wendilandi	79	67	67	35	66	13
C. strigosa	79	71	71	34	58	12
C. chrysocarpa	53	30	30	30	58	11
C. punctata	51	47	26	25	56	11

With the possible exception of *C. rivularis* these species can be rated in three groups:

The first group are decidedly promising and include *C. mollis, C. arnoldiana* and *C. sanguinea.* The latter is deeper rooted and requires careful handling at digging time.

The second group are only moderately good and include *C. caesis, C. wendilandi* and *C. strigosa.*

The third group are poor and include *C. chrysocarpa* and *C. punctata.*

C. rivularis has a definite dwarfing effect on all scion varieties tested. Varieties budded on it ripened up 10 days to 2 weeks earlier and the diameter of the scion variety is in all cases less than the diameter of the stock. Only time will provide us with the answer to the question of whether we have in this case an incompatibility which will result in a short life or whether we have a useful dwarfing stock.

I fully realize that this is only a meager beginning in the long process of selecting a suitable hardy rootstock. However, based on results of this test to date we are now including *C.*

mollis, the downy hawthorn, along with *C. arnoldiana*, the Arnold hawthorn, in our recommendations, as suitable hardy *Crataegus* rootstocks.

All of the material from this experiment will be replanted in the spring of 1965 and the remainder of this story will unfold with the passing years.

MODERATOR SHUGERT: Thank you very much, Mr. Cumming. Next speaker on our program will be speaking about nursery propagation of Carpathian Walnuts, Ben Davis II, Ozark Nurseries, Tahlequah, Oklahoma.

NURSERY PROPAGATION OF CARPATHIAN WALNUTS

BEN DAVIS II
Ozark Nurseries Company
Tahlequah, Oklahoma

The first step in nursery propagation of Carpathian Walnuts is, thorough and adequate soil preparation. The site chosen for planting may have swags or low places that will need leveling. Either a dozer blade or a large float may be used to fill in the swags so that water will not stand in the field. After the site is properly leveled, it must be broken. At Ozark Nurseries we use a large offset disc, which cuts 9½ feet wide and 10 to 12 inches deep. The disc has the advantage of chopping up any trash present, while breaking the ground. After the ground has been broken, and the trash worked into the soil, some type of subsoiling should be done. This allows the ground to store up water during heavy rains and give it back to the plants during dry weather. The loosened soil also encourages better growth and makes digging operations easier when the trees are ready for sale. For nut trees, we use a large ripper which breaks up the soil to a depth of 36 inches. After this is done, it is necessary to run the offset disc again to level the soil and fill in the furrows left by the ripper. Then a disc harrow, with a spike toothed harrow pulled behind, is used to break up any clods and smooth and level the soil for planting.

Planting operations are begun in the fall by marking off rows 4½ feet apart with a V-shaped shoe that leaves a smooth furrows 2 to 3 inches deep. This shoe is mounted on a one-row tractor and is followed by a planting crew which drops the nuts, by hand, 5 to 6 inches apart. The nuts that we use are Native Black Walnut, or *Juglans nigra*. Immediately behind the crew dropping the nuts follows a one-row tractor with disc hillers. The disc hillers pull the soil in over the rows to cover the nuts. This keeps them moist until spring and prevents them from being heaved out of the ground during freezing and thawing. Once the nuts are covered they are left undisturbed throughout the winter.

The following spring, as soon as the weather warms up, the nuts are checked periodically by digging down into the hills to *mollis,* the downy hawthorn, along with *C. arnoldiana,* the Arnold hawthorn, in our recommendations, as suitable hardy *Crataegus* rootstocks.

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The following spring, as soon as the weather warms up, the nuts are checked periodically by digging down into the hills to see if they have started to germinate. As soon as root sprouts are evident coming out of most of the nuts, a spike-toothed harrow is dragged over the rows. This pulls down the dirt that was hilled up over the nuts the previous fall. After this operation is completed, the nuts will be 2 to 3 inches below the surface of the soil.

If there is an exceptionally good stand of seedlings, it will be necessary to thin them as soon as all the seeds have germinated and the sprouts are evident. We think that thinning out to a distance of 10 to 12 inches is best. This will allow them to reach proper size for budding the same season.

The seedlings are fertilized several times during the season. The first application is made as soon as the seedlings are big enough to be seen. The fertilizer is put on at the same time the seedlings are cultivated, with a fertilizer side dressing attachment. As the seedlings grow larger, the fertilizer is put on in larger doses, each application consisting of about 50 pounds of 15-10-10 analysis commercial fertilizer per row. The rows are approximately 650 feet in length.

During the time the seeds are germinating and the seedlings are being fertilized, an intensive irrigation program is carried out, unless of course there is adequate rainfall. The idea of the intense fertilization and irrigation is to grow the seedlings as large as possible before budding time in August. Irrigation is carried on all summer to keep the seedlings in an active stage of growth so the buds will heal on satisfactorily. If the seedlings are allowed to stop growing, the buds will not live, even though the sap may be good enough for budding. The seedlings *must* be in a highly vigorous state of growth until after the bud has completely healed on. We have learned this the hard way in our experiences with budding Pecans. However, we have found that budding Carpathian Walnuts has not been as difficult as budding Pecan.

The method of budding used is the Forkert Method, which is explained and illustrated in the *Grafter's Handbook,* by R. J. Garner. The only difference is that we wrap the buds with poly vinyl tape rather than waxed cloth as mentioned in the book. Use of this method of propagation for nut trees was discussed previously by the writer at the 1962 meeting. Some of the material presented here duplicates the previous paper.

We have been fairly successful using this method of budding on Carpathian Walnuts. The take has never been less than 70% and as high as 100%. This sounds very good, but before anyone gets too excited, I would like to point out that we have not been able to get the buds to force out in the spring as they should. The seedling tops are cut off about 3/8 inch above the bud eye just before the understocks start to leaf out in the spring. Periodically, all the seedling suckers are pulled off the understocks leaving only the bud sprouts, if any. However, it seems no matter how many times we pull the suckers off the understocks, about 70 to 80% of the live buds refuse to force out.

This year, we began Walnut budding on August 14th. We tried a total of 15 experiments with late summer bud forcing to try to overcome the spring bud dormancy on Carpathian Walnuts. We tried crippling the understock by breaking it over 3 to 6 inches above the bud at several different intervals after the budding was done. The best results were obtained by breaking over the understocks 9 days after budding. In this experiment, 25 understocks were broken and 25 were left unbroken for comparison. On both the broken and the unbroken understocks, we obtained 100% bud take. On the broken understocks 72% of the buds sprouted, and on the unbroken understocks only 4% of the buds sprouted. We are reserving judgment on these results until we find out how well the sprouts survive the winter.

In another series of experiments, we tried solutions of Giberellic Acid, Napthaleneacetic Acid, and Indolebutyric Acid. These solutions were painted on the buds 10, 14 and 21 days after the budding was done. In all of the experiments in this series, the bud take was not affected and seemed to be no better nor worse than the buds left untreated for comparison. There was no sprouting as a result of the application of these materials. In another test, the bud shields were completely immersed in a solution of Gibrellic Acid before the buds were set in place. This solution was mixed as follows: 2 tablespoons full of a 500 parts per million solution, per ½ measuring cup of water. In this experiment, 96% of the buds turned black and died and did not at anytime start to unite with the understock. Four percent lived but looked very sickly. On the buds left untreated for comparison, there was a 100% bud take, but none of the buds sprouted.

It would take too much time to go into the details of all the different experiments we tried, and the ones we hope to try next spring. However, it is hoped that we will able to give a complete report on all the tests we tried and the results obtained, at a later date.

Our overall results for the 17,117 *Juglans nigra* understocks which were budded last August were as follows:

Black Walnut Varieties: a total of 5,739 buds were done and 5,102 buds lived for a live bud percentage of 88.9%.

Carpathian Walnut Varieties: a total of 11,378 buds were done and 8,712 buds lived for a live bud percentage of 76.6%.

If we can work out a system of successfully forcing the Carpathian buds, we will have solved our main problem in producing these trees.

To us another major problem in the propagation of Carpa thian Walnuts is that of obtaining an adequate supply of budwood. To achieve this purpose we have established several small test orchards which consist mainly of varieties we obtained from Royal Oakes at Bluffs, Illinois. Most of our trees were first planted in 1956 but many had to be replanted in later years. We do have several trees that survived the first planting in 1956 and they are now getting large enough to furnish us quite a lot of budwood.

In the slide presentation which follows, you will see some of the work we have been doing in trying to establish our own source of budwood, both for Carpathian and Black Walnuts.

Polyvinyl Tape Used To Wrap Walnut Buds
½ inch by 300 foot rolls
All Purpose Grade
Manufactured by: L. E. Cooke Company
5716 North Vista Street
San Gabriel, California

Gibrel Growth Promoting Substance
Manufactured by: Merck Chemical Division
Merck & Co., Incorporated
Rahway, New Jersey

Handled only through distributors. Write them for distributor nearest you.

Napthaleneacetic Acid
Manufactured by: Millmaster Chemical Corporation
99 Park Avenue
New York 16, New York

The Grafters Handbook, by R. J. Garner
Oxford University Press
New York, New York

GibTabs
Manufactured by: Eli Lily & Company
Greenfield Laboratories
Box 708
Greenfield, Indiana
Dr. Edwin F. Alder, Head
Plant Science Research

MODERATOR SHUGERT: If you have any questions for the three speakers of the first quarter, please write them on a slip of paper and place them in the question box. Kicking off the second quarter, a paper "Isolation of a Dampening-Off Inhibitor from Sphagnum Moss' prepared by Gayle Fleming and Dr. C. E. Hess. It is with a great deal of pleasure that I introuce Dr. C. E. Hess who is going to present the paper to you at this time.

THE ISOLATION OF A DAMPING-OFF INHIBITOR FROM SPHAGNUM MOSS

Gayle Fleming and Charles E. Hess
Purdue University
Lafayette, Indiana

Sphagnum moss is used extensively as a medium for seed germination because of its ability to prevent damping off. Up to a few months ago, it had not been established whether the fungistatic activity of the sphagnum moss was due to environmental conditions, such as a low pH value, or that it contained a specific fungistatic substance. During the past summer it has been possible to demonstrate that the activity is due to a specific fungistatic substance or substances.

Aqueous, alcoholic, and acetone extracts were prepared from ground sphagnum moss. A highly active substance(s) was extracted with 50% ethanol or with acetone. The substance(s) was partially purified by paper and thin layer chromatography. *Pythium ultimum* was used as the test organism to locate the fungistatic substance on the chromatogram.

During the extraction studies, bacteria were isolated from the water extract which produced a very powerful fungistatic substance. All growth of Phythium was blocked for several centimeters around the colony. The bacteria were grown in a broth and a cell free extract was prepared. Preliminary results indicate that the fungistatic substance(s) produced by the

Figure 1. Tomato seedlings germinated with and without sphagnum moss. The flat containing sphagnum moss is on the right.

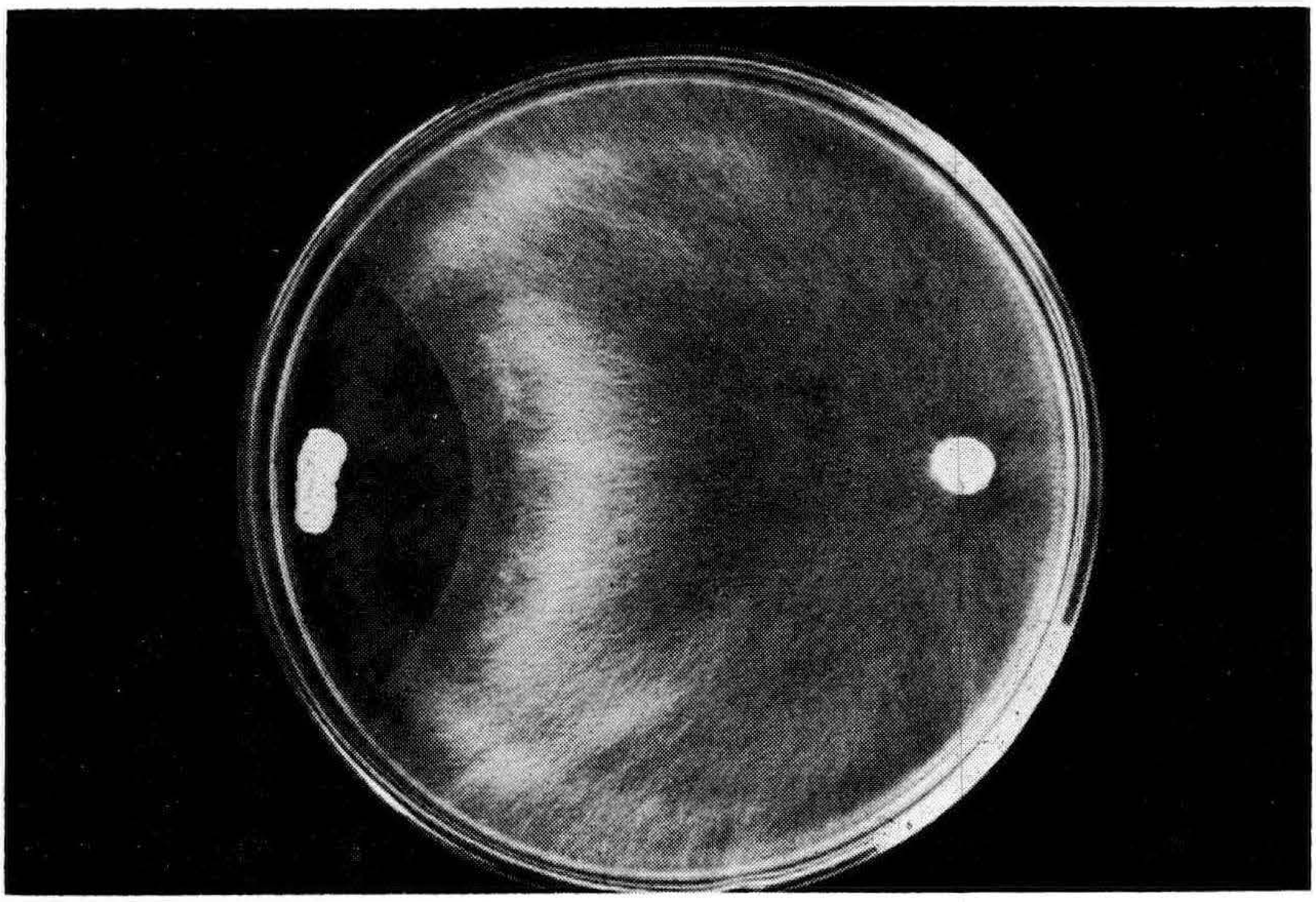


Figure 2. The fungistatic activity of bacteria isolated from sphagnum moss.

bacteria is identical to the substance(s) extracted from the sphagnum moss. The bacteria may in fact be the source of the fungistatic material(s) found in sphagnum moss. The substances from both sources control the growth of *Rhizoctonia* and *Fusarium* as well as *Pythium*.

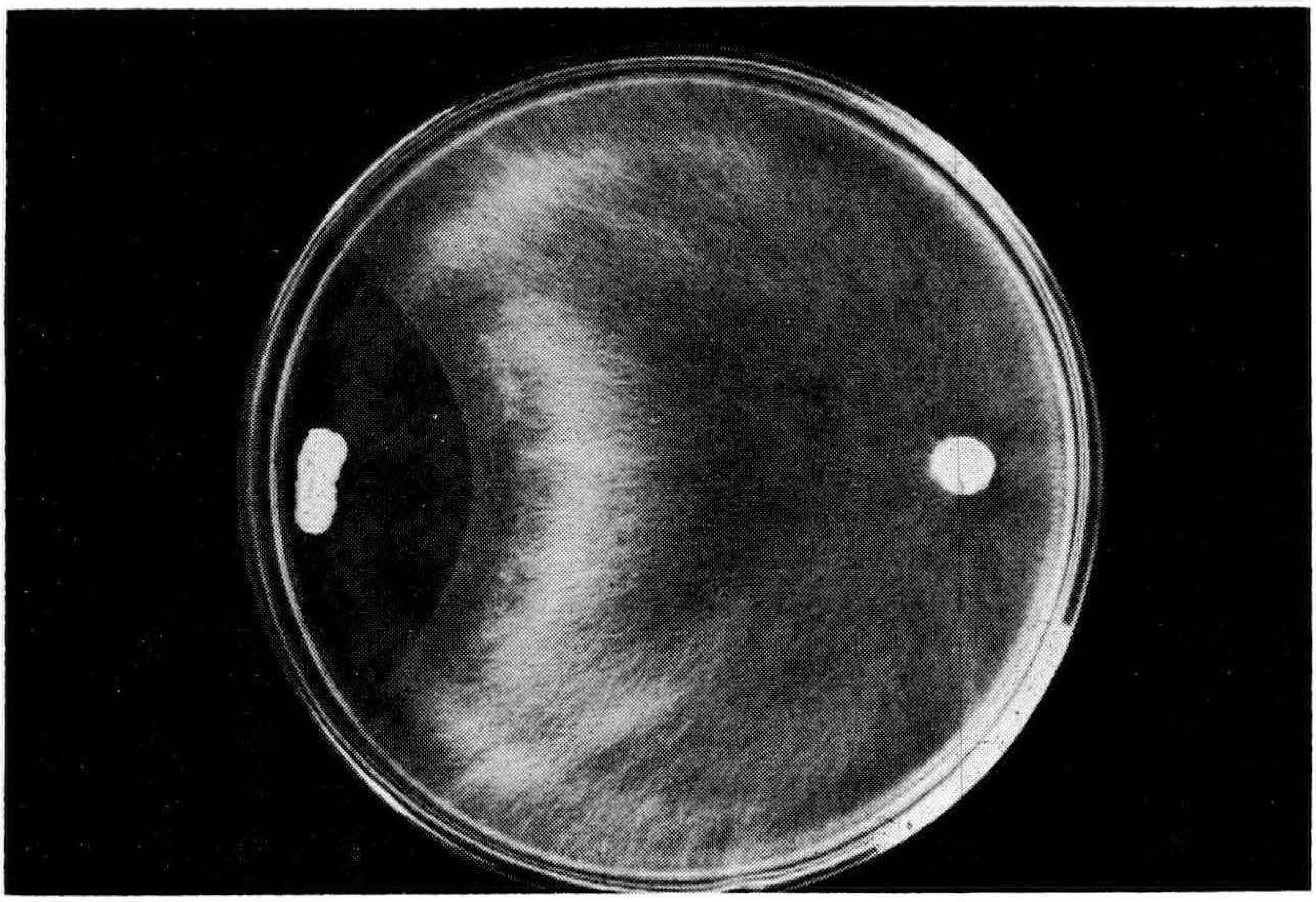
MODERATOR SHUGERT: Thank you, Charley, very well done. Our next speaker on this part of the program with the very intriguing title "From Near Laboratory Propagation Conditions on to the Average Commercial Situation," Frank Turner, Berryhill Nurseries, Springfield, Ohio.

FROM THE NEAR LABORATORY PROPAGATION CONDITIONS TO THE AVERAGE COMMERCIAL SITUATION

FRANK TURNER
Berryhill Nursery
Springfield, Ohio

This is an examination of at least two sets of working arrangements and aims for results that propagators have. Some of us are connected with commercial establishments, where factors of quantity and costs are paramount. Others are members of institutional type staffs. These latter often represent the more altruistic value of the search of knowledge for its own sake and the value of teaching others.

This comparison is made, not for presenting one of these types of endeavor as either inferior or superior to the other, but



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This comparison is made, not for presenting one of these types of endeavor as either inferior or superior to the other, but in the hope that at least partial survey will bring about understanding and mutual advantage on both sides of the picture.

Many of the plant subjects we work with are not stable. Where the instability is understood and laid down in references it would appear that research oriented organizations with more knowledgable chiefs and staff members would be better equipped to cope with the maintaining of strains and types of plants.

This peculiarity regarding the plants sometimes goes to the extreme of causing the commercial house to grow from seed whereas the other man grows from cuttings.

At any rate it needs to be pointed out that commercial nurserys handle very small lots of plants even those of great virtue at a serious disadvantage. They have also to admit that they often do not have the perceptive personnel to apply to the many points of selectivity that need to be taken into consideration in the selection of cuttings, their location on the plant, stage of juvenility, or other desired characteristics.

A redeeming point in favor of the businesses that grow plants for sale is that many maintain stool blocks for some kinds and stock plants for others. The benefits of this practice have been previously thoroughly covered in our proceedings.

The organizations for plant propagation under discussion here often vary widely in the items of structures and equipment devoted to the work. This is probably not as great a variant as it would first appear to be for the simple reason that the successful business house should be able to afford the best there is in these items. There remains only in this connection to point out that as structures and equipment grow more costly the business operator is under greater obligation to make them pay out on the investment.

There is just about this same to say regarding the modern array of precision measuring and recording devices that are presently at hand. All propagators are searching for the more or less automatic controls that tend to reduce the factor of human error in the handling of seeds, cuttings and grafts.

We had it said here yesterday that the nursery business is tending to develop the ability to dig (harvest) at almost anytime. This aspect of things certainly has its counter part in the field of propagation.

It brings on what may be called the calculated risk in the matter of timing. A commercial house today often works intentionally on disadvantageous timing caused by economic factors such as labor supply and perhaps the fact that none of us are as fully departmentalized as we would like to be.

Closely allied to that opinion there is, and should be, a variance in attitude toward risk. A business firm seeks a minimum of risk. It chooses the sure thing over trial and often persists in its former ways and methods although they are not the most advanced ones.

In contrast the propagator working toward goals of research and experiment can choose his best methods from probably better knowledge of inherent principles. He can fail, find the cause, and do it over.

Improvements in ways of propagating and the ones offered in the compiled proceedings of this Society alone are very great are not an easy thing for all of us to return home and put in force.

They are possibly less easy for the commercial firm to realize quickly on than for others. This is for the reason that improvements can be faulty from the aspects of slowness, tediousness, and not leading to rapid substantial quantity production. They often have a requirement for the working out of additional "know how" as it applies to an individual establishment. To make this clear I am referring to what the automobile industry calls "bugs" in its new models.

We can very easily find differences in attitude regarding nurse systems to carry the newly propagated plant onward. On a trial basis, it is justifiable to carry the new plant through, such as the first over wintering, regardless of all factors needed.

These measures are not so easily justifiable by the propagator who is restricted by end prices and by the division of their facilities among sizeable numbers of runs in large amounts.

Appearances indicate that a broad sector of propagators connected with educational activities do have distinct advantages in communications among people doing similar work. Their policies regarding publication are more disciplined and they seem to be in position to derive greater benefit from correspondence and publication. Their opposite numbers in commerce are simply under a different kind of pressure. Their activities are such that though very willing their time for this type of effort is limited.

Their remains a final question to answer. Are all propagators building a suitable and adequate historic record? It should be one that assures that old practices, some very ancient are not senselessly dropped. We need also measures to cause newer findings to be hastened into more general use.

MODERATOR SHUGERT: Thank you very much, Frank. Our next speaker in the program is Dr. Harold Davidson from Michigan State University, East Lansing who will speak on clonal and sexual differences in the propagation of Taxus.

CLONAL AND SEXUAL DIFFERENCES IN THE PROPAGATION OF TAXUS[1]

HAROLD DAVIDSON AND ARTHUR OLNEY
Michigan State University
East Lansing, Michigan

Investigators have found that certain inherent characteristics of plants influence their rootability. Among the character-

[1]Paper number 3524 Michigan Agr Exp Sta, East Lansing, Mich.

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Investigators have found that certain inherent characteristics of plants influence their rootability. Among the character-

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istics affecting rooting are inherited clonal variations and sexual differences.

The influence of sex in the propagation of plants by cuttage has received very little attention. Snow (9) reported that cuttings selected from male trees of the Red Maple rooted at a higher percentage than did cuttings selected from female trees. Neal et al (4) found that in *Ilex verticillata* male cuttings taken at certain times of the year rooted better than comparable female cuttings. In a somewhat different morphological situation, O'Rourke (5) reported that vegetative wood of Blueberry rooted better than flowering wood.

Since a number of propagators (7, 8, 10) have made reference to the fact that various clones of Taxus are difficult to root, it was decided to conduct an experiment to determine if there was a difference in the rootability of Taxus clones and to see if the difference might be associated with the sexual character. And since male plants of *Taxus cuspidata expansa* (Japanese Spreading Yew) appeared to be more numerous than female plants in landscape plants, a survey was conducted of some relatively large plantings of this species to determine the ratio of male plants to female plants. Another experiment was also conducted to study the rooting response of cuttings selected from male verus female plants of this variety.

In order to assess the sex ratio of *Taxus cuspidata expansa* twelve samples were taken. Sex determinations were made in the fields of nine nurseries in Michigan. A large block of this species was entered at random and determinations made in a row and when necessary the next adjacent row. Determinations were also made in three relatively large plantings associated with a landscape surrounding a building or in a garden on the campus of Michigan State University. The sex ratio was tested

Table 1. Sex-ratio of *Taxus cuspidata expansa* in selected nursery and landscape plantings in Michigan.

Planting	Classification		Sex
	Male	Female	Ratio
1	82	18	4.56
2	76	24	3.17
3	82	18	4.56
4	75	20	4.00
5	90	10	9.00
6	80	20	4.00
7	49	51	0.96
8	73	27	2.70
9	74	26	2.85
10	20	6	3.33
11	13.5	7.5	1.80
12	13	4	3.25
Mean	60.6	19.6	3.09

for significance by the Chi Square test. Theoretically, a ratio of 1 to 1 should be expected in a population of this species if it had segregated normally for sex.

The results of this survey (Table 2) indicate that there was a difference in the number of male versus female plants. Male plants were found to be present in a ratio of 3 to 1.

In order to evaluate the rootability of cuttings of *Taxus cuspidata expansa* two hundred male and two hundred female cuttings were selected from large vigorous plants growing in the Horticultural Gardens on the campus at Michigan State University. Seven-inch tip cuttings were made, divided into 20-unit samples, and placed in sand media in a completely randomized design using five replications. Hormones were not used on the cuttings. The cuttings were stuck December 9, 1963, lifted and rated according to the Method of Ranks (3, 6) on May 9, 1964.

The results (Table 2) indicate that cuttings from male plants of *Taxus cuspidata expansa* rooted better in the five month period, than did the cuttings from female plants. The ratio was in the order of 2 to 1.

Table 2 Rooting Index for Male versus Female Cuttings of *Taxus cuspidata expansa*.

	Sex of Cuttings		
	Male	Female	Ratio
	75	32	2.25
	61	54	1.13
	66	24	2.75
	63	21	3.00
	80	42	1.90
	78	38	2.05
	70	33	2.12
	77	18	4.28
	32	27	1.19
	54	25	2.16
Mean	65.3*	31.4	2.08

*Means are different by odds of 99-1

In order to determine whether or not there was a difference in the rootability of several clones of Taxus an experiment was made using seven clones (Table 3) in a replicated, randomized design similar to that of the first experiment. The differences for clones were established by use of Duncan's Multiple Range Test (2). The difference between sexes was tested by an orthogonal comparison with one degree of freedom.

The results of this experiment indicated that there was a difference between the rootability of the seven clones of Taxus. Of the seven clones, 'Hatfield' rooted the best or with the greatest ease and *Taxus cuspidata* 'Nana' was the most difficult of the group to root. The comparison between male and female was significantly different by odds of 19 to 1. But in this experiment the difference was in favor of the female cuttings.

Table 3. Rootability index for Seven Clones of Taxus.

Clone	Sex	Index
Hatfield	Male	64 a
Halloran	Female	42 b
Wardi	Female	36 b
Densiformis	Male	21 c
Browni	Male	20 c
Hicksi	Female	17 c
Nana	Male	4 d

DISCUSSION

The results of these investigations indicate that some mechanism is operative that caused populations of *Taxus cuspidata expansa* plants to segregate in a ratio to 3 to 1 in favor of the male plants, rather than an expected ratio of 1 to 1. This segregation might be explained by the fact that male cuttings of this species rooted more readily than did female cuttings and as a result propagators might inadvertenly be selecting for male plants. If this selection was carried through many populations it could end in much higher ratios as was found in one nursery where the ratio was 9 to 1.

The exact cause as to why the cuttings from male plants of *Taxus cuspidata expansa* rooted better than did the cuttings from the female plants and why in the study on the rootability of Taxus clones, the results were in favor of the female group is yet to be determined. This data will indicate that it is not associated with a male gene as might be expected if all male clones rooted better than female clones.

Edgerton (1) and Neal et al (4) have suggested that the difference in the rooting of the sexes was related to carbohydrate content of the cuttings. They suggest that the cuttings from female plants might have a smaller carbohydrate supply because it was used in fruit production. But if it were strictly a carbohydrate relationship, all male clones would be expected to root better than the female. But it is to be noted from Table 3 that *Taxus cuspidata 'Nana'*, a male clone, had the poorest rooting index and the clones 'Halloran' and 'Wardi', both female clones, had relatively good rooting indicles. This would suggest that perhaps another factor other than carbohydrate content is operative in controlling the rootability of Taxus clones. Studies are now underway to determine the cause of this difference.

It should be pointed out that many of the cuttings that were slow to root would eventually develop a good root system and that treatment with root accelerating compounds would undoubtedly be of value. It is also highly possible that if these same clones were tested another year or under a different environment that they might respond somewhat differently. Nevertheless, the conclusion is clear, namely: there was a real difference in the rootability of Taxus clones and that cuttings from male plants of *Taxus cuspidata expansa* rooted more readily than did the cuttings from female plants.

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MODERATOR SHUGERT: Thank you very much, Dr. Davidson for that very fine paper. Gentlemen we have 10 minutes for questions.

MARTIN VAN HOF: What I want to ask the last speaker is how do we distinguish male Taxus from a female?

DR. DAVIDSON: We can distinguish the female from the male Taxus very rapidly, of course, when it is in fruit. Only the female will have fruit. You can distinguish the male from the female at almost any other time of the year by the shape of the flowering buds. The flower buds of the male forms are quite round or ball shaped. The flowering buds of the female are quite elliptical. They are very different. Also the male usually has tremendous numbers of buds.

ROLAND DEWILDE: Did you say that the Hicks was a male form?

DR. DAVIDSON: To the best of my knowledge there are two forms, male form and a female form.

DR. CHADWICK: I'll take a guess at this. That the male forms of Hicks are costage.

JOHN VERMEULEN: When the taxus Hicks was brought into the trade, there were two different "species" of plants given to us at Hick's Nursery. I dont know exactly where they came from, but they were distinctly different and they are both called Hicks. When we started to make cuttings and distribute them, both types were distributed under the same name. Later we called them Hick's number one and Hick's number two. Number two is the male and number one is the female. The number one grows a little straighter and number two has a tendency of bending over slightly on the top.

DR. PRIDHAM: I have been down to Mr. Hicks at various times and he has pointed out the plants which he considers are Hick's Yew. I would like to ask Mr. Vermeulen just where the female tree was located that Mr. Hick's showed him.

JOHN VERMEULEN: It isn't there anymore. But it was by the greenhouses, and near the fence.

DR. PRIDHAM: That's the right one.

MR. BORK: I want to ask Professor McDaniel how he controls witches'-broom in Hackberry.

PROFESSOR MCDANIEL: Some of our people at Urbana have controlled witches'-broom by spraying. Witches'-broom is the result of the combined action of powdery mildew and a mite. You can control either one or the other and not have the witches'-broom. However, I have not studied the pathology of it myself.

VOICE: We have a bug coming from Hackberry the latter part of September. If the tree is near the house, the insects penetrate the house, covering the screens, coming under the screens, and everything. There are just millions of them.

PROFESSOR MCDANIEL: I have heard of this problem, but I cannot give the control.

HARRY HOPPERTON: Has anyone had any luck budding Hackberries?

PROFESSOR MCDANIEL: We have had about 50% but with limited quantities. We use the chip bud and have used the bark graft on some of them also. It is a little difficult to bud by the "T" bud method. I prefer to use the chip bud where the wood is left on the bud. The bark is rather fragile and tends to splinter.

MR. PLUMER: We have had good luck budding Hackberries with a heel bud. But the thing is you've got to have big, vigorous understock and good budwood. We get sixty to seventy percent, sometimes higher, but never below sixty.

DR. STADTHERR: I would like to ask Dr. McDaniel, if all of the Hackberries are so heavy fruiting, will this not detract from their use as street trees?

PROFESSOR MCDANIEL: Grey's manual calls them scant fruiting although he may have got there late in the season. The fruit is attractive to the birds, and they work on it. I have been looking for non-fruiting trees but so far I have not found one that would qualify.

MODERATOR SHUGERT: We will now go into the third quarter with a paper entitled, "The Diffusion of Root Promoting Substances from *Hedera helix Stems*." The paper written by Ronald Girouard and Dr. C. E. Hess. Mr. Girouard is going to present the paper for us at this time.

THE DIFFUSION OF ROOT PROMOTING SUBSTANCES FROM STEMS OF *Hedera helix*

R. M. GIROUARD AND C. E. HESS
Horticulture Department, Purdue University
Lafayette, Indiana

1. Introduction

The vegetative propagation of plants by cuttings has attracted the attention of commercial propagators and research workers for many years. As a method of reproduction it has varying degrees of success depending upon the species, cultivar, clone, or growth phase of the plant used (1, 6). Internal and external factors and interactions of these influence the initiation of roots on cuttings (6, 7, 8). The root promoting substances or cofactors extracted and characterized by Hess (4, 5) are examples of internal factors. Recently the movement of these substances in a downward direction as influenced by the presence or absence of leaves on stem cuttings of juvenile English ivy, was studied. It is this work which we would like to review at this time.

2. Materials and Methods

To determine the activity of substances with root promoting properties, mung bean (*Phaseolus aureus*) seedlings were grown in a controlled environment chamber. At the end of ten days the seedlings were cut 3cm below the cotyledonary node. To each bioassay vial containing four ml. of indoleacetic acid solution, ten bean cuttings were added; several of these vials were kept as controls (3).

In one set of experiments, juvenile *Hedera helix* shoots eight inches in length were cut, stripped of only a few basal leaves and added base down in increasing numbers to vials with bean cuttings. At the end of four to six hours glass distilled water was used to restore the level of the liquid in the vials and thus prevent dessication of the cuttings.

In a second series of experiments one major change was made: the ivy cuttings were completely defoliated before being placed in the vials.

Diffusates, or substances slowly released from the base of ivy cuttings in liquids, were collected over a period of two days in a small volume of glass distilled water, evaporated almost to fruit is attractive to the birds, and they work on it. I have been looking for non-fruiting trees but so far I have not found one that would qualify.

MODERATOR SHUGERT: We will now go into the third quarter with a paper entitled, "The Diffusion of Root Promoting Substances from *Hedera helix Stems.*" The paper written by Ronald Girouard and Dr. C. E. Hess. Mr. Girouard is going to present the paper for us at this time.

THE DIFFUSION OF ROOT PROMOTING SUBSTANCES FROM STEMS OF *Hedera helix*

R. M. GIROUARD AND C. E. HESS
Horticulture Department, Purdue University
Lafayette, Indiana

1. Introduction

The vegetative propagation of plants by cuttings has attracted the attention of commercial propagators and research workers for many years. As a method of reproduction it has varying degrees of success depending upon the species, cultivar, clone, or growth phase of the plant used (1, 6). Internal and external factors and interactions of these influence the initiation of roots on cuttings (6, 7, 8). The root promoting substances or cofactors extracted and characterized by Hess (4, 5) are examples of internal factors. Recently the movement of these substances in a downward direction as influenced by the presence or absence of leaves on stem cuttings of juvenile English ivy, was studied. It is this work which we would like to review at this time.

2. Materials and Methods

To determine the activity of substances with root promoting properties, mung bean (*Phaseolus aureus*) seedlings were grown in a controlled environment chamber. At the end of ten days the seedlings were cut 3cm below the cotyledonary node. To each bioassay vial containing four ml. of indoleacetic acid solution, ten bean cuttings were added; several of these vials were kept as controls (3).

In one set of experiments, juvenile *Hedera helix* shoots eight inches in length were cut, stripped of only a few basal leaves and added base down in increasing numbers to vials with bean cuttings. At the end of four to six hours glass distilled water was used to restore the level of the liquid in the vials and thus prevent dessication of the cuttings.

In a second series of experiments one major change was made: the ivy cuttings were completely defoliated before being placed in the vials.

Diffusates, or substances slowly released from the base of ivy cuttings in liquids, were collected over a period of two days in a small volume of glass distilled water, evaporated almost to dryness and streaked on two-inch-wide strips of Whatman No. 1 chromatographic paper. Using 80 per cent isopropanol the chromatograms were equilibrated for six to ten hours and developed by descending chromatography. The solvent front was allowed to move 30cm from the streak or origin before being stopped by drying. The chromatograms were cut into fifteen equal sections and tested for root initiating activity with mung bean cuttings.

All of the experiments mentioned above were repeated several times and the roots formed on the mung bean cuttings were counted at the end of six or seven days.

3. Results and Discussion

In Figure 1 the top horizontal line indicates the number of roots formed per control bean cutting, that is, per bean cutting where ivy cuttings were not added to the vials. The bars below the line indicate a reduction in rooting. By increasing the number of juvenile ivy cuttings placed base down in an aqueous medium, we were unable to detect the presence of substances which stimulate the initiation of roots. These results were possibly due 1) to the inactivation of indoleacetic in solution, 2) to the rapid uptake of the auxin by both kinds of cuttings, 3) to

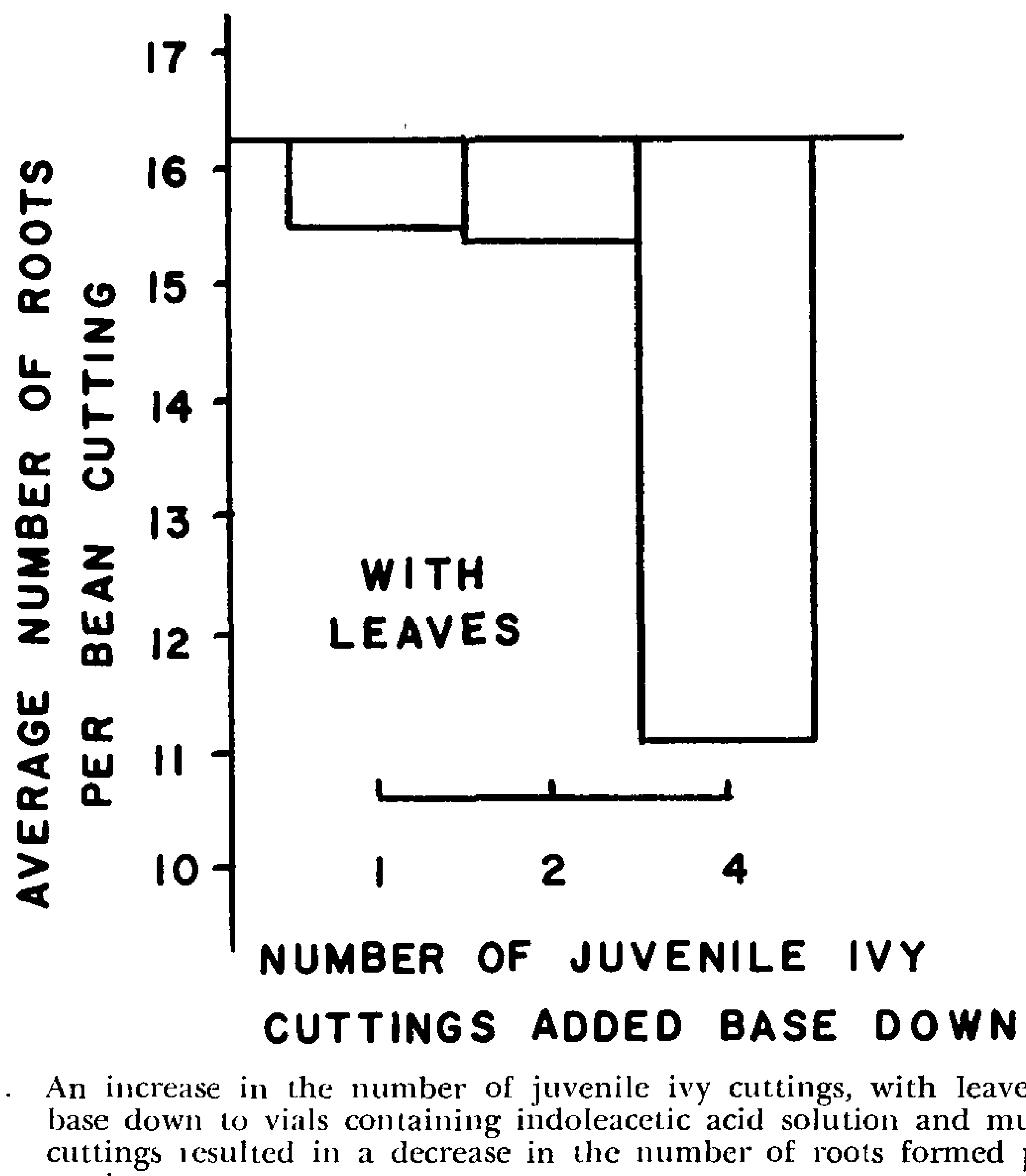

Figure 1. An increase in the number of juvenile ivy cuttings, with leaves, added base down to vials containing indoleacetic acid solution and mung bean cuttings resulted in a decrease in the number of roots formed per bean cutting.

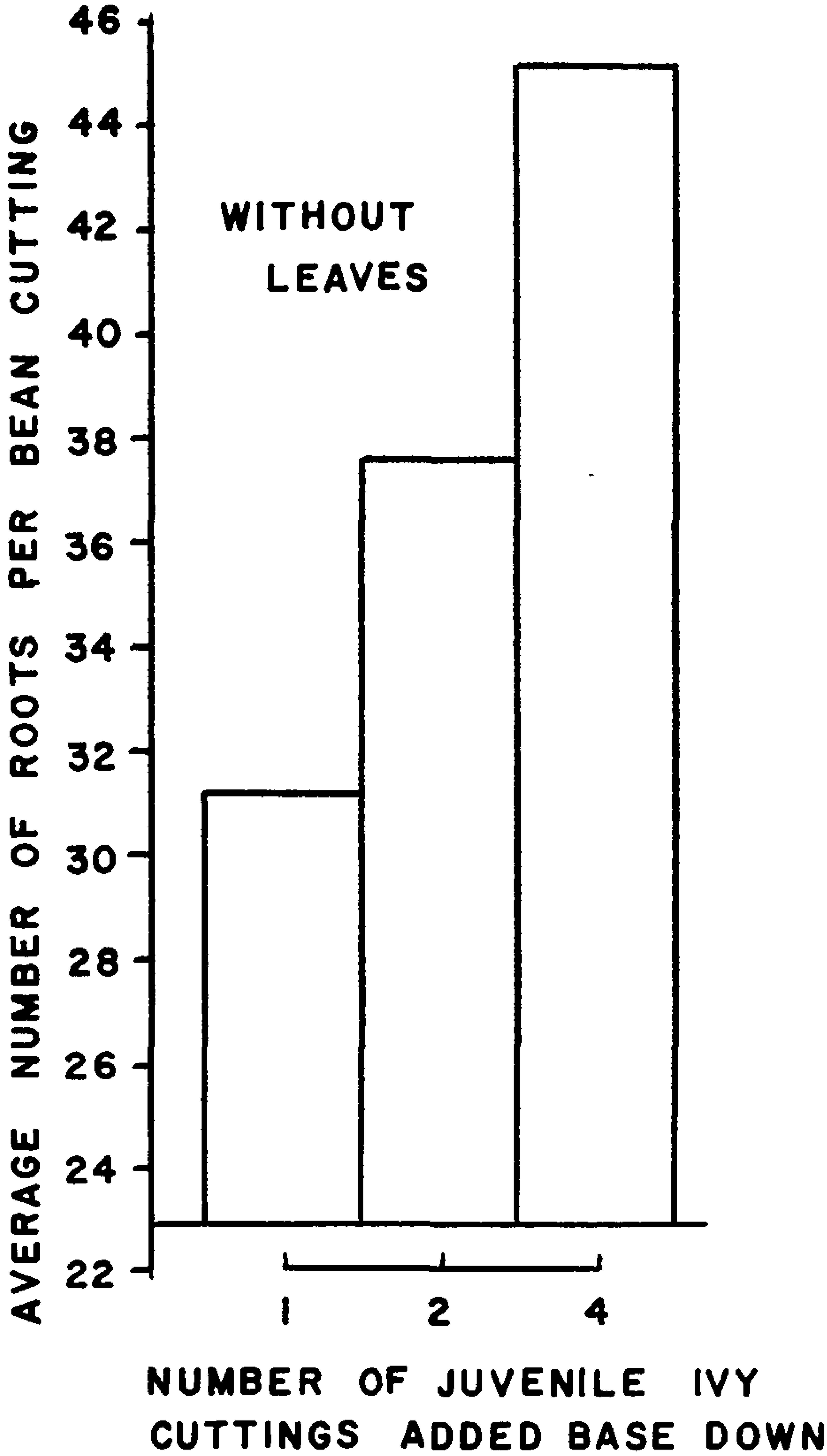

Figure 2. Addition of leafless juvenile ivy cuttings in increasing numbers to bioassay vials resulted in an increased number of roots forming per bean cutting.

the slow movement of root initiating substances out of the ivy stems, or 4) to several of these factors.

At this point one might suspect that inhibitors were affecting the rooting of the cuttings, but later analyses of diffusates will show that this was really not the case.

Next, in Figure 2 we note that when leafless ivy cuttings were added base down to the bioassay vials the rooting of the bean cuttings was promoted with increasing numbers of ivy cuttings. This shows then that substances which enhance root initiation definitely moved out of the stem cuttings of ivy. Perhaps with removal of the leaves the uptake of water and auxin by the cuttings was greatly reduced and therefore, this may have allowed release of substances from the stems in detectable amounts and action of auxin in the rooting processes. The data seems to indicate that leaves left on the cuttings play a major role not only in the synthesis and breakdown of organic compounds but possibly in reducing the loss of substances from detached plant parts. It was encouraging to find that substances with root initiating capacity were able to move down to the base of cuttings where the roots generally form.

In Figure 3 a histogram shows the biological activity of diffusates from juvenile *Hedera helix* stems as determined under lighted conditions by a mung bean rooting bioassay. At Rf .3, .4 to .6, and .9 to 1.0 the activity tended to correspond closely with rooting cofactors 2, 3 and 4 described by Hess.

Kawase (2) working in Canada has reported that the diffusate of *Salix alba* cuttings was strong in root promoting activity at Rf 0.2 to 0.4 which is characteristic of cofactor 2. It

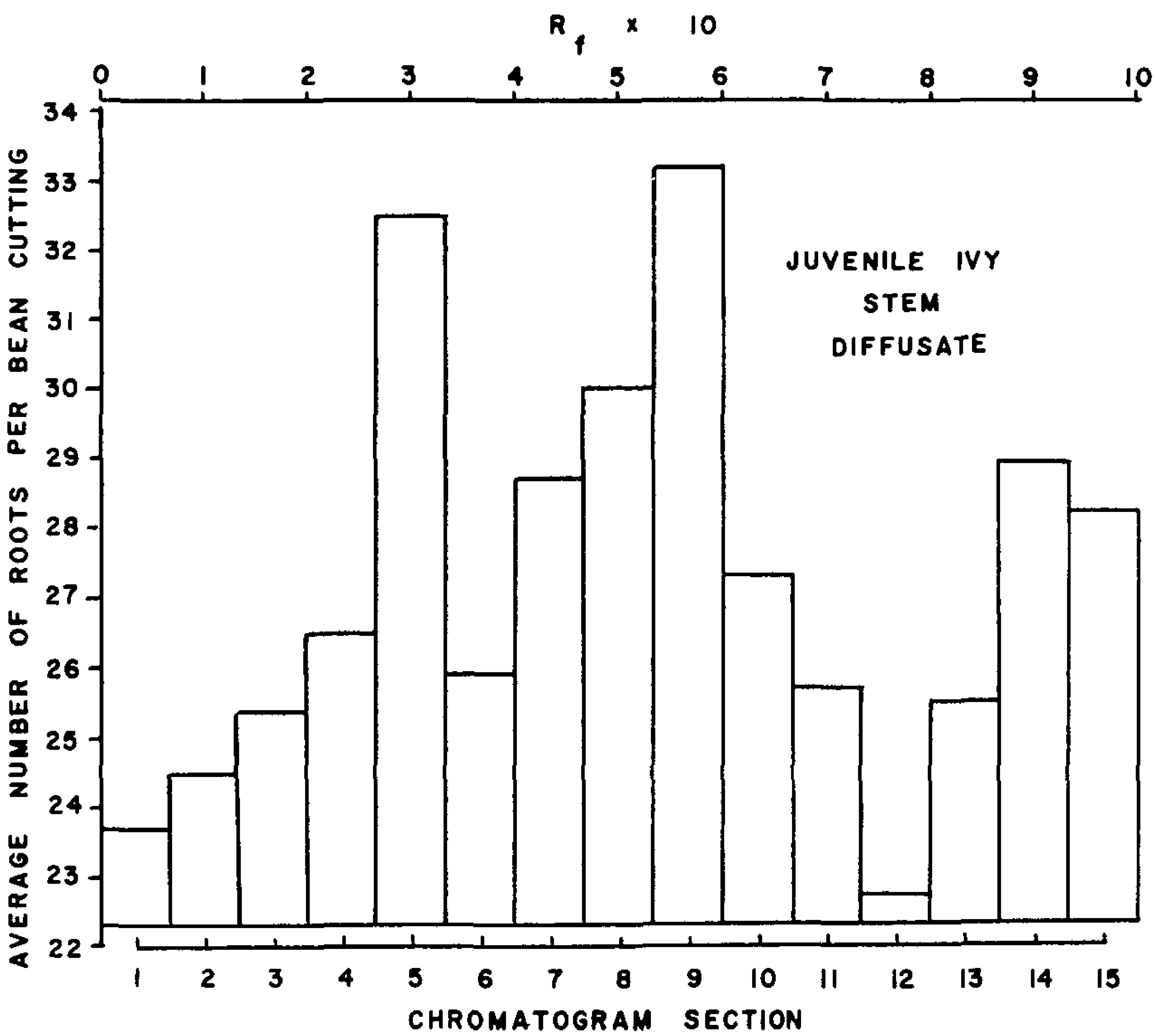

Figure 3. This histogram shows the biological activity of diffusates from juvenile *Hedera helix* stems as determined under lighted conditions by a mung bean rooting bioassay.

is interesting to note that he could concentrate diffusate by centrifuging leafless cuttings and that these cuttings rooted better than those which were not centrifuged.

4. Summary

We can say that leaves on stem cuttings of juvenile *Hedera helix* tended to reduce or interfere with the downward movement of substances which promoted root initiation. Diffusates collected from the base of stem cuttings had activity corresponding to rooting cofactors 2, 3 and of 4.

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MODERATOR SHUGERT: Our second paper in this quarter is by Mr. Donald Wedge from Albert Lea, Minnesota. He will tell us about lilac production at the Wedge Nursery.

LILAC PRODUCTION AT WEDGE NURSERY

DONALD WEDGE
Wedge Nursery
Albert Lea, Minnesota

The common Lliac, Syringa vulgaris, is one of the most popular and prominent shrubs. It succeeds in all but the warmest sections of this continent and grows particularly well in the colder areas. A Lilac will out live the person who plants it and will outlast the house near which it is planted.

Our nursery has grown Hybrid Lilac since 1902. In 1935, realizing many nurseries were having difficulties propagating Lilac and we were having fair success, we decided to specialize in Hybrid Lilac and stepped up our propagation. For the past 12 years we have grafted 120,000 to 150,000 Lilac per year, depending on our balanced supply of scion wood which has been a limiting factor, growing mainly for other nurseries under contract. We are now growing 38 out of the 40 top A rated varieis interesting to note that he could concentrate diffusate by centrifuging leafless cuttings and that these cuttings rooted better than those which were not centrifuged.

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The next few slides will give you some idea of contrasting color combinations found in Hybrid Lilac:

1. Katherine Havermeyer — Pink AD
2. Chas. Joly — Red BD
3. Jan Von Tol — White BS
4. Monge — Purple AS
5. Jacques Calbot — Lilac BS
6. Reaumur — Red As
7. Pres. Lincoln — Blue AS
8. Mrs. W. E. Marshall — Purple AS
9. Victor Lemoine — Lilac AD
10. De Mirabel — Violet AS
11. Lucie Baltet — Pink AS
12. Paul Harriot — Purple AD

In 1956 at the first meeting I had the pleasure of attending, I along with 5 others talked on lilac propagation. Three propagated by means of early Spring soft wood cuttings, one summer soft wood cuttings, one by grafting on Privet, and myself by grafting on Green Ash.

In brief our method of propagating Hybrid Lilac is to bench graft the Lilac scion on Green Ash piece roots. We use a whip graft and secure the graft with grafting thread. The completed grafts are packed in poly bags, without packing material, sealed with a twist-em and put in open wooden boxes, then placed in cold storage where they are left until we are ready to plant them directly to rows in the field. About the last week in April or the first in May, or after completing the planting of hard wood and rooted softwood cuttings.

The next few slides will show some of our operations:

1. Two row trencher on Farmall M with two-way Hydraulic system to apply pressure to push down as well as lifting.
2. Grafts packed in poly bags and rows planted ready to be packed.
3. Closeup of a handfull of grafts — Note buds are still dormant.
4. Planting grafts in open trenches
5. Close-up of grafts after being packed with a packer — Next operation is cultivation.
6. One year block of Lilac planted in May. In November these are cut back to force more canes.
7. Two year block of Lilac, 60 rod rows
8. Close-up of two year Lilac — mostly 18-24 inch with some 12-18 and 2 - 3 ft.
9. Three year Block
10. Close-up of Three year Lilac showing a 3 ft. spade, mostly 2 - 3 and 3 - 4 ft.
11. One year old Green Ash seedlings, planted in April.

12. Shaker Digger on a D 2 Caterpiller which takes most of the hard work out of harvesting. This idea was originated by my father, Robert C. Wedge. Many nurseries are now using this method of digging.
13. Three year Lilac showing roots that would make hand pulling almost impossible using stationery lifter.
14. Shows part of our scion block.

This fall we received a letter from C. M. Hobbs and Sons, asking if our Hybrid Lilac are grafted or on their own roots. The answer was yes they are grafted and yes they are on their own roots. Evidently grafting and being on their own roots are not supposed to go together (Show sample of Ash roots appendix ready to sluff off, most plants don't even show this when dug). The Ash root serves to feed the scion until it is able through it's own roots to take care of itself.

In most of our experiments 500 to 1000 grafts were used and repeated for two years or more to double check the results.

When I report a 10 percent increase, it means if we had a 75 percent stand under usual or checked proceedure, we received 85 percent stand under the new proceedure.

Why Grafting — First, May is too busy and hectic a time for us to take time to secure and plant cuttings. Second, Bench grafting keeps our key help busy the months of January and February when outside work is usually impossible. It dovetails nicely between grading stock in storage and potting roses and shrubs for Spring sale.

Why Green Ash Root Stock — First, we had a 9 percent better stands average than on Privet and 19 percent better stand than on Villosa Lilac. Second, Green Ash is cheaper to produce.

Why Waxed Thread — We feel the graft can be more firmly bound with thread and that tape prohibited roots from forming at the base where they are most apt to form first. Our experiments have proven this true.

Why Cold Storage — Cold Storage is necessary to keep buds and scion in a dormant condition until the field and weather conditions are suitable for planting. It also give us a chance to plant our rooted softwood cuttings to the field first. These we leave in the beds over winter. Varieties such as Alpine Currant start leafing out very early so need to planted early.

Why Callusing — We found a number of years ago that the grafts packed in moist shavings and kept 7 or 8 days in our warm grafting room would make good callusing and increased the stand on an average of 13 percent.

Why Poly Bags — Packing grafts in poly bags without packing material resulted in an average increase of 17 percent. This also allowed us to eliminate sealing the upper tips with shellac which we formely thought necessary.

We wish we could combine successfully packing in poly bags and callousing grafts in a warm room. One test did result in a 4 percent better stand than either method alone. But all other tests failed to give good stands because mildew forms on the grafts. We have attempted trials dipping grafts in Captan Fungicide (5⅓ tablespoons per gallon), blowing terra-clor dust into the bag without good results. Callusing is very slow in the poly bags.

For the past four years we just pack in poly bags and kept them in cold storage. Average of 13 percent better stands than when we callused the grafts in shavings.

CASE HOOGENDOORN: At the time you line out these lilac grafts are they callused?

MODERATOR SHUGERT: We will have our question period after the next speaker. Thank you very much, Don, for a very nice presentation. Our next speaker, speaking on "Use of Simazine on a Limited Scale" Klas Van Hof, Van Hof Nurseries, in Rhode Island.

USE OF SIMAZINE ON A LIMITED SCALE

KLAAS VAN HOF
Van Hof Nurseries
Portsmouth, Rhode Island

I want to emphasize that care must be taken in the application of Simazine 80W. Our application is usually on the light side, and we do not try to attain 100% control for twelve months. It is our belief that if we can get reasonable control for the Spring and early summer months, that this gives us the opportunity to exert all our efforts on shipping and planting without the fear of being choked with weeds. We normally apply Simazine in the later part of November on plants that have been established for one year. I have no doubt that with another application in the Spring we could get that 100% control, but we feel that the chemical is relatively new and hasn't been tested long enough to make us feel that there will not be a build-up.

We have used Simazine 80W for five years and have always had complete control of chick-weed, most of the fall grasses, and the early summer weeds. Although Simazine is primarily a pre-emergence herbicide it will eradicate mature chick-weed. I would like to add that we start cultivating as soon as we can get the tractor in the fields in the Spring. We attempt to cultivate once every ten days. Of course sometimes this is impossible. In spite of this constant cultivation we are practically weed-free until August. By this time our application has lost it's efectiveness, and we have to employ mechanical means towards the elimination of weeds.

I would like to state at this time the importance in the method of application. It is my belief that the reason many nurserymen have had unpleasant experiences with Simazine is because of careless methods of application. Many times failures occur because the operation is left in charge of an employee who other tests failed to give good stands because mildew forms on the grafts. We have attempted trials dipping grafts in Captan Fungicide (5⅓ tablespoons per gallon), blowing terra-clor dust into the bag without good results. Callusing is very slow in the poly bags.

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We use Simazine wettable powder at the rate of 3 lbs. per acre. The recommended dose for our soil type would be about 3.75 lbs. per acre. Our 200 gallon spray tank is filled with 190 gallon of water and 15 lbs. of Simazine 80W. This will treat five acres.

A Tee-Jet nozzle #6506 is used, spaced 20″ apart on the boom and 22″ above the soil level, maintaining 30 lbs pressure and moving at the rate of four m.p.h. We have 12 Tee-jets on a home-made boom. This can easily be made with ½″ galvanized pipe and Tee's. Our tractor is equipped with a Tachometer. This of course is not necessary to determine speed rate. A measured distance and a watch with a second hand can be fairly accurate. Our pump is a P.T.O. piston pump which delivers 12 G.P.M. Each Tee-Jet delivers .52 G.P.M. at 30 lbs. pressure. Information on Tee-Jets can be obtained from Spraying Systems Co., 3201 Randolph St., Bellwood, Ill.

Our experience is almost entirely with Simazine 80W wettable powder. We feel that we can get a more even coverage with a sprayer. Another important factor is cost. The cost to treat an acre with Simazine as a spray is $7.56, compared to $21.18 if used in a granular form.

There are of course many plant varieties that Simazine can safely be used on, but we have limited it's use to Taxus, Junipers, Pines, Arborvitae and Cotoneaster. Last year we tried Pieris japonica with success. I realize that many nurserymen are using it on non-recommended plant species, and with excellent results.

In closing I would like to repeat that care in the weighing and measuring of material and the calibration of equipment is extremely important.

MODERATOR SHUGERT: I will now entertain questions.

CASE HOOGENDOORN: Hooray! Are those grafts callused by the time you line them out?

MR. DONALD WEDGE: No, they don't show callus when we put them in cold storage without callusing. But prior to cold storage we place them in a warm room for a period of time and the upper scion shows callus. They are grafted in January-February and planted in the early part of May.

MR. HOOGENDOORN: You put them in poly bags right away, then you put them in cold storage.

MR. WEDGE: Right.

MR. HOOGENDOORN: Now, that's why I ask you. By the time you plant them, is there any callus on those grafts?

MR. WEDGE: No outward appearance of callus.

MARTIN VAN HOF: Are those grafts waxed or are they not?

MR. WEDGE: They are not waxed.

MR. VAN HOF: You have no problem of drying out by the time you plant them?

MR. WEDGE: That's the reason for the poly bags.

MR. VAN HOF: Yes, I know, but suppose you have a dry spell after planting?

MR. WEDGE: They are planted so only an inch or less is above the ground.

MR. ED AMBO: I would like to ask the young Van Hof to explain a little more about Simazine. You hear so much controversy about the use of this material. How long have you been using it?

KLAAS VAN HOF: About five years. I think the reason some people run into trouble using it, is because they don't take care to calibrate their machinery, they don't take care to weigh the material, they just do it haphazardly. They just give it to an employee to throw some Simazine in a tank and off they go. To me, this is very dangerous.

MR. AMBO: You said something about constant cultivation. You can't cultivate if you put Simazine on!

KLAAS VAN HOF: No. Absolutely. I would add too, that I am a firm believer in a dust mulch and consequently I like to see loose soil. I feel if we did not cultivate we probably would have control for a longer period. It's true we don't have control for 12 months. Around the first of August, we get some weeds and have to do a lot of cultivating and hand weeding after the first of August until frost. But still the Simazine takes the burden of weeds off as in the spring, which to me is very important.

MR. AMBO: You said you used half strength? Is that what you use?

KLAAS VAN HOF: No, we don't use half strength. We could use about 3¾ pounds per acre, but we cut it down to 3 pounds.

MR. AMBO: You have noticed no ill effects?

KLAAS VAN HOF: Absolutely none. Every year we have check plots to compare the growth on plant varieties and there has been absolutely no difference.

MR. AMBO: What do you do from August on, when the weeds start coming back?

KLAAS VAN HOF: Then we employ hand methods, hoes and that sort of thing.

MR. VINCE BAILEY: Have you found any plants which are injured at this rate of application?

KLAAS VAN HOF: We have done very little in testing a large variety plants for injury, but what ever we use it on, we find no injury, what so ever. Last year some *Ilex hetzi* was accidently sprayed. There was some discoloration of the foliage but no reduction in growth.

MR. VINCE BAILEY: I might say that our experience is very similar to yours, although we have had some injury on mugo pine. We treat about 100 acres a year. We use two pounds per acre active ingredient, banded.

GERALD VERKADE: Klaas, do you run into a problem with crab grass?

KLAAS VAN HOF: Yes, we do. We can really get a build up of crab grass in August. I understand that heavier dosages of Simazine control this, but I'm still afraid of it, and we just struggle along with the crab grass. I also understand with some of the other chemicals you can control crab grass.

VOICE: Do you have any problem getting the Simazine into solution?

KLAAS VAN HOF: No, we don't. We mix the Simazine first in a five gallon bucket, with some water and use an electric drill paint mixer on it and we get a good emulsion. Then we put it into the tank and stir it by hand after it goes in and again every 15 minutes to make sure it is in suspension. We haven't had any trouble.

TOM PINNEY: It helps also to use warm water. We mix it up to a paste and it works very well.

HARRY HOOPERTON: Do you get foaming in the tank? We get a little foaming.

KLAAS VAN HOF: No, we have no trouble.

HARRY HOOPERTON: I might say we tried several strengths — single, double, and triple on a few items, especially privet. We had the prettiest golden privet you ever saw. Two years later, it was back to normal green. We dug them and checked the roots and found no ill effects. You get the same thing on forsythia, Euonymus, and quite a few other things. We could not find any ill effects on the roots but we did have a little bit of growth retardation in the first year. But after that we could find none.

MODERATOR SHUGERT: I would like to direct a question to Mr. Wedge. Do you find any of the varieties of lilac which have difficulty going on their own root?

DONALD WEDGE: Yes, some of the white varieties for example — Mount Blanch is the first one the ash seems to be persistant on, but that is the only one.

CASE HOOGENDOORN: After you have these planted and hilled up, do you keep your hill around there constantly in order to make these "eyes" go over on their own root? You don't hoe between the plants?

DONALD WEDGE: Yes, we hoe between the plants.

CASE HOOGENDOORN: You knock down the hill? You don't hill them after you plant them?

DONALD WEDGE: We cultivate up. Then we hoe it away. We cultivate them up. Hoe them away. That's the way we get rid of the weeds.

CASE HOOGENDOORN: And still they go on their own roots?

DONALD WEDGE: Yes.

CASE HOOGENDOORN: Wonderful! I wish we could do it.

PETER VERMEULEN: Klaas, do you feel an application of

Dacthal in August, when your Simazine starts wearing off, ought to be practical?

KLAAS VAN HOF: I might possibly be, Pete, but we've had no experience with it and I couldn't comment on it.

JOERG LEISS: Why do you spray over all, if you cultivate in the rows?

KLAAS VAN HOF: Well, I know several nurseries are using band spraying, Mr. Bailey said he used this method, but I can't give you a good reason except to say an overall spray is what we have used and just haven't bothered to change it. I realize that we probably spray about 20 acres, possibly a little more, so the cost is not too different.

MODERATOR SHUGERT: Would Mr. Dugan like to comment on weed control in Ohio?

DAVE DUGAN: I will not have time to hit them all. I don't know why you are using Simazine. That went out three years ago. There are four or five I think you should be trying. We do use Simazine at four pounds. Dacthal is an excellent material, working in Ohio, of course it is made in Ohio. Have you got casoron yet or dymid? Casoron is the one you put on, cultivate it in, plant in it and then go fishing, and this is looking terrific in Ohio. Dymid will take all this grass stuff out and do everything else Simazine will do and Chloro I.P.C. is still good, applied in fall or spring when cool and moist. The whole thing is to add about 10 feet to your herbicide shelf each year. You have to work along with your material, your weeds and your soil type. We were whispering in the back there and we were up to a thousand pounds of Simazine on some rhododendron in complete peat. But don't try that on sand.

MODERATOR SHUGERT: We are now in the last quarter of the afternoon, and our first speaker — who I am pleased and proud to have with us — talking on over wintering and early shipping, is Mr. Leslie Hancock from Woodland Nurseries, Cooksville, Ontario, Canada.

OVERWINTERING AND EARLY SHIPPING

LESLIE HANCOCK
Woodland Nurseries
Cooksville, Ontario

The subject on which I have been listed to speak is somewhat misleading as I am by no means an authority on either over-wintering or early shipping. Nevertheless, I am keenly interested in both, first as a plantsman to bring material readied for sale through the winter in good health, and secondly to get on with the job of distribution well ahead of the time we should be replanting the nursery.

There are many nurserymen who will consider that this problem has been solved, for we already have huge storages where millions of plants are stacked in shingle tow and shipped

Dacthal in August, when your Simazine starts wearing off, ought to be practical?

KLAAS VAN HOF: I might possibly be, Pete, but we've had no experience with it and I couldn't comment on it.

JOERG LEISS: Why do you spray over all, if you cultivate in the rows?

KLAAS VAN HOF: Well, I know several nurseries are using band spraying, Mr. Bailey said he used this method, but I can't give you a good reason except to say an overall spray is what we have used and just haven't bothered to change it. I realize that we probably spray about 20 acres, possibly a little more, so the cost is not too different.

MODERATOR SHUGERT: Would Mr. Dugan like to comment on weed control in Ohio?

DAVE DUGAN: I will not have time to hit them all. I don't know why you are using Simazine. That went out three years ago. There are four or five I think you should be trying. We do use Simazine at four pounds. Dacthal is an excellent material, working in Ohio, of course it is made in Ohio. Have you got casoron yet or dymid? Casoron is the one you put on, cultivate it in, plant in it and then go fishing, and this is looking terrific in Ohio. Dymid will take all this grass stuff out and do everything else Simazine will do and Chloro I.P.C. is still good, applied in fall or spring when cool and moist. The whole thing is to add about 10 feet to your herbicide shelf each year. You have to work along with your material, your weeds and your soil type. We were whispering in the back there and we were up to a thousand pounds of Simazine on some rhododendron in complete peat. But don't try that on sand.

MODERATOR SHUGERT: We are now in the last quarter of the afternoon, and our first speaker — who I am pleased and proud to have with us — talking on over wintering and early shipping, is Mr. Leslie Hancock from Woodland Nurseries, Cooksville, Ontario, Canada.

OVERWINTERING AND EARLY SHIPPING

LESLIE HANCOCK
Woodland Nurseries
Cooksville, Ontario

The subject on which I have been listed to speak is somewhat misleading as I am by no means an authority on either over-wintering or early shipping. Nevertheless, I am keenly interested in both, first as a plantsman to bring material readied for sale through the winter in good health, and secondly to get on with the job of distribution well ahead of the time we should be replanting the nursery.

There are many nurserymen who will consider that this problem has been solved, for we already have huge storages where millions of plants are stacked in shingle tow and shipped to their destination weeks ahead of any chance to have them freshly dig from the open.

The success of these storages from the dollars and cents point of view is conceded, but I remain unconvinced that they are in the best interest of the plants. There have been too many experiences of plants arriving looking normally healthy, yet failing later to leaf out; too many shipments with etiolated white young growth, that have later died en bloc. Though perfectly satisfactory for some lines of stock, such storages are far from suitable for all. I am especially interested in bringing certain broad-leaved evergreens such as Euonymus fortunei varieties, Mahonia, Rhododendron, Pieris, Pyracantha etc. through the winter in first class condition. To achieve this I consider the following points essential.

1. The plants must have light.
2. The roots must either be balled and burlapped or set in soil.
3. The plants must be protected from wind.
4. They must be protected from sudden and violent drops or raises in temperature, but must be subjected to a certain amount of winter freezing. Tempeerature should not fall below 5 degrees F. above zero, (-15 Celcius) or rise above 40 degrees F. for any length of time.
5. Ventillation is imperative in mild thawing weather.
6. Internal conditions must be watched for soil and air humidity. A certain amount of watering is essential.

The old-fashioned winter storage pit with manually operated glass sash provided for all these essentials but the main faults were, (a) too high cost, (b) too restricted storage space and (c) too much manual operation. If we can correct these faults into high storage capacity and less manual operation, we are proceeding in the right direction. To provide these essentials we propose as follows:

1. Use polyethylene to provide light.
2. Retain earth floor for moisture contact and heeling-in ground.
3. Protection from wind to be obtained by retaining the sunken pit idea and perfect sealing against cold air intake obtained by polyethylene.
4. Sunken pit concept also modifies temperature by taking advantage of sub-soil heat. Reduction of the polyethylene to one third the roof area tends to spread the heat intake over three times the floor area. If experience shows it to be necessary, some thermostatically controlled electric heat could be provided for periods of sub-zero temperature.
5. Ventilation to be provided on both sides of the building through two feet of wall space above the outside ground level. These ventilators can be opened manually or automatically.
6. Manual watering by hose to be performed as necessary.

The other critical factor which concerns all of us of course, is cost. Like many others, when polyethylene first came on the market we thought it was going to be an inexpensive cure-all for overcoming the ills of a North American winter. We soon learned differently.

We started with an adaptation of a polyethylene quonset-shaped structure that is used in Canada for the production of early spring garden crops. These pre-fabricated polyethylene units are known as Portagreens and come in standard sections five feet wide and with a spread of eleven feet. We built a 60 foot by 11 foot low wall structure into a bank along the lines of sash covered winter pit, roofed it with twelve sections of the quonset-shaped Portagreens and filled it with the plants needing protection.

We arranged for some ventilation but not enough. When the sun shone on the polyethylene, the temperature inside the building shot up alarmingly. On cold nights, even with everything seal-tight the temperature inside was barely ten degrees F. better than the recorded outside low. We soon realized that if this rapid fluctuation continued throughout the winter our stored plants would be ruined. The polyethylene roof was therefore covered with reed mats to reduce direct sunlight which saved the situation but added considerably to the cost. By opening doors on mild days however, the plants, mostly broad-leaved, came through the winter in good condition.

It was clear that such a shelter, even if planned on a large scale, could not be an economical success, but valuable lessons had been learned. We found that even with the reed mat covering there was still good light within. Hence in our second storage effort, pictures of which will be shown, the same area of polyethylene roof is used for a building three times the size. Also a much more satisfactory arrangement for uniform ventilation has been planned. Stock to be stored can be trucked into the building, and thought it can be faulted as still too small for the operations of a modern nursery, it is as large as one dares to go until the answers have been worked out. Again the question of cost comes up. It was hoped at the beginning that floor space could be provided in this 60′ x 33′ building for an overall cost of $1.50 per square foot. This figure is now more nearly $1.75 per square foot. If we introduce automatic temperature or ventilation controls, the per square foot cost could climb to $2.00 per square foot or higher, which may be considered too high as an inexpensive method of winter protection.

We believe no artificial heating will be necessary for the building, as the heat intake of the polyethylene in March should take the frost out of the interior earlier than it leaves the ground outdoors.

This short paper is merely a progress report on an attempt to provide more natural winter storage, in particular for broad-leaved evergreens. The big problem of course is one of economics. In the past, heated sub-tropical conditions have been supplied in the north at great cost for the housing of tender plants. Far more necessary it seems, is the wintering of many of our normally hardy plants in their early stages of development. Is it not conceivable that some modification of our northern winters is economically possible in the future on a large scale? I feel certain it will be so and that structures will be built to provide all essentials of a controlled modified winter climate.

MODERATOR SHUGERT: Our next speaker is Mr. Bill Cunningham from Waldron, Indiana, who will speak on over-wintering in poly structures.

OVER WINTERING PLANT MATERIALS IN POLY STRUCTURES

W. E. CUNNINGHAM
Cunningham Gardens, Inc.
Waldron, Indiana

In recent years this subject has been discussed at great length by many speakers, and the subject still bears interest because growers are deeply concerned about ways and means of successfully over-wintering container-grown plants. Perhaps my subject should be titled, 'controlling environment in poly structures.'

I hope you will forgive me if I seem rather brusque in this opinion, but I believe the problem of winter-storage of plants in containers is an elementary one. Permit me to say, when plant materials are grown in containers and winter-stored above ground, then subjected to wide temperature extremes, often coupled with high wind, we cannot expect 100% survival every winter. In simple terms, the environment is unsatisfactory.

What is the answer? In my opinion any nursery stock worth propagating and growing should not be subjected to deep-freeze conditions while above ground. There's no doubt the market for nursery stock in containers will be even greater in the future, so let's face it, if we are to produce and have available a continuous supply of prime stock, then this material *must* be grown in structures wholly suitable for the growing season as well as for protection from wind, freeze and thaw during the dormant period. To succeed, we must have greater control over the environment in which we grow container stock.

To accomplish this I feel the wind-resisting, versatile and functional quonset-type polyhouse permits a means by which producers may successfully manage these crops. Of course, I realize construction costs do not permit rapid nor complete change-over to this system, for in many instances very large acreages are involved. But there must be consideration of this or a similar program in order to profitably compete, otherwise in the future the greater part of this production will be in frost-free areas of the country.

I believe we are justified in using heat to control minimum temperatures in poly-covered storage units, just as we are justiplied in the north at great cost for the housing of tender plants. Far more necessary it seems, is the wintering of many of our normally hardy plants in their early stages of development. Is it not conceivable that some modification of our northern winters is economically possible in the future on a large scale? I feel certain it will be so and that structures will be built to provide all essentials of a controlled modified winter climate.

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I believe we are justified in using heat to control minimum temperatures in poly-covered storage units, just as we are justified in relying upon refrigeration for storage. Either system has cost involved, and I don't believe any of us will argue that refrigeration isn't practical. Refrigerated storage is controlled environment, so perhaps we can look upon the use of heat in plastic house storage in the same way. We're exercising some control over the elements.

Now, perhaps we can disregard he costs involved in erecting facilities suitable for growing and storing container stock, for there are so many variables involved. Construction standards vary from grower to grower. If poly is used as an annual protective covering, compared to standard greenhouse construction, we know the costs are substantially less.

Quonset-type construction permits an easy application of poly for winter cover, and equal ease in removing the cover in the spring. Then by putting on saran, we also find it easy to convert these facilities to conditions most favorable for summer-growing. No other type of construction permits such fast and easy exchange of fabrics.

Exclusive of electric power and routine maintenance costs, polyhouses can be covered with liners inside and out and heated with unit heaters burning LP fuel, and carried at frost-free temperatures at an annual cost of less than 12c per sq. ft. of area covered. So in conclusion whether we are storing ground cover stock or larger canned material, we believe these costs are fully justified. These costs are minor, certainly, considering the assurance we have that our production inventory is protected.

MODERATOR SHUGERT: Our final speaker this afternoon is Bill Flemer who will answer the question, "Does cultivation preserve soil moisture?"

DOES CULTIVATION PRESERVE SOIL MOISTURE?

WILLIAM FLEMER, III
Princeton Nurseries
Princeton, New Jersey

At the time of the publication of Laurie and Chadwick's *The Modern Nursery* in 1931 and for countless years before, there would have been hesitation in answering affirmatively the question which forms this title of this paper. Agricultural and horticultural experience had long endorsed the practice of cultivating the soil not only to control weeds, but to conserve soil moisture during summer dry periods.

So the matter rested until the advent of the modern herbicides which for the first time made it possible to control and virtually eliminate weeds in crop rows without even a single cultivation during the growing period. Soil scientists at many experiment stations began to question whether there was any value to cultivation at all, now that weeds could be suppressed by herbicides, and experiments seemed to show that soil moisfied in relying upon refrigeration for storage. Either system has cost involved, and I don't believe any of us will argue that refrigeration isn't practical. Refrigerated storage is controlled environment, so perhaps we can look upon the use of heat in plastic house storage in the same way. We're exercising some control over the elements.

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The coming of the herbicides was enthusiastically received in the nursery world as well as among the row crop cotton, soy bean, and corn farmers, and in several widely read articles the cultivating tractor was said to be joining the hoe in the museum of technological obsolescence.

We at Princeton have always felt that thorough cultivation was a prerequesite for successful field production and have been doubtful about the idea that just as good or better crops could be grown in uncultivated fields. Conclusions which might be justified in crops like corn and soy beans might not also apply to nursery crops which are quite dissimilar in growth habits and requirements.

To begin with, corn lands treated with herbicides and not cultivated were not planted at the row widths and at the population density common in former times. Rows were greatly narrowed and the spacing of seeds in the rows increased so that much greater surface coverage was achieved and much less sunlight and wind could strike the soil surface to dry it out. New harvest machinery was designed to accommodate the narrower rows and the whole concept of yield per acre was upgraded. In the case of nursery production most of which is not a one year crop like corn or cotton, row width and spacing satisfactory for the first year or so in the field will not permit the develoment of a saleable finished plant in later years. Harvesting equipment presently available will not adapt to greatly reduced row widths or plant density in the row without excessive breakage or loss. Consequently it is impossible to plant nursery plants in the field closely enough to get any appreciable shading effect and conserve moisture during the first few years of a field crop cycle.

A second consideration was the quality of cultivation used in those experiments with nursery stock which seemed to indicate that the practice was unnecessary. The art of setting cultivator teeth properly to obtain an even, thorough job of cultivation is apparently rapidly dying out anyhow, and will soon join that ox shoeing if the present trend continues. Nursery experiments comparing cultivated with non-cultivated areas have been largely based on very small plots in which hand tool scratching of doubtful thoroughness was the "cultivation" practiced. In farm field experiments, often no mention was made of the depth of cultivation practiced, and it is well known that deep cultivation of corn, for example, does sever valuable brace and feeder roots and reduce yields.

With the above doubts in mind and with the whole problem of moisture control becoming more acute during the past three summers of severe drought conditions, we determined last spring to do a series of relatively large scale but simple experiments to determine whether field cultivation was worth the time and expense put into it. I regret to say that we did not install moisture recording devices in the soil of these plots, but merely recorded the growth of the plants involved in comparison with check plots ,but the results were significant to us, at least.

Plots were laid out in fields of the following varieties planted in the row widths given. All plots were 200 feet long.

Number of Rows Cultivated	Not cult.	Variety	Age	Row Width	Plant spacing in the row
6	6	Juniperus horiz. plumosa	2 yrs.	4 ft.	18 in.
8	8	Acer platanoides	4 yrs.	8 ft.	2 ft.
10	10	Ligustrum ovalifolium	2 yrs.	4 ft.	8 in.
7	7	Taxus cusp, densiformis	3 yrs.	4 ft.	18 in.

The cultivated rows were sprayed in a band approximately 14 inches wide with a mixture of Kloben and Dow Pre-Merge in late March. The spray was directed at the bases of the plants.

The uncultivated rows were sprayed over the entire row width to cover the ground with herbicide.

At the end of the growing season in late September the plants in each plot were counted. The results are tabulated as follows.

Juniperus horizontalis plumasa

	12 to 15 in.	15 to 18 in	18 to 24 in	2 to 2½ ft.
Uncultivated Plot	280	310	180	3
Cultivated Plot	170	288	265	65

Acer platanoides

	6 to 8 ft	8 to 10 ft	1¼ - 1½"	1½ - 1¾"	1¾ - 2"
Uncultivated Plot	212	352	210	18	-
Cultivated Plot	92	220	361	124	4

Ligustrum ovalifolium

	18 to 24 in	2 to 3 ft	3 to 4 ft.	4 to 5 ft
Uncultivated Plot	890	1410	645	-
Cultivated Plot	87	1060	1643	211

Taxus cusp. densiformis

	12 to 15 in	15 to 18 in.	18 to 24 in	2 to 2½ ft
Uncultivated Plot	315	420	172	
Cultivated Plot	121	450	260	88

Multiplying the above figures by the prices of each grade of material shows at once that if all plants were sold the upward shift in grades more than compensated for the added costs of cultivating each pot so handled and turned in substantial profit as well. Costs of cultivating such a small area were very difficult to arrive at and were roughly estimated at about forty dollars per plot for the total of seven cultivations.

Sample diggings at monthly intervals in each plot showed that the soil dried out more rapidly in the uncultivated areas, although both started on an equal basis in early May. The most marked difference was the degree of penetration after our one substantial rain last summer. In the cultivated plot the moisture had penetrated over 14 inches in three days time, while in the hard surfaced uncultivated plots the rain did not enter more than 4 inches of the soil, and runoff was substantial.

The results of this little test are certainly not remarkable, but they gave us concrete and indisputable evidence that proper shallow surface cultivation does preserve soil moisture and enhance the growth of the nursery crops tested.

MODERATOR SHUGERT: Are there any questions?

ROLAND DEWILDE: I would like to ask Bill Flemer, isn't it true that the biggest benefit that you get from cultivation is that the moisture you do get, particularly in dry times, has greater penetration, rather than preserving that which was already there?

BILL FLEMER: I think both are involved, Roland. If you have ever seen some of the shade tree growers in the Portland area, you can see the results of good cultivation. I think they practice better cultivation than you see anywhere else in this country. In the Portland area, after June or shortly after that, they have no rain what-so-ever for the rest of the summer. You get some cool fogs, but no rain. And yet by cultivating constantly, very shallowly, dragging a chain behind the cultivator teeth and what not, they preserve the moisture that is in the soil and get fabulous growth on shade tree whips. But back East where we do get rain I think you're right. You get twice the value out of it — that is, compared with uncultivated soil. We had a little contest one time with a neighboring New Jersey Nursery. He said that he could get better growth of shade trees with sod culture than we could with clean culture. So we bet $25.00 on the thing. We took a row of his plane trees and calibrated them very carefully, as well as ours. Then we went through the summer. Well, his seemed to grow faster at first. We had two or three good rains during the summer. Ours grew considerably faster during the latter part of the period, and I got my $25.00 dollars hands down.

MR. LOWENFELS: Did you say you used herbicide or not?

WILLIAM FLEMER: We do use herbicides. We used them in both plots in this test. In the plots which were cultivated we sprayed just in a band where the plants were. This is our normal practice. The other plot was sprayed so as to cover the whole surface and then not cultivated throughout the summer. We use the band spraying for herbicides because we believe we are going to have to cultivate anyhow to control moisture. And we use one third less herbicide by spraying in a band; and if there is any possibility of build up, which I sincerely believe does exist with Simazine, the fact that we use only a third or a fourth as much on the acreage, means that you are going to have that much less problem with build up. We spray just where the plants are, in a banded spray, directed at the bases of the plants, but not on the roots.

PETER VERMEULEN: The one and three quarter cent cost that you had for the poly, did that include labor? What mil poly did you use outside and inside? What degree of shade did you have on the saran?

BILL CUNNINGHAM: The one and three quarter cent cost does not include labor. We started to use 40% shade saran but found that 36% shade was better. We used four mil poly on both the outside and the inside. We tried the 6 mil and, although it works well, the cost is too high. Four mil is adequate. You can use 2 mil inside and certainly it is as good as four mil. but we prefer to have all the poly the same guage so that once we remove it from the house, we have the opportunity to use it for other purposes. Four mil polyethylene will overwinter well as long as it is put on drum tight. Put it on just as tight as you can so there is no movement in the poly. But if it flaps in the breeze it will wear out.

CASE HOOGENDOORN: Do you mean to tell me that you use your poly the second winter again?

BILL CUNNINGHAM: No. We use it only one time. But as everyone knows there are dozens of uses for polyethylene, if it is reasonably good.

VOICE: This question is to Bill Flemer. What is the depth of cultivation of small material and the intervals between cultivation?

BILL FLEMER: About 2½ inches in the ground. We set the teeth more shallow by the plants and deeper in the center of the row; it averages out to about 2½ inches. We used seven cultivations last summer, because it was a dry summer and once the dust mulch was established we did not have rains to break it up again. So we averaged out to once every 10 days to two weeks. Had we had a rainy summer we would have had to cultivate more.

MODERATOR SHUGERT: Before I turn the program back to the President, I would like to make a few comments. First of all I want to acknowledge with deep thanks and appreciation, all the speakers we had this afternoon. They did an excellent job, and I am certain you appreciated it as much as I did. I would also like to acknowledge the standby speakers. As the program began to gel, we put out a request for a few more speakers and the following people volunteered to appear on the program: Merton Congdon, Hoy Grigsby, Al Pridham, Howard Johnson from the University of Minnesota, Al Fordham, and Albert Lowenfels. I would like to direct a comment to the program chairman for next year. Going back through the Proceedings, back in 1962, I quote — "That future speaker-exhibitor symposiums be comprised of a certain number of the most appropriate papers submitted during the previous year. It would be preferable but not required to have the author present his own paper. This paper should not be previously circulated." This statement was made by Peter Vermeulen and certainly it was one of the points he stressed in his communications talk that we all remember quite vividly. Also in 1962, Steve O'Rourke said, "I have attended every meeting of the Plant Propaagtors' Society since 1951 when we started except when I was overseas. My personal experience is that we derive more information from short speaker-exhibitor talks than from any other feature of the program. So let us try to further participation among the membership at large." All I can say to both of those remarks is 'Amen' — I do hope that next year the program chairman will entertain the idea of having the speaker-exhibitor symposium last through an entire afternoon. I will now turn the program back to President Roller.

PRESIDENT ROLLER: Thank you, Ralph. I think you have done what Dr. Chadwick once said: "The mind can only absorb what the seat can endure." The only thing I want to say is that I absent-mindedly neglected to announce that Case Hoogendoorn is a member of the 1966 site committee.

DR. HESS: I would like to suggest that those members who did not have an opportunity to present a paper this afternoon, send them to me for publishing in the Plant Propagator.

FRIDAY EVENING SESSION

December 4, 1964

The evening session convened at 8:00 p.m., President John Roller, moderator.

PRESIDENT ROLLER: We will begin the evening session with summaries of the roundtable discussions. We will hear first from Harvey Gray who recorded the session on Storage of B and B Plant Materials.

STORAGE OF B & B PLANT MATERIALS

ARIE J. RADDER, *Moderator*

HARVEY GRAY, *Recorder*

The material which I will offer for your recognition are the high lights of the discussions on the storage of B and B Plant Materials. There seemed to be an overall thread or feeling that the presence of light is apparently not a factor in winter storage, if the temperature is maintained at 35° F. or less, and number two, the humidity is kept close to 100% at all times.

In the discussions that developed this humidity factor was approached from a number of different angles, such as syringing, misting, wetting, and a variety of other details but primarily as I visualize it, and recognize it, it was a matter of some how or another of maintaining a humidity factor close to 100% at all times. Now the structures that came out in this discussion by and large were vapor proofed and they varied considerably. A good deal of emphasis developed out of the area of the Connecticut River Valley where tobacco industry for some reason or other has moved into the production of nursery stock good, bad, or otherwise. Nevertheless, this is an area of concern. As far as the nursery industry and the storage of plant material, they have a large number of tobacco curing or drying sheds. It is quite possible that they can put these drying sheds into use for storage of the variety of material that is grown on what was tobacco growing land. So a good deal of emphasis was placed on this type of structure, a shed that was made by one devise or another, vapor proofed to major extent, and dark to a high degree. Two other areas of concern and interest in this area of wintering material were such things as the conventional shade structures, shade houses with plastic placed over them. There also appeared in our discussion a fact that some areas were used for wintering over B and B material where the only protection that plants received was from a barrier such as a lath or snow fencing device around the plants with full sunshine. That is the composite picture. Do with it what you will, think of it as you will. However, emphasis was put on the fact that a tightly closed structure is a prime requisite for success where you are attempting to approach a vapor barrier with the idea of maintaining a good quality stock over this winter storage period.

Then we got into the area of the fact that fine plant material will come out of storage in the spring if number one, the root ball has good moisture content during storage (there are number of suggestions of how this might be brought about by watering them much or little, and using rot proofed burlap) but basically point number one is the root ball has a good moisture content during storage. Number two, a high nutrient content should exist in the plant when it goes into storage and evidence seems to indicate that this is best accomplished by a late October application of a fertilizer with emphasis on nitrogen. Number three as far as the prime plant material coming out of storage in the spring, is that we protect the roots from exposure to deep cold. Now I didn't quite get the specific temperature in this overall discussion so I can only report it as being a deep cold. And this I think you will recognize by the following comment. This is accomplished by using mulches, such as sawdust, wood chips, shredded sugar cane and various gradiations of this sort of thing down to the plunging of the balls in soil.

Winter protection varies according to the statements that were made during the discussion from the wind barrier in full sun to placing plants in total darkness with a high percentage of humidity.

In the development of this discussion the subject of anti-dessicants came up and two points were rather strongly brought to the floor — number one it is most important when using the various anti-dessicants that this material should be applied on the underside of the leaf if it is hoped to get any value or advantage out of its application, for the simple reason that your stomates are predominantly present on the underside and almost absent on the upper side of the leaves. And also another point was developed in this area, had to do with the duration time, when this coating or these applications were efficient. If was pointed out that these materials are rather short lived. This is a point that needs further discussion. Dr. Snyder's work on this and others of course will reveal further information.

The final point was a point that I developed at the close of the meeting and that was a fact that no one mentioned, and it is worthy of some consideration, to give recognition to the fact that fungi of certain sorts such as Botrytis can become a problem. Botrytis can be activated and is liable to be active at low temperatures. So therefore it would be wise to give consideration to an application of fungicidal material that will be effective in the control of an organism such as Botrytis which can very readily cause defoliation of your material in storage. I submit this as the recorder for this particular area of discussion.

PRESIDENT ROLLER: Next we will have the report on the roundtable discussion on Viruses — their importance to the plant propagator. [*Editor's Note*: Zophar Warner presented the report and Donald Cation prepared a summary for the Proceedings.]

VIRUSES — THEIR IMPORTANCE TO THE PLANT PROPAGATOR

DONALD CATION

Michigan State University

Viruses are submicroscopic infectious entitites that multiply intracellularly and are potentially pathogenic. It is well known that viruses are extremely small, they get inside a plant by one means or another and multiply only inside living cells. Infectiousness means that they can spread, enter and reside within a plant. Pathogenic means disease producing, resulting in an abnormality that we can see or detect, such as lack of chlorophyll as seen in rings or mottles, dead spots in leaves, dead cells within the plant, reduced size or oversize of cells, excessive or reduced cell division or stunting of plants.

Viruses are only potetntially disease producing. They can infect a plant, increase in number and spread from cell to cell and may or may not cause disease in the process. Most of us are aware that viruses cause destructive or even mild diseases, but many are not aware that viruses can exist in certain plants without causing recognizable disease. In such cases the virus is said to be latent or hidden. It is these latent viruses that are of special concern, for a virus can be latent in one variety and be destructive to another.

A virus is not confined to a variety or species. Many of them infect plants in other genera, even in other families. We think of X disease of peach infecting stone fruits. Actually it can infect carrots, tomatoes, composites and widely unrelated hosts. Alfalfa dwarf is caused by the same virus the produces Pierce's disease of grape vines. The Green Ring Mottle virus of sour cherry is carried without symptoms in sweet cherries, apricots, plum and peach. Elm mosaic has been transmitted to peach with symptoms resembling peach rosette mosaic disease. Peach rosette was shown residing in red maple and recently Kirkpatrick in Wenatchee found tobacco mosaic in symptomless apple trees.

Some latent viruses are important to consider in disease control and others may be of small consequence. Cherry Yellows virus ruins a peach tree and also Italian Prune for productive purposes but it does not occur naturally on peach or Italian Prune in Michigan but does jump from cherry to peach in California causing the disease known as peach dwarf.

What about the increasing number of new viruses we hear about? Are they really new? This is hard to determine for viruses can mutate. But many are old viruses that are now recognized following more intense, directed observation. These old viruses may be new to a district or new to a crop. New varieties of plants are shipped around the world with the speed of jets. New crops are grown intensively in the various countries. A new disease appeared on Cocoa in west Africa and threatened to ruin their industry. This virus disease, called Swollen Shoot, was found to spread from certain plants of the native vegetation. It was a new disease but not a new virus. The stem-pitting virus of apple has been demonstrated present in about 40 percent of the apple trees of the average orchard. It was only discovered when we started topworking the varieties Hyslop and Virginia Crab that happen to be susceptible to this virus. Discovery of the virus causation of stem pitting explained what in this instance was considered incompatibility.

Once inside a plant the virus can't get out and spread without help. Probably every virus that has been perpetuated has a vector, such as an insect helper that spreads it from plant to plant. A very few viruses are spread by pollen transmission and a few by seed. A few are spread under favorable conditions by rubbing juice from an infected plant to a healthy plant. The surest method of spread is by vegetatve propagation, such as division, cuttings or grafts. By this means the propagator can unwittingly spread latent or faintly perseptible but potentially destructive vriuses. I will cite a few examples.

Green ring mottle of sour cherry is symptomless on peach. It was known to be widely present and symptomless on sweet cherries but a survey of peach for this virus was neglected. I encountered this virus in peach 12 years ago when attempting to inoculate little peach virus into sour cherry. The cherry did not get little peach but all five inoculated trees showed the typical green ring mottle. I then inoculated back from cherry to peach to see if little peach and green ring mottle were caused by the same virus. They weren't. Meanwhile Dr. Fridlund of Prosser, Washington was indexing peach and other stone fruits for virus freedom and found green ring mottle well distributed as a latent virus in peach and apricot. He couldn't find a Sunhaven, Richhaven, or Rio Oso Gem peach free of this virus. We verified his findings and also found green ring mottle in one or two other new varieties considered for introduction through our peach breeding program. We are now indexing all introductions from our South Haven station.

Buds of Sunhaven and Richhaven have gone out from Michigan all over the world to peach growing areas. Perhaps green ring mottle has always had a world wide distribution but if it hadn't it has now. Stanley Johnston, our peach breeder, wrote to the leading fruit breeders of the U.S. and Canada asking if they were indexing their introductions for virus. None of them were.

Two years ago Dr. Mulder of Holland asked if I had Golden Delicious scions free of Rubber Wood virus. It appears that Golden Delicious scions first into Holland were grafted to a local tree to get a rapid increase. The local tree had rubber wood virus and all the Golden Delicious trees in Holland then carried that virus. We learn the hard way.

How can we circumvent the latent virus problem? In stone fruits we find some varieties that react visibly and clearly to several viruses. A minimum number of host plants to divulge all known stone fruit viruses consists of ten specific varieties. The host range originally suggested is Elberta, Montmorency. Bing, Napoleon, Lambert, Kwanzan, Shirofugan, Italian Prune. Shiro plum and Tilton apricot. Several substitutions and omissions have since been proposed.

There is an interregional stone fruit virus project known as IR 2, headed by Dr. Paul R. Fridlund at Prosser, Washington. The objective is to find and maintain virus-free clones of all fruit varieties. Every worker who had a clean variety sent it to Prosser where it was reindexed on the host range. Each variety that indexed free was established in an isolated location where it can't pick up viruses from outside sources. Scion wood from these elite, virus-free trees are distributed on request to experiment stations for further increase and eventual distribution to nurserymen.

If you get this wood make sure it goes on virus-free stock. Mahaleb, Mazzard and peach root stocks can carry ring spot and cherry yellows that transmit through the seed. Virus free certified seed and seedlings are becoming available.

We hope that apple certification will soon be perfected.

What can the propagator do about viruses? He should be alert and aware of the virus problem and propagate from virus-free stock when it is available.

BEN DAVIS: Is crown gall of peach caused by virus?

PROF' CATION: Crown gall is caused by a bacterium that can also live for some time in the soil, even in fallowed soil. It is controlled by dipping the seeds in calomel suspension before planting, by rotating with grain crops, etc.

BEN DAVIS: We had 50% gall in our peach. The following year a nematocide reduced gall remarkably.

PROF. CATION: This is noteworthy and should be followed experimentally.

JERRY VERKADE: Can viruses be combatted with chemicals or sprays?

DR. CATION: Outside of insect control in certain cases, no. Some success is obtained with certain viruses by treating with heat. This has given virus-free trees for increase.

MR. FILMORE: We are experiencing late summer defoliation of Kwanzan cherries and certain ornamental malus. A spray program was successful on the cherries but not on the malus. Where can plants be sent for indexing?

DR. CATION: I would suspect this is spray injury or apple scab rather than virus. Workers currently indexing for apple viruses are Dr. Gilmer, Geneva Station, N.Y.; Dr. Ralph Shay, Purdue Experiment Station, Lafayette, Indiana; Dr. Gaylord Mink, Irrigation Station, Prosser, Wash.; and Me at Michigan State University, East Lansing.

DR. REISCH: What is the potential for reinfecting disease-free stock?

DR. CATION: It varies with the vrius, the crop and the isolation. Sour cherries, with 1/4 mile isolation from cherry yellows have remained free for 13 years. We hope to get a tree to full size and bearing before virus hits. A young tree with this virus is practically hopeless. For asters, another virus, aster yellows is prevalent in nearby weed hosts. Asters had to be grown under cloth to keep out insect vectors. Now we have resistant varieties. The same disease on head lettuce was reduced by spraying the edge of the field with parathion.

DR. MAHLSTEDE: Certain viruses can be eliminated by growing the plants under extreme heat. The tip of the plant is then excised and forced into growth, free of virus.

MR. NORDINE: Can you distinguish aphids, virus or other insect symptoms on leaves?

DR. CATION: Usually, yes. Occasionally this is difficult even for experts. Quince rust fungus on Delicious apples looks like aphid injury. Mineral excess or deficiencies may result in virus-like symptoms.

PRESIDENT ROLLER: Going now to Hans Hess for a report on the discussion of timing to take cuttings.

HOW CRITICAL IS TIMING IN TAKING CUTTINGS?

DR. F. O. LANPHEAR, *Moderator*
HANS HESS, *Recorder*

We had a very interesting discussion on how critical is the time of taking of cuttings. To begin with Dr. Lanphear from Purdue presented some general facts on a few of the difficult-to-root plants and the critical importance of timing in the taking of cuttings of these. Two examples that he gave were the umbrella pine — as you all recall Sidney Waxman a few meetings back told us about taking cuttings on certain time in late March to get good rooting. The time was very critical, a few weeks prior or a few weeks past the optimum time the rooting difference was terrific. Good rooting at the proper time and practically no rooting if it were too early or too late. Another thing that was mentioned by Dr. Lanphear were the deciduous azaleas which are very critical in the timing as far as taking cuttings to get successful rooting. Another example of timing and the use of supplemental lighting was brought out. The fact that Japanese yew cuttings taken in late winter and given supplemental light. The light promoted growth and the cuttings were actually retarded in rooting from those that were given no light. The conclusion here was that dormancy is beneficial for good rooting of Taxus.

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Timing, it was brought out, must be determined for different species of plants. One member stated that he had faster rooting of junipers taken in February than those taken in November. Another said he had good success taking the same juniper variety in July. Then we had another gentlemen who contributed this statement, that he had good success with cuttings taken in November or February as long as he was willing to wait long enough. Hemlock was reported to give no rooting except when taken in March, similar to the umbrella pine. And this indicates another plant which is very specific as far as timing is concerned. The use of forced cuttings from plants brought into the greenhouse in late February or early March giving 90% rooting in about four weeks indicating again that timing important was discussed. The azaleas were brought into the greenhouse and laid on their sides to force a large number of cuttings.

It was brought out that timing must be scheduled according to each season, rather than any specific calendar date. For example, during a dry season cuttings would be harder and therefore would have to be taken earlier to get good rooting success.

A very interesting discussion came up between Jack Hill and Roland DeWilde as to how you determine the proper time a cutting was in optimum condition for rooting. Roland gave a very good answer to Jack. He said I don't know exactly how I tell but, "I just look at them, squeeze them a little bit, and it's either too hard or it's just right or it's too soft. I don't know how, but I can put my fingers on it." So there I think it is a case of a man having a number of years actual experience in propagation before he is really qualified to determine whether a cutting is in the proper condition. You have to work under some body like Martin Van Hof or Pete's father or somebody like that.

In summarizing we must determine timing not by the calendar but by the season and by the varieties we are working with. We can not at this time by chemical analysis determine whether the cutting is in optimum condition or not. That will probably come. But for the present we have to use the old rule of thumb method, go over and get a hold of the cutting and bend it a little bit to know whether it is right.

PLANT PROPAGATORS' QUESTION BOX

MODERATOR ROLLER: The question and answer part of our program will be conducted by the moderator of all moderators, Mr. Hugh Steavenson.

HUGH STEAVENSON: We have a number of questions here and we've got a whole room full of brains to answer them. The first question is "Has anyone grafted the dove tree (Davidia) on *Nyssa sylvatica?*"

JOHN VERMEULEN: We have tried it a number of years ago and had no success. We had some callus but they did not unite in the proper way. They lived for a while but were dead about six months afterwards. We tried it for two seasons and gave it up.

HUGH STEAVENSON: Why not graft the dove tree onto the dove tree?

CASE HOOGENDOORN: You can grow Davidia from seed but it is a very difficult process. Al Fordham told us how to do it. He said to keep the seed for 3 months in the greenhouse at 60° - 70° F. and then you sow them. And we had them. We potted them in 2½ inch pots and they grew probably four inches high. Then we planted then out in the spring and had a hard wind and lost all but eighteen.

JEORG LEISS: We had Davidia from Holland and they were all layered which may be the best way.

HANS HESS: You fellows in Canada are lucky. You get them in from Holland and they don't gas them. When we get them from Holland, they are gassed and all die.

CASE HOOGENDOORN: If they come from layers, we should be able to root them some day because they go on their own root. But in this great country layering is out of the question.

MR. LOWENFELS: I got this right from an expert in the city of Rochester. He said freeze the seeds and let them freeze hard, plant them outside if you want, and they will come up in the spring and you will have Davidia.

MODERATOR STEAVENSON: Has anyone compared chloromone with indolebutyric acid?

HANS HESS: When I first got a sample of chloromone I put it on the shelf thinking that here is another batch of stuff that might be well to forget about. We had a batch of *Ilex glabra* cuttings we are putting in and I thought well I'll see how good this stuff really is, so I dipped the cuttings in the full strength chloromone (these were dormant cuttings not summer cuttings). I was amazed about 3 weeks later. I took a couple of cuttings out and they were virtually exploding with roots. There is no two ways about it, they rooted 100% and they had a mass of roots. There has been a lot of adverse talk about it. Charley Hess analyzed it and it is a high concentration of naphthaleneacetic acid. The material does work well on dormant cuttings of all Ilex varieties. It also works well on Taxus and on Pfitzers. If you mess with the stuff for a while and dilute it for various varieties so it doesn't burn, it gives good rooting results and it gives them consistantly. Now this is my own experience, I know others have not been as successful. It's just a question of finding out how much to use and when to use it and what type of cuttings. Also when you put the cuttings in, instead of dipping them an inch or an inch and a quarter into the solution, just dip in about a quarter of an inch of the cutting into the material and that is all that is necessary.

PRESIDENT ROLLER: I'd like to go along with Hans. I've always had the stable stuff and have used it on hundreds of thousands of cuttings with this reservation. That it is more effective on the broad leaved evergreens we grow in the south than on the conifers. We use it on our regular production have for several years.

PETER VERMEULEN: Dr. Cathey mentioned last January at our New Jersey meetings that he used chloromone on soft wood *Rhododendron Roseum elegans* cuttings and got amazing results.

CASE HOOGENDOORN: I've had a wonderful experience! I bought a bottle of this chloromone one time and next thing I had an inspector from the food and drug come in. He said did you buy any of this chloromone? I said, "Yes, I did." He said is it any good? I said I tried a little of it, and up to now I don't think much of it. He said where do you get it from. Well, I think it was in Jersey some place. And he said, would you mind giving us this bottle. They want to prosecute the people for misrepresentation. He said how much did you pay for this bottle. I said three dollars. He said would you mind giving us this bottle for three dollars. I said, no, go ahead, it's no good anyhow.

Anyhow, we have had a lot of trouble rooting *Taxus repandens,* and last year I got a brainstorm. I dipped those repandens in chloromone and #3 powder. Then we stuck them in peat and perlite. As we were sticking them a fellow came in and said "You sticking them in peat and perlite?" I said well there's nothing like trying. He said we've done a lot of them and they all rotted. Well, that didn't sound good. Well we had some also in peat and sand. Most of them were in peat and perlite and we lost them, but the few we had in peat and sand, rooted heavily. And it was straight chloromone and #3 powder and that's how we're going to stick them now.

MODERATOR STEAVENSON: Now that we have taken care of chloromone, is there a difference between using IBA in powder form or as a liquid dip?

DR. HESS: We have tried this comparison a number of times and using the same concentration of IBA in talc and in the liquid form, we found the liquid form was much more effective, giving higher rooting results. I think there are several reasons for the better results with concentrated dip. First the IBA is dissolved in the concentrated dip so that it can enter the plant directly, second on cuttings with smooth stems you get a good film of IBA whereas with talc much of the material falls off, and third, I feel you get a more uniform coating. For example, when you stick a group of cuttings in talc it is not likely to flow around the cuttings as easily as a liquid will. But whatever the reasons may be, the results have consistently been in favor of he concentrated dip. There are disadvantages in that the concentrated dip is not available commercially so you have to prepare it yourself.

VOICE: How do you calculate the strength?

DR. HESS: We use a range of concentrations, starting with 0.2%, 0.6% and going as high as 1.0% active material. A one percent concentration would be one gram of indolebutyric acid in 100cc of 50% alcohol. When preparing the IBA it is important to dissolve the it in alcohol first because it is not very water soluble. The procedure for the 1% concentration would be to take 1 gram of IBA and dissolve it in 50cc of methyl or ethyl alcohol and then add enough distilled water to make a total of 100cc. The cuttings are dipped in the solution for 2 - 3 seconds and are then ready for sticking.

Another disadvantage of the concentrated dip is the chance for the transmission of disease. I am not sure how serious this problem is since the 50% alcohol solution should not support the growth of too many organisms. Two other points, is that you should prevent the evaporation of the solutions. Don't let them stand open for long periods of time, because the concentration of the alcohol will drop, and if it gets too low, the IBA will not stay in solution, particularly if you use high concentrations. Finally, it is best to store the IBA solution in a dark bottle and keep it in a refrigerator when you are not using it so as to prevent deterioration of the IBA either by light or high temperature.

JEORG LEISS: Can you add fungicides?

DR. HESS: Yes, this is possible.

MARTIN VAN HOF: Charley, you mentioned the 0.6% concentration. Can't we use #1 hormodin?

DR. HESS: No, Number #1 is 0.1% IBA, No. 2 is 0.3%, and No. 3 is 0.8% IBA.

MARTIN VAN HOF: I thought that No. 2 was 0.6%.

VINCE BAILEY: I would like ask Charley if he finds the concentrated dip more effective than the soak?

DR. HESS: Vince, we have not made a comparison ourselves since most propagators are reluctant to make their cuttings, and then let them soak in an auxin solution for 18-24 hours before sticking. They rather treat them and stick them in the bench right away. However, I know at least one case where an excellent response is obtained with the soaking technique. This is Hudson Hartman's work with hardwood pear cuttings. Hardwood cuttings are difficult to treat since materials do not move in too readily and by using the soak there is more time to get the active material into the cutting.

VOICE: Can you use quick dip on heavily wounded rhododendron?

DR. HESS: Yes, I see no particular problem here.

ROLAND DEWILDE: The problem we found was variation in humidity. One day we may have 25% humidity and the next time it may be 75% and obviously the rate of evaporation is going to vary and so will the uptake of the solution. So each day the uptake may be a little different from the day before. When they put talc in we didn't have this problem. Also I am under the impression that by use of the talc made it a little more tolerant to overdosage and burning was not so severe a problem.

DR. HESS: Roland, I believe that the reason the talc seems more tolerant is that at a given concentration it is not as effective as the concentrated dip. If you have good results with 0.3% IBA in talc and then use the same concentration with the concentrated dip you may get some injury because you are getting more efect out of the IBA you are using.

TOM PINNEY: Some one mentioned the use of carbowax. We found this very effective. You have no problems of evaporation as with alcohol. We use carbowax 600 and you can buy it for a couple dollars a gallon and you can go as high as 10,000 ppm active material without any trouble. Then you can add water to get the proper dilutions.

MODERATOR STEAVENSON: What is the most effective control of white fly in the greenhouse?

HARRISON FLINT: There are a number of materials that can be used, but the important factor is several repeated sprays. Three of four successive times at four day intervals.

MODERATOR STEAVENSON: Should crab apple grafts be coated with wax to increase their stand in the field?

MARTIN VAN HOF: We wax all our grafts, we dip them right into the wax. We store them away in peat, put them in a cooler, and put them out as soon as the ground opens up for the March planting. And we have excellent results.

HANS HESS: I woud like to say something about the use of wax on grafts. The use of wax has been in our experience not beneficial. When the grafts are planted out and are just starting to develop along comes a 85° F. temperature. Right at the soil level the wax melts and girdles the scion and that's the end of the plant.

CASE HOOGENDOORN: You plant them too late!

HANS HESS: No sir. We don't plant them too late. But when you plant them and the wax melts in the sun you have trouble. Maybe where you are you have cooler air, but where we are, we have trouble.

BEN DAVIS: We graft a lot apples both fruiting and flowering crab, and we don't use any wax at all. We just use the regular grafting tape. We plant the graft union below the soil and cultivate up so only an inch or a half-inch of the scion is exposed. That seems to work best for us.

MODERATOR STEAVENSON: Can some one give us some information on the use of B-9 for rhododendrons, the strength used and time of application, and also the results.

DR. MCGUIRE: It's difficult to recommend a special time by the calendar, it depends upon the stage of growth of the plant. When the flush of growth is in a semi-hard condition this is the time to treat them. You can use the first or second flush. We have used a half percent and three-quarters percent and haven't seen any difference between the two. As I said we apply it in the semi-hardwood condition and then apply it again ten days later, because, of course, not every shoot on each plant is in the same stage of development. I will say that in the field we find quite a bit of variation from plant to plant. We have not had as good as result as compared with the container plants. On containers we can put buds on quite effectively.

MODERATOR STEAVENSON: How can we pack lilac liners in poly bags and still callus the grafts?

MARTIN VAN HOF: I don't think the poly bag has an effect. It is the temperature. Don't put them in a cold, you know, put them in a greenhouse.

DR. CHADWICK: You can cut your scions early, before the rest period is broken, make the grafts, put them in polyethylene, and store them at about 60 degrees for two weeks, and after they have started to callus, then put them back at the low temperature.

CASE HOOGENDOORN: Yes, but when you callus them don't you force growth into the scion?

DR. CHADWICK: No, not if you cut the scions before the rest period is broken.

MODERATOR STEAVENSON: How important is shade in the rooting of softwood cuttings and when should it be taken off?

MR. LESLIE HANCOCK: Shade is all important unless you have mist. You take it off once the cuttings are rooted, but you can't take it off all at once, there must be a transition shade.

PETE VERMEULEN: We put shade over our open mist beds this year. We used 20% shade. We got this figure from Charley from some work he did at Cornell as a graduate student some 8 or 10 years ago. We found very good results with it. I don't say we rooted cuttings any better than we did before but it was real good. It was sort of like the Nearing Frame. We put the shade over the mist bed and hung it over the south side, so that we got a lot of light from the north but no direct sunlight.

MODERATOR STEAVENSON: This question is directed to Henry Homer Chase. Is your layering technique useful in areas other than Chase, Alabama?

MR. GERALD VERKADE: I would say that it is not restricted to Chase, Alabama because we layer in Connecticut and I've seen it in Cleveland.

MODERATOR STEAVENSON: Has any one had experience with nutrient mist?

ROLAND DEWILDE: I never used nutrients in the mist system but I did feed the cuttings one time while under mist. You really had a big problem even putting it on in low concentrations. You get a green slime over your sand, and then on the cuttings. I lost more growth than if I had waited until first potting the cuttings.

JOHN VERMEULEN: We have for the first time used nutrients in our mist. We have found it very effective in holding up the foliage in our deciduous cuttings. There was no yellowing. We found that they rooted sooner and they started to grow more than at any other time. I do not know exactly the strength but I believed we used 20-20-20 at about a teaspoon per gallon. We put it on two days in succession and then switched to other beds and kept switching until the cuttings were rooted.

MODERATOR STEAVENSON: This is for Bob DeWilde. What fungicide do you use for dipping your lilac grafts?

ROLAND DEWILDE: I believe he used Captan.

MODERATOR STEAVENSON: What type of cuttings should be used for clematis?

WILLIAM CUNNINGHAM: We utilize the double node system for all clematis cuttings. The percentage of rooting is 95% and in some cases 100%.

CASE HOOGENDOORN: Including Jackmanni?

WILLIAM CUNNINGHAM: Including Jackmanni. Using the double node system we can root Jackmanni 100%.

AL LOWENFELS: When do you take the cuttings and what hormone do you use?

WILLIAM CUNNINGHAM: All of our clematis rooting is done during the summer months because that is the only time that we have greenhouse space. Six months of the year we are rooting mums. We use Charley Hess' quick dip No. 2 (0.2% IBA in 50% alcohol).

BEN DAVIS II: What stage is the wood in when the clematis cuttings are taken? Is it mature and brown or is it real soft and thin, or is it the light green wood that's in between these two groups?

WILLIAM CUNNINGHAM: We take approximately four flushes of cuttings each summer. We use the blooming time as a guide to start on the blocks. The cutting wood is soft and the buds are showing at the leaf axils. We prefer soft wood. As the season goes on, and if you miss a flush of growth, the wood becomes hard and your percent rooting goes down.

DICK VANDERBILT: Bill, how do you overwinter the cuttings?

WILLIAM CUNNINGHAM: About this time of the year the clematis becomes dormant and some varieties have fall color like the trees. They become hard and the buds are initiating in the leaf axils. At this time of the year, and for the next two or three months, we wrap the clematis and put them in refrigerated storage and hold them in a dormant condition. They are already potted before storage and are wrapped in foil.

MODERATOR STEAVENSON: How do you explain increases in carbohydrate and N, P, and K under mist?

HAL TUKEY: The increases you saw in the slide of mineral nutrients are experimental error. Most of the increases are very small and are not significant. The increase in carbohydrates is just the growth of these very fast growing herbaceous plants. They continue to manufacture carbohydrates under mist very well.

MODERATOR STEAVENSON: This question is directed to me. What form of nitrogen do you use to take care of your saw dust mulch?

As far as nitrogen is concerned, whatever is the cheapest. Usually, around our way, ammonium nitrate is the cheapest form of nitrogen unless we used anhydrous ammonia. I should say that the saw dust is used as a mulch and is not worked into the soil. So the nitrogen is primarily put on to maintain a good nutrient level in the plant. The saw dust is not worked in until the soil is prepared for the next crop and by that time it is pretty well broken down. The next question is, "What causes large callus formation instead of roots? Should such cuttings be discarded or can callus be cut to induce rooting?" Charley?

DR. HESS: Actually this was discussed earlier in the evening. I believe Dr. Chadwick had worked on this problem and suggested that if the pH of the medium is too high, callus was formed instead of roots.

DR. CHADWICK: Callus is formed by proliferation of tissue either by the phloem or pericycle. In several plants, probably not all of them, high water content in the medium showed an increase in callus formation. Also, there has been an indication on some plants, particuarly Andorra juniper, that pH may regulate the size of callus. You seem to get a larger callus at pH values around 7.0 or 7.2 and more alkaline conditions and less callus at pH 6.5 and more acid conditions. As far as cutting off the callus is concerned, my personal experience is that it doesn't do much good. I think you get better results if you break it off with your fingers. If you try to cut it off you always leave some of the callus tissue there, and very often you just get a greater proliferation of callus.

PRESIDENT ROLLER: There is one other thing I found on some plants, particularly with certain junipers. The location on the plant from which the cutting is taken plays a role. Tip cuttings will give a large callus, cuttings from down in the body of the plant will give you roots.

CASE HOOGENDOORN: Dr. Chadwick, we run into this callus problem every so often. Could it be to over stimulation caused by too strong a hormone?

DR. CHADWICK: I cannot find any relationshio between the use of growth promoting substances and callus formation on the bases of cuttings, one way or the other.

MODERATOR STEAVENSON: How do you propagate *Ginkgo biloba* vegetatively?

HANS HESS: Ginkgo can be rooted from soft wood cuttings. Under mist they root fine.

DR. CHADWICK: You may want to go back to a thesis written by a man of the name Chadwick. He reported excellent results from Ginkgo softwood cuttings taken about the first of July.

MODERATOR STEAVENSON: Dr. Cation, what is the value of virus free stock to the nurseryman?

DR. CATION: Since we started distributing virus free bud wood to nurseryman they have far better stands of cherries, more uniform and a larger size than they had when they used wood that was contaminated with ring spot.

MR. VINCE BAILEY: I can only speak from experience. We use nothing but certified virus free scions and budwood. We think we are getting better stands and a little better growth.

MODERATOR STEAVENSON: Has anyone grafted *Acer griseum* on the Trident maple?

WILLIAM FLEMER III: We have tried it on *Acer tridens* but it doesn't work.

MODERATOR STEAVENSON: What is the best procedure for rooting crab apples?

ROLAND DEWILDE: I've been doing it for about five years. first experimentally, and now we do it regularly. The crab apples will root. We have a little trouble with *Malus baccata* because they are so subject to apple scab that it is hard to keep the leaves on. We have best results with fairly juvenile wood, such as the shoots from the sides of the older stem, the so-called sucker shoots. We make the cuttings 6 to 10 inches long and stick them in sand and use either Hormodin No. 2 or No. 3, depending upon how hard a particular cutting is. Even on one shoot, we may use No. 2 for the top and farther down use No. 3. It takes anywhere from 3 to 6 weeks to get roots.

MODERATOR STEAVENSON: My experience with rooting *Cotoneaster apiculata* and *C. horizontalis* have been poor. Could someone comment on a successful method giving time of year cuttings were taken, hormone treatment, medium, etc?

MARTIN VAN HOF: This is from Newport country — it is in the United States. The cuttings are taken in the latter part of July and treated with #2 Hormodin and are placed under intermittant mist. The medium is pure sand.

VOICE: We have had the experience that if the cuttings were taken too soft, they would root without trouble, but soon developed a root rot and were lost. Cuttings taken later, such as late July, rooted well and did not rot. I think we need a greenwood cutting rather than a softwood cutting.

MODERATOR STEAVENSON: When do you top work nut trees?

BEN DAVIS II: We found that we can top work just when the leaf buds start breaking open. We even top-work successfully when the plants are in full leaf or almost in full leaf.

MODERATOR STEAVENSON: What effect does stock plant nutrition have on the rooting of cuttings? Is rooting improved?

PETER VERMEULEN: Definitely!

MODERATOR STEAVENSON: When irrigation is used to prevent frost damage, should it be left on until warmer temperatures return?

GERRY VERKADE: I have used irrigation on *Pyracantha* in containers. We brought them out of storage and they were breaking into growth. Then we had a frost. I put the water on, and kept it on, until all the ice was off.

HANS HESS: I might add to that. We had an early frost this fall. We had cuttings in the mist bed and didn't want them damaged. So we turned the mist lines on to run continuously. It ran all night and the next day until the ice melted off. The plants were not damaged with the exception of two flats of azaleas which were under a line that was not turned on.

DR. CATION: I think it is well established with strawberry growers that they leave the water running until the danger of frost is completely past. When they shut it off too early, the low temperature goes right through the ice and kills the blossoms. It's best to keep the water running. There is little or no insulation value in ice.

MODERATOR STEAVENSON: At what point should the mist intervals be decreased?

CASE HOOGENDOORN: When the cuttings are rooted.

MODERATOR STEAVENSON: What is the best spray program for the control of apple scab?

DR. CATION: The best material for apple scab is Cyprex. Cyprex not only eradicates the scab lesions, but it also prevents the formation of secondary spores from leisons already established on the leaves. The recommended dosage of Cyprex is one half pound per hundred, but growers have been using 3/8 of a pound and some are getting down to a quarter of a pound.

SATURDAY MORNING SESSION

December 5, 1964

The Saturday morning session convened at 9:15 a.m. Mr. Judson P. Germany, Jr., Germany's Nursery and Landscape Co., Fort Worth, Texas was moderator.

MODERATOR GERMANY: Our first speaker this morning is Dr. Gustav A. L. Mehlquist from the University of Connecticut.

SOME POINTS TO CONSIDER IN THE BREEDING and PROPAGATION OF RHODODENDRONS

GUSTAV A. L. MEHLQUIST
Plant Science Department
University of Connecticut
Storrs, Connecticut

Most nurserymen who have tried to carry a reasonably complete line of Rhododendrons and Azaleas have probably found, first, that a fairly large number of varieties are required and, secondly, that in the Northeast at least it is difficult to obtain dependable varieties in each category. Assuming that one wishes to provide at least four colors say — red, white, pink, and blue (lavender) during the main flowering season, it would be necessary to have an early, a mid-season, and a late variety in each color. This alone would bring the number to twelve; and if one were to consider having each of these in a dwarf, a medium and a tall variety, the number would rise to thirty-six. One need only to be aware of the fact that there is considerable variation in texture and flower size to realize that a really complete assortment of varieties would be large indeed.

Unfortunately, it is difficult to find dependable varieties in all these categories. Of course, it is also difficult to define dependability accurately, but if with "dependable" one means a variety which will be bud and plant hardy in any winter regardless of when and where it is planted, very few varieties, if any, will meet the specifications. To make the nursery production of Rhododendrons profitable, nurserymen often attempt to obtain additional flushes of growth in order to produce a large plant in a relatively short period of time. It has been my experience that plants which have been given enough water and fertilizer in the field to make two flushes of growth in a season instead of the usual one are much less cold hardy than those which have made only one. This applies to both plant and bud hardiness. If, in addition, such soft nursery grown plants are planted in the garden in the fall, in a fairly exposed place with insufficient protection against wind and sun, the results are not likely to increase the sales of rhododendrons. It may be expedient for the wholesale nurseries to get their stocks distributed to the retail outlets in the fall but, in that case, the plants should be held under protection until spring when planting can be done more safely.

With the variation in climate which exists in southern New England (and probably most other areas) from season to season, place to place and garden to garden, it is no wonder that nurserymen have tended to stick with those varieties and forms which show the greatest amount of hardiness regardless of other qualities. This desire to save replacement costs has resulted, in our area at least, in the use of large numbers of collected plants of *R. carolinianum*, *R. catawbiense* and *R. maximum* as well as seedling plants from the hardier hybrid clones. Together with the fact that some of the most desirable clones are difficult to propagate, this has led to a situation where many of the better clones are not readily available.

I do not mean to imply that it is necessarily bad to sell the public collected or seed grown plants of our native species whether it be *R. carolinianum*, *R. catawbiense*, *R. maximum* or what have you, but I do mean to say that the forms usually offered in this group often are uninteresting, to say the least, and not likely to enhance anyone's interest in the genus *Rhododendron*. This is unfortunate, for not only are these species in their best forms good landscape plants, but they are the backbone of any breeding program aimed at the production of really hardy rhododendrons.

Of course, if a good range of color and types were available at a reasonable price in perfectly hardy and dependable clones, there would be little interest in the ordinary forms of these species. Since this is not the case, the problem becomes one of improving the offerings in this group. Do not misunderstand me, I am not against the great effort now being made to produce better hybrid clones, for actually I am one of those working with this problem, but this will require a good deal of time. Efforts to raise the quality of seed-propagated plants will not only help to fill a void but will also help to hold the public's interest in this remarkable genus until suitable clones are generally available. It is with this objective in mind that the following notes were prepared.

When a population of plants is raised for the purpose of using the population as a whole rather than for the selection of a few to be propagated as clones, it is generally desirable that the population be relatively unform and, of course, of sufficient overall quality to be used as a whole. To produce such populations two conditions must be met. First, the genotypes of the parent plants must be such as to be capable of producing the required quality. Generally speaking, the higher the quality of the parent plants the higher the likelihood of obtaining high quality progeny. The old proverbs "like begets like" and "the apple does not fall far from the tree" are indeed based on factual observations. Homozygosity, on the other hand, is harder to come by; and complete homozygosity probably never obtains, but ordinarily species come closer to homozygosity than any hybrid. Consequently, crossing two species or a species to a hybrid is more likely to produce a reasonably uniform group of plants than any combination of hybrids. Picking the right parent to produce whatever the objectives call for requires experience and knowledge. Probably no one hits the jackpot every time, but close attention to available information and good judgment help to insure success. In this connection it should be pointed out that good judgment is usually nothing but paying close attention to the nature and behavior of the available parent material and acting accordingly. With behavior I mean not only the individual behavior of prospective parents over several seasons but also the results from crosses, for in breeding work a good parent is one that produces good progeny. If combinations of the worst looking rhododendrons in the world produced good progeny, they would have to be considered good parent. Fortunately, the objectives and circumstances limit the choice of prospective parent plants considerably. For instance, if the objective is to produce a population hardy enough to be grown in the Northeast, there are not many species that qualify. Among them, however, are three American species, *R. carolinianum, R. catawbiense* and *R. maximum* all of which are good parent species provided the right forms are used. Since lepidotes *do not ordinarily cross with elepidotes*, *R. carolinianum* is at once seperated from the other two, both of which are elepidotes. If, in addition, wind and heat resistance is desired in the progeny, *R. catawbiense* is to be preferred since it is superior to *R. maximum* in this respect. On the other hand, if late-flowering hybrids are desired, *R. maximum* is superior to *R. catawbiense*. Needless to say, the best form of the species should be used or rather the one best suited to the objectives of the cross.

Selecting the hybrid parent is more difficult, and it pays to obtain as much information as possible pertaining to cultural characteristics, breeding behavior, etc. Little is known about color inheritance in the genus *Rhododendron;* but the more that is learned from various other genera, the more apparent it becomes that certain results are the same for many different genera. Thus, in general, if both parents are of the same color, all or most of the progeny will be of the same color, the remainder being usually recessive forms. If, on the other hand, the two parents differ widely in color, the progeny may be intermediate, like one of the parents, or different from both. Recessive forms (dwarfs, albinos, light-colored flowers, etc.) often give the same results in cross-breeding as the normal forms since the recessive genes of one parent may be counteracted by normal genes of the other. A most striking instance of this is when two pure-breeding albinos produce nothing but colored

* **lepidotes,** scaly-leaved rhododendrons
elepidotes, non-scaly-leaved rhododendrons

progeny when crossed, due to complementary action of the genes.

To illustrate some of the principles set forth above, let us consider a few crosses to meet certain objectives. Since red-flowered Rhododendrons are so much in demand today, let us start with this color. There are no really red hybrids dependably hardy for this Northeast area, but there are several such as 'Mars,' 'Vulcan' and 'Jean Marie Montegue' which will survive in sheltered locations. The so-called hardy reds such as 'America,' 'Atrosanguinea,' 'Kettledrum,' 'Nova Zembla,' etc., are really deep pink or cerise. Any one of the three first named crossed to one of the reddish forms of *R. catawbiense* would be as good a bet as any. Although even the reddest forms of this species are not really red compared to the first named hybrids, they are nevertheless dependably hardy. The resulting populations would undoubtedly be highly colored, deep pink or almost red, of reasonably good habit and far superior to the commonly sold collected forms of *R. catawbiense* but perhaps not quite so hardy. A more highly colored progeny but somewhat less hardy might be obtained by crossing either 'Mars' and 'Vulcan' to such acknowledged standbys as 'Atrosanguinea,' 'America' or 'Nova Zembla'. Such crosses, however, would be likely to produce less uniform progeny, but the chances are that most of the plants would be saleable.

White-flowered progeny of good merit might be had by using one of the white forms of *R. catawbiense* such as 'Catalgla' or perhaps better 'LaBars White'. Since all the white forms of *R. catawbiense* that have been discovered to date have a rather poor growth habit, it would be advisable to cross them to hybrids of better habit though probably less hardy.

Likewise, bluish or lavender progeny might be had by crossing such hybrids as 'Blue Peter' or 'Purple Splendor' to a bluish form of *R. catawbiense* or to such hardy hybrids as 'Purpureum Elegans' or 'Purpureum Grandiflorum.' There are very few good pink-flowered forms of *R. catawbiense,* and most of them are not free from bluish overtones. If they are crossed to clear-colored hybrids they might produce some plants with muddy-pink flowers, but even so, the chances are good that the plants as a whole will be better than most collected plants.

Since most forms of *R. catawbiense* flower in mid-season, most hybrid progenies with this species as a parent will also tend to flower in mid-season. If a late-flowered progeny is desired, it would be better to use *R. maximum* which also is available in many color forms. 'Russell Harmon' allegedly a natural hybrid between *R. catawbiense* and *R. maximum,* and in itself a pretty good rhododendron, might also be of value in this connection.

R. carolinianum being a lepidote (scaly-leaved) does not cross readily with the elepidotes (to my knowledge only one such hybrid is known) and, as a matter of fact, it does not cross readily even with other lepidotes to give large hybrid populations. Since it can be grown to flowering size from seed in only three ot four years, selfing the better forms would be advisable. Many of the better forms of this species come relatively true from seed, and saleable plants can be produced very reasonably.

Dwarf and especially semi-dwarf rhododendrons are much in demand today, and although it probably will not be easy to produce uniform hybrid progenies of this type, it is well worth trying. There are compact forms of *R. catawbiense*, but, unfortunately, they tend to be of rather harsh colors. The hybrid 'Boule de Neige' is a good semi-dwarf which tends to transmit its compact habit to its progeny. Because some of its seedlings do not flower readily at an early age probably due to it being of *R. caucasicum* ancestry, this hybrid should be mated to something which tends to impart floriferousness to the progeny. A much heralded Japanese species *R. Yakusimanum* looks very promising, but due to its scarcity it has not yet been utilized to any extent except by people who are primarily interested in the production of fine hybrid clones.

There are undoubtedly many other Asiatic species which could be used in similar manner, but as yet I have not had sufficient experience with them to warrant making any definite suggestions.

What I have said about the typical rhododendrons might well apply to that section of the genus known as Azaleas as well but, since plants in this group normally produce larger numbers of cuttings, the incentive to grow large hybrid populations except for the purpose of producing new clones is not so great. However, some of the deciduous types are not so readily rooted from cuttings so their seed propagation based on the principles stated above might be advisable.

The question is often asked as to the direction in which a cross should be made. Although there are some authentic cases in which the results are different depending on the direction in which the crosses are made, by far the greatest number of crosses give identical results regardless of whether a parent is used as seed or pollen parent. However in practice it pays to take advantage of the fact that some forms of species and many hybrids produce pollen sparingly but set an abundance of seed when pollinated with good pollen. Thus, when 'Mars' and 'Vulcan', which I regard as good parents in the production of highly colored hybrids, are pollinated with pollen from many hybrids and species they will produce an abundance of good seed but when the pollen from these hybrids are used the result is much less seed. In other words some forms and hybrids are what the plant breeder would call good receptors but poor donors.

There are also instances when certain plants will not produce seed freely in combination with certain individuals of the species but will in combination with others regardless of the quality of the pollen. This phenomenon which is known as incompatibility occurs in the genus *Rhododendron* but is not widespread enough to interfere seriously in the production of large hybrid populations as outlined above.

MODERATOR GERMANY: Our next speaker is a very erudite gentleman who recently, I understand, celebrated the 100th anniversary of his firm. This morning he is going to give us a talk on chemical weed control in seed beds, Mr. Tom Pinney, Jr.

CHEMICAL WEED CONTROL IN THE SEEDBED

THOMAS S. PINNEY, JR.
Evergreen Nursery Co., Inc.
Sturgeon Bay, Wisconsin

Hand weeding of seedbed areas is a costly operation. It will reduce our firm's profits this year by $4,435.13. This figure represents only the direct labor costs and doesn't include applicable overhead items such as social security, workman's compensation, group insurance, etc.

Our cost estimating system reveals some rather interesting facts concerning the cost of hand weeding our seedlings. Although our field inventory showed we had approximately 5,750, 000 salable seedlings as of August 15th, 1964, past sales records and transplant production schedules indicated that we could expect to market or use only 3,450,000 of these seedlings. This represents just 60% of our original inventory! The difference is mainly caused by: a. over production of specific items due to lack of market forecasts, coupled with inadequate preparation and use of production schedules. b. destroying of desirable seedlings in the hand weeding operation. c. weed competition. d. winter kill. Since the field inventory includes one, two and three year old seedlings, the figure of 3,450,000 was developed with the assumption of one "turn" every 2½ years. Too often costs are developed, and then quoted, based on the total plants a nursery has to sell — rather than what will *actually* be sold or used.

If we include the overhead items applicable to this situation, we would need to add 7.0% to the direct labor charge of $4435.13. The figure would then amount to $4745.59. Since we estimated that we would sell or use only 60% of our inventory of 3.450,000 seedlings, the cost per 1000 plants would be $1.38 or approximately $1.40 per year. If the item is a two year crop — the cost would be $2.80 per 1000 and on a three year item — $4.20 per 1000 plants. This often represents 20% of the selling price. Looking at it another way, we have approximately eight acres in actual seedling production which means it costs us approximately $600.00 per acre, per year, to hand weed these areas.

Other than overhead, hand weeding is our most costly expense in the production of seedlings. Therefore several years ago it became apparent that we must consider a chemical weed control program for our seedling production. The development spread enough to interfere seriously in the production of large hybrid populations as outlined above.

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Other than overhead, hand weeding is our most costly expense in the production of seedlings. Therefore several years ago it became apparent that we must consider a chemical weed control program for our seedling production. The development of such a program will help us as a firm to achieve many of our goals such as: 1. mechanization of production practices to the highest level economically feasible. 2. the development and maintenance of a "team" of well paid, well respected, permanent key employees coupled with an ever decreasing number of seasonal, low paid laborers. 3. the continual striving for the quality plant best suited to meet the needs of a particular market in addition to 4. helping improve the image of the industry.

We have worked with a chemical weed control program in our transplant areas since 1954 and it has been a great success. We have approximately 70 acres of land containing 2,350,000 transplants under this program. In 1964 it costs us $3017.16 for this program including direct labor (both hand & chemical) and applicable overhead such as machinery depreciation, maintenance, etc. Past records indicate that 75 - 80% of this stock is sold or replanted. The approximate cost to us in 1964 for this chemical weed control program on our transplants was $1.75 per 1000 plants per year or $45.00 per acre per year! This is a tremendous savings over the $800.00 - $1200.00 per acre per year it cost to hand weed prior to 1954.

There has been a great deal of information published on chemical weed control in transplants compared to seedlings. The seedling areas add some problems and certainly require a more refined program. There are three general approaches to a chemical weed control program for seedbed areas: (1) Sterilization before planting the seeds (2) a pre-emergence program (pre-emergence refers to the weeds, not the seedlings) and (3) a post emergence program.

Since I am a nurseryman and not an expert in the field of chemical weed control, the comments which follow are observations and conclusions developed through working closely with the various university personnel in this field, discussions with fellow nurserymen and actual field tests conducted at our nursery. Therefore, much I have to say may be applicable only to our particular soils, climate and operation.

The sterilization approach has been used successfully for many years. There are two general categories — steam and chemical. The chemical category is typified by products such as Methyl Bromide, Vapam, Mylone, etc. The main advantage is that some of these chemicals kill soil born organisms such as nematodes and damping off organisms in addition to the weed seeds.

There are, however, several disadvantages. Steam sterilization is rather expensive and bulky to handle. The Dutch have developed an elaborate steam sterilization program utilizing the "steam rake" and other refinements. The normal sterilization process is not selective and destroys both the desirable as well as the undesirable organisms. A recently developed concept called "areated steam" may partially overcome this disadvantage.

Another serious drawback is the "blow in" problem. There is no residual effect to a sterilization program and thus the area treated may be re-inoculated by wind or other means. Most of the products used require, or give the best results, when tarped. Although this process is now mechanized, it is still costly.

Another disadvantage with chemicals in our area is that they must be applied when soil temperature are quite high, such as July and August, and left tarped until used in November, to prevent "blow in." The cost per acre of these chemicals and their application is $300.00 - $700.00 per acre and we can observe little control of weeds past the first year. It appears to us that this method at present is not too well suited to our particular seedling production program.

Our successful transplant chemical weed control program is basically of a pre-emergent type. It has the excellent advantage of being inexpensive. If we were able to secure somewhat near the same degree of control with chemicals in the seedling program as in the transplant program, it would cost us approximately $ .15 per 1000 per year as compared with $1.40 for the hand weeding operation. A further advantage is that the material can be re-applied as the residual decreases. The residual factor could be a disadvantage too. This can be largely overcome by laboratory and field experimentation which will determine the residual properties of a specific chemical. This means that one must then carefully select the proper chemical for a specific job.

Another advantage is that most of these chemicals have little effect on the soil organism "balance." Again this can be a disadvantage if it is necessary to control the pathogenic organisms present in the soil. A final advantage is the flexibility of such a program since there are more chemicals and combinations to choose from. It appears to us that this approach to a chemical weed control program in seedlings has some real advantage.

The third approach, post emergence, attempts to kill the weeds after they have germinated and started to grow. Stoddard solvent is a typical example. This approach has several disadvantages. One group of these are contact killers which burn off the young weeds and generally will burn most deciduous seedlings as well. Also this group has little or no residual effect. The second type, which generally kills by interference with some metabolic system of the plant, is not sufficiently selective to differentiate weeds from desirable seedlings.

Although we have continually experimented on a small scale with chemical weed control in seedlings, our first real concentrated effort was begun last summer. We gradually developed a plan of attack by first eliminating sterilization methods since they were rather expensive and difficult to program into our operation at the present time. It thus appeared that a combination of pre-emergence and post emergent method offered us our best avenue of approach.

The first step will be to eliminate all existing weed vegetation, especially perennials, by good rotation methods which in our case is a series of green manure crops of silage corn. This means we are planting into an area in which any future weed population would have to come from seed rather than existing roots.

Once the seeds were planted, and up to the time they germinated, the weeds would be controlled by a very powerful post emergence contact killer which has no significant residual properties to hinder germination of the seedlings. The chemical we plan to use in this phase is Paraquat at ½# - 1# actual per acre.

The second phase begins when the desirable seed germinates and the straw is removed, exposing the delicate seedlings. From this point on we will make use of a pre-emergence type chemical. Here is where most of our experimentation was centered last summer and fall. There is a wide range of chemicals to choose from. We selected five pre-emergence chemicals for study during the summer. Dacthal, Vegatex, Eptam, Propazine and Diuron. Dacthal should be applied at rates of 4 - 8# per acre. (all rates are actual) It is prepared as a 50 or 75% wettable powder and requires constant agitation. It has a very short residual and works best when soil moisture is adequate. Incorporation into the soil is of no benefit.

Vegatex (CDEC) should be applied at rates of 6 - 12# per acre. It contains 4# per gallon. It too has a rather short residual and works best when soil moisture is adequate. Incorporation into the soil may help.

Eptam should be applied at rates of 4 - 6# per acre. It contains 6# per gallon and performs best when worked into the soil. Treatment results have often been erratic.

Propazine should be applied at rates of 1# per acre. It is prepared as an 80% W.P. and needs constant agitation. It has a much longer residual than either Vegatex or Dacthal. Since it is slightly soluble in water, it doesn't move down into the soil where it could be absorbed by the desirable seedling roots.

Diuron should be applied at ¼ - ⅓# per acre. It is prepared as an 80% W.P. and needs constant agitation. It, too, has a rather long residual and doesn't readily move in the soil.

Some general observations from last summer's experimentation with the above chemicals indicate (1) Dacthal and Vegatex must be applied soon after germination of desirable seedlings since they are effective only on newly germinated weed seeds. Also one application apparently will not "hold" for the entire season. (2) Eptam gave good control in two year old seedlings that were cleaned of weeds and the chemical then applied. However, it had an effective residual of only two months. Also a later application of the same rate, and under generally the same conditions, was completely ineffective. (3) Propazine apparently works rather slowly as does it's relative Simazine. When Propazine was applied to the clean weeded two year seedlings it was slow to take effect. At first the Eptam looked excellent, but after two months the Propazine looked better and held it's effectiveness through the entire season. (4) When ¼# of Diuron was added to the 1# Propazine, the results were much improved and even afforded some control of existing perennials weeds which had come from roots remaining in the soil after the weeding operation. (5) It appears that much more study of the timing aspect of the pre-emergence chemicals is necessary so as to secure maximum weed control with a minimum of injury to the desirable seedlings.

At this point it would be well to note that presently there are no outward manifestations of phytotoxicity with any of the rates mentioned on conifer seedlings. Most of the applications were made, however, only after the seedlings had gone through one winter. One deciduous item (*Eleagnus angustifolia*) showed leaf burn and reduction in stand when the ¼# Diuron was added to the 1# Propazine.

It is important to remember several factors which are vital to the success of this type of chemical weed control program. (1) Be sure that all machinery has been *properly calibrated* so as to apply the correct amount of material. (2) Begin experimentation on a *small scale.* Never spray more plants than you are willing to *kill* for experimental purposes. (3) Apply at three rates, ½ the recommended, the recommended and twice the recommended rate. (4) *Record* and *analyze* your data. (5) Have at least three years experience with a specific chemical, rate, time of application, variety, etc. before placing large areas under such a program. (6) Never say it can't be done—just visit your progressive fellow nurseryman.

Since most of our observations are based on only one year's work, it would be best not to list the varieties we observed to be tolerant since someone is sure to go home and spray a large area only to find that one year's work does not supply sufficient data on which to base major decisions.

We are sure that within 5 - 8 years we will have a full fledged chemical weed control program for our seedbed areas. We have been challenged to cut the cost of production of seedlings in view of absolute necessity of increasing profits in our industry — and we are planning and intend to meet this challenge.

MR. CASE HOOGENDOORN: What colors would you use in crossing Rhododendrons to obtain a good yellow?

DR. MEHLQUIST: If I knew the answer to that question, I would be millionaire, because everybody wants yellow. The trouble is that there is not a single yellow that is even relatively hardy. I would suggest crossing the clearest and hardiest yellow you can get your hands on — it will not be any hardier than H-3 or H-4 — cross it with something that is very hardy such as catawbiense. Now catawbiense album is recommended as is LaBar's white. I am not absolutely certain that it makes any difference which one of the catawbiense you use, because your first generation hybrids will not be yellow in any case, I don't think.

Then select the best out of those first generation hybrids and intercross them and self them and I guarantee that you will get some yellows back. You may not get the yellow color with the degree of hardiness or shape in the first try. It may take very large numbers because there may be three of four genes for color and three or four genes for hardiness, and three or four genes for shape and habit. Bear in mind that if you have only 3 genes involved your recessive segregates will occur only once in 64 times. If you have four genes once in 256 times. So you may have to raise large numbers. But if you raise limited numbers from the best selections for a few generations, you will have your hybrid I think. You must realize that either you or I may not see the results. Many of the finest hybrids we have today were bred by people who have long past to their just reward.

CASE HOOGENDOORN: Do you have any history of the Dexter Rhododendrons?

DR. MEHLQUIST: No, I don't think anybody has much of a history except that which they have been able to reconstruct from the behavior of Dexter hybrids in breeding programs, together with what little information Mr. Dexter left behind. Unfortunately, Mr. Dexter made a large number of hybrids involving many species and then he gave away large numbers of these species. Most of the Dexter hybrids we have today were developed in that group which he gave away with little information. Most of the people who received these seedlings have already passed away, so we can only reconstruct the probable path of progress.

CASE HOOGENDOORN: I have a yellow Dexter, a real good yellow, and I wonder if you have any history on its crosses or how he arrived at this selection?

DR. MEHLQUIST: I'll come over and get a couple of plants for breeding work.

CASE HOOGENDOORN: Try and get them!

DR. MEHLQUIST: All fooling aside, Case, the yellow breeding program is probably the most complex part of Rhododendron breeding we can underetake. We have found in many plants that the clear yellow colors are recessive to all other colors. That means quite a bit of work. It took me thirty years to work out the breeding of yellow carnations. Now I can breed them at will, but I still haven't produced a single yellow carnation that is as good in other respects as the Sim's carnation. But it took a whole life time to breed the Sim's carnation.

ROLAND DEWILDE: I may have missed part of what Dr. Mehlquist said, but I got the idea that he advocated the growing of a number of hybrids from seed. They would be produced by definite crosses and that they could be sold.

DR. MEHLQUIST: Yes, to replace the large amount of collected material that is now being sold, most of which is not what it could be. It's not difficult to raise them from seed.

ROLAND DEWILDE: I realize that, the only problem that I want to point out is that you get a large variation in hardiness in hybrid seedlings.

DR. MEHLQUIST: Not if you always use for one of the parents one of the hardy species. If you use catawbiense or maximum you will nearly always get hardiness, particularly if you use catabiense because that one is almost homozygous for hardiness.

ROLAND DEWILDE: That's true enough. But to get any kind of a color that doesn't contain too much of the catawbiense you have to pick your seeds from the hardiest reds. And even then about 10% of the population in my climate tends not to be bud hardy. And the hardiest ones tend to be the ones with the poorest color.

DR. MEHLQUIST: That is because there is a linkage between catawbiense characteristics and hardiness. In other words the gene for hardiness also carrys that bluish color you are trying to get rid of. But if you cross catawbiense to one of the really red hybrids such as vulcan and then intercross these hybrids, you soon get good reds. You will have varying degrees of hardiness but these first generation hybrids will be very deep pink and will serve your purpose for reds just as well in my opinion as nova zembla until we get good clones. Now, I have no doubt that for the future, Rhododendron plantings will be based on fine clones. But since it takes 10 - 15 years to put a clone on the market and get it generally established — it takes time to propagate them and one or two bad winters to really find out what is really hardy — in the meantime we would have something that would be, in my opinion, far superior to the usual forms of catawbiense and maximum that are now being offered to the public.

ROLAND DEWILDE: This may be theorically true, but I do not know whether I agree with you from the economics standpoint. I've already found out, for one thing, that I can raise a rooted cutting of a red clone considerably cheaper than I can raise seedlings. I think a two year seedling on the average will cost me somewhere between 25 and 30 cents and for that I can root a one year cutting and may be even a little cheaper from a production standpoint. And at the rate of two year plants I am going to have a plant a lot bigger and a lot better with no more cost than I would have if I grow a two year seedling. I feel we already have some pretty good red hybrids such as nova zembla which is a very reliable red in most areas of the country and kettle drum that are fairly hardy. All in all I find it hard to beat these clones with hybrid seedlings.

DR. MEHLQUIST: I would agree with everything you say except your cost figures. If you can raise rhododendron cuttings for 25 cents then you should be in business doing that and nothing else. The market price for the varieties you cited runs from 40 to 90 cents in limited lots. I have never seen them offered for less than 40 cents even in very large lots. If you can produce them that cheaply, by all means do it. But there are may people who persist in selling the collected plants of catawbiense and maximum. It is primarily to these that I am directing my views of growing hybrid seedling populations.

RICHARD FILLMORE: Occasionally in the south you will find isolated areas of catawbiense with as few as 50 - 75 plants in an acre or less of land with no other indigenous catawbiense for 40 or 50 miles around. Are these catawbiense likely to be exactly like the ones in the mountains, for example, with respect to heat resistance?

DR. MEHLQUIST: I wouldn't know. There is only one way to find out and that's to try them. Generally speaking, the plants which grow on the mountain tops have higher cold resistance and it seems rather peculiar that they would also have higher heat resistance. The reason they acquire the heat-resistance growing on a mountain top where it is normally cool, is that they are exposed to drying winds. Any plant which through evolution becomes adapted to withstand drying winds is usually heat resistant. But the fact remains you have to try them.

Now, most of the people I have been observing in the nurseries have some nice catawbiense and maximum sitting around which they thought were too good to let go for the price which these plants brought. So they kept the best ones at home, properly so. These plants are the ones which they should use in their own breeding program — plants which have good looks and have withstood the conditions in their nurseries for some time. You will bear in mind that I said when it comes to knowing the plant material, it ought to be observed for a number of years before you make up your mind about it.

MODERATOR GERMANY: We have reached the end of our time. It's been a pleasure to be your moderator today, I think we have finished a very fine program. I will now turn it back to President Roller.

[*Editor's Note*: President Roller conducted the business session and introduced the new president, Mr. Vincent Bailey.]

TECHNICAL SESSIONS

Thursday Morning Session
October 15, 1964

The Fifth Annual Meeting of the Plant Propagators' Society, Western Region, convened at 8:00 A.M. at Hotel El Rancho, West Sacramento, with some opening remarks by President Bill Curtis. He then introduced Bob Boddy, Vice-President in charge of program.

MODERATOR for morning session: Dr. Howard Brown.

TEXAS TIPS

JOHN B. ROLLER
President, Eastern Region
International Plant Propagators' Society

At the meeting of the Eastern Region in St. Louis last December, it was decided that since the visiting presidents of the respective regions were more or less a necessary evil, they should do a little something. It provides a reason and an alibi for wanting to come and visit the meeting of the Western Region. Bill Curtis suggested for me a topic titled "Texas Tips." Now, coming to California to give tips on plant propagation and producton is like going to Detroit to tell how to build automobiles because California is considered to be a leader in this field. So it caused considerable thought as to what I could say that would be helpful. I came up with two or three suggestions that I hope you will find interesting.

California sends nearly 3 million plants annually to Texas. Among the many varieties sent there are hibiscus, particularly tree hibiscus. Now the tree hibiscus that I noticed in greatest quantities were not necessarily the most beautiful varieties and were on their own roots. I wondered why the best varieties you had were not either budded or grafted onto vigorous upright growing varieties.

I have a few slides to show how this can easily be done. The first slide shows the first step in grafting hibiscus. A simple wedge graft is inserted about 4 to 5 feet on the stem of the understock and tied with a conventional budding strip. The next slide shows a polyethylene bag placed over the graft, gathered tightly at the bottom, and a twistem used to fasten it tightly. Sufficient air can be forced in the bag to prevent it from falling around the graft and possibly injuring it or pulling it from it's proper position so that a good union can be made.

The next slide shows a paper bag slipped over the poly bag and stapled on to provide the necessary shade if the grafting is done outdoors; if done under lath sade, the paper bag is not needed.

After the union is made and the graft is ready to grow, the poly bag should be loosened at the bottom to permit air to enter. Or a hole can be torn or cut in both bags in such a position that direct sunlight cannot hit the graft until it has hardened up somewhat, a matter of 3 or 4 days. Bags can then be removed entirely.

The next slide shows the very simple and well known technique of budding. Budding is in my experience the better method in making tree form hibiscus. They seem to grow off faster and are easier to shape. There is only one tip in budding hibiscus to be really successful. The bud must be placed in a tender, growing part of the plant. If it is set on wood that is too old there is a tendency for a heavy corky callus to form that pushes the bud out and union is not made. This slide shows the bud tied with a budding strip as is usually done. After union is made the top is removed usually in about two operations. Side limbs below it are removed about ⅓ to ½ at a time so as not to force the bud to grow as rapidly. It is weak and must be supported.

Now, so many times in past meetings of the Plant Propagators' there has been much discussion as to the merits of various mist nozzles, discussion of the amount of water needed and, also, how much would be fatal. Some of us get the impression that it does take considerable sums of money to set up the apparatus to successfully propagate plants under mist. It involves time clocks, electronic controls, and decisions as to which of many brands of nozzles to purchase. We over-complicate our problems many times. This slide shows an unique set-up that is extremely economical, extremely simple and very effective if you have a media that will permit its use, pine sawdust. This is a rainbird 25 sprinkler. Underneath this one sprinkler 200, 000 plants per season can be propagated, possibly 300,000 plants in California's longer season. These cuttings are stuck 200 per flat in pine sawdust, at least 3 years old, with the flats set upon pallets to provide good drainage. In effect, this gives intermittent mist. Total water volume does not exceed some of the conventional nozzles required for the same number of cuttings. It also permits propagation of desired plants when possibly existing facilities are loaded or inadequate since it can be set up very quickly.

It is painful for the nurseryman to spend his good money to destroy plants that are overgrown and are in the way. The next slides will attempt to show how a potential loss can be turned to a profit. The potential here is just as great as your imagination and ingenuity. (Slides illustrated the practice of pruning evergreens that are old and ready to be destroyed into bizarre shapes). Incidentally these plants sell for two to three times their values before they were messed up, so to speak. They transplant well because the balance between foliage and root systems is good.

Thank you for your time and it has been a real pleasure to visit and talk with you.

[*Editor's note*: Mr. Roller left the meeting at close of talk. Following comments were from a later questions and answer session.]

DR. WALTER LAMBERTS: Mr. Roller made the statement that the Hibiscus could be grafted and budded on root stock and I got the impression that this could increase vigor. What was the control to compare increased vigor and why will it do it for Hibiscus whereas it will not do it to any marked degree for roses?

DR. BROWN: He was talking about standard hibiscus, and perhaps he meant that it would not be more vigorous as a result of the budding or grafting, but certain stocks would make the standard quicker and then you graft the desired variety on to that. We've done a little work on the hardiness of Hibiscus at the college. We're in an area where Hibiscus is marginal for some sections of the campus even. We find that if we use the variety Agnes Galt as a root stock, then we can graft or bud some of the Hawaiian varieties and the Florida varieties that normally would not tolerate our winter temperatures. It seems to impart a certain hardiness for if we do get a severe frost that kills them back, it kills them only to the graft union; and tree hibiscus can be budded or grafted again that same year and you don't lose the entire plant.

MR. RALPH PINKUS: I asked him a similar question. He said that he used Anderson Red as the understock because it was so very vigorous. It didn't give any thing to the top but it provided that long stalk. He was growing standards four feet tall until he got the Anderson Red up high and then he would topwork another variety on top just to get the height. He wasn't trying to improve that variety, just trying to get it up in the air.

MR. STANLEY SPAULDING: I would like to point out a problem on the tree Hibiscus that develops from a semi-dormancy which is induced by a cool spring season. The top of the plant becomes quite dormant and with the resurgence of growth the lower buds on the stem are activated. The plant is no longer a standard as it grows into the spring of the year. I might compare this with the problem of developing oleander standards. However, with oleander we have suckers from the base of the plant. From the Hibiscus, the buds along the stem come to life and debudding is necessary.

MR. E. J. JELENFY: Some mention was made by Mr. Roller on sawdust for rooting mediums. Would some one like to comment on that please? How much used, or how much work has been done with sawdust?

DR. BROWN: Would anyone in the audience care to comment on this?

MR. DON DILLON: We've tried this with some of the citrus cuttings in flats, not in pots. One problem is roots, so many roots you can't get them apart.

DR. BROWN: Was this redwood sawdust, Don?

MR. DON DILLON: Redwood sawdust, untreated, just off the pile, thrown in the flats.

DR. BROWN: So the problem was overrooting almost: this might be corrected by proper timing. I might mention too that some people have recorded an antibiotic quality in sawdust as a rooting medium. This of course would be very desirable from the standpoint of rooting cuttings here because it cuts down on the disease.

MR. ART MYHRE: We tried some easy-to-root rhododendrons in fir sawdust and they made wonderful roots, nice white roots, but you have to have the right nitrogen combination in the medium.

MR. STEVE FAZIO: Most of our sawdust from Arizona comes from the Ponderosa Pine, and in some of it having a high pitch content we did run into a toxicity problem. Some batches we would get excellent results. Those with a high pitch content, we did run into a toxic condition.

DR. BROWN: In regard to the redwood, some growers recommend leaching it very heavily before using it, yet Don Dillon reports no bad results from taking it just the way it comes from the saw mill.

DR. WILLIAM LIBBY: My comment comes from reading the Australian literature yesterday. They were commenting on pine sawdust. They mentioned toxicity in the first year and very favorable results after letting it rot for a year.

MR. EARNEST JENSEN: I think one thing that may be we are overlooking about John Roller's setup is the fact that he used fairly copious amounts of water and provided for excellent drainage through the sawdust which might be part of the answer to why he didn't get into trouble. In that particular area they'll have a mixture of soft wood and hard wood in their sawdust.

COMPARISONS: EUROPEAN AND AMERICAN PROCEDURES IN HORTICULTURE

OLIVER A. BATCHELLER
Department of Ornamental Horticulture
California State Polytechnic College
San Dimas, California

With the enthusiasm of "Youth" and the optimism of a "Freshman," I started on my sabbatical leave with the idea of comparing "Horticultural Procedures in Central Europe with those in the United States."

My colleagues had given me names and addresses, and by contacting the Ministeries of Agriculture and Education, I was able to make appointments and have interviews at 28 schools, cuttings in flats, not in pots. One problem is roots, so many roots you can't get them apart.

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My colleagues had given me names and addresses, and by contacting the Ministeries of Agriculture and Education, I was able to make appointments and have interviews at 28 schools, colleges, and universities where horticulture was taught. I also visited 51 nurseries, 22 arboretums or parks, 16 horticultural markets, 16 private gardens, and 8 flower shows or fairs. In all I drove 5,892 miles.

The trip in the United States included 34 schools, colleges, and universities in those states which lead in the production of horticultural crops. Needless to say, I visited many nurseries, parks and arboretums. In all I took 600 colored slides, 400 black and white pictures, and tape-recorded all of my interviews. From these tapes I have made four complete factual notebooks.

In the allotted time it would be impossible to give you a complete summary, so I have reviewed my notes and slides and will give you only the highlights.

In general the people of Europe are more law-abiding than Americans. They are extremely polite, thoughtful and careful in their personal relations with each other, and we found they responded quickly and warmly to friendly actions.

There is great interest on the part of the general public in agriculture and horticulture. Wherever space is available, people have gardens, both vegetables and flowers. City parks rent out 30′ x 30′ plots called "folk gardens" at a nominal fee ($3.00 per year) so that the apartment dwellers may grow plants and get next to the soil. These gardens are open, and seldom bothered. The net result has been a wider knowledge of generic and species names, knowledge of what constitutes good nursery stock and recognition of individuals having training or having special abilities in the horticultural field. Horticulture is thought of as a profession, not as a gardening trade.

Institutions Teaching Horticulture

I found the institutions teaching horticulture were small and set apart from the large liberal arts colleges. This provided a setting with no crowding pressures and considerably reduced administrative problems. This is a far cry from what we are doing in the United States where we pile great masses of humanity on top of each other in small areas and snuff out a good horticultural program. This is happening in all of the colleges throughout America. Locally we are all familiar with the tragic closing of the horticultural program at the University of California, Los Angeles.

Instruction in horticulture is available at many levels and is arranged to suit practically any situation for both men and women. There are (a) evening classes, (b) day release classes, (c) apprenticeship programs, (d) institute programs of 1, 2, or 3 years, and (e) full university programs. As a result, you can see there are a great many more individuals trained at all levels.

As an example, Aalsmeer in the Netherlands has a population of 15,000 of which 266, ages 14 years and older, are in the Elementary Horticultural Education, 92 in Secondary Horticultural Education, 104 in Vocational Horticultural Programs, 75 in Special Horticultural Programs, and 53 in Horticultural Training Courses for a grand total of 590 students over 14 years of age in horticultural training dealing with floriculture and ornamental horticulture.[1]

In the publication, "Enrollment and Degrees in Agricultural Institutions of Higher Education," issued by the United States Department of Health, Education and Welfare, there were, during the same period, for the entire United States only 143 Floricultural undergraduates and 325 Ornamental Horticultural students and even if we add in the 937 General Horticultural students, which include pomology, fruit production, vegetables and crops, this gives us a total of only 1,405 students out of our total population of 185,000,000. The report covers all universities, colleges, and junior colleges. No report is available on high schools, but few have horticultural programs.

There is no doubt that Europeans slant the technical school programs toward the commercial phase of horticulture, or that they use a great deal more time in laboratory classes to attain this. These schools work closely with the universities and their research experimental stations. The newly found information is continually being put to immediate practical use.

Regardless of the level of instruction in which the student was enrolled, I felt that he looked upon his education as a real opportunity and definitely a necessary preparation for his life's work. In general the students appeared to have quite clear cut objectives in mind and were working toward them. Opportunities are available only to those who are academically trained or professionally accredited. Here in the United States, the students seem less eager, have no clear-cut objectives, and often fail to take advantage of their opportunities in college.

On the Continent I found that each of the universities, technical colleges and apprentice schools had their own very rigid entrance requirements. Most required from one to three years of practical work experience in a commercial field, before admittance. All institutions required evidence of proper academic competence for their level of instruction. Interviews of prospective students was common, and many were not admitted because of poor attitude or lack of interest. On an average, it can be said that more than half of the students who applied were refused admittance, even in the apprentice program.

In the United States we not only lack the number of institutions, but we have few or no programs for non-college students. Regrettable is the fact that the horticultural enrollment of the colleges I visited in 1961 was low: it averaged less than 17 students per department.

It appeared to me that much of the research being carried on in Europe had more practical application than that which I saw in the United States. As an example, the following are

[1]Extension Service Publication for Floriculture. Aslsmeer. 1960.

three of the recent projects that have been successfully completed: (1) the investigation and development of tomatoes with more chlorophyll to grow under poor light conditions; (2) the development of a commercial red delphinium to increase sales of this plant (incidentally, they used a native wild plant from California for one parent) ; (3) the development of a good garden pea in which the pod as well as the pea could be eaten.

On the other hand, our basic research is excellent, with money and laboratory equipment often coming out of our ears. Because of the emphasis placed on advanced degrees and publications in our institutions, the undergraduate is frequently the forgotten man, and enters graduate work with little or no concept of commercial work or practices. One Ph.D. Thesis I heard discussed was "The Classification of Crab Apple Trees by a Microscopic Analysis of the Stem Tissues."

I have promised Dr. Brown I would not steal his thunder by covering our method of teaching Horticulture at Cal Poly, Kellogg Campus, Pomona. Suffice to say we have a current enrollment of 75 degree students in Ornamental Horticultural and 230 degree students in the Landscape Architecture program.

The European Horticultural Industry

In all of the parts of Europe that we visited, the normal concept of a nursery is an establishment where plants are propagated, grown, and sold. For the most part nurseries are small, two acres or less, usually family owned and operated. The range of material handled is broad, from annuals and perennials sold by the dozen, to large specimen trees field grown to be dug in season on order. The rest of the general nursery stock is sold either bare-root in season or balled and burlapped. The only container-grown material are pot plants for summer plunging and house plants. The one exception to this was in the Riviera area where specimen boxed trees were available as was a small amount of container stock.

From the standpoint of quality, efficiency of growing and ingenuity, one would have to rank the nurseries of the Netherlands as the most outstanding. The average nursery stock was better than the United States average, and the best European nurseries excelled our best in all phases. The only possible exception would be in the use of mechanization, but with the availability of well-trained inexpensive labor, the net result would still favor the European nursery.

In the matter of quality control, the Dutch use the bud wood from one tree to bud one row. If disease or virus appears in the parent stock, the budded row is destroyed.

The I.T.T. or Horticultural Engineering Department at Wageningen tests and reports on all equipment sold in the Netherlands and carries on a terrific research program on all engineering phases of horticulture. I saw no "Mickey Mouse" piece of equipment in Europe.

The grower associations in the Netherlands are socialistic in nature and the industry is so closely regulated by these associations as to stifle the younger people. New facilities cannot be constructed or acreage of crops changed without approval of the association responsible for its control. For instance, all the cyclamen growers send three of their best plants of variety and color to Aalsmeeer for show and testing, and only seed from the best plants are allowed to be harvested and sold. Ninety percent of the horticultural products are exported from the Netherlands, and this is carefully controlled so that only their top quality merchandise leaves the country. In England, Germany, France and Switzerland horticulture is an open industry with no controls except for quality, disease and pests. However, most require an individual to pass an examination or to appear before a board to show competence before he can open a new business.

It is interesting to note Americans spend less than five-tenths of one percent of their income on horticultural products as compared to one percent spent by Europeans. The Europeans pay more for their horticultural products on the basis of wages than do Americans, but at the same time they are receiving a better quality plant backed up by sound practical horticultural advice. The shows and fairs plus the recommendation of the horticultural societies play an important part in the buyers selection. Varieties placing well at the Royal Horticultural Society "fort-nightly" shows, automatically becomes a best seller, so highly is the society regarded. The "Modern Garden Center" is fast becoming a normal method of selling all things for the garden and their best equal our best in California. The "Farmers Market" is a historic tradition and seems to take care of surpluses and home produce and are found in most all towns in all countries.

At the wholesale level the "Veilings" or markets of the Netherlands and Belgium are outstanding but only operate when there is a total involvement of all growers in the one marketing organization. Under these circumstances, it becomes a highly efficient bargaining center.

In closing I would say Europeans are more horticulturally minded than Americans, better informed, and more conscious of quality and value. The nurserymen are better trained in all departments. Each man knows his job and is an authority within his realm. Bosses are bosses and having worked up through the ranks, they are able to direct and supervise all jobs under their control. In Europe the way to the top in horticulture is slow but thorough.

MR. WESLEY KEYES: Where is the source of the red delphinium?

MR. JOLLY BATCHELLER: That was at the Horticultural school in the Netherlands, Wagingen.

MR. DARA EMERY: Gardening Illustrated, a British pub-

lication, carried a good article on the origin and development of this red delphinium within the last year.

MR. JOLLY BATCHELLER: When Dr. Doorembos got his Ph.D. at U.C.L.A., he took the seed back from a native plant. I don't know whether he was actually in on the development of it or not.

MR. DARA EMERY: The man who did the work on the hybrid delphinium was Legro.

DR. DENNISON MOREY: In connection with the *cardinelli* hybrids, if you're anticipating development work, get in touch with Dr. Gustav Melquist at Storrs, Connecticut. He initiated work at U.C.L.A. with *cardinelli* twenty years ago and has been carrying it on with some of the Pacific hybrids. I think he is now concerned with rhododendrons. I know him well enough to know that he would have material that the *cardinelli*'s left and it might be of interest to you.

THE ROLE OF RESEARCH IN PLANT PROPAGATION[1]

WILLIAM E. SNYDER
Department of Horticulture and Forestry
Rutgers — The State University
New Brunswick, New Jersey

[1]Originally presented at the 13th Annual Meeting, Eastern Region, St. Louis, Missouri, December 7, 1963 and published in *Proceedings. Annual Meeting, International Plant Propagators' Society*. 1963. 13:153-158.

THE EFFECT OF SEVERAL ANTI-TRANSPIRANT MATERIALS ON APPARENT TRANSPIRATION OF SELECTED ORNAMENTAL PLANTS[1]

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Transpiration is the evaporation of water from plant tissue. Basically it follows the physical laws which govern the evaporation of water; however, there are modifications based on plant structure. Woody twigs may lose water through the lenticels; however, the major path of water loss from the plant is through the leaves.

An examination of the structure of a leaf will help to understand transpiration more completely (Figure 1). Both the upper and lower surfaces of a leaf are covered with a layer of

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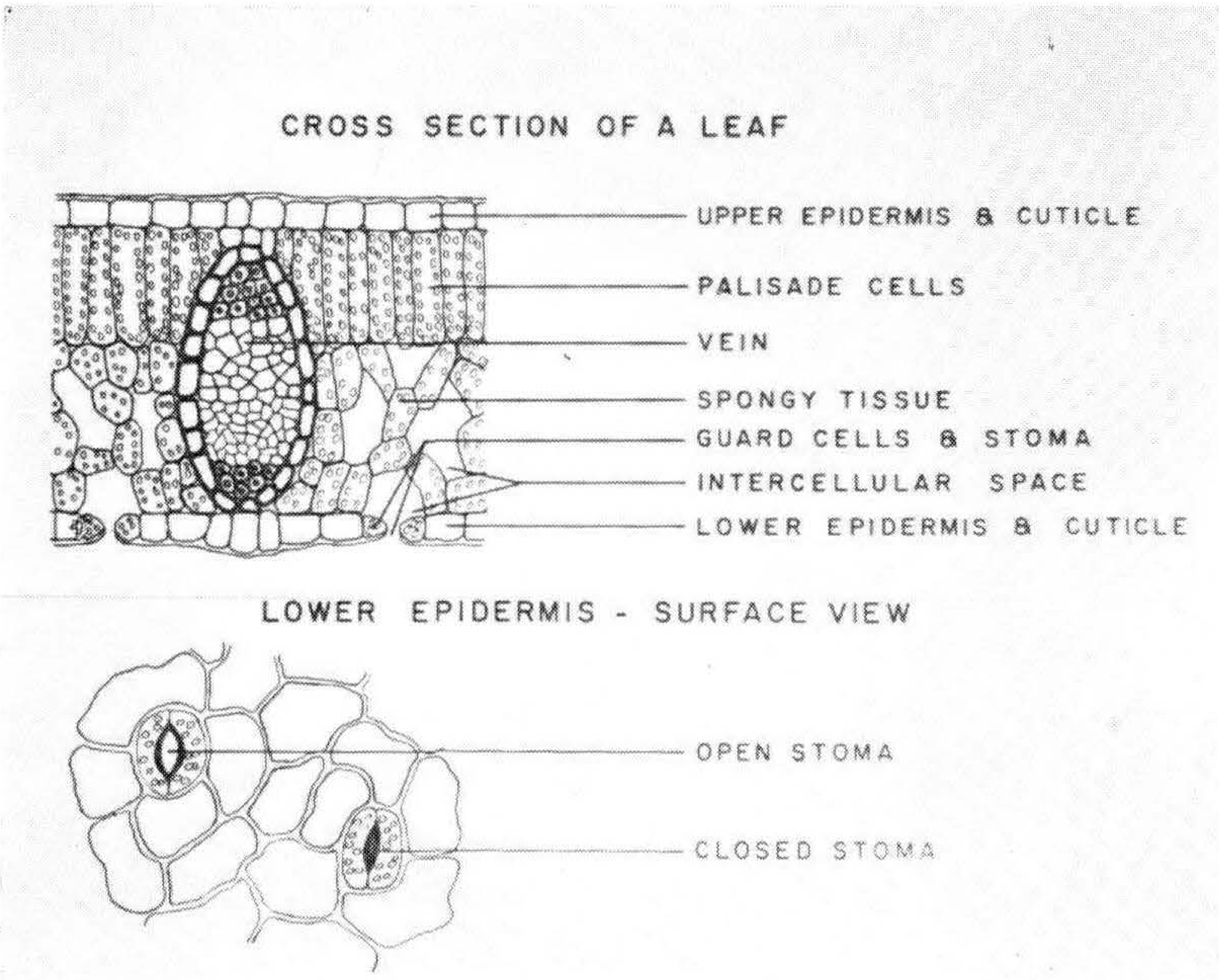

Figure 1. Diagrammatic representation of the cross-section and lower epidermis of a leaf.

cells called the epidermis. A layer of waxy material, called the cuticle, is found on the outer surface of the epidermis. The cuticle is continuous except where small openings, called stomata, occur. The cuticle varies considerably in thickness for different kinds of plants and very little water or gas passes through it.

The epidermis may be broken by small openings, called stomata (singular, stoma). Scattered among the ordinary epidermal cells are pairs of crescent-shaped cells called guard cells. When full of water these guard cells become distended, causing the stomata to open. When low in water, the guard cells collapse and the stomata close.

Immediately below the upper epidermis will be found a layer (occasionally two or more layers) of cigar-shaped cells. These cells contain the majority of the chlorophyll and are known as the palisade layer. Below the palisade layer and extending to the lower epidermis are loosely connected cells. This area resemble the structure of a sponge and is known as the spongy tissue. The large passage-way between these cells are known as intercellular spaces and are connected with the stomatal openings. Veins, which contain the water and chemical conducting units, are found near the juncture of the palisade and spongy tissues.

Stomata may occur only on the lower surface, only on the upper surface, or on both surfaces. Of thirty species of woody ornamental plants examined this summer, we found stomata only on the lower surface of 27 species and on both surfaces of 3 species. Stomata are very small. In holly they average 12.5 by 6.5 microns (one micron = 1/25,000 of an inch). They are exceedingly numerous, 72,000 per square inch of leaf surface having been reported for black poplar and 625,000 for the scarlet oak. An area equal to the cross-section of the lead of an ordinary pencil would contain between 600 and 2,700 stomata, depending upon the species of plant. When open, the stomatal area is frequently only about 1% of the total leaf surface. In spite of the small area occupied by the stomata, approximately 95% of the water lost by the leaf occurs through the stomata and only about 5% through the epidermis.

Characteristically the stomata are open during the daylight hours and closed during darkness. The major function of the stomata is to permit the entrance of carbon dioxide into the plant so that carbohydrates can be manufactured (photosynthesis). With the stomata open, there is created a natural exit for water vapor from the leaf. Transpiration does perform a beneficial function in that the heat required to evaporate the water prevents the build-up of high leaf temperatures.

Water from the soil enters the plant through the roots, and moves up the stem and into the leaves through the vascular tissue — cells specialized to conduct materials. Water evaporates from the cells of the leaf into the intercellular spaces and passes through the stomata into the atmosphere.

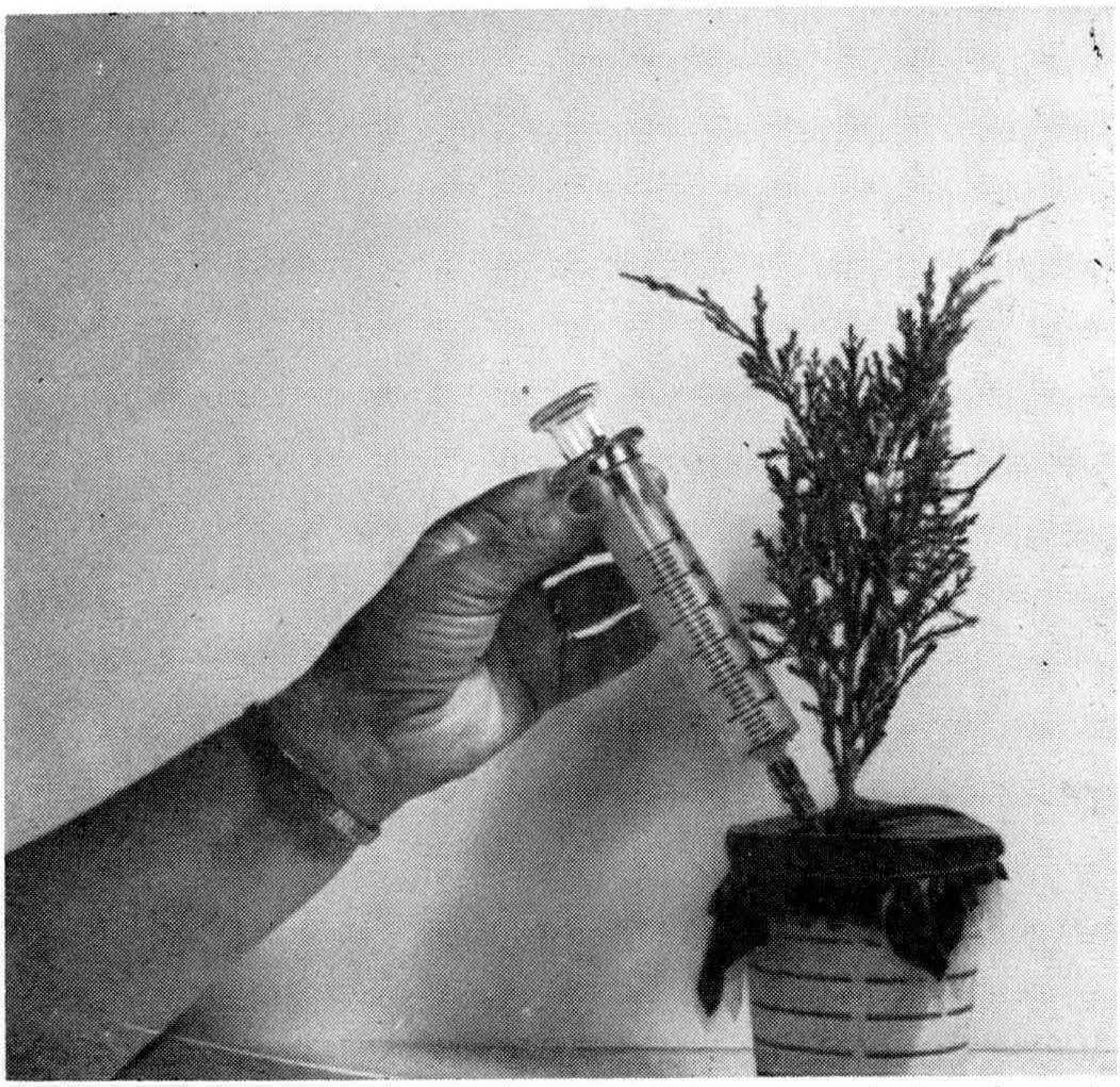

Figure 2. Method of growing the plants and adding water during the test periods.

Since the greatest amount of transpiration occurs through the stomata, the effectiveness of chemicals to reduce water loss must be by controlling stomatal transpiration. There are two major types of anti-transpirants: one, chemicals which are absorbed through the roots and cause the stomata to remain closed for a period of time regardless of the presence or absence of light, and two, chemicals which are applied as a film to cover the leaf surface — both epidermis and stomata. The discussion today is limited to recent investigations of the effectiveness of several polyvynal chemicals applied as a film to the leaves.

In these studies of transpiration, measurement of water loss was determined by differences in weight. Plants were placed in containers sealed with polyethylene as shown in Figure 2. The weight was taken at the start of the test and again at specific intervals. The difference in weight, thus, is a measure of apparent water loss. A slight error results from any increase in weight of the plant during the test period; however, this error was found to be negligible for the 3½-day periods between weighings. The amount of water lost by transpiration was replaced by the use of a hypodermic syringe and needle as shown in Figure 2.

Well rooted cuttings or seedlings which had become established in 3-inch pots were used in all tests. The plants were not dormant but had completed active growth for the season.

The test materials used included Foli Gard, Plant Shield, Rhoplex, Vapor Gard and Wilt Pruf. The stem and leaf parts of the plants were dipped in the test materials at a strength of one part of the material to four parts of water and allowed to dry. Preliminary tests had shown that spraying and dipping were equally effective.

The results of these experiments are expressed as water lost by treated plants as percent of water lost by the untreated control plants. For example, if the untreated plants lost 100.0 grams of water during a period and if the plant treated with an anti-transpirant lost 57.8 grams, the water loss for the anti-transpirant-treated plant would be expressed as 58% water loss.

Before determining the percent water loss, the quantities of water lost were adjusted for equal leaf tissue to compensate for differences in leaf size of the test plants.

Briefly, the results of this series of tests show that the effectivenes of polyvynal materials in reducing water loss varies

1) with the anti-transpirant used,
2) with the kind of plant, and
3) with the time following the treatment.

Let us now examine some of the specific responses.

The test results revealed that anti-transpirants would not reduce water loss for all species of plants and that the several anti-transpirants were not equally effective. The water losses, expressed as percent of the water lost by the untreated plants, for fourteen plants are shown in Table 1. The data represents

WATER LOSS AS PERCENT OF UNTREATED PLANTS

PLANT TESTED	FOLI-GARD	PLANT SHIELD	RHO-PLEX	VAPOR GARD	WILT PRUF
TAXUS HUNNEWELLIANA		98	99	94	96
JUNIPERUS HORIZONTALIS	80			80	63
J. CHINENSIS 'PFITZER'		83	74	17	40
THUJA OCCIDENTALIS NIGRA	83			68	65
TSUGA CANADENSIS	56			63	24
ILEX OPACA 'HEDGE HOLLY'	77			81	78
ILEX CRENATA CONVEXA	87			74	48
ILEX CRENATA ROTUNDIFOLIA		75	71	55	62
BUXUS SEMP. 'NEWPORT BLUE'	88			98	91
MAHONIA BEALEI	66			84	56
WEIGELA FLORIDA			116	122	110
FORSYTHIA SPECTABILIS			91	75	61
LIGUSTRUM OVALIFOLIUM			76	56	40
L. OBTUSIFOLIUM REGELIANUM			108	93	88

Table 1. Effect of polyvynal materials applied to the foliage on water loss expressed as percent of water lost by the untreated plants.

the water lost during a five-week period following treatment with the various anti-transpirant materials.

Of the fourteen species of ornamental plants included in these tests, ten lost appreciably less water following treatment with the anti-transpirants than did the untreated plants. These included four narrow-leaf evergreens (*Juniperus horizontalis, J. chinensis 'Pfitzer,' Thuja occidentalis nigra,* and *Tsuga canadensis*), four broad-leaf evergreens (*Ilex opaca 'Hedge Holly,' I. crenata convexa, I. crenata rotundifolia* and *Mahonia Bealei*), and two deciduous species (*Forsythia spectabilis* and *Ligustrum ovalifolium*). The water loss was not appreciably affected by the anti-transpirants for three species (*Taxus hunnewelliana, Buxus sempervirens 'Newport Blue,'* and *Ligustrum obtusifolium regalianum*). With one deciduous species, *Weigela florida*, there was an indication of an increase of water loss following treatment with the anti-transpirants. This possible stimulative effect needs to be verified and, if true, would be of extreme interest.

An examination of these results also shows that the several anti-transpirants varied in the effectiveness of reducing water loss. No single material was superior for all species; however, Foli Gard, Vapor Gard and Wilt Pruf were consistently more effective in reducing water loss than were Plant Shield and Rhoplex.

The responses to four anti-transpirants for one species studied (*Juniperus chinensis 'Pfitzer'*) are shown in Figure 3. Comparable results were obtained with several other species. The data is expressed as percent water loss of the water lost by untreated plants and is shown for weekly periods following a

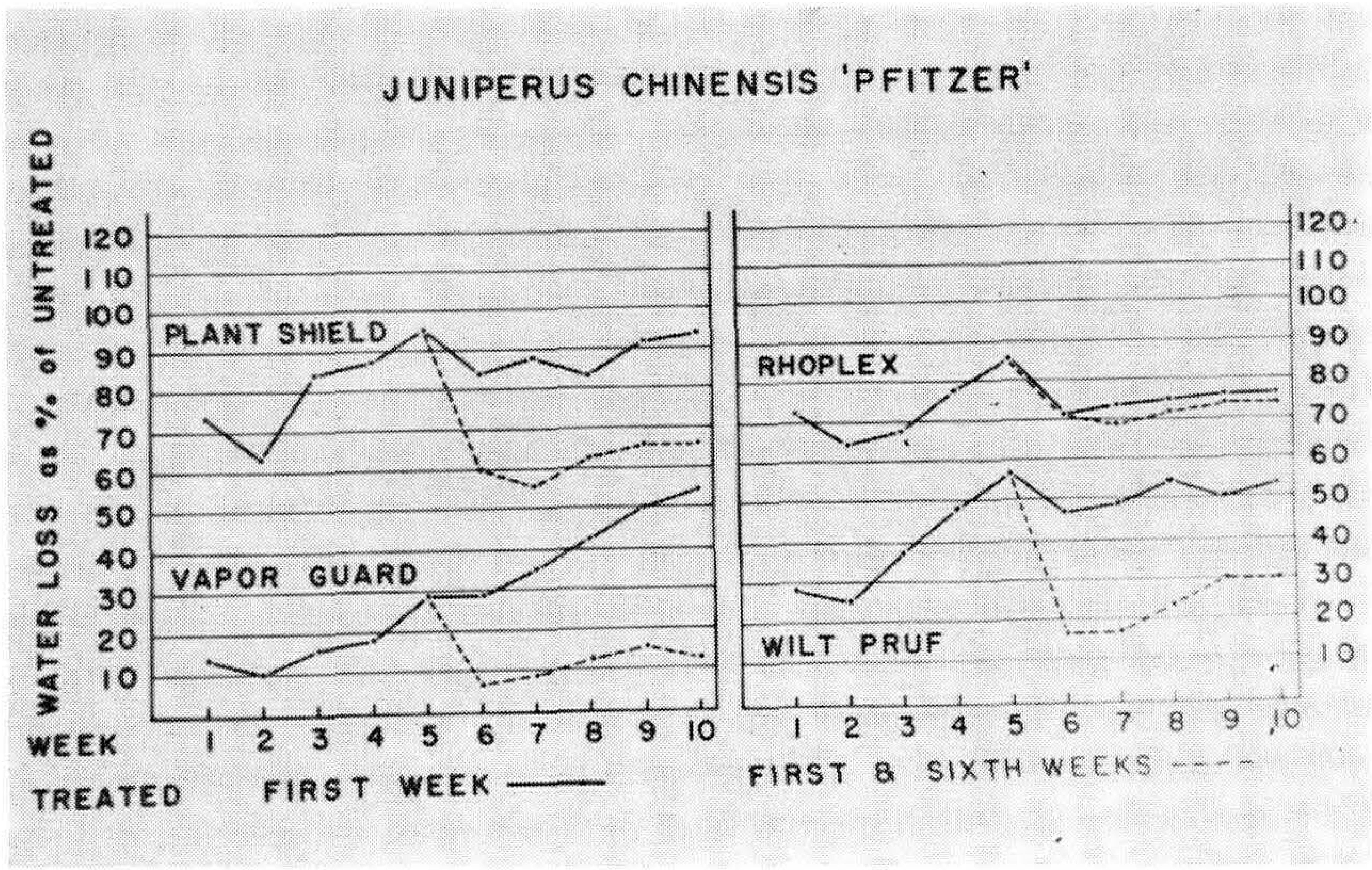

Figure 3. Effect of four polyvynal materials on the water lost by Juniperus chinensis 'Pfitzer'.

single treatment (expressed by the solid line) and for a second application made at the start of the sixth week (expressed by the broken line).

It is obvious from these data that all four anti-transpirants reduced water loss compared with the untreated plants and that Vapor Gard and Wilt Pruf were more effective than Plant Shield and Rhoplex. Following the initial treatment there is a marked decrease of effectiveness of the anti-transpirant treatment until the fifth week, after which only a moderate reduction in water loss was measurable. Re-treatment at the start of the sixth week re-established the effectiveness of the anti-transpirants. During the five weeks following the second treatment, the effectiveness of the treatment to reduce water loss remained about constant.

The weekly water loss for two species, *Ilex crenata rotundifolia* and *Juniperus chinensis 'Pfitzer,'* treated with Vapor Gard is presented in Figure 4. Groups of plants were treated at the start of the experiment (represented by the solid line) and a second group was given a second treatment at the start of the sixth week (represented by the broken line). The results are expressed as percent water loss of the water lost by the untreated plants. It is readily apparent that Vapor Gard was more effective in reducing water loss for the Pfitzer's juniper than for the roundleaf Japanese holly. It is also apparent from the data that there was a gradual decrease in the effectiveness of the treatment during the five weeks immediately following the initial treatment. About the sixth week there was a rapid loss of effectiveness of the anti-transpirant treatment for the holly. The loss of effectiveness of a single treatment was gradual over the ten-week period of testing for the Pfitzer's juniper.

A second treatment, made at the start of the sixth week, brought about a marked increase in the effectiveness of the anti-transpirant to reduce water loss. Following this second treatment, there was a gradual loss in the effectiveness of the treatment with time.

Comparable results were obtained with the other anti-transpirants studied and with the other species of plants.

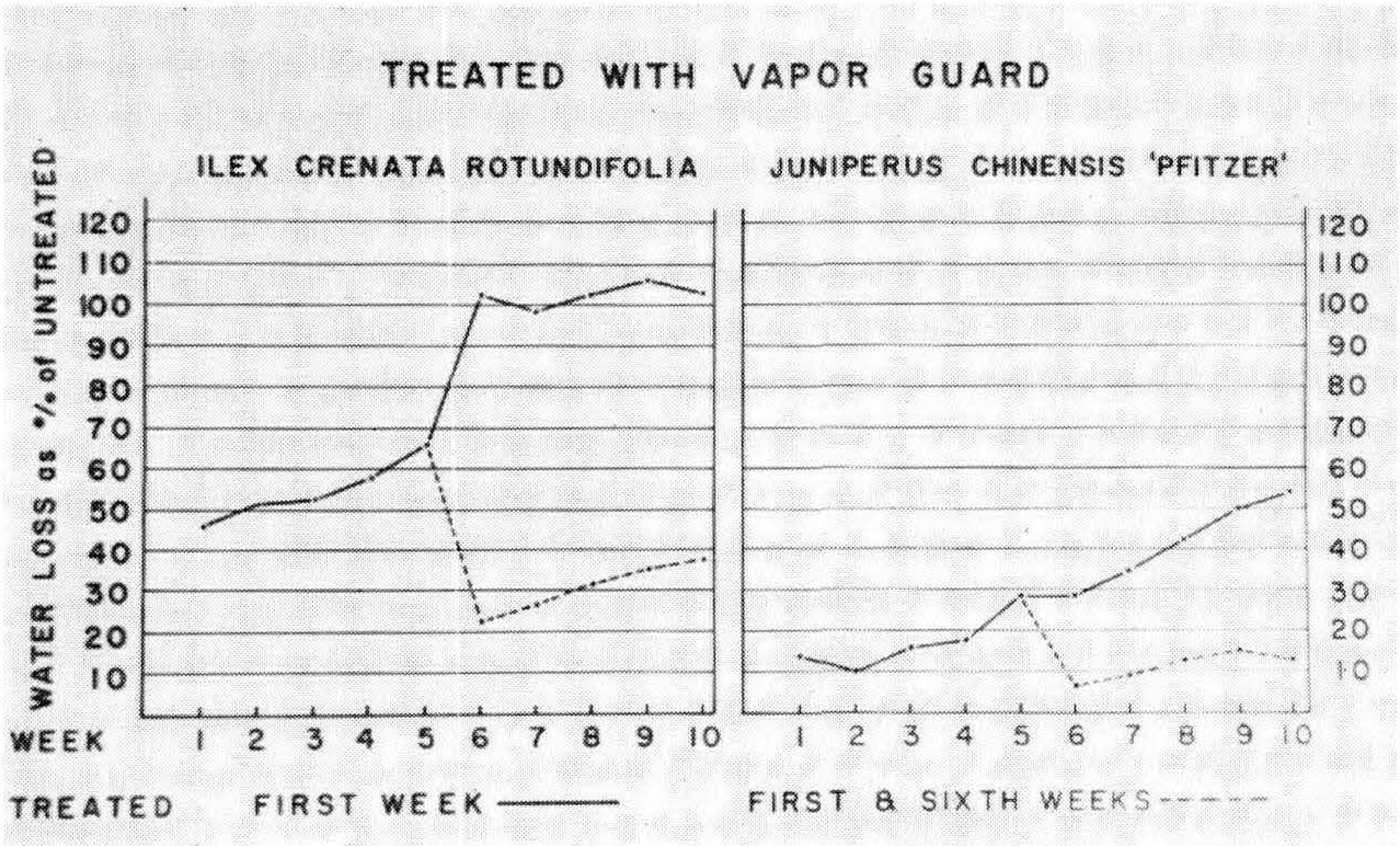

Figure 4. Comparison of the water loss by two ornamental plants following treatment of foliage with an anti-transpirant (Vapor Gard).

From the results of these tests, we may conclude that under greenhouse conditions:

1. Anti-transpirants were effective in reducing water loss.
2. Application of anti-transpirants by spraying or by dipping were equally effective.
3. Some of the anti-transpirant materials were more effective than others.
4. The effects vary with different kinds of plants:
   a. with some the water loss was reduced,
   b. with some the water loss was not affected.
   c. with some the water loss might be increased.
5. The effectiveness decreased with time, and in most instances, the anti-transpirants were relatively ineffective about five weeks after application.

There are, obviously, many questions about anti-transpirants, both basic and applied, that need to be answered.

DR. ANDREW LEISER: I believe you mentioned that you'd used primarily polyvinyl compounds. Have you tried any of the polyethylene emulsions?

Dr. William Snyder: It's my understanding that some of the materials which we are currently testing are polyethylene, but I have no results on it.

Dr. Leiser: Is the loss of control that you observe at five weeks in transpiration largely associated with additional growth of plant and pulling surface or to the weathering of the anti-transpirant materials?

Dr. Snyder: It is not due to additional growth because material which we were testing had completed growth, although they were not complete dormant; they were quiescent. I believe it's due to a breaking of the film.

Dr. Robert Norton: What is the effect on gaseous exchange and photosynthesis of these plants?

Dr. Snyder: We haven't done too much in that area. In the material which we carried for the ten week period — Pfitzer Juniper, Holly — we did make comparisons of the dry weight of Pfitzer Juniper and holly at the beginning and the end of the experiments. With that material in which there was no active top growth, although there was probably root action, there was no difference between the treated and the un-treated. In a paper from Israel with the bean plant there was reported an indication of reduction in photosynthesis. We are following up on some of that with clonal material. I would expect there would be some reduction.

Mr. Russell Byerley: Has there been any work done on storage of dormant roses?

Dr. Snyder: Not to my knowledge has there been any thing done on dormant roses or any other material in storage of this particular item.

Dr. Morey: Practically anybody who has worked with roses has tried some of these materials but hardly in a way that leads to a lot of progress. The materials that have been tried to my knowledge are the polyethylene emulsions, polybutylene emulsions, polypropylene emulsions, polymethylene emulsions, some of the acrylic materials, various emulsions of paraffin, and the old standby of hot paraffin dips. The effectiveness is about in that order, and in general the polyethylene emulsions result in some damage.

Dr. Morey: Dr. Snyder tells me just recently that there is experimental work that shows that transpiration in strawberries can be significantly reduced for fourteen days by giving them 8-hydroxy quiniline sulphate which seems to keep the stomata closed.

Dr. Snyder: We have had some damage to the plant with that material.

Dr. Morey: Some foliar damage. What concentrations?

Dr. Snyder: Thousand parts per million.

Dr. Walter Lamberts: I have a patent on a weed killer whose primary function is to prolong dormancy of roses in packages. This product greatly reduces the amount of transpiration in the stems of the roses so that at the end of a month they are not dried out. If any want more details on this, contact me.

COMPLIMENTARY, SUPPLIMENTARY AND SYNERGISTIC EFFECTS IN ROOT INDUCING COMPOUNDS

DENNISON MOREY
General Bionomics
Santa Rosa, California

The following presentation will be less of a revelation than an appeal. My own experience is limited to a few empirical trials and word of mouth suggestions. It is my feeling that virtually every propagator who works with recalcitrant materials has done and discovered as much. This is particularly true of our academic colleagues who have the opportunity to test ideas which they conceive themselves and ideas stimulated by their more or less constant contact with researchers in the area of auxins and hormones and also contact with the literature.

Unfortunately for everyone this information is diffuse, and difficult to come by. Most of it is considered to be insufficient in content and scope for publication and when published it appears sparsely scattered and so lost from sight and mind.

My intention is to try to accomplish two things today:

1. To illustrate that this scattered information on the subject of my title is of tremendous potential value, and
2. To convince this society that it would be worth while to finance a search of the literature, circulate a fact finding questionnaire, and publish the aggregated information in a concise, useful, practical form.

As stated above, there are few of us who have not experienced beneficial results from using mixtures of things as rooting aids. Ordinarily these contain an auxin plus divers and sundry other classes and genera of chemicals.

In discussing and thinking about these mixtures three kinds of effects may be observed: 1. complimentary, 2. supplementary, and 3. synergistic. The latter, of course, may be a feature of either 1 or 2. There is a fourth event as well called negative results, but I shall exclude failures from this discussion. However, in preparing a good survey, things that don't work need summarization as well as those that do.

In my discussion I shall construe these terms as follows: complimentary—producing an additional benefit in a different way; supplementary—producing an additional benefit through the same kind of event or in the same or similar way; synergistic — the combined effect of two or more substances is greater than the sum of their individual effects.

For example, a mixture of an auxin and an oxidizing agent which gives better results than either alone would be a complimentary event A mixture of two auxins giving a greater or spiration in the stems of the roses so that at the end of a month they are not dried out. If any want more details on this, contact me.

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For example, a mixture of an auxin and an oxidizing agent which gives better results than either alone would be a complimentary event A mixture of two auxins giving a greater or better result than either alone would be supplementary. In either case if the combination of substances exceeded the benefits to be derived from their use individually the event would also be synergistic. Synergism as far as the practical propagator is concerned is simply increased efficiency.

Many of us have enjoyed the benefits of using small amounts of 2,4,5-T in conjunction with IBA and NAA in rooting Rhododenrons. Similar exotic brews have been successfully employed with other difficult materials.

Several years ago Dr. Charles Hess showed us benefits from the use of Methylene Blue. I also have data which show that Methylene Blue used with IBA is highly beneficial for widely different genera. I also have data showing an even greater effect when purine denatured ethanol is used as the solvent for IBA. (Since this talk was presented I have learned that this is very old knowledge which I feel reinforces my conviction that a thorough summarization is in order). There are many many other instances. At the time of Dr. Hess's methylene blue dislosure, Dr. Stoutemyer raised the question of Pyrocatechol as an even stronger oxidizing agent. This chemical has a long and successful history of use on potato seed pieces. I have used it with benefit on piece root cuttings. Someone must have tried it with IBA if I knew who, if you knew who, it would obviously save us both a lot of time.

My basic mission today is to encourage this society to locate all of the many people, often our reticent colleagues, who have information on any effect of any substance on rooting and get it effectively assembled in one practical place.

* * * * * *

Post Mortem: At the conclusion of my talk and during the question and answer period the value and importance of my proposal became more and more obvious. I learned that my experience that 8-hydroxyquinoline sulfate as an extremely useful aid in propagating cuttings was due not only to fungistasis but probably also to stomtal anesthesis. A few moments later I learned from Prof. A. M. Roberts of Oregon State University that a student of his had "discovered" a paper bearing on this subject. He kindly sent me a copy. He also tells me that Mr. David Adams the discoverer has surveyed the literature in this connection. This article,* however, illustrates my thesis well. It was published in 1940 and covers trials in which nitrogenous compounds of many types were used in rooting mixtures, many of which proved beneficial, and a few of which were spectacular. There must be many other hidden gems which a simple questionnaire would uncover.

MR. CARL SCHMIDT: What is 2-4-5-T?

DR. MOREY: It is a brush killer. It's related to 2-4-D

*B W Doak 1940 The effect of various nitrogenous compounds on the rooting of Rhododendron cuttings treated with a Naphthalene-acetic acid New Zealand Journal of Science and Technology pp 336A to 343A April, 1940 only apparently more reactive on woody plants. However in low concentrations it evidently assists in the rooting of hardwood cuttings.

MR. CARL SCHMIDT: What is it chemically?

DR. MOREY: 2-4-5-trichlorophenoxyacetic acid.

MR. JOHN IKELSER: Would you have any comment on the use of fungicides?

DR. MOREY: I think it's a very valuable practice to include a fungicide in a root inducing compound. My own experience has been that I get a synergistic effect. Of course, this is an illusion. If one does not lose cuttings to fungi, he gets a better stand. In my experience one of the more useful compounds is 8-hydroxy quinoline sulphate. I prefer to use it with rooting solutions rather than trying to mix it with talc. I use it at rates of about 1:2000. If used regularly, particularly if it is used as a dip (e.g. a twenty-four hour dip), one will find that the cuttings will take up enough to give a significant decrease in losses, particularly if any bacterial problems exist. In this connection in growing seedlings I've found out that regular use of 8-hydroxy quinoline sulphate is very helpful in damping-off. It won't stop damping-off. If a damping-off problem is already at hand, don't think you're going to cure it with 8-hydroxy quinoline sulphate. However, if you run a test putting a weekly application at about one to ten thousand from the time the seeds are planted on a portion of a planting, you'll find that you have some significant decrease in damping-off as against the controls(providing you have a problem develop). If one carries on an experiment in which no problem arises, he may automatically come to the conclusion that the treatment is not doing any good. This is another reason for accumulating the experiences of a lot of people on any problem. Practical experience of a lot of people will show whether or not the same practice is good, bad or indifferent, due to chance alone.

There are other fungicides which can be used, Captan and the carbamates Dexon, PCNB, etc. I have not been altogether happy with my experiences with them, but that's personal.

DR. WESLEY HACKETT: Which purine compound are you referring to?

DR. MOREY: I don't know which compound. The one used for denaturing alcohol.

DR. HACKETT: Generically there are several purines. The California Biochemical Corporation produces them.

(* Imidazo (4,5-d) pyrimidine. Some natural occurring purines include adenine and guanine. Other related compounds are known as cytosine, uracil and thymine. These are constituents of chromosomal material).

MR. RALPH PINKUS: What is the trade name of the fungicide 8-hydroxyquinoline sulphate?

DR. MOREY: There is no trade name as far as I know. It is available from the New York Quinine Chemical Company, from Bryant Labs in Berkeley, California, from Eastman Kodak. The quinolinol itself is insoluble in water. It will go into alcohol, but one wants 8-hydroxy quinoline sulphate in my opinion. If you dislike the smell of quinine or are allergic to it, do not mess with it.

MR. DICK HILDRETH: Is this the same material that also has an effect like colchicine and inhibits spindle formation in mitosis?

DR. MOREY: I have seen no evidence of polyploid induction with the concentration that I have used.

DR. NEAL CUNLIFFE: Have you done any work with the use of cycloheximide as a compliment or supplement to rooting compounds?

DR. MOREY: I have used this material in many ways, and I find it extremely useful, also very touchy. It is to be recommended, but don't treat the whole planting the first time. Regardless of the recommendations the manufacturer gives with antibiotics, it has been my experience that it is better to start out by cutting all recommendations in half. Also I have found that with things like streptomycin and some of the other early antibiotics, phytotoxicity in some plant materials is extremely acute. When using aureomycin or any other antibiotic you undoubtedly will find that certain plant materials will give you problems no matter what concentration is used. But these are very good bacteriocides and many are quite active against many fungi, as well, in my experience.

MR. E. R. VAN CLEVE: Do you have any experience with Agrimycin in your dip solutions in rooting cuttings?

DR. MOREY: Some while back, while I was at Jackson and Perkins we did quite a lot of work with Agrimycin. As I remember it this material is a mixture of streptomycin and terramycin; but here again phytotoxicity was the problem. However, in very weak concentrations cuttings that have been allowed to soak for twenty-four hours will apparently take up enough of the material without phytotoxicity to have some resistance to crown gall formation provided callusing and rooting proceeds within about six weeks. Now with crown gall I think those of us who have to worry about it from a practical point of view are pretty well convinced that after rooting has taken place and callus formation is complete and soft tissues have hardened, galls will not become a problem unless you have nematodes or some other way for infection to take place. It is during the formation period in which the roots develop that crown gall occurs. Agromycin in a soak seems to be beneficial but again the problem of phytotoxicity often is severe. Incidentally, the cheapest way to get terramycin is to buy chicken water treating chemical and adjust your concentrations. I think the diluent in this formulation is sugar, which ordinarily isn't going to hurt ones cuttings.

MR. JOHN WHISLER: Some of our olive people have been working on a control for olive knot and have a control through some of the hydro-carbons. Kerosene will kill these bacteria.

DR. WALTER LAMMERTS: I might state that for the benefit of those that want to try it, that as long ago as 1935 while I was at Armstrong Nurseries and first tried indoleacetic acid as a rooting compound, I found that one can be too antiseptic. One got better results when he made a mixture of green algae and poured it over the plants in order to establish an algal overgrowth.

MR. E. R. VAN CLEVE: We are interested in soak solutions. Does anyone on the panel have any discussion on mixtures for dipping cuttings just prior to sticking them into the greenhouse bench or in the flats?

DR. BROWN: We have found an excellent material to use is Tersan, a fungicide which can be used as a soak or a quick dip for cuttings for fungus control. We use one tablespoon per gallon of warm water. The cuttings can be soaked up to fifteen minutes. However, I think just a complete submersion is just as effective as a fifteen minute soak, and this is a standard procedure we follow at Cal. Poly, San Luis Obispo, in dipping our cuttings before we stick them. It's very important in using any of these materials that you use a wettable powder rather than a liquid, because a liquid often times has oil base carriers and this oil can be toxic. There are only two or three species of plants that we found to even be questionable as far as damage is concerned with the Tersan dip. If we are concerned about insects, we will use a tablespoon of fifty per cent wettable malathion in the dip. There are many more plants that are affected adversely by this. Also where we're handling it with a number of students and inexperienced help, we're not concerned at all about the danger of Tersan, but we certainly wouldn't want them dipping their hands or inhaling the fumes from the malathion.

DR. SNYDER: We have been using a slurry dip composed of Algen, which is a suspension material, Tersan and Hormodon 3 which we just dip the cutting in. A greenish film is left on the cutting which is stuck directly into a two inch peat pot in soil for rooting a wide range of herbaceous and soft wood materials. They root and are immediately transplanted without any set back. Whether it will be effective in reducing disease problems I don't know because we haven't run into that, but I should imagine that it would be.

MR. DON DILLION: We're using Captan and Terrachlor. This is for dwarf citrus.

DIRECTIONS FOR PREPARATION OF ROOT-PROMOTING SUSPENSION CONSISTING OF HORMODIN #3 AND TERSAN

Suspend 2 rounded tablespoons of the mixture of equal parts of Hormodon #3 and Tersan in 5 ounces of water. After the powder is thoroughly wetted and stirred into a smooth suspension, add with rapid stirring 5 ounces of 4/10% solution of Algin. The latter material is a suspending agent which helps to keep the insoluble material from settling out.

Dip the basal end of cuttings into this root-promoting suspension to a depth exceeding that to which the cuttings will be placed in the propagating medium.

THURSDAY AFTERNOON AND EVENING SESSIONS

OPPORTUNITIES AND OBLIGATIONS OF THE INTERNATIONAL PLANT PROPAGATORS' SOCIETY

PERCY C. EVERETT
Rancho Santa Ana Botanical Garden
Claremont, California

It has been my privilege to have been one of the few charter members of the International Plant Propagators' Society from the west in what is now mainly the Eastern Region. How I gathered that honor, I have never been quite sure. Perhaps it was because I subscribed to Trees Magazine, and Ed Scanlon sent me an application. I realized the value of this sort of organization because there was no other like it, and because, having troubles in our propagation department, I wanted some answers for my problems. This was the sort of Society badly needed by the propagator. Although unable to attend the annual Conferences because they were always held in the east during the winter, I gained a wealth of information from the Proceedings and the quarterly, The Plant Propagator. It was through that valuable contact, I became increasingly more interested in the Plant Propagators' Society, as it was then known.

A few years back, I received letters from some of my Davis friends that indicated there was some thinking going on toward the establishment of a western group. I asked to be included in the discussions, and while I was unable to attend some of the meetings, ground work was laid for what has now become the Western Region. At the initial Conference in Aslomar, we were most fortunate in having in attendance several dynamic and enthusiastic individuals from the Eastern Region. They grafted into us their intense enthusiasms — the real meat and substance of this Society. After certain birth pains we became the International Plant Propagators' Society. We became the Eastern and Western Regions, each with its own officers. We have an overall governing Board of Directors.

This thumbnail sketch of our Society's history here given for the benefit of those unaware of its beginnings leads us to examine our opportunities in this association. All of us can enjoy the rubbing of shoulders, exchanging bits of information, gaining new horizons from all the many kinds of individuals who make up the roster of our profession. These contacts, individually and collectively will do much toward raising your ideals and all of those with whom you make contact. This in turn will be of greater benefit to all in our efforts to upgrade the plant propagator profession. After all it is with you — the professional propagator — that all this begins; you are the foundation; its your basic work, the methods you discover and pass on to others that really pays off.

Along with the many opportunities you have of meeting with eminent scientists, and the beginner in the field of propagation, you have this eager sharing of knowledge, this esprit de corps that I have never witnessed in any other organization. I so well remember the first Conference at Asilomar — "Jolly" Batcheller coming out of one of the sessions, his eyes aglow, his face lit up, exclaiming, "I've never seen or felt anything like this"! This is the way it has been at each of our Conferences, and what you would experience if you went to any of the Eastern Region meetings.

However, you do have certain obligations that go along with all of these worthwhile opportunities. I refer in particular to parts of Article 3, Section 2, which has given your Board of Directors a great deal of concern. In part, it states "individual membership shall be available only to those persons who have made a significant contribution in the field of plant propagation by experience, teaching or research." This means you must have had at least five years experience in the field of plant propagation. Then, "it shall be the duty of a member to attend a minimum of one regional meeting each three years or, in lieu of attendance, to contribute a written article for publication in the Newsletter. Failure to comply with these conditions will subject the member to being dropped from the rolls." It is this last part that is the crux of the situation. There are a number of members who have not met these obligations, and while we certainly do not want to drop them from the rolls, this will be necessary if these obligations are not met. I make this plea to you to consider this vital obligation to your Society to see to it that you faithfully do your part in fortifying the strength of your Society. Some of you may say, "why, I can't write — or I don't have anything to contribute." That isn't entirely the idea. You can come. And who is to know what you have to offer unless you are willing to communicate? Every effort is made to shift the meetings in each region frequently enough to permit us to attend at least once every three years. Some of us find the Society so valuable we don't want to miss any of the Conferences. So will you, each individual, resolve to help the officers make your organization a much more successful one. Thank you.

TEACHING OF ORNAMENTAL HORTICULTURE ON A COLLEGE LEVEL

HOWARD C. BROWN
Ornamental Horticulture Department
California State Polytechnic College
San Luis Obispo, California

Teaching of Ornamental Horticulture on a college level, or on any other level for that matter, can be effective only if we have good students to teach. To me, it is the primary responsibility of an industry to do the recruiting of young people to train for key positions in the future of the industry. And in Ornamental Horticulture I don't believe that we have done a good job of recruiting.

When I was younger, growing up in the horticulture trade, one of the big crops was geraniums. It was a common practice for the grower to have all of his geranium plants in one house. As the plants came into bloom they would be sold — the earliest blooming and most vigorous plants selling first. Propagation was done by taking cuttings from those plants that were not sold and the grower's constant complaint was that strain was running out.

I believe that many of us in horticulture have done the same thing. Someone else has taken the early blooming and vigorous young people. Many of those coming into our industry are the ones that were left.

We need to do a better job of selling. We need more pride in our business, and we need to convince ourselves that it has a future. I can recall several years ago of taking our students on field trips to one of the most successful nurseries in the area. The owner would always greet us with the question "What do you want to go into the nursery business for? You'll never make any money." I am sure that deep down in his heart the nursery owner didn't believe what he was saying. Perhaps he was just afraid of future competition.

Contrary to common belief, not all of today's youth are out solely for the dollar. Many of them select a career because it presents a challenge, because of previous experience, or because of the romance involved. Horticulturalists need to dress up their image to compete with the romance of aviation or the pres-your Society. Some of you may say, "why, I can't write — or I don't have anything to contribute." That isn't entirely the idea. You can come. And who is to know what you have to offer unless you are willing to communicate? Every effort is made to shift the meetings in each region frequently enough to permit us to attend at least once every three years. Some of us find the Society so valuable we don't want to miss any of the Conferences. So will you, each individual, resolve to help the officers make your organization a much more successful one. Thank you.

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Contrary to common belief, not all of today's youth are out solely for the dollar. Many of them select a career because it presents a challenge, because of previous experience, or because of the romance involved. Horticulturalists need to dress up their image to compete with the romance of aviation or the prestige of some of the professions. We need to educate the high school counselors as to the possibilities in Ornamental Horticulture, because it *is* one of the fastest growing and most challenging areas of all of agriculture.

The teaching program in Ornamental Horticulture that I am going to describe is quite different from that which you may be acquainted with in the Land Grant Universities. The one with which I am concerned is the type found in California in the four-year state colleges.

The responsibilities for education in California, as defined in the study of higher education, makes a distinct division of authority among three areas of post-high school study.

The areas of research and agricultural extension are reserved for the university, as is most of the graduate work in agriculture.

The role of the junior colleges, and each year we have more of them offering instruction in horticulture, is that of vocational training. Even though some of their graduates go on to a state college or university, the junior college emphasis is upon a two year terminal program to place a well trained man in vocational employment in the local community.

The role of the state colleges in California is somewhere in between these other two areas. While each of our students at Cal. Poly must complete a thesis as a prerequisite to obtaining his bachelor of science degree, and some of these amount to pretty good research problems, our real goal is the training of young men and women to assume key managerial positions in the production areas of the nursery, florist, and landscape industries of California.

Their training must be a combination of knowing how to perform a given operation as well as knowing why it is being performed. Our program is set up so that the students take courses in their major, beginning with their first quarter of college. With major work as a background we believe that they have a greater appreciation for the chemistry, genetics, physiology, and economics when they reach that point of their studies.

Cal. Poly is probably unique in the United States in the respect that our teaching program is set up along the lines of commercial horticultural operations. The students maintain a commercial nursery and flower shop on the campus and own most of the plants that are grown. They share in the profits from the materials sold and, believe me, the monetary incentive is just as evident during this training period as it is later in life.

The College's good relations with the various trade associations in horticulture play a most important part in the educational program. Each year over 200 members of the California Association of Nurserymen meet on the campus for their annual Refresher Course. Many of them attend our Horticulture Club Awards Banquet and they mingle with the students for two and a half days. What better way to inspire students for a career in the nursery industry or to acquaint the nurserymen with our program of education?

The California State Florists Association has worked with us for the past nine years and was responsible for the establishment of our program in floral design. They have contributed financially each year, enabling the students to have a much greater supply of flowers than could be provided through the state budget alone. They also have made available the services of outstanding guest floral designers.

The International Shade Tree Conference and members of the California Landscape Contractors Association meet regularly on the campus, presenting an opportunity for students to participate in their programs and to learn about possibilities for careers in the areas that these associations represent.

I would like now to elaborate on the commercial type production program that our students follow in their four years at Cal. Poly.

The entering freshman starts with a course in Orientation to Ornamental Horticulture in which he learns about the many phases of the industry as well as the operation of the department. At the same time he is taking the course in Nursery Operations in which he studies the preparation and treatment of standardized soil mixtures, seed sowing, transplanting, potting, canning, etc. We probably mix and sterilize more soil in one quarter than most college students will see during their entire careers. We were one of the early adherents to the U.C. program of growing healthy container stock, even at a time when Dr. Baker's ideas were not popular among some segments of horticulture. Manual 23 is practically the Bible for our department and even when the nurserymen eat their refresher course luncheons in our head house you can always find the crock of formaldehyde solution for sterilizing anything that hits the floor.

During the second and third years our students interested in growing nursery stock take two courses in propagation. In addition to their greenhouse work they follow through on a complete seed bed program and field growing operation. This includes seed extraction and cleaning as well as treatments to speed up germination of seeds. A typical crop grown by the students is Modesto Ash. This begins with sowing of seed in a prepared bed and growing the seedlings on for a year. The second year they are lined out in the field during the fall, where they make sufficient caliper for late spring budding. After lopping in June the bud strikes and the tree will make a five foot whip that same year.

In the Advanced Plant Propagation course we also do a considerable amount of grafting. Although grafted conifers are not commercially important in our area, we believe than bench grafting is a technique that every plant grower should master. Each year we receive *Picea abies* understocks from Jack Hill at Dundee, Illinois. These are forced in the greenhouse until white roots appear and are then veneer grafted. Our other major grafted crop is Juniper, in which we side graft juniper clones onto *hetzi* liners. Since the academic year is divided into twelve-week quarters, we have to force the grafts to get results before class is over. We have settled on a program of forcing which involves heat and mist, as well as plunging the grafted plants. It probably increases the mortality but it certainly saves time.

With this as an introduction to our instructional program, I would like to show some slides which will better illustrate what we are doing toward meeting the need for trained horticulturalists.

(*Slides*)

To conclude my presentation I would like to emphasize several points that we consider essential to a good teaching program in college horticulture.

1. We must have support of the industry.
2. We need a better recruiting program for good students.
3. Students should begin their major work early in their careers to keep up their interest. This is the key to keeping them in the department.
4. Students should be kept busy with work related to their major. We like to see them around the greenhouses during their spare time.
5. We must maintain high standards in workmanship as well as in academic areas.
6. We need a good placement program to fit these students into the right job.
7. We should follow up on our graduates to see how well they are doing the work *for which we thought they were trained.*

This teaching of Ornamental Horticulture is a rewarding career. With 113 students in the department there is never a dull moment. The students are optimistic about the future and their enthusiasm and interest are contagious.

Keeping up with the progress and success of approximately 250 of our graduates gives me the feeling that they are living up to our expectations and that there truly is a future for our industry.

MR. JOLLY BATCHELLER: Howard, I think they would be interested in the per cent of placement in the field we have.

DR. BROWN: I know in a good many areas of education there always is a question of how many of these students go into the line of work in which they're being trained. One of the things we encourage our students in Ornamental Horticulture to do is not to over-specialize. In other words, don't say, "I'm going to be a nurseryman. I don't want anything in floriculture or landscaping, or I don't want to take any courses in sales or business. They have to take a fairly wide variety of courses the first two years. Then in the third and fourth year they can specialize in these major areas. The survey that I mentioned of two hundred and fifty of our alumni in ornamental horticulture indicated that approximately eighty-five per cent are still employed in ornamental horticulture or a very closely allied business. Now, this would mean sales and field representative for insecticide companies, fertilizer companies, teaching of horticulture, or this type of thing. Your figures, Jolly, would be about the same I would imagine. A lot of them do stay right within the area for which they are trained. This is interesting too because we have had a few that have gone from ornamental horticulture into electronics and some of these areas. Their degree in O.H., if they go to work for Aerojet, for instance, is just as valuable to them as one in engineering as long as they've got their degree and can do the work. There is a real temptation for them to jump to another line of work where the salary might be higher, but I think most of them are in this line of business because they really enjoy it.

ROUNDTABLE DISCUSSIONS

CHIEF MODERATOR — DR. J. HAROLD CLARKE

I. Greenhouse plants

MODERATOR: R. E. WEIDNER

SEED GERMINATION OF GREENHOUSE CROPS

WESLEY N. KEYS
Greenhouse Manager, Bodger Seed, Ltd.

After spending the first 36 years of my life as a dairy farmer in Fond du Lac, Wisconsin, I spent 2 years teaching in a floral design school in Denver. I then went in the florist business with one of my students in Lompoc, California. In 1949 I went to work for the Burpee Seed Co. as their Double Petunia Propagator and Greenhouse Manager. In 1956 with the onset of Red Satin Petunia I went to work for Bodger Seeds Ltd. as their manager.

If you are successful with your present method of producing good seedlings, don't change; but if you are having trouble, the first thing to do is order Manual 23 (The U. C. System for Producing Container Grown Plants) available for $1.00 from any University of California Agriculture Station.

At Bodgers we grow about 5,000 seedling flats, 40,000 pricked off flats, plus 100,000 pots for seed production of F_1 petunias, F_1 snaps, Coleus, Impatiens and Gloxinias. In our specialize in these major areas. The survey that I mentioned of two hundred and fifty of our alumni in ornamental horticulture indicated that approximately eighty-five per cent are still employed in ornamental horticulture or a very closely allied business. Now, this would mean sales and field representative for insecticide companies, fertilizer companies, teaching of horticulture, or this type of thing. Your figures, Jolly, would be about the same I would imagine. A lot of them do stay right within the area for which they are trained. This is interesting too because we have had a few that have gone from ornamental horticulture into electronics and some of these areas. Their degree in O.H., if they go to work for Aerojet, for instance, is just as valuable to them as one in engineering as long as they've got their degree and can do the work. There is a real temptation for them to jump to another line of work where the salary might be higher, but I think most of them are in this line of business because they really enjoy it.

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We use equal parts by volume of sharp fine sand (free of all clay) and peat moss (Canadian) to which we add 3 lbs. of the following fertilizer mix to each mixer (1/3 yard) of soil:

25 lbs. Blood Meal
59 lbs. Single Super Phosphate
50 lbs. Dolomite
50 lbs. Calcium Carbonate
8 lbs. Muriate of Potash
8 lbs. Ferto Sil (trace elements)

The soil mix is then steam sterilized for 2 hours at 180° F. Seed is planted immediately upon cooling. Such seed as petunia and snaps are planted in shallow rows without any cover and watered with a Fogg—it nozzle until the flats are thoroughly soaked and water is running from the bottom of the flats. Larger seeds are covered no deeper than the diameter of the seed. Any slow germinating seed such as primrose, pansy, delphinium, aquilegia, etc. we use a thin layer of sphagnum moss on top of the flat before planting the seed. After planting the seed we cover slightly with our regular sand peat mix. The sphagnum moss helps retain moisture much needed for uniform germination.

For very difficult seeds, we use and highly recommend a misting system over a heating cable such as we use for rooting cuttings. Out mister is set at two minutes every hour.

We germinated 4 year old primrose selections this summer *under our mister and had nearly 90% germination. We also* use this misting system for germinating gloxinia seed on top of sphagnum moss without any cover. This moss is sprinkled on top of our regular soil mix. We use Consan 20% (1 teaspoon to 10 gallons of water) to control algae on top of flats.

As soon as germination takes place we water our seedling flats with Plant Chem (2 lbs to 1000 gallons of water) in which is added 4 oz. of panogen drench 15. This same procedure is used every watering until plants are ready to prick off. We maintain a temperature in our seedling house of not less than 60° and never higher than 80° F. When our plants are pricked off we add 2 ounces of Superthrive to our fertilizer mix just before and afer pricking off. This prevents shock to the newly pricked off plants. The second watering we add 2 lbs. of Ammonia Nitrate, 2 lbs. of muriate of potash and 1 lb. iron sulphate or, if you prefer, chelated iron. This is only if your water is a problem and you have pH problems. When we mention watering we mean a thorough leaching and then do not water again until flats are fairly dry. This also prevents any salt buildup.

You may also set up for mechanical watering using plastic pipe with the new nylon nozzles but in most cases a booster pump is necessary for sufficient pressure.

We water our entire 100,000 pot set-up with plastic tubes. We use insecticide, fertilizer and fungicide all in the same water with 2 regular Smith Proportioners. This saves us over $20,000 in labor a year.

You must remember we are growing plants to be set out in the field for seed production. They are planted out as soon as hardened off as a production of 500 flats a day soon uses up all existing space. These methods will have to be altered with higher phosphate and potash and less nitrogen so as to carry the plants longer to prevent them from becoming overgrown.

We do not profess to know all of the answers but these methods work well with us. We suggest that you try them and make any alterations to fit your own needs and growing conditions. In my spare time I grow potted Cyclamen and have my own strain of F_1 Hippeastrum Hybrid Amaryllis in both seed and bulbs.

We hope you will find our methods as beneficial to you as they have been to us. Thank you and be careful where you locate the plantings of your Phildodendrons.

DR. CLARKE: What are people using around here to counteract algae? Mr. Keyes mentions using Consand. What is consand?

MR. KEYES: It is an algecide used for swimming pools. Dimethyl ethylbenzyl ammonium chloride manufactured by Consan Chemical Products, 1143 East Ten Mile Road, Madison Heights, Michigan. For tender plants we use 1 teaspoon to ten gallon water; more for hardier plants. For clay pots — we use one cup in 100 gallons to thoroughly soak. Some experimenting will have to be done as no recommendations are made for plant use. I used it for Cyclamen pots and it keeps algae off for over a year.

DR. CLARKE: There's a rhododendron breeder in New Jersey who made a practice of innoculating his seed pots with a certain species of moss which he claims is very effective in damping-off.

MR. JOLLY BATCHELLER: I remember going through Armacost Orchid House in Los Angeles and Mr. Armacost held up two seed flats in orchids. Both flats were planted the same day, the same seed pod, the same media, under the same conditions. He pointed to one and said this one is absolutely sterile and this one is contaminated. I wish I knew what it is contaminated with because the growth is twice the size of the other.

MR. SAM SPAULDING: What's this twenty thousand dollar money saving water scheme?

MR. KEYES: We developed this at Bodgers at the onset of growing Thumbelina zinnias. We won on All-American award on Thumbelina zinnias and we were short of stock seed. We had to grow seven thousand plants of Thumbelina zinnias in the greenhouse in a hurry. As you all know, zinnias watered by overhead irrigation are very subject to mildew. Well, we cut up a bunch of this tubing in short lengths and put four small tubes in flats, planted twenty-five seeds in each flat, and we produced the entire crop of Thumbelina zinnias in greenhouses and that paid for the stock seed. Then we started using it on a hundred thousand pots of our F-1 hybrid petunias, our F-1 hybrid snaps inbreds. We purchased the spaghetti tubing from the Plexton Specialty Company, Glendale, California. It can be purchased in large lots for a dollar fifteen per thousand feet. You can get it in a smaller lots. The most economical way to buy it is in five hundred thousand foot lots. The average nursery would use five hundred thousand foot. It's the cost of extruding this plastic and the amount of plastic they extrude that sets the price. We can set this system up for eleven dollars a seventy-five foot bench. Now a seventy-five foot bench in our greenhouse would hold between three and four hundred seven inch pots. The entire cost of all the material and all the labor costs us thirty-seven hundred and fifty dollars for a hundred thousand pots. We saved the labor of twelve women doing our watering.

We use ½ inch lines and ¾ inch headers. We use 200 mesh stainless steel strainers on all lines when fertilizing or, using insecticides. All may be used in the same proportioner at the same time. We cut our spaghetti tubing with a sharp razor blade on a diagonal to make it easier to insert. All spaghetti tubing must be the same length on the entire line; otherwise shorter tubes would get more water. In our watering we let as much run through the pot as stays in or thoroughly drench every time we water. This eliminates salt buildup from use of fertilizers in every watering. We use a 4-inch plastic plant label to hold the tube in the pot. We use a sharp finishing nail 1/10 inch in diameter inserted in a small piece of dowel for punching the holes for the spaghetti tubing. Tubing must be inserted as soon as hole is made as they gradually push out again.

FOLIAGE PLANTS

RICHARD L. PLATH
H. Plath & Sons
South San Francisco, California

Propagation of Foliage Plants

To start with — all our propagating material and containers are steam sterilized.

Propagating Material — Olympic sand, peat moss. 50% peat moss and sand, and a modified soil containing peat moss, Colma sand (which is a very sandyloam) with a little superphosphate added.

Propagation of Philodendron Cane — The cane is cut up into pieces, single eyes. These are potted in Olympic sand and placed in benches with bottom heat and a temperature of 65° maintained. After the plants are placed they are then covered to a depth of about ½ inch with peat moss, which is kept damp at all times.

Dieffenbachia and Chinese Evergreen — These are cut in pieces with one eye and placed in benches with about two inches a hundred thousand pots of our F-1 hybrid petunias, our F-1 hybrid snaps inbreds. We purchased the spaghetti tubing from the Plexton Specialty Company, Glendale, California. It can be purchased in large lots for a dollar fifteen per thousand feet. You can get it in a smaller lots. The most economical way to buy it is in five hundred thousand foot lots. The average nursery would use five hundred thousand foot. It's the cost of extruding this plastic and the amount of plastic they extrude that sets the price. We can set this system up for eleven dollars a seventy-five foot bench. Now a seventy-five foot bench in our greenhouse would hold between three and four hundred seven inch pots. The entire cost of all the material and all the labor costs us thirty-seven hundred and fifty dollars for a hundred thousand pots. We saved the labor of twelve women doing our watering.

We use ½ inch lines and ¾ inch headers. We use 200 mesh stainless steel strainers on all lines when fertilizing or, using insecticides. All may be used in the same proportioner at the same time. We cut our spaghetti tubing with a sharp razor blade on a diagonal to make it easier to insert. All spaghetti tubing must be the same length on the entire line; otherwise shorter tubes would get more water. In our watering we let as much run through the pot as stays in or thoroughly drench every time we water. This eliminates salt buildup from use of fertilizers in every watering. We use a 4-inch plastic plant label to hold the tube in the pot. We use a sharp finishing nail 1/10 inch in diameter inserted in a small piece of dowel for punching the holes for the spaghetti tubing. Tubing must be inserted as soon as hole is made as they gradually push out again.

FOLIAGE PLANTS

RICHARD L. PLATH
H. Plath & Sons
South San Francisco, California

Propagation of Foliage Plants

To start with — all our propagating material and containers are steam sterilized.

Propagating Material — Olympic sand, peat moss. 50% peat moss and sand, and a modified soil containing peat moss, Colma sand (which is a very sandyloam) with a little superphosphate added.

Propagation of Philodendron Cane — The cane is cut up into pieces, single eyes. These are potted in Olympic sand and placed in benches with bottom heat and a temperature of 65° maintained. After the plants are placed they are then covered to a depth of about ½ inch with peat moss, which is kept damp at all times.

Dieffenbachia and Chinese Evergreen — These are cut in pieces with one eye and placed in benches with about two inches of peat moss with eyes facing up if possible, especially the Dieffenbachia. If they are *not* placed this way they have a tendency to develop a curve in the cane when mature.

Dracaena Cane — The cane is cut into short pieces of about 3 inches long and laid on sand and covered with a light layer of peat moss and sand, nor more than ½ or ¾ inch. As soon as the eyes develop and get long enough to handle, they are cut off and potted in peat moss and sand and set out on benches; or they can be left on the cane until roots frm and then potted into soil.

Unrooted Cuttings — Most of these can be rooted easily in peat moss and sand with or without bottom heat. With some experimenting we find that a lot of these can be potted in our propagaing soil mixture; but of course care must be used in watering until they are rooted.

A partial list of plants we grow in this way are: *Aphelandra, Hoya, Fittonia,* Aluminum plants, *Sansevierias, Maranta,* almost any of the *Peperomias, Dracaena godseffiana, Dracaena sanderiana* and others. *Ficus* can be easily grown by air layers.

Bromeliads are finally becoming popular and can be propagated from divisions and also grown from seed, although this is a very slow process.

Schefflera and *Tupidanthus*

These are mostly propagated from seed sown in a light mixture of peat moss and sand which has been sterilized. When the seed is sown, it is given a drench of Dexon Terraclor. These can also be raised from cuttings provided the cane is light enough.

Ferns

Ferns are becoming very popular again and are more and more in demand. Of course, the so called *Pteris* ferns have been used right along for dish gardens but are now being sold in larger containers to the retail nurseries. Most of these ferns have to be grown from spores. Care must be used in doing this as it is very easy to have fungus develop just as the prothalium starts to cover the surface. A drench of Dexon seems to stop it immediately. Some varieties of ferns can be propagated by division. The *Nephrolepis* can be grown in benches, well spaced. When the runners develop, the little plants are cut off and potted in a light soil in 2¼ or 3 inch pots.

Polystichum capensis is better when divided from mature plants. Some ferns make terminal buds which can be removed and laid on damp peat moss and covered with glass until they take root, such as *Asplenium bulbiferum.*

SOME OF THE CURRENT PROPAGATION CONSIDERATIONS WITH THE POINSETTIA

PAUL ECKE, JR.
Paul Ecke Nursery
Encinitas, California

The present techniques used commercially for propagating poinsettias from softwood varies considerably from one part of the country to another. For all practical purposes, it can be said that propagation is practiced either in raised beds or in one of three types of pots — clay, plastic or transplanter peat. The media regardless of what system is being used will range from sand, sand and peat, sand and perlite, perlite alone, peat and perlite, peat and soil or soil and perlite, usually on a basis of 1 to 1 ratio by volume.

Various root-promoting materials are used, but it must be said that the greatest success is usually with materials of mild strength. There have been many cases where strong concentrations have caused unusual swelling, cracking and discoloration of the stem with unusual elongation between the nodes as well as petiole distortion in the form of a corkscrew effect. Various factors, such as daytime temperature and humidity, will play a role in whether or not a given preparation is satisfactory or not.

The nutritional level of the stock plant is also quite important. Should a plant be on the deficient side in N, P or K, it would be normally expected that the cutting would root much slower. It has often been suggested that when the fertility level is too high it is possible that the susceptibility to various unexplained soft-rots is more pronounced. There have been reports from various parts of the country the last few years regarding an unusual soft rot which amounts to complete disintegration of the stem below the media level. This condition usually starts after the third day and is complete prior to the seventh day. Often this unexplained condition occurs at a time of daytime temperature above 85°, with high light intensity during the long days of summer when the humidity is high. Conceivably more alert sanitation procedures could minimize this problem. The disease control on poinsettia propagation is most important and a complete sanitation program is mandatory.

There has been a certain amount of discussion relative to the usefulness of cutting dips but successful propagators are using Agrimycin and Morsodren with good success. The material LF #10 is a formulation, when used as a cutting dip, can like all other chemicals, cause difficulty when used stronger than the manufacturer's recommendations. Terraclor, as a drench on the cuttings in the propagating area, should be used at no stronger rate than ¼# per 100 gallons. Several years ago, the recommended rate for Terraclor was 1½# per 100 gallons. It has slowly been reduced now to 8 oz. per 100 gallons. There is some thought that overdoses of Terraclor have contributed to blindness on certain blooming crops of poinsettias.

Poinsettias normally can be kept vegetative throughout the year by the use of accepted lighting technique and this practice is generally satisfactory for the regular commercial varieties. The normal propagating season on poinsettias is from June through September.

Mist propagation is now accepted as the standard procedure for propagating poinsettias. The difficulties occur sometimes because propagators have not used the proper timing cycle and the cuttings have been kept too wet. It appears the best rule of thumb, regardless of what system is used, is to keep a light film of moisture on the foliage at all times during the daylight hours. Too much moisture, of course, can enhance the possibility of rot and will certainly elongate the cuttings out of proper proportion. The water quality used, naturally, has a great influence when using the mist system, and the poor quality Colorado River water which is unusually high in total soluble salts is responsible at times for marginal foliage burn.

A factor that has not been given much consideration until recently is air pollution. No doubt, some of the unexplained reasons for the erratic rooting of poinsettias, unnatural leaf loss and similar problems can be correlated to air pollution. There are just too many unexplained problems in the poinsettias propagating program to eliminate the possibility of air pollution being a real factor.

Most of the popular present-day commercial varieties are mutations. There is a certain amount of interest in some new seedling varieties. These have to be handled in an entirely different way. One of the principal problems with many of the new seedlings is that they will form flower buds at odd times of the year. This of necessity requires an entirely different approach to the total handling of the plant material.

In the propagation program it appears that it will be a matter of taking cuttings from shorter shoots, that is, shoots that have not formed as many leaves. There seems to be a correlation between numbers of leaves and the potentiality of forming a flower bud. There is also the possibility that at temperature below 60° the tendency to form a flower bud might be enhanced. It is a known fact that the normal lighting technique to keep poinsettias vegetative during the short days of the wintertime will not always keep these seedlings vegetative. Much research is being conducted at the present time in various experiment stations, universities and commercial establishments in an effort to find out more about this particular annoying problem.

It seems that whenever a seedling has some Ecke White in its genetic make-up, it will rot much faster and much easier. Certin new seedlings have very limited latex. It appears that whenever a plant has no latex at all or a smaller amount than normal, it is much more susceptible to attack by any of the spider mites and it is also a curious thing that certain new seedlings also attract various new unidentified types of worms.

Generally speaking, working with some of these new seedlings is a real challenge to the poinsettias propagator and it appears that a great deal is going to have to be learned before this new crop of poinsettia seedlings can be handled without any problems.

PROPAGATION OF HYDRANGEAS

WILSON MCCAHON
McCahon & Dahlen
Half Moon Bay, California

The two crops I would like to discuss with you are African Violets and Hydrangeas. Our production of Violets is a six months' program, and of the six months three and a half months are in the propagating house. The steps we take in preparing this house are:

1. Heavy shade in summer with cold-water paint. Winter rains will reduce the shade in the winter, but the glass is never allowed to become bare.
2. Sterilizing with steam all propagating mixes, flats, etc. Good sanitary house keeping procedure should follow.
3. Humidity is kept high by wetting walks and under the benches, but never on leaves.
4. Cuttings should be approximately three inches long and spaces sixty cuttings per flat, which is 23″ X 41″. They are left in flats until plants are large enough to shift into four inch pans for finishing.
5. Temperature — 68°, night
   80°, days
   Water temperature and house temperature never vary more than ten degrees.

Hydrangeas fit well into our program, and will work the same in most flowering pot plant ranges because they do not have to be put into greenhouses for forcing until January. They force easily for Easter and Mother's Day. Our methods of handling Hydrangeas are:

1. Cuttings taken right after Easter. The propagating house has to be heavily shaded.
2. Steam sterilize rooting medium, flat, etc.
3. Mist system for approximately two and a half weeks. Ready for potting in three and a half weeks.
4. Stub cuttings preferred.
5. Potted ino 4″ pots in May.
   Pinched in June.
   Field in September.

In order to grow our greenhouse crops efficiently and to maintain quality, it is very important to have planned production of a good assortment of crops so we may keep experienced help twelve months of the year. For example, during the slack Violet season we find Gloxinias and Aphelandra do well under

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DR. CLARKE: Is there any interest in that field in meristem propagation? Recently we had the question raised with respect to rhododendrons. We have a rhododendron foundation which is in the process of bringing over a great many rhododendron species from Europe. Some of them are pretty difficult to propagate. The question that's arisen is whether this method of propagation can be used for a woody plant like rhododendrons.

VOICE: Tell me what it is.

DR. CLARKE: Well, as I understand it, the orchid people have found that by taking a tiny bit of meristem out of the growing point that's just started to push and growing it in nutrient solution, it forms a tiny pseudocorm. It can be divided and divided and will continue to grow in a nutrient solution so that in a course of year or so a particular plant could be propagated into perhaps thousands of individuals. With orchids there's been two problems. One is if you produce a very fine hybrid it takes a great many years to propagate it and get enough for commercial production. Another factor has been virus. With this method growth seems to be able to get ahead of the virus. I understand there is a concern in Los Angeles now that's commercially propagating orchids on the basis, so much a plant. They'll give you a little plant, a dollar apiece, or something like that. A question has been raised as to whether this would work or not with rhododendrons and I presume to any woody plants.

DR. DALE KESTER: I'm not familiar specifically with rhododendrons, but I do know that in a number of woody plants, the propagation of this small meristem has not been possible. It's been done easily with strawberries and a number of things like carnations and geraniums that are relatively easy to propagate. For most of the woody plants where it's been tried, you can get the excised shoot to grow for a short time but some thing is required that is not known. So as far as I'm aware it's not been done with woody plants.

MR. BOB WEIDNER: Dr. Phillips from Maryland and Neal Stewart have been doing a lot of work on this. With the addition of intensive heat he can shoot these plants up. I don't see any woody ones there but he had a wide variety of plants. Intensive heat and intensive humidity can stretch a plant up rapidly.

DR. WESLEY HACKETT: We have tried this on *Hedera helix*, ivy. We found it is very difficult to do as compared to others like carnations or large stock (*Matthiola*) so there probably is a species difference. Carnations can only give one plant per apice. They establish a mother block of clean plants from this. It isn't quite like the orchid.

DR. ANDREW LEISER: Harry Kohl has tried it with azaleas but has not been successful yet. They live for a period of time, make little growth, and give up.

II. Commercial Production of Fruit Trees

MODERATOR: Mr. Walter Krause

DECIDUOUS JUNE BUD FRUIT TREES

WALTER MERTZ
Armstrong Nurseries
Wasco, California

Deciduous nurserymen are confronted with a myriad of problems, many of which are self inflicted. Not the least of these is our terminology or nursery jargon. I have always considered the terms "June bud" and "Yearling" as problems which the nursery industry has inflicted upon itself. A June bud may or may not be budded in June and a Yearling, which to the novice sounds like a year old tree, is actually a two year old nursery plant. Confusing as these terms are to some, they are the terms we use in the trade. Therefore, it might be fitting to start a discussion of deciduous June bud fruit trees with a working definition. I would like to suggest the following:

> The term "June Bud" refers to a budded deciduous fruit tree which is grown in a single season, achieved by early budding and rapid forcing techniques, produced primarily for the commercial orchardist who frequently contracts for the trees prior to budding.

To further clarify our understanding of the term "June Bud," as differentiated from a "Yearling," our discussion will center around several features which characterize this important type of deciduous nursery product and the techniques used in its propagation.

The Deciduous Varieties Most Commonly June Budded: The varieties of fruit trees which lend themselves most readily to June budding consist primarily of the stone-fruits including peaches, nectarines, almonds, apricots and plums. These are most commonly grown on peach seedlings, less often on plum cuttings and occasionally on almond rootstock. Our firm plants its seed and cuttings on a 3″ spacing, thinning to 6″ before budding. This is true of both June buds and Yearling stock.

The Time of Budding: The June bud is budded just as early as the understock and scion wood will permit. In our central valley of California such conditions are usually found by approximately May 15th. By this date, the understock may be 12″ or more in height and perhaps ⅛th″ caliper. The scion wood, which consists of the current year's growth, is usually large enough and mature enough by this date to permit budding.

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The terminal dates for June budding are almost as important and critical as the starting date. In our southern San Joaquin location we prefer not to June bud beyond June 15th. However, due to late contracts we frequently do not finish our program until the end of June or even the first week of July. The terminal date is important and the ultimate size of the nursery stock is adversely affected with each week of budding after the mid-point of June.

The Length of the Growing Cycle: A June bud deciduous fruit tree is produced in a single growing season, usually within nine to ten months from the planting of the seed (if spring planting practices are followed). This growing cycle is contrasted to a two year growing period for a Yearling fruit tree.

This short growing season makes the early budding a necessity. It also requires a series of cultural operations designed to force the bud into immediate and rapid growth, uninterrupted throughout the entire growth cycle. With the June bud, time is the essence of success. There is no second season to correct the errors of the first, or to make up for delays or improper cultural practices.

Special Budding and Forcing Techniques Used in June Bud Propagation: The following steps used by our firm are probably quite typical although there are certainly differences in specific techniques between various fruit tree nurserymen, somewhat governed by soil and climatic conditions. Terminology, too, may vary somewhat, but I believe this description, coupled with the slide presentation, will adequately illustrate the budding and forcing techniques involved.

1. *Budding*: Most nurserymen employ the T budding technique in the propagation of June buds. This is usually coupled with another special technique referred to as "wooding the bud." This latter practice is one in which the bud is almost, but not quite, sliced from the budstick. A second knife cut is made at right angles to the first, cutting only through the bark above the bud. The bud is then lifted from the budstick leaving the tiny silver of wood beneath it still connected to the budstick. This practice permits the concave layer of the bud, free of any wood, to fit snugly around the cambium layer of the understock when inserted into the T incision. This process gives maximum contact. Due to the small diameter of the seedling at the time of budding, the tiny bud may actually wrap almost halfway around the stock.

June buds are budded higher on the stock than Yearlings. The buds are usually inserted some 5 - 6″ above the ground when June budding. The reason for this height is to assure maximum leaf area below the bud which is required during later forcing operations.

June buds are usually tied with rubber. We use 4″ x 3/16″ x .010 rubber budding strips.

2. *Topping*: We consider the newly inserted bud knit to the stock four days after budding. At this time the first forcing

technique is started. This consists of topping the understock. At least half of the stock is cut away and frequently all but 4″ of the stock above the bud is removed in this operation. This step is designed to force the bud into immediate growth just as soon as the bud and understock are knit.

3. *Stubbing*: Two weeks after budding, or some ten days after topping, a second pruning operation takes place. At this time, with the bud already beginning to grow and forming its first leaves, all of the stock above the bud is cut away. This is usually done at the top of the T incision. If the budding rubber has not already snapped off, this cut usually accomplishes the process.

4. *Nipping*: Within another 2 - 3 weeks the bud has grown 8 - 12″ in height. During this growing period one to several nippings are made on the rapidly growing sprouts of sucker growth below the bud. Care must be taken not to eliminate the entire leaf area, but only to nip this growth and reduce its rampant vigor. Leaf area below the bud at this stage is essential.

5. *Clean-up*: The final step in the early forcing technique is generally referred to as clean-up. This consists of completely removing all sucker or sprout growth below the bud. This step should not be done until the bud has reached a minimum height of 8 - 12″. Frequently this can be delayed until the bud is 18″ or more in height. Until this minimum height is attained the plant must have the additional leaf area below the bud to compensate for the severe pruning above the bud and to help balance and feed the root system.

As the weeks progress after the initial clean-up, one or more additional clean-up or suckering operations should be carried out to keep the lower trunk free of growth which could compete with and retard the growth of the bud.

After these initial forcing techniques are accomplished, the goal is to encourage uninterrupted growth of the bud throughout the balance of the growing season. To help achieve this goal, our firm practices a pre--fertilization program for June buds, applying 500 to 700 cu. ft. of #1 chicken manure per acre some seven months before planting. This nutritional program coupled with frequent irrigations on perhaps a 7 - 10 day cycle and a constant and vigilant pest control program results in a rapid and uninterrupted growth pattern. It is highly desirable to maintain a strong central leader. This can best be done by controlling pests, particularly thrip. As the tree grows and limb development gets well underway, we usually perform a limbing operation up to a height of some 8″ above the bud union.

The Market for Which the June Bud is Grown: June buds are primarily grown for the commercial orchardist. They frequently are grown under contract, entered into during the budding season or just prior to this, to meet the specific field planting requirements of the farmer. There are a number of reasons why the June bud is suited to this market:

1. *Price*: The June bud is generally priced lower than a Yearling. There is frequently a 5c to 10c difference in price between comparable grades.
2. *Speed of Production*: A June bud can be delivered some six months after the orchardist has contracted for the trees and the stock has been budded. This compares with sixteen to seventeen months with a Yearling.
3. *Ease of Transplanting*: The June bud normally peaks on 3/8" to 1/2" and 1/2" to 5/8" caliper, if all growing and cultural practices are carefully controlled. This tree size is considered by many to be the ideal size for transplanting. The one year root is harvested with less pruning than a two year root system and hence transplants with a minium of shock.
4. *Ease of Training*: The commercial orchardist frequently prefers to train his own scaffold. June buds normally have a better and lower limb development than a Yearling. The lower limbs on a Yearling tend to shade out and this can seriously limit the orchardist in his scaffold building.

The Exacting Quality Standards Demanded by the Commercial Orchardist and State: The high capital investment of an orchard program and the competitive market which confronts the orchardist, has forced him into demanding a nursery tree combining high productivity, the finest of fruit quality and stock free from the more serious and common diseases and virus problems. These rigid requirements are true of both the rootstock as well as the scion. In these demands the orchardist has been strongly supported by the State Department of Agriculture and his County Agricultural commissioner.

These quality standards have resulted in a number of highly important and effective cultural changs in June bud culture during recent years. These new practices have been widely accepted and put into practice by most of the nurserymen growing and supplying June bud trees.

1. Rigid and State regulated soil fumigation practices for the control of nematode.
2. The development of vigorous new rootstocks highly resistant or immune to nematode.
3. Sanitation techniques during the preparation and planting of nursery seed, liners and cuttings.
4. Scion wood selection from the most productive and highest quality strains, indexed for freedom from the more common and detrimental viruses and planted into indexed scion orchards under the nurserymen's jurisdiction.
5. The development of a State certification program to encourage and promote the elimination of viruses and the development of so-called indexed or "clean" stock.
6. The development of index programs and heat chamber equipment by individual nurserymen designed to expedite and lower the costs of the "clean-up" program.

Conclusions: The Ultimate Product: If the forementioned cultural practices, are carefully observed and carried out to near perfection, coupled with excellent weather conditions, the final product will result in a June bud which perhaps peaks on 3/8″ to 1/2″ or 1/2″ to 5/8″ in caliper and with a height of some 3 to 5 ft. This tree was frequently grown on nematode resistant rootstock. It most certainly was grown on fumigated soil assuring freedom from nematode at the time of delivery. It most likely was grown with indexed rootstocks. It is obvious that the June bud of today has been designed and produced from start to finish to meet the exacting requirements of the commercial orchardist and the state.

Perhaps the day will come, when the nursery trade will develop a term better suited and more descriptive of this highly developed product. Until such time, we will continue to refer to our one year old fruit tree as a "June bud."

YEARLING FRUIT TREE RAISING IN IDAHO

WARREN CARNEFIX
Fruitland Nursery
Fruitland, Idaho

Peach root is used predominately for all varieties of peach, plum, and apricot except on heavy soil; then plum root is preferred. Lovell pits are used mostly and planted in rows 42 inches apart. Planting is done here about the first of October as we have two weeks of irrigation season left to soak the ground well before winter sets in. Pits are then covered with one inch of soil and 2 inches of sawdust. After this has been done a disc hiller is used to cover the sawdust 2 to 3 inches deep to prevent it from blowing away over winter and early spring.

Usually about the 10th of May the seedlings emerge. When the seedlings first come through the ground they are very susceptible to frost. Some years we have had as much as 80% loss by frost. This is why we plant 15 to 20 pits per foot. If germination is good and we have no frost we have far in excess of seedlings necessary for proper stand so we have to thin to 2½ to 3 inches apart. We have had a spotted stand upon some occasions and with careful handling and lots of water seedlings can be thinned and transplanted and get a very desirable seedling for budding. Transplanting is done only on abnormal years of weather or stand. Thinning is done when the seedlings are about 6 to 8 inches high. Seedlings are cultivated at 10 to 14 day intervals until about August 1st., when we start budding. Seedlings are 5/16 to 3/8 inch caliper when we start budding and 3/8 to 1/2 inch caliper when budding is completed. We spray twice, about July 10 and August 1st. for control of peach borer.

We raise about 12 varieties of peaches, about the same of plums and prunes and four varieties of apricots. Buds are placed on the north east side of the seedling about 2 inches

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Fruitland Nursery
Fruitland, Idaho

Peach root is used predominately for all varieties of peach, plum, and apricot except on heavy soil; then plum root is preferred. Lovell pits are used mostly and planted in rows 42 inches apart. Planting is done here about the first of October as we have two weeks of irrigation season left to soak the ground well before winter sets in. Pits are then covered with one inch of soil and 2 inches of sawdust. After this has been done a disc hiller is used to cover the sawdust 2 to 3 inches deep to prevent it from blowing away over winter and early spring.

Usually about the 10th of May the seedlings emerge. When the seedlings first come through the ground they are very susceptible to frost. Some years we have had as much as 80% loss by frost. This is why we plant 15 to 20 pits per foot. If germination is good and we have no frost we have far in excess of seedlings necessary for proper stand so we have to thin to 2½ to 3 inches apart. We have had a spotted stand upon some occasions and with careful handling and lots of water seedlings can be thinned and transplanted and get a very desirable seedling for budding. Transplanting is done only on abnormal years of weather or stand. Thinning is done when the seedlings are about 6 to 8 inches high. Seedlings are cultivated at 10 to 14 day intervals until about August 1st., when we start budding. Seedlings are 5/16 to 3/8 inch caliper when we start budding and 3/8 to 1/2 inch caliper when budding is completed. We spray twice, about July 10 and August 1st. for control of peach borer.

We raise about 12 varieties of peaches, about the same of plums and prunes and four varieties of apricots. Buds are placed on the north east side of the seedling about 2 inches above the ground. Sawdust still makes the ground loose and easy to work as well as easy to keep weeded.

About the 25th of October seedlings are sprayed with a fungicide to help prevent any bud loss from excess moisture and control any blight or fungus which might over winter on the seedlings. No protection is needed for buds to over winter as we usually have snow covering the buds in any severe weather between December 10 and February 1st.

Buds are cut off and suckered about the 15th of April and about two more suckerings are required to transfer all the growth to the budded tree. Usually we have to side limb once and sometimes twice each season. Side limbs are removed to a height of 18 inches.

About the first of June we apply a spray for insect control. About July 1st an application for aphid and mite control. July 10th and August 1st we spray for the control of peach borer. Usually we have such long warm falls that two sprays for peach borer is necessary. By the end of the growing season we have a large percentage of $5/8$ caliper trees.

Digging usually is done about November 15th as most all leaves are off and trees are dormant by this time. Trees are graded and stored in a dirt floored cellar and the roots covered about 16 inches deep with sawdust. Doors are left open until the weather outside gets to 10 degrees above zero, then they are closed to prevent excess chilling. This make the trees dormant for spring plant. Usually some poison bait is placed among the trees to prevent mice from burrowing in the sawdust and eating the roots.

Cherry seedlings are bought from seedling growers and planted 7 inches apart in rows 42 inches apart. We use a No. 2 seedling as No. 1's get too large. Mahaleb are used predominately as they do better in this area and gall is not a very serious problem. Spraying is the same as other trees except that only one spray is applied for borer. These are not a problem on cherry.

Pear seedlings are also bought by us. These are also planted 7 inches apart. No. 2 seedlings are used. Either French or domestic Bartlett are used. Domestic Bartlett usually makes a much more fibrous root but either one does well here. We usually spray three times for pear psylla and blister mite. These are no problem with us here but spraying must be done.

Apple seedlings are also bought by us. Planting and spraying is done the same as pears as they are planted close in the nursery. Buds are all placed on the north east side of the tree about 2 inches above the ground. This protects the buds from winter sun as it is quite bright here. All clonal rootstocks are budded 8 to 10 inches above the ground but also on the north east side of the tree. This give a long shank on the tree to allow deep planting and also leaves the bud union above the ground when planting in the orchard.

We find it very important to be through budding by Septetmber 10th. The sap is still up until the last of September but the bud stand drops off sharply after this date. Sometimes we will leave some seedlings until spring if we are a little undecided as what to bud. We can bud by April 15 to 20th and grow mostly 5/8 inch caliper trees which the trade prefers in this area.

We find that apple and prune trees headed at 42 to 48 inches in the orchards make the nicest trees to shape and the best angles for scaffolds so 5/8 in. caliper trees are desired. Cherry and pears may be headed somewhat lower as they tend to grow very erect if not summer pruned the first year of planting.

PROPAGATION OF CITRUS PLANTS

HARLEY MARTIN
S. A. Camp Companies
Shafter, California

Citrus plants are quite simple to reproduce. Grown from seed, they do not usually produce true-to-type progeny; therefore, to maintain genetic continuity vegetative techniques are required. The familiar "T" bud is used almost universally to bud onto a suitable rootstock seedling. Plants bud easily in early spring or fall. Bud stands in excess of 90% are easily obtained with most varieties.

If citrus plants are so easy to propagate, why discuss them at all? Well, they are easy to reproduce but any citrus nurseryman can recall a few nightmares about mutations and virus diseases. Anyone can propagate citrus plants if he can control temperature, but few of us in the business have escaped some problems with mutations, or virus. Thus, a citrus nurseryman's primary concern is not with reproducing trees but protecting his customer and the citrus industry from the spread of virus disease and introduction of mutant or variant strain.

The citrus industry does not have any of the virus controlling techniques common to deciduous plant propagators. We can't use cuttings from rapidly growing terminals. We cannot use heat chambers. We cannot now use meristem cultures or other exotic methods used with ornamental plants. We do, however, have a trick of our own. Plant propagators have long known that the seed is a good shield against viruses. Seedling progeny rarely carry the virus diseases of their parents. A question is usually asked at this point if citrus seedlings are not true-to-type how is it possible to maintain varietal or genetic continuety using them to escape virus? To circumvent this problem the citrus industry has learned to take advantage of a peculiarity of citrus seed. The seed of many varieties produce more than one seedling from a single seed. They produce the normal gametophytic seedling plus others which arise from the nucellus, a tissue surrounding the sexual embryo. These nucel-

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Citrus plants mutate readily. Mutant strains have been propagated accidentally with catastrophic results. Growers have invested thousands of dollars in groves only to discover, when they began to bear fruit, that the fruit is off-type and of little value. The citrus nurseryman must be constantly alert to prevent introduction of off-type or mutant strains into the industry. All mutants are not necessarily bad. Many of the outstanding varieties of fruit grown today are the result of mutations, but improvement through mutation is rare. In spite of the fact that most citrus varieties are easy to reproduce, the nurseryman has more than his share of troubles. Virus, mutation, and the usual soil born diseases and parasites are enough to cause many sleepless nights.

VIRUS INACTIVATION IN STONE FRUITS

DAVID ARMSTRONG
Armstrong Nurseries
Ontario, California

Viruses in stone fruits generally have serious economic effects ranging from complete loss of crop, if not death of the tree, to subtle loss of vigor that often has been wrongly attributed to "poor culture," if noticed at all. Freedom from most, if not all, viruses is apparently desirable.

Propagators have the basic responsibility to see that virus-free propagating materials are used. Once infected, the tree is infected for life for all practical purposes. Every propagator should be familiar with the symptoms of virus diseases, indexing techniques, and means of achieving and maintaining virus freedom.

Many viruses are significantly spread only through use of infected propagating material, and simple knowledge and use of virus-free propagating material is all that is necessary for lar seedlings are not a product of sexual pollination and are, therefore, vegetative extensions of their fruit bearing parents. Having originated from seed they are, so far as is known, free of virus. Now another question must be answered. How are nucellar seedlings separated from sexual seedlings? This is not easy to do. Some sexual seedlings can be identified by deviation in leaf structure and physical expression. The remaining seedlings must be allowed to grow to fruiting. Fruit from these trees is observed for a period of years to establish trueness to type. Many citrus varieties have been freed of virus using nucellar propagating techniques. The varieties which do not produce nucellar seedlings remain a problem. Many virus diseases which are not readily apparent can now be detected by indexing, grafting suspected tissue into a suitable indicator plant. Spread of virus can therefore be minimized by selecting bud wood only from fruit bearing trees which have been indexed and determined free of major virus problems. Indicator plants are not now available for all virus diseases.

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Many viruses are significantly spread only through use of infected propagating material, and simple knowledge and use of virus-free propagating material is all that is necessary for control. Where natural spread occurs, control is achieved through isolation from infected hosts and vectors.

The key to practical virus control by the propagator, however, is the obtaining of virus freedom in the first place and the maintenance of this freedom from virus. For many stone fruit varieties this has been done so far by experiment station researchers as an extension of their study of fruit viruses. Agricultural regulatory authorities have set up so-called "certification" programs to ensure maintenance of freedom from virus. The most comprehensive and rigid program is probably that in California, covering not only stone fruits but many other fruit crops also.

What I would like particularly to emphasize is that the propagator, the commercial nurseryman, has the means available himself to carry out a practical virus-control program more efficiently, at less cost, than is done by government agencies, certainly less red tape. The taxpayer is now unnecessarily subsidizing virus certification programs or where nurserymen are paying fees they are very high if the costs are fully recovered.

The researcher should be relieved of routine service programs and left to do basic research. The basic techniques for virus control are worked out, though there are some problems that need to be overcome. The propagator or commercial nurseryman should assume a program for freedom from virus just as he has other pest control programs.

Regulatory authorities, as a matter of political principle, should stay out of certification programs that are no more than setting quality control standards. Regulatory authorities should be involved only where there is genuine public concern—only with those viruses that are both of serious economic consequence and spread beyond the control of the propagator or commercial nurseryman and the ultimate user, the orchardist. Generally these viruses are limited to certain areas and are already covered by quarantine programs.

The majority of stone fruit viruses are not known to spread except by propagation. Also the economic importance of many virus diseases is yet to be fully demonstrated. This should be done before regulatory authorities step in, since without this, genuine public concern cannot be proven.

Heat treatment to inactivate viruses in living plants is the technique that helps make a do-it-yourself virus-control program practical for the propagator or commercial nurseryman. The *basic method presently used is to grow living plants in containers* at temperatures of 98° to 100° F. for periods of four to six weeks. This standardized treatment will inactivate most viruses. Buds or cuttings taken from heat-treated plants can then be propagated free of virus. Where viruses are more resistant to heat, tip grafts from new shoots grown in the heat chamber will often be free of virus when buds or cuttings from old wood are not. There is good probability that those few viruses that are not now inactivated under heat treatment can be inactivated under refinements of the method.

Simple heat chambers of various sorts built very inexpensively or making use of existing facilities have been put into effect by a number of nurseries. In our own experience at Armstrong Nurseries, we have very easily inactivated ringspot in many stone-fruit varieties. Our facility was an existing 8′ x 16′ greenhouse with an oil heater and evaporative cooler, that as made into a heat chamber merely by putting in a new thermostat to cover the higher temperature range. This operates quite satisfactorily when outside temperatures are above 50° F. Temperatures are not always between 98° to 100°, being sometimes a few degrees higher and lower than that; however, this does not affect the results. No artificial light is used. Shading is provided by ordinary lath frames.

Indexing is accomplished by budding on to indicator hosts. Development of serological methods will eventually permit a quick chemical test.

For many varieties the use of heat treatment to eliminate virus is not necessary. Existing trees of varieties can be found free of virus. It can be quite tedious to find such a tree through indexing large numbers of trees; however, once such trees are located the varieties can be maintained free of virus quite easily. This has already been done for many stone-fruit varieties by researchers.

Heat treatment by the nurseryman has numerous advantages. It can be done cheaper than by the experiment stations and he can treat the varieties he wants when he wishes. This has competitive value. Where nurserymen are introducing new varieties and sports, it becomes a necessity. Also where there are particular selected strains or proven true-to-type varieties in a scion orchard, he can treat these and not have to accept varieties, from other and possibly unproven sources, put out by experiment stations. The procedure is simple and requires only a practical knowledge of viruses.

The nurseryman can cut costs by fitting his virus-control program to his own needs and needs of his customers. He takes reasonable risks. He must be familiar with virus diseases, periodically inspecting his scion orchard and indexing every few years for easily spreading common viruses such as ringspot. Ringspot apparently spreads by pollen. However, except for an awareness of them he can disregard the more serious viruses since those that spread naturally are controlled by quarantine. The remainder are transmitted through propagation only. Once clean the latter remain clean. Nurseries should obviously be outside quarantine areas.

Reasonable isolation of a virus-free scion orchard is only being practical. However, risks can be taken. Occasional infection of a scion tree with a common virus like ringspot can be tolerated, the tree being rogued when detected. More than one tree of a variety is usually present or a clean tree can be recovered from the nursery stock. If necessary, heat treatment will clean it up.

The program outlined does imply the practical desirability of a scion orchard rather than cutting wood from miscellaneous orchards. Inspection of nursery stock should not be necessary other than routine observation than is done in any growing operation. With some knowledge of symptoms on nursery stock, the grower would be able to detect any significant virus infection. With a clean scion orchard the chance of any virus in the nursery stock would be very remote. Even if there was an occasional tree with a minor virus like ringspot, the significance to an ultimate user would be nil.

Official certification programs are expensive because of the inherent high overhead costs of government agencies and the unwillingness to take reasonable risks, "bending over backward" to ensure absolute freedom from all viruses in every nursery tree, with overly stringent indexing, isolation and inspection procedures, using highly trained personnel on routine matters that less skilled persons could do. The practical program outlined for nurserymen will achieve the same freedom from virus for all practical purposes.

In conclusion, it is suggested that commercial nurseries establish their own virus-control programs, with heat chambers, rather than let regulatory agencies pre-empt the field. Not only is it more practical and cheaper, but in principle the responsibility lies with the nurseryman. Most viruses are important as affecting tree quality, of concern only between the nurseryman and the orchardist. The regulatory agency has no business setting quality standards. As already pointed out, though, it should have the responsibility where certain viruses are of serious importance and spread beyond the control of nurserymen and orchardists — becoming of genuine public concern.

While I have been discussing stone fruits, I believe the same thing applies to other plants.

[*Editor's Note*: The following paper was presented by Dr. John Mahlstede, Iowa State University].

PEACH BUD — GRAFT UNION ON *Prunus besseyi*[1,2]

W. E. FLETCHER[3]

Introduction

The use of selected rootstocks for dwarfing fruit and ornamental plants has been an established practice in Europe for many centuries (Dana, 1952 and Scholz, 1957). Only recently.

[1]Based a portion of a dissertation submitted by W E Fletcher to the Graduate College, Iowa State University, Ames, in partial fulfillment of the requirements for the Ph D degree, 1964 The author is grateful to Professors J P Mahlstede and J E Sass for advice during the course of the study and for presentation of the paper at the Western Regional Meeting

[2]Journal Paper No -5040 of the Iowa Agricultural and Home Economics Experiment Station, Ames, Iowa Project No 1310.

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however, has the use of dwarf fruit and ornamental plants gained widespread acceptance in the United States. This has developed primarily because of increased production costs in commercial orchards that have relatively tall bearing trees. Contemporary architecture, featuring the single-story dwelling, has also created a demand for low-growing trees and shrubs which will maintain the scale of the home-lot landscape complex.

As a result of continued research and experience, the use of vegetatively propagated dwarf fruit trees has gained popularity. Reasons include (1) reduction in operational cost and damage to trees as a part of the necessary cultural operations, (2) the facility of handling a greater number of varieties per unit area, (3) reduced injury to developing fruit and trees as a result of severe winds, (4) earlier bearing and increased yields in comparison with standard-sized trees, (5) higher quality, improved color and better-flavored fruits, and (6) trees more adaptable to mechanized culture.

Some of the main disadvantages of grafted dwarf trees include (1) shorter life of dwarf trees in comparison with standard units, (2) increased need for pruning and maintenance practices as compared with those required for standard trees, (3) higher initial cost of the plant, (4) the difficulty of finding compatible or winter hardy sttocks suitable for dwarfing pur-

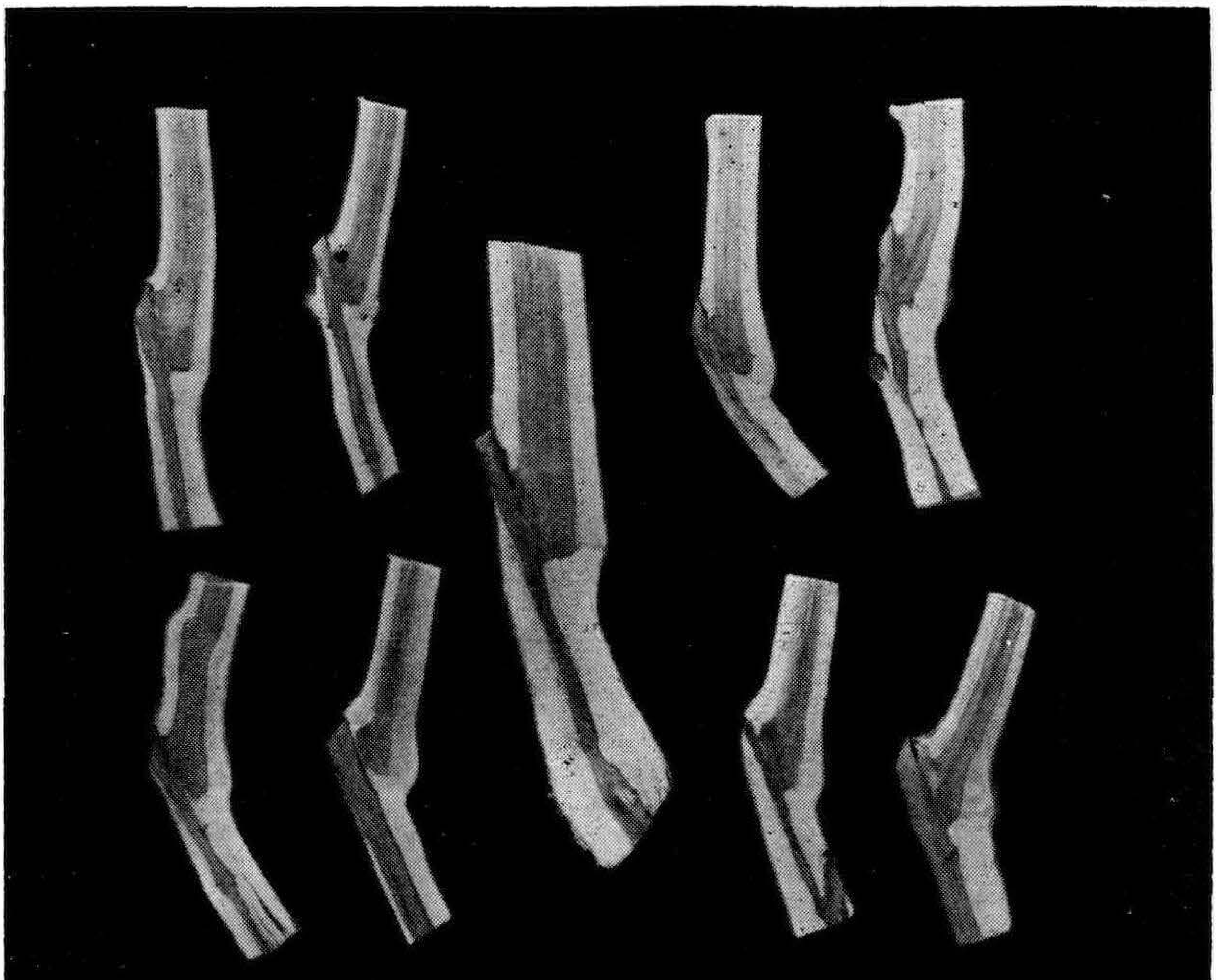

Figure 1. Longitudinal sections of the bud unions of the Polly peach budded onto **Prunus besseyi** rootstocks, showing the internal structure of bud grafts.

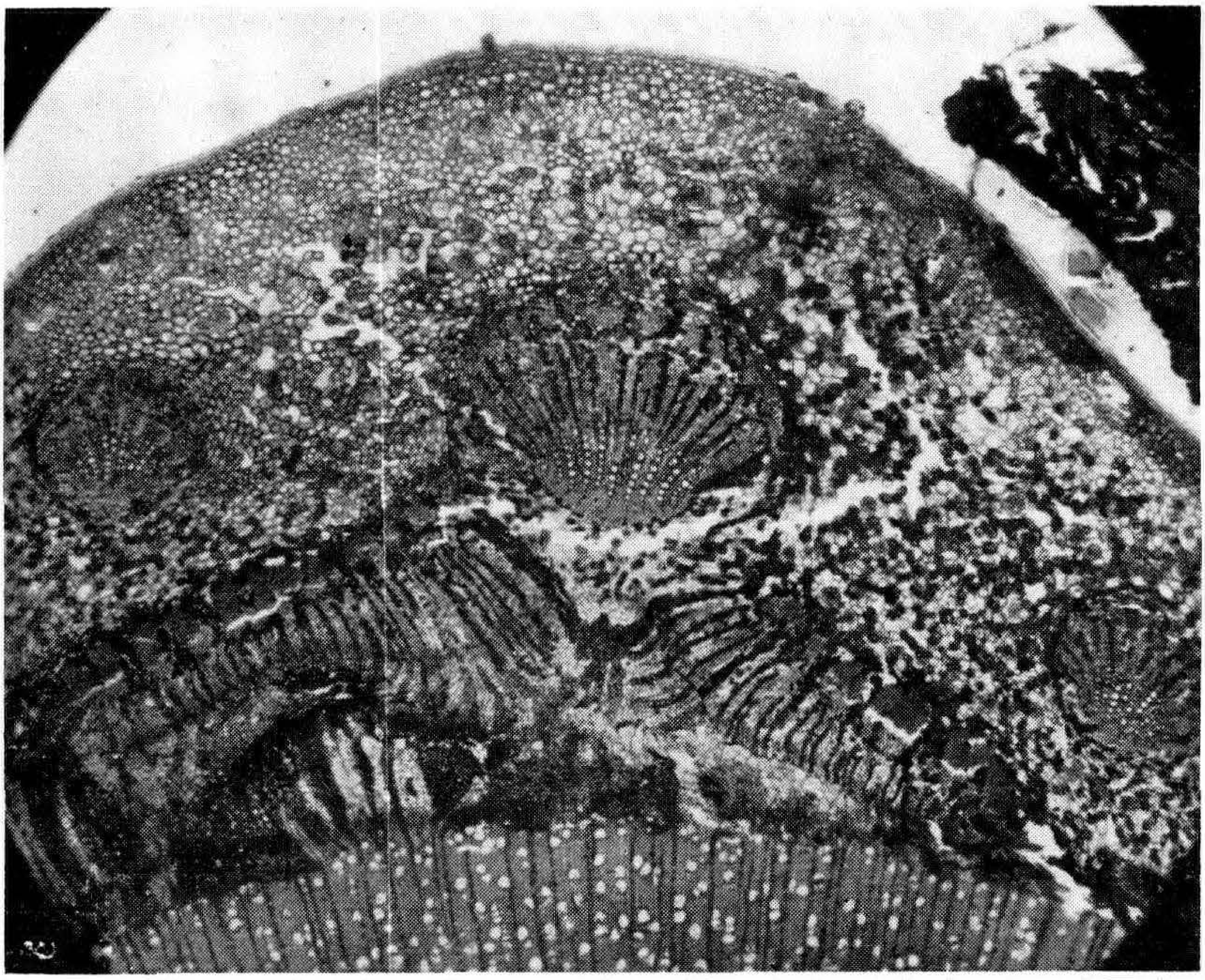

Figure 2. Cross section through a normal peach/sand cherry bud union eight days after budding. 36X. Upper right, bark flap; top, inserted bud; center region of merged calli of stock and scion; and bottom, stock.

poses, (5) the tendency for many dwarfing stocks to sucker and (6) the large number of trees that are poorly anchored or have an undesirable root system attributable to the dwarfing stock employed.

One specific problem which has been partially investigated is concerned with the use of the western sand cherry (*Prunus besseyi*) as a possible dwarfing stock for peaches. Although this rootstock has many attributes that make it one of the best of the dwarfing peach stocks, delayed incompatibility, resulting in loss of plants in the nursery, has created a serious problem for plant propagators.

This study was undertaken to investigate the histological process of bud union development between the peach and the western sand cherry. The purpose of this project was to follow the normal sequence of events that result in a successful union between component parts and to investigate the possible reasons for delayed incompatibility or graft failure.

Review of Literature

The western sand cherry has several attributes which should make it a good dwarfing stock for peaches, (Brase, 1953 and Brase and Way, 1959). It is a dwarf plant naturally, is very hardy and can easily be grown from seed. The propagation of clonal selections would be quite easy since the plants sucker readily in the field.

Sax (1956a) also advocated the use of *Prunus besseyi* for the production of dwarf peaches. Brase (1956) maintained that seedlings of *P. besseyi* had a limited use as dwarfing rootstocks for peach varieties, but Overholser *et al.* (1943) maintained that peaches, as a rule, were not satisfactorily grown as dwarfs.

In the early 1950's, peach varieties grafted onto *P. besseyi* in Iowa showed disorders that closely resemble symptoms expressed by the X virus. In addition, nurserymen observed that bud take and the subsequent growth and development in the field were not satisfactory during the first year of growth, when these plants were used as rootstoks. An extensive study has indicated that the incompatibility between peach varieties and these rootstocks is not disease induced, as previously postulated, but is attributable to a poor graft union (Agrios, 1960).

Brase and Way (1959) reported a similar problem in the State of New York. Trials began in 1944 involving the use of *P. besseyi* as a dwarfing stock for peaches indicated that combinations utilizing this stock have disorders similar to those found in Iowa. Bud unions developed abnormally, primarily because of the injury of the phloem tissue of the understock seedlings.

Figure 3. Cross section through the bud union area 25 days after budding. 36X. Abnormal unoin. Note the injury to the xylem area during budding and the arrested development of the scion (bud).

In transplanting tests, the budlings that grew normally without bud union disorder developed into typical dwarf trees. Trees that defoliated prematurely either failed to grow or made poor growth. Death usually followed within two years after transplanting.

Materials and Methods

During a two-year study, buds of the peach variety, Polly, were placed onto a dwarfing rootstock, *P. besseyi*. Budwood used in these investigations was collected from stock blocks certified to be virus-free as well as from trees which had not been indexed. Buds of these two types were placed onto both young and more mature growth of the dwarfing rootstock by use of the "T" budding technique.

A regular collection schedule was followed in which developing unions, as well as those not growing satisfactorily, were periodically removed for laboratory examination. Samples of unions were collected from one day to a point sixty days after budding. Field observations were recorded on symptoms used to detect early union, per cent bud take, per cent budding development and growth after two and three years in the nursery.

Summary and Conclusions

The major results from this study are:

1. The mechanical operations of removing the bud and included shield from the bud stick and preparation of the T incision on the understock injures or destroys all tissues that are either cut or torn. These injured cells form a necrotic plate over the interface of the graft components.
2. The development of callus strands from the terminal, uninjured cells of the immature xylem of the stock occurred rapidly and ruptured the necrotic plate of the stock in the normal sequence of bud healing by the fourth day. Shortly thereafter, the necrotic plate contained on the bud shield was also ruptured by callus; growth, mainly the result of divisions in the secondary phloem. Delayed penetration of the necrotic plate by callus tissue results in the death of the bud, caused by the absence of connective tissue and resultant desiccation.
3. Active cell division was observed in some bud unions collected two days after budding. By the fourth day, considerable callus had been produced by dividing cells of the stock. In sequence of meristematic cell activity, the intact cells of the immature xylem adjacent to the lateral flaps were the first to activate, followed by the extremities of the bud shield and finally the area immediately below the central axis of the inserted bud.
4. Six days after bud insertion, contact between the callus produced by the stock and scion had been established. By eight days, the lower half of the bud shield was connected to the stock by callus bridges. The area of the bud shield adjacent to the horizontal stock incision may never fill with callus.
5. The first continuous cambium connecting component parts

of the bud graft system occurred shortly after fourteen days. Subsequent development of xylem and phloem tissues by this layer forced the bud away from the stock. Although the intact cambium layers of the stock and scion contribute little to the early development of a successful union, cambium continuity was established between graft components.

6. Distinct differences in the rapidity of cell divisions and completeness of healing were observed between unions collected after fourteen days. After three weeks distinct areas devoid of cells were apparent in all bud unions. Although these areas may persist, they are not believed to influence the effective functioning of the union.

7. Symptoms of incompatibility were expressed as early as the third week and could be discerned anatomically in the stock-scion interface, or in the area of the stock adjacent to the T incision. In the order of occurrence, disorders between the stock and scion were observed in the following sequence: (1) necrotic tissue inclusions and the presence of wound gum ribbons in the anastomosing calli, (2) necrotic cell areas present on the stock-scion junction, (3) large deposits of wound gum in the connective tissue region and (4) failure of callus formation on an injured portion of the stock or scion.

8. No discernible differences were observed in the rate of healing, in the morphology of the bud union and in the gross appearance of the budlings when current season's growth or shoots in their second year of development were used as the rootstock. Under the conditions of this experiment, no differences in the morphology of the bud graft union or plant performance were found between seedlings budded with indexed and nonindexed scions.

9. The general processes of development for the peach-western sand cherry bud graft are basically the same as for other plant material propagated in this manner. The events were (1) formation of necrotic cell areas over cut or torn tissue regions, (2) formation of callus from the uninjured cells adjacent to the wounded portion, (3) formation of callus in the stock-scion interface, (4) formation of a continuous cambium between scion and stock from resultant callus differntiation and (5) resumption of cambial activity, lignification and connection of fascular tissue.

10. Bud failure between the peach-western sand cherry graft combination may be the direct result of propagation technique, environmental conditions, inherent differences between graft components or the failure of either symbiont to function normally. Under the conditions prevalent in Iowa nurseries, incompatibility of peach on *Prunus besseyi* casts doubt on the suitability of this rootstock for dwarf peach tree propagation.

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DR. CLARKE: Is *Prunus besseyi* useful as a dwarfing rootstock for peach or just what is the interest there?

DR. MAHLSTEDE: In our part of the country the nurseries are using primarily two stocks, namely, *Prunus tomentosa* and *besseyi*. Neither is entirely satisfactory for dwarfing peach. Nurserymen are using them but they are not satisfied with the performance of these stocks in the nursery. When you are talking stands of sixty or seventy per cent salable trees, you are talking money.

DR. AL ROBERTS: Karl Brase at Geneva, New York, has worked with *P. besseyi* and has suggested that some of the *besseyi* types are sufficiently compatible with peach but they need to be selected and propagated as clones.

We have work under way using the Wild Pacific plum, *Prunus subcordata* as a dwarfing interstock for peach. Twenty years ago, we selected a number of types of this species from native thickets in Southern Oregon. We propagated these on a number of stocks: peach, *P. americana,* Myrobalan and Marianna. It is compatible with all these plums. Gordon Kershaw of Medford, Oregon, suggested we test this wild plum as a dwarfing stock for peach. We ran into considerable difficulty when trying to transplant seedlings of *P. subcordata* from the wild or even seedlings grown in nursery row. It has an unbranched taproot and suckers badly even if successfully transplanted. We, therefore, decided to use 12-inch stem-pieces of the wild plum as dwarfing interstock between Lovell peach, Myrobalan and *P. americana* as roots and certain peach varieties as scions. This test has been on a limited scale, but it is amazing how compatible these combinations have been. A combination consisting of Lovell roots with a 12-inch stempiece of *P. subcordata* with Redhaven or Improved Elberta as scions has given us a half-standard tree that is thrifty and early bearing. We have obtained varying degrees of dwarfing depending on the wild plum selection used. The one that looks most promising as a dwarfing interstock for peach is a selection we call Klamath I, a very small growing tree in the wild. We are considering such dwarf peach tree as possible units in hedgerows for mechanization.

DR. DALE KESTER: What experience have you had in overcoming incompatibility by double budding? The reason I ask is that I have seen different experiences or opinions in the literature whether it works or not.

DR. MAHLSTEDE: This technique, as you know, was described by Nicolierin in Germany about the same time Garner came out with his doubleshield method of budding. The techniques are essentially the same. We haven't run comparisons long enough to tell much about either technique. We've worked specificaly with apple using this intershield in dwarfing combinations. Clark Dwarf, being used as the intermediate originally was a fairly good dwarfing understock or inter-stock in our part of the country. Lately, however, it has proven to be either virus infected or having some other problem evidenced by stem cracking. Our thought here is that if we use a budless shield as an interstock that it will be eventually covered up. If it does the job, we are ahead of the game so far as dwarf production is concerned.

DR. ROBERTS: Along this line, I think it is important that we consider early work in England and a recent study in Germany with pear on quince, with various compatibility bridges. The response to interstocks whether used as compatibility bridges or as dwarfing stempieces seems to be influenced by the length of the insert. I think this has been overlooked by many of us. Some of our work and certainly that in England and Germany shows the length of the bridge to have a pronounced influence on the thriftiness of the combination and early flowering. We have a five-year old block of Starking and Golden Delicious apples with 3, 6 and 12 inch stempieces of Malling IX (dwarf) with Malling XVI (very vigorous) as roots. There is little difference in the size of these trees; if any, the longer stempieces have given us larger trees, but there is a great difference in flowering habit. In the early years the longer stempieces have given us more bloom.

III. Difficult to Root, General Ornamentals

MODERATOR: Mr. William Tomlinson

THE PROPAGATION OF DECIDUOUS AZALEAS FROM CUTTINGS

P. H. BRYDON
Director, Strybing Arboretum
Golden Gate Park, San Francisco, California

Today's discussion deals primarily with the propagation of Knaphill Azaleas Exbury strain, although I am sure the techniques described would prove successful with other deciduous azales. As a preface, it might be of interest to review the background of this particular strain.

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The Exbury azaleas are predominantly North American in specific origin. Of the nine species involved in their background, the following are native Americans — *R. viscosum, R. nudiflorum, R. calendulaceum, R. speciosum, R. arborescens,* and *R. occidentale.* Of the remaining three, *R. molle* comes from China, *R. japonicum* from Japan, and *R. luteum* from Eastern Europe. In the latter part of the eighteenth century *R. viscosum, R. nudiflorum, R. calendulaceum* and *R. speciosum* were introduced into Europe when they were combined with the European *R. luteum* by Mortier of Belgium to produce the now famous Ghent azaleas. However, the real advance came about 1859 when Anthony Waterer of England recombined *R. calendulaceum* with the Ghents and added *R. molle.* Later he crossed the various progenies with *R. japonicum, R. arborescens,* and *R. ocidentale.* From these crosses Mr. Waterer obtained a race of azaleas which genetically possessed hardiness, fragrance, a color range from white through pastels to deep red, an extended flowering season and an increase in flower size and substance. In the 1920's some of Mr. Waterer's seedlings were sent to the late Lionel deRothschild at his estate in Exbury, England. From them he selected the very finest and in particular a variety called George Reynolds, which is a large flowered yellow with broad petals of excellent substance. This, among others, was crossed with a select form of *R. molle* to further improve the Knaphill strain.

As the new seedlings bloomed, Mr. Rothschild selected superior color forms and keeping the colors together crossed reds with reds, whites with whites and so on. He never kept a plant unless it was vastly superior to its parent stock and, as each succeding generation flowered, he consigned all but the best to the bonfire. His discerning eye and ruthless elimination of second rate plants has resulted in a superior strain of deciduous azaleas.

I began to import the named varieties of Exbury azaleas in 1949, and by 1952 had 72 varieties on hand. The problem was to increase these clones vegetatively for sale in this country. Layering is a slow process and propagation by this method produces plants which are awkward to handle. While it is much quicker than layering, grafting on *R. luteum* has its drawbacks, the principal one being that in many cases the understock overcomes the scion and the customer wonders why he now has a vigorous growing small flowered yellow azalea in place of the large flowered pink or red which he purchased. In the early 1950's, to my knowledge, no commercial propagator had succeeded in raising deciduous azaleas in quantities from cuttings. When doing some experimental work with the propagation of Rhododendrons from cuttings in 1934, I recalled that I had included a few *Azalea mollis* hybrids and they rooted with ease, but the following spring they failed to break into new growth and were discarded. This seemed to be a common experience with others who had tried to root deciduous azaleas from cuttings. The solution to the problem was suggested to me by Dr. Kraus of Oregon State College who told me that by increasing the day length this would assist in the formation of new growth and, furthermore, cuttings which made top growth before going dormant would "break" the following spring. This proved to be true, but while it was the most significant single factor in the success or rooting Exbury azaleas, there are other precautions and techniques which play an important part in obtaining high percentages of rooted cuttings. These are as follows:

Condition of Stock Plants: The proper care of stock plants is an important consideration and one which is frequently overlooked by many propagators. My stock plants were kept in a block by themselves and given at least three feedings in the spring months when growth was "making up." They were sprayed regularly with malathion to eliminate aphids and discourage leaf miners and caterpillars. Prior to taking cuttings, the stock plants were thoroughly soaked the previous day so that the wood would be turgid and crisp. Strong vigorous canes were headed back in early summer to promote shorter growths from auxillary buds. Older canes were removed completely to allow air and light to penetrate.

Take Cuttings: The wood was taken early in the morning and kept moist in a cool cellar until ready for insertion. The time of year varied with the weather conditions, but I would say that in the northwest it would be between June 15th and 30th, and in the San Francisco Bay Region about two weeks earlier. As most of you know, the maturity of the wood at time of taking is difficult to describe and the "feel" is only acquired after many years of practice. All I can say is that the wood should be green, taken before the lower portion becomes hard and brown, and before the apical bud is evident. Thin side growth with short internodes are much to be preferred over thick terminal shoots with long inetrnodes. It is easier to make a branched plant from the former. The cuttings were made about four inches long with the cut just below the node and all leaves except the top four removed. They were not pinched and as a general rule, the leaves were not reduced in length. A thin slice of wood was removed from the lower 1½ inches of the cutting prior to dipping them in Hormodin #3. The "wounding" of the cuttings aids considerably in reducing transplanting losses. In deciduous azaleas, the weight of the root ball is often such that unless there is a solid union of roots and stem, the two part company when being cut out of the bench. In a "wounded" cutting the roots originate from a wider area and are less liable to break off when being transplanted.

Rooting Medium: I have had most success with a medium composed of equal parts, Canadian Peat Moss, washed river sand, medium grade perlite. The peat was moistened and rubbed through the hands and long fibres and roughage removed. After thoroughly mixing the medium, the benches were filled to a depth of eight inches which allowed for 1½ inches at the bottom for the heating cables. The cedar benches were cleaned out each year and the interior painted with copper naphthalene as a control for any injurious fungi which may have gained admittance.

Insertion of Cuttings: The cuttings were spaced two inches within the rows and three inches between the rows, lightly tamped, and watered into place. The bottom heat was set at 65° F. Lengths of heavy grade wire were bent at right angles to form a framework over the bench and polyethylene (4 mil grade) was placed over the top and sealed along the sides to prevent the escape of moisture. Unless some extraordinary occurrence took place within the closed frame, such as an insect infestation, or an unusually high percentage of wilting, the frames were left unopened for two or three weeks and when the cover was rolled back, the cuttings were examined and the medium flooded to the point where the water ran freely out of the bottom of the bench. This deep watering is beneficial in that it provides a change of air and water in the medium. Depending upon the variety, rooting commenced in about 4 to 6 weeks; however, the removal of the cuttings was delayed until they had a solid ball of roots. As a general rule, transplanting began in late August and continued through October, since some varieties will take up to three months to form a solid root ball. In the beginning the rooted cuttings were potted in 4″ pots, but the potting was subsequently eliminated and the cuttings were transplanted directly into peat beds, in benches under glass. By so doing, the plants made more than twice their growth than in pots and the root system was more extensive and plants became more quickly established when planted out of doors.

Increased Day Length: Perhaps the most critical factor in the successful propagation of deciduous azaleas is the increase in day length to initiate top growth prior to leaf drop. Once this growth has been made there is every chance that, after dormancy ,the rooted cutting will push new growth in the spring. My first installation was a row of 100 watt Mazda lamps, three feet apart, suspended three feet above the cutting bench. Beginning in August, the time switch turned them on at 5 p.m. and off at 12 midnight. To be perfectly sure that growth would be sustained throughout the shorter days of late fall and early winter, I left the lights going until Jan. 1st, after which most of the cuttings had lost their leaves and were in a dormant stage. Incidentally, as new growths were formed, four leaves were allowed to develop and then the cutting was pinched to promote a better shaped plant. In later installations, the Mazda lamps were replaced with Grow Lux lamps which, though more costly to install were cheaper to maintain.

Subsequent Care: Depending upon the weather, transplanting began about the last of March, or early April, when the plants were lined out in lath house beds. By then they were from 6 to 12 inches tall. By the fall of the same year the average plant would be a husky 10 - 12″ and have at least three branches. In most cases, flower buds would form the second year after striking and the plants were sold in the fall as 12-15″ and 15-18″ grades.

MR. CARL SCHMIDT: Please repeat the time period of artificial light used while rooting deciduous azaleas.

MR. BRYDON: From five p.m. to twelve midnight August first to Janpary first.

DR. ANDREW LEISER: Have you tried interrupted or intermittent light?

MR. BRYDON: I'm sorry I have not.

DR. ANDREW LEISER: Are azaleas rooted before lights are on?

MR. BRYDON: As a general rule by August the first most of them are forming some roots at the end of the cutting and the lights are turned on August the first to January first. I was assuming that they are rooted before the lights are turned on.

CUTTAGE PROPAGATION OF *Xylosma congestum*

WESLEY P. HACKETT AND DAN GOLDMANN
Department of Floriculture & Ornamental Horticulture
University of California, Los Angeles, California

The basic requirements for the successful propagation of broad-leaved evergreen plants by stem cuttings are as follows:

1. The cutting must have the capacity to form roots when given the proper treatment and environmental conditions.
2. The rooted cuttings must have a viable bud or the capacity to form one.
3. The cutting must have enough leaf surface to promote rooting and the rooted cutting enough leaf surface to promote growth of the bud into a shoot.

If all three requirements are fulfilled a new plant will probably result. If one or more of these requirements is difficult to fulfill the plant will be difficult to propagate by stem cuttings. It is indicated by our general topic "Difficult to Root, General Ornamentals" that it is difficult to fulfill at least one of these requirements for the cuttage propagation of *Xylosma congestum.*

From personal experience and from observation of the results of other propagators it appears that there are two difficulties in the stem cuttage propagation of Xylosma. First of all it may be difficult to get rooting and secondly it is usually difficult to prevent the leaves from abscising during or after the rooting period.

We have been doing some experiments at U.C.L.A. in an effort to analyze these problems and possibly come up with some answers to them. I will present results of two of these experiments and then discuss the factors that seem to be most important for successful propagation of Xylosma by stem cuttings.

In one experiment we tested the effect of two factors, age branches. In most cases, flower buds would form the second year after striking and the plants were sold in the fall as 12-15″ and 15-18″ grades.

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In one experiment we tested the effect of two factors, age of wood and "hormone" concentration, on root initiation and leaf abscision. Wood of different ages was obtained by selecting growing shoots about 18″ long which had 1 year old wood at the base and then subdividing them into a tip and middle portion of current season's growth and a basal portion of one year old wood. Cuttings were about five inches long and had four leaves per cutting except for tip cuttings which had four or more leaves. The cuttings were rooted under mist (2 sec./min.) with minimum bottom heat and air temperature thermostatically controlled at 70° F. Maximum air temperatures reached about 95° F. Indolebutyric acid was applied in a talc powder or as a 5 sec. dip in a 50% ethyl alcohol solution. The rooting medium was coarse vermiculite.

The results of this experiment taken after 60 days under mist are shown in the first slide. The most important point brought out by this experiment is that cuttings from current season's growth root at a much higher percentage than those from one year old wood. The average number of leaves remaining on rooted cuttings was 1.7 for basal cuttings (1 year old wood), 1.6 for middle cuttings (current season's growth) and 1.2 for tip cuttings. So even though the tip cuttings rooted at the highest percentage they retained fewer leaves than cuttings of the other two categories.

Secondly, the concentration of indolebutyric acid also affects the percentage of cuttings rooted. Indolebutyric acid solutions of 1.0% and 1.5% were superior to Hormodin 3 as a treatment to promote rooting. The results with 2.0% IBA were variable so it is difficult to draw a conclusion as to its effectiveness. The cuttings treated with IBA solutions had root systems superior to those treated wtih Hormodin 3 and this is illustrated in the next slide. The larger root system may indicate a faster rooting response. However, rooted cuttings which had been treated with Hormodin 3 retained more leaves than those treated with the higher IBA concentrations in alcohol solution.

In the second experiment, the effect of type of humidity control and hormone concentration on root initiation and leaf abscission was tested. The three humidity controls used were mist (with conditions as previously described), closed case and fog or high humidity. In each case bottom heat minimum temperature was thercmstatically controlled at 70° F. but air and cutting temperatures were not necessarily comparable. Likewise light intensity was not camparable being a maximum of 2500-3000 foot candles under mist, 500 foot candles in the closed case and 750 foot candles in the fog house. When considering the experimental results. these differences as well as the differences in humidity control should be kept in mind. Material for cuttings was selected in the same manner as for the previously described experiment. However, only the basal portion of current season's growth was used. Hormone treatments and other conditions were as previously described.

The results of this experiment taken after 60 days in the rooting environment are shown in the next slide. In general, the percentage of cuttings rooting was somewhat higher in the closed case than it was under mist or in the fog house. This could be due to one of several environment factors and not simply humidity control. The effect of hormone treatments was quite similar under the three environments and in general IBA solution treatments gave a higher percentage of rooting than did Hormodin 3.

The average number of leaves retained per cutting was 1.6 for mist, 1.5 for the closed case, and 1.4 for the fog house. Although the number of leaves retained per rooted cutting was not greatly different for the three types of humidity control, there was a great difference in the appearance of the leaves. As shown in the next slide, the remaining leaves of cuttings from the closed case were much darker green in color than those from the mist and slightly darker green than those from the fog house. This observation may be important as leaves that turn yellow have a greater tendency to abscise than leaves that are a dark green color.

The results of these experiments show that current season's wood roots more readily than one year old wood. However, tip cuttings lose more leaves than cuttings from slightly older current season's growth. This is probably due to the fact that the

Table 1. The effect of age of wood and indolebutyric acid treatment on rooting of **Xylosma congestum** cuttings.

"Hormone" treatment	Current Tip	Current Base	1 year Old
Control	12*	25	8
Hormodin 3	48	40	28
1.0% IBA	96	64	33
1.5% IBA	64	64	33
2.0% IBA	76	60	8

*Figures represent the percent of total cuttings which rooted.

Tabe 2 The effect of rooting environment and indolebutyric acid treatment on rooting of **Xylosma congestum** cuttings.

"Hormone" treatment	Rooting Environment		
	Mist	Closed Case	Fog
Control	25*	8	8
Hormodin 3	40	56	44
1.0% IBA	64	80	72
1.5% IBA	64	76	48
2.0% IBA	60	60	44

*Figures represent the percent of total cuttings which rooted succulent tips have a great tendency to wilt and die back during the rooting period. Cuttings from the slightly hardened, actively growing, current season's growth probably have the best chance of rooting and survival. It has also been shown that hormone treatments can greatly influence the rooting response.

Control of leaf abscission is very difficult. In all of our treatments an average of 50% or more of the original leaves abscised on rooted cuttings. There is some indication that environment may influence the color and quality of leaves retained by cuttings. The fact that sweat box rooted cuttings have leaves with better color than those from mist may indicate that leaching of leaves is a factor contributing to their deterioration. However, other environmental factors such as temperature and light intensity could also be involved. Our present work involves experiments to determine what factors influence leaf deterioration and abscission in Xylosma.

DR. HOWARD BROWN: What is the influence of season of the year on rooting and what effect did timing have on rooting?

DR. HACKETT: I cannot answer this question directly because we haven't tried rooting experiments at various seasons of the year. Our work has been during the late spring and summer when growth is occurring. From our experiments, it can be said that age of wood and vigor of growth are important so perhaps it can be implied that time of year might also be important.

MRS. FRANCES SPAULDING: Are you working on sucrose to overcome leaching and leaf abscission?

DR. HACKETT: We did one experiment in which we presoaked the base of the cuttings in sucrose solution before we stuck them. We could see no difference in leaf retention in this experiment but there was some indication that the root system was somewhat better developed in the sucrose treated cuttings.

MRS. FRANCIS SPAULDING: Have you tried nutrient sprays on cuttings in the afternoons after the mist cuts off?

DR. HACKETT: No, we have not. We tried fertilizing at weekly intervals with a quarter, half, or full strength Hoagland's solution but this only created an algae problem. We intend to try applications of nutrients through the mist system.

MR. IVAN STRIBLING: Have you found that it helps to cut light intensity in the hardening off periods after rooting under mist?

DR. HACKETT: Again, I can't give a direct answer because we haven't worked with the hardening off period. However, in our experiment where we compared closed case with mist as a rooting environment there was a much higher light intensity under mist than there was in the closed case. As you may recall, leaf deterioration was greater under mist than in the closed case. Perhaps this result can be interpreted as an effect of light intensity as well as it can be interpreted as an effect of leaching by mist.

DR. CLARKE: Could you describe xylosma briefly?

DR. HACKETT: It's a shrub. It can be used as a wind break or a shield and is used to a large extent along freeways as a baffling. It is propagated in quite large quantities in southern California.

MR. JOLLY BATCHELLER: I have an experience that might relate to this propagation. My associate took home two five-gallon cans of Xylosma. He put them on the north side of the house and forgot about them for a while. There was a cold spell and they practically defoliated. He brought them back into the greenhouse and they started to leaf out, so he decided to make hardwood cuttings just as they started to grow. He got around ninety percent. I can't tell you whether he used mist, or the media, or whether he used hormone.

I found it true with Fatshedra which roots very easily anyway, but bring this in out of the cold in the greenhouse for a week before making cuttings, you can make single eye cuttings. You get ninety-nine percent.

THE ROOTING OF MONTEREY PINE

W. J. LIBBY
School of Forestry
University of California
Berkeley, California

In 1929, J. F. Field stuck branches from nineteen-month-old Monterey pine in the damp, sandy soil in a New Zealand nursery. He found that they produced a large amount of callus in three months and rooted in five months, with roots as regular as those of seedlings. While he made no accurate count, he claims to have achieved at least 95% rooting on this first major attempt to root Monterey pine. These rooted cuttings were four inches tall in 1929, and averaged twelve feet tall in 1934 when he reported his studies in the New Zealand Journal of Forestry.

Based on Field's success, the Australians began rooting Monterey pine on a large scale. M. R. Jacobs reported on his extensive studies in the Australian Capital Territory in 1939. He predicted that 80% rooting success was possible with six-year-old trees, although few of his reported experiments reached this level of success. Like Field, he relied on an open nursery with little protection beyond maintaining the soil moist by watering.

J. M. Fielding reported on continuing Australian operations in 1954. Several of his reports mention rooting percentages in excess of 90%, although most of his data is in the range of 50-80%.

This by no means exhausts the list of foresters who have rooted Monterey pine with disarming ease and great success. It is time, however, to get around to me and us. "Us", who find ourselves here in a session devoted to difficult-to-root species

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Based on Field's success, the Australians began rooting Monterey pine on a large scale. M. R. Jacobs reported on his extensive studies in the Australian Capital Territory in 1939. He predicted that 80% rooting success was possible with six-year-old trees, although few of his reported experiments reached this level of success. Like Field, he relied on an open nursery with little protection beyond maintaining the soil moist by watering.

J. M. Fielding reported on continuing Australian operations in 1954. Several of his reports mention rooting percentages in excess of 90%, although most of his data is in the range of 50-80%.

This by no means exhausts the list of foresters who have rooted Monterey pine with disarming ease and great success. It is time, however, to get around to me and us. "Us", who find ourselves here in a session devoted to difficult-to-root species (which seems to be a reverse kind of progress), and "me", who seems to be the only forester in the business who is having difficulty rooting Monterey pine.

Unlike the Australians and New Zealanders, we decided to root in a greenhouse, using intermittent mist. The cuttings were collected in five trips, during the period 11 November to 28 December, 1962, from the three native stands of Monterey pine at Ano Nuevo, Monterey and Cambria. They were held in cold storage for varying periods of time (two days to three months). Nine cuttings (with a few exceptions) were taken from each of 540 trees growing in the wild. An equal number of cuttings in each clone was given one of two auxin treatments, or was untreated as a control. The age of the wild trees varied from two to nine years, with a few trees from ten to seventeen years being included in collections from State Parks where young trees of adequate size were scarce. The trees varied in vigor from rapidly-growing trees occurring in openings to slow-growing suppressed trees in the undisturbed State Parks.

We at the University were primarily interested in sampling the total variation of Monterey pine as it now occurs in the natural stands for further genetic studies. We have used random procedures, which got us the sample of 540 clones we wanted. However, these procedures produced a pretty strange-looking experimental design for evaluating rooting. Therefore, my comments today are going to be more in the line of relating our experience to date, rather than any rigorous hypothesis testing. A more critical and complete statistical analysis of the data is in progress, and will be submitted to *Forest Science* in the near future.

Our period of field-collection was in the middle of the season, if you add six months for the change of hemispheres, suggested by Jacobs and Fielding as the most effective time for collecting Monterey pine cuttings. During this period, the trees are fairly dormant (Monterey pine never really gets dormant), just prior to the first big spring growth flush which normally occurs in January. The data on date of collection is confounded with the geographic origin of the clones, their subsequent length of cold storage, and the rooting environment once they finally did get into our rooting benches. In spite of this confounding, a few observations may be worthwhile.

First, we did not do nearly as well as the people Down Under say we should be able to do. Our maximum rooting percentage for one of these collection dates was only 57.6%, while our minimum was 43.1%.

Second, there is not really much difference in the final rooting percentages between the five collection dates. However, cuttings from the 22 November and 8 December dates not only ultimately rooted a little better, but seem to have reached just about their total rooting by the thirtieth week in the bench, as compared to the one later and two earlier collections which rooted more slowly, and continued to root in appreciable numbers through the fortieth week in the bench.

Cuttings from Cambria rooted better than cuttings from Monterey, which in turn rooted better than cuttings from Ano Nuevo. However, cuttings from the 8 December collection, which rooted best, and cuttings from the 27 December collection, which rooted worst, are both from the Monterey population, and are essentially random samples of that population. Therefore, I think we may suspect that the geographic origin, or native population, of the cuttings is not primarily responsible for the differences in the raw data associated with the rooting performance of cuttings from the different populations. It is more likely that the confounding date of collection, length of cold storage, or subsequent rooting environment account for most of the differences observed. This by no means indicates that there are no differences between the three populations of Montrey pine. It merely says that this data is not sufficiently good to prove it one way or the other.

Throughout the sampling period, we kept records on the length of time the cuttings were held in cold storage (38° F). There is no clearly-defined trend of final rooting percentage associated with storage time. However, those cuttings stored 20 or more days had a major rooting surge in the 21-30 week period after being placed in the rooting bench, while those stored less than seven days fell behind during the period, then closed the gap during the following ten weeks.

Besides percentage of cuttings rooted, I think we are interested in the quality of the rooted cutting, and to a degree that quality depends on the number of roots that we get on a cutting. It appears that cold storage of about 20 to 50 days may be beneficial in terms of number of roots produced, although this observation must be cautiously interpreted due to the confounded nature of the data. Storage of less than 20 days, or 50 to 90 days, seems to allow the cuttings to perform at least as well as unstored cuttings. This we may at least conclude that cold storage of periods up to, and perhaps beyond, three months is possible with Monterey pine without damaging the cuttings, and that such storage may be in some ways beneficial.

Fielding and Jacobs both report that the age of the tree from which the cutting is taken has an important effect on rooting, as one would expect from the general rooting literature. Fielding mentioned 88% rooting from 3-year-old trees, 68% from 5-year-old trees, and only 11% from 26-year-old trees. We have a younger age range, but do have a clearly-defined downward trend of rooting percentage with age. It moves from about 58% rooting for 3-year-old trees down to about 46% for 9-year-old trees. There also seems to be a downward trend in the number of roots per rooted cutting with increasing age of the parent tree, running from an average of about four roots per rooted cutting for young trees 2-to-3 years old, to about three roots per rooted cutting for sapling trees 7to-9 years old.

We were also interested in what effect the apparent vigor of the parent tree would have on rooting. We defined vigor simply as the height of the tree divided by the age of the tree. We suspected that this would be a rather different number for young trees as opposed to older trees, so we arbitrarily split our data into three age groups: 2-4; 5-7 and 8-plus years old. This analysis indicated that young trees outroot older trees, even if they are growing at the same average height per year. It further indicated that the more vigorous trees clearly are not better rooters. If anything, there is a slight downward trend in rooting percentage with increasing vigor. I expected that, since more vigorous trees generally had bigger cuttings, these cuttings from the vigorous trees would produce more roots per cutting. However, the data seems to indicate no relationship of roots per rooted cutting to vigor of the tree.

All cuttings were recut after storage, and vertically scarred for a distance of about ½-inch from the bases with razor blades. Three cuttings from each clone were given no auxin treatment. Six cuttings from each clone were given a 5-second dip in 4000 parts per million indolebutyric acid in 95% ethanol. Three of these six were given an additional treatment of Hormodin #2 powder, applied while the cutting bases were still moist from the IBA liquid dip. These three treatments were randomized within each clone, and immediately placed in the rooting bench. Since all cuttings within a clone received identical treatment prior to and after the auxin treatment, comparisons of rooting performance related to the two auxin treatments and the control are unbiased by the possible confounding factors discussed above.

The IBA quick-dip consistently rooted better than the IBA quick-dip plus Hormodin powder, which in turn consistently rooted in higher percentages than did the untreated controls. The IBA quick-dip alone produced about 20% more rooted cuttings than the controls. Of perhaps as more interest, the IBA quick-dip cuttings tended to root faster than did the controls, and at 20 weeks in the rooting bench, were rooting at 150% of the control rate.

While the IBA plus Hormodin did not root in as high percentages as the IBA alone, this combined treatment consistently produced more roots per cutting than did IBA alone, which in turn produced more roots per rooted cutting than did the controls. Furthermore, it was frequently observed that roots on the controls were thin, as compared to the heavier roots which were typical of the auxin-treated cuttings (Figure 1). I don't know if one or the other of these types of roots is preferable for a rooted cutting, but if it turns out to make a difference, this point may be worth more attention.

In all comparisons where roots per rooted cutting was scored against time in the rooting bench, the cuttings which rooted prior to the twentieth week in the rooting bench maintained a relatively high average number of roots per cutting (about 3 to 4½). However, with increasing time required to root beyond twenty weeks in the rooting bench, a considerable downward trend developed in the average number of roots per rooted cutting. It may be that the slow rooters begin to run out of nutrients or other factors which increase number of roots. Or, it may be that slow rooters, by the very fact of their being slow, were less capable not only of rooting, but of producing high numbers of roots.

We in forestry consider that a symmetrical root system is important, both in terms of giving us a cutting which is somehow more comparable to that form taken on by a seedling, and in terms of the ultimate health of the tree. In order to develop this type of root system, we grow our rooted cuttings in peat pots. After putting the rooted, potted cuttings through a hardening period to wean them away from the mist, we hold them for an additional month or so before planting them. During this period, the roots continually come through the pot, die at the tips, and regenerate behind the pot edge inside of the pot, resulting in a more-or-less symmetrical root system when we finally plant the tree, (Figure 1). Monterey pine, as you may

Figure one: Left: Cutting with several roots. The tips of the roots were cut off about two weeks before this picture was taken. Note vigorus regeneration of secondary roots, restricted to roots which had previously developed from the cutting. Center: Single thick root, frequent in both auxin-treated cuttings and untreated cuttings. Further initiation of roots from the cutting after a root has attained this size is rare, if it occurs at all. If an asymmetrical root system is to be avoided, this root must be pruned so that secondary roots from this root form the main system at the time of planting. Right: Thin root frequently observed initiating from untreated cuttings, but rare from auxin treated cuttings.

Figure two: Top row: Plants of seedling origin. Bottom row: Plants of cutting origin. These plants alternate in a row, and average about one meter in height two seasons after outplanting.

know, has an extremely high root regenerating potential, and is capable of regenerating roots behind such dead or cut ends at almost any time in its development and in almost any season of the year.

Finally, it is of some interest to know if and when cuttings become comparable to seedlings, or if not, in what ways they are different. Figure 2 presents three typical cuttings and three seedlings alternated with them and planted the same day. After two growing seasons, the cuttings seem more open, but otherwise are difficult to tell from seedlings. Experiments are planned to compare development patterns in cuttings and seedlings more critically.

DONALD STEELE AND DARA EMERY: Why grow the pine from cuttings when you can grow it so easily from seeds.

DR. LIBBY: We would like to grow the best trees, which may be most effectively accomplished by vegetative propagation. We should also like to use this procedure for studying genetic variation over a range of environments. Vegetative propagation will increase the efficiency of ecological and other types of experiments by getting rid of extraneous sources of variation. Another reason is that we think we are going to get some sexual precosity from rooted cuttings and can therefore establish a clonal orchard with small trees for seed production. There is some indication that rooted cuttings give better form from a timber point of view than seedlings of the same genotype. There is also some indication (and there is conflicting evidence on this) that we get reduced animal damage. The Australians actually find they get preferential grazing from sheep and rabbits on rooted cuttings as opposed to seedlings. Along the north coast region of California, we have observed a strong preference of deer for seedlings over rooted cuttings.

JACK BARRINGER AND BILL CURTIS: What is the best method to use in rooting the true firs and douglas-firs?

DR. LIBBY: With the true firs you have to pay some attention to what kind of branch you are taking to avoid problems of its thinking it is still a branch many years after you have rooted it. I have seen some very satisfactory trees fifteen or twenty years old from rooted cuttings which for all intents and purposes look like seedling trees. I would suggest you write for the work of Dr. Griffith, who is on the faculty of the University of British Columbia, Department of Biology. He has done some work on douglas-fir in the past with considerable success. Some work is currently being done at the Institute of Forest Genetics, so I pass the buck to Stan Krugman.

STAN KRUGMAN: Well, we are primarily in the propagation of pines. In the past five years we have started the propagation of fir. They can be propagated. They root better from younger sources of material but we have propagated from hundred-year-old trees that fell over by rooting from different parts of the crown. Those from the upper part (the very tips) of the crown will give you suitable plants if you are willing to go up eighty or ninety feet to get them. The same way with douglas-fir. You do not get enough material for mass production. Some things we are working on is bringing down suitable material from tops of trees and grafting it on to younger rootstocks. A couple of years after the union has taken, we propagate from those and increase rooting. Again with the true fir, they may behave as if they are from lateral branches. There is a limit to what you can do with this type of material.

R. H. KNOWLES: How acceptable is the leaf bundle cutting procedure? What is the method for propagating pine species?

DR. LIBBY: Pine leaves come in bundles of usually more than one, and this bundle is morphologically a short shoot. It has a meristem in it as you would have every reason to expect, that given the right treatment, this meristem might produce a shoot. These leaf bundles do, in fact, produce an acceptable plant. There are some tricks to it, however. The most important trick is not to get roots on these things, but getting the meristem to break after you get the root. I think the best way around this is to get the meristem to develop into a larger bud before you take the bundle off the tree. This means some kind of mutilation of the branch, in general between three months and a year ahead of the time you want to take these short shoots off. One obvious advantage is that there are a lot more needle bundles on a small tree than there are branches. The other advantage is harder to prove, but frequently these meristems show juvenile characteristics when they break from one of these needle bundles. They have primary needles instead of secondary needles and other characteristics that behave in a juvenile manner. This apparent reduction in physiological age, whatever this is, may make them easier to root. One other piece of advice: some of these meristems, instead of just developing a bud will immediately develop a shoot. Then you're dealing with a shoot like any other, and the advice is to let it harden off. Don't try to root it like a short shoot, but let it go eight or ten months on the trees before you try to take it off and root it.

IVAN STRIBLING: Do you believe seedlings grown from seed gathered in the Monterey area produce a better strain of Monterey pine seedlings than seed from the other two native stands?

DR. LIBBY: We have three native populations of Monterey pine in California, one near Santa Cruz, one in San Luis Obispo County, the other in Monterey. I am going to give you five answers to this question. The first: I don't know. The second: This would depend on the use you intended for it; perhaps a Monterey tree might be better for timber while a Cambria tree might be better for ornamental purposes. The third: Australian tests indicate that the Cambria origin seedlings are not quite as gcod as those from either Ano Nuevo or Monterey for timber purposes. They don't grow quite as fast or quite as straight. The fourth: I suspect that within-population variation will prove to be greater than that between-populations. This "better strain" will probably be drawn from the better genotypes of all populations. The fifth: This is the question that is asked in our current research and I believe we will have better and better answers on his as the years go on.

DR. KRUGMAN: What about the position of the cutting in the tree, actual age versus physiological age?

DR. LIBBY: The best guess is that the physiological condition varies quite remarkably within a large tree. Some of these differences that would affect rooting, I suspect, are such things as vapor tensions, mineral and carbohydrate nutrition, and hormones. You would expect the morphology and anatomy of shoots in different parts of trees to vary, which may also affect rooting. Relative to Monterey pine, the advice is to use lower branches which have recently originated from either the tip bud on a major branch or those immediately lateral to it, in other words, first or second order branches of lower branches. We haven't tested this.

PROPAGATING EUCALYPTUS FROM CUTTINGS

STEVE FAZIO
Arizona Agricultural Experiment Station
Tucson, Arizona

The selection of evergreen shade trees for southern Arizona is limited due to temperature extremes between winter and summer. It is not unusual for temperatures to range above 100°F. in July and August, and there are instances when the temperature will go above 110° F. accompanied by low humidity and hot dry winds. At the other extreme, winter temperatures will drop below 20° F. and remain at this low level for several hours. Survival of trees under these extremes of temperature is limited to a very few specimens including *Rhus lancea,* Olive, Pepper tree and Eucalyptus.

Eucalyptus rostrata and *Eucalyptus polyanthemos* represent two species which are in widespread use throughout the lower elevations of southern Arizona. They survive the environment conditions just mentioned, but there has been observed a noticeable change in the appearance of tree shape and foliage characteristics of trees growing in home yards and in parks.

Landscape architects have indicated a need for eucalyptus of uniform characteristics to achieve the desired effect of uniformity in their landscape plantings. Nurserymen have also been aware of the need for more uniformity in the growth habits of eucalyptus, but their experience with the rooting behavior of these trees have made it uneconomical to propagate them vegetatively.

The Horticulture Department, University of Arizona, initiated vegetative propagation studies several years ago and observed some erratic rooting behavior of the *Eucalyptus rostrata* and *polyanthemos.*Cuttings taken from trees showing any indication of iron chlorosis did not root regardless of treatment used. There appears to be some clonal resistance to iron chlorosis as evidenced by photos taken of a planting of eucalyptus in one of our city parks in Tucson. Poor rooting was also experienced with cuttings taken from older trees ranging 10 years or older, regardless of the type of wood used for cutting material. A higher percentage rooting was obtained from younger trees but this presents a problem to the propagator since he cannot evaluate the desirability of these young trees at the time the cuttings are taken. This would necessitate propagating a number of cuttings from outstanding, individual young trees to serve as future propagating material if the parent trees developed desirable characteristics.

Cuttings taken from sprouts developing at the base of the trunk of old trees rooted as well as cuttings taken from young words, first or second order branches of lower branches. We haven't tested this.

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Cuttings taken from sprouts developing at the base of the trunk of old trees rooted as well as cuttings taken from young trees. The amount of material obtainable from this source would be limited but the growth habits of the tree would already be established.

The cutting material used in the propagation tests included greenwood, soft wood, semi-hardwood and hardwood. The cuttings were obtained at different times of the year: July, September, November and March. Decay of greenwood and softwood cuttings was much greater than for the other types of wood.

The combination of napthaleneacetic and indolebutyric acid (2 grams NAA, 2 grams IBA per 100 cc 45% ethyl alcohol) gave the best rooting results of all the compounds used in the tests. The basal one inch of each cutting was wounded with a razor blade in three different locations prior to a three-second dip in concentrated growth regulators.

The rooting medias consisted of perlite, vermiculite, sawdust, sand and various combinations of these compounds. There was no appreciable differences in the percent rooting of the cuttings in the different medias.

The cuttings were placed under intermittent mist (on 10-seconds, off 2 minutes) and bottom heat was set at 70° F. Full sunlight was permitted except during the summer months when some shading was necessary to prevent sunburning. The time required for rooting varied from 10 to 12 weeks.

Under our conditions, cuttings taken in early March gave the best rooting response. The highest percentage rooting obtained with *rostrata* amounted to 65%. There were some species of eucalyptus which would not root regardless of treatment or time of year.

DR. WALTER LAMMERTS: Have you tried *Eucalyptus ficifolia?*

MR. FAZIO: No. We have trouble trying to grow them in Tucson. They will not survive our climatic conditions and no propagating material was available for testing purposes.

DR. LAMMERTS: Have you tried cutting old trees back one third their height and taking cuttings of forced growth after this pruning?

MR. FAZIO: No. This may work and will be included in some of our future tests. We have observed that propagating material taken from younger trees gave us the best rooting response. You may have outstanding young trees two or three years old and not know for sure what their characteristics are going to be when they approach maturity. We are attempting wounding techniques to obtain sprouts on the lower portion of outstanding old trees for cutting material.

MR. GREG TAKSA: How do you apply honey? Does it work?

MR. FAZIO: One citation in the literature indicated honey was used in the rooting of cuttings. The question of how do you apply honey to cuttings. It was diluted in water and used as a soak but we gave it up because of a decay problem.

MR. FRED REAL: What type of propagation materials do you use?

MR. FAZIO: We use semi-hardwood stem cuttings about one quarter of an inch in diameter. Each cutting measured approximately five to six inches in length and contained one to three leaves.

MR. RALPH MOORE: What about wounding? What is the length of eucalyptus cuttings?

MR. FAZIO: Five to six inches in length. Making three cuts through the bark with a razor blade approximately one inch long near the bottom end of the cutting resulted in a higher percentage of roots.

MR. BRUCE BRIGGS: Did you run any tests for the reason for making three wounds rather than just one wound?

MR. FAZIO: No. They were made on three equal sides; possibly one would have been sufficient.

DR. LAMMERTS: Did the shoots from which the cuttings were taken come from the base of the tree right near the soil.

MR. FAZIO: Yes, at the soil line.

VOICE: Did these new shoots from the base that came following wounding have the form of seedlings or mature leaves?

MR. FAZIO: They showed characteristics of mature leaves; there was no evidence of juvenility.

IV. Bedding Plants and Ground Covers

MODERATOR: Mr. Carl H. Zangger

PROPAGATION AND GROWING OF GROUND COVER PLANTS AT PERRY'S PLANTS, INC.

CARL ZANGGER
Perry's Plants, Inc.
La Puente, California

Perry's Plants are primarily growers of bedding and ground cover Plants. We produce several hundred thousand flats of annual and perennial bedding plants as well as over 100 varieties of herbaceous and woody types of plants used for ground cover planting purposes. All of our production of ground cover plants, with a very small exception, is sold by the flat of 64 to 100 plants depending upon the variety. The great majority of these plants are sold at a price varying from .02c to .03c per plant. You can see that it then becomes necessary to produce saleable varieties at an absolute minimum of cost. This price includes not only the rooting and growing of the plant, but must also cover all other costs of doing business, and allow a small profit as well. Simplification and standardization of procedures is an absolute necessity. All varieties are rooted, grow on and you apply honey to cuttings. It was diluted in water and used as a soak but we gave it up because of a decay problem.

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We use the U. C. system of growing. Except for the soil used for planting seed we have only one soil mixture. This is a mixture of ⅔ fine silt sand and ⅓ Canadian Peat with necessary nutrients added. All of our soil is mixed in a stationary mounted cement mixer that is capable of handling 7 yards of soil at a batch. Soil is mixed and steam sterilized while mixing right in the mixer. After sterilizing the soil is dumped on a conveyor belt and transferred to a flat filling machine from which the soil is dispensed into the individual flats. This machine is timed to fill 16 flats per minute. After the flats are filled they are placed on pallets and taken by a fork lift truck to the particular area in which they are to be planted. We do all of our planting at the bench or house area where the flats of cuttings will be rooted. This enables the person doing the planting to place the flat of cuttings on the bench avoiding the necessity of having another party handle and transport the flats of cuttings to the growing area.

Nearly all of our cutting wood comes from our planting of stock plants for this purpose. We have approximately 4½ acres devoted to this purpose. Cutting wood is brought in from the field to the women making the cuttings. Varieties which can be processed by snapping the wood by hand are processed in this manner for two reasons. One is that there is less possibility of the transfer of disease organisms from the knife or shears. Secondly, cuttings can be made much more quickly. After the cuttings have been made, all cuttings go into tubs of fungicide, containing 2 teaspoons of Morton's Soil Drench and ¼ cup of 75% Terrachlor to 5 gallons of water. Cuttings are thoroughly drenched and then removed and placed into the flats of soil. Again we follow the same procedure on all varieties. One exception is that many varieties of Verbenas seem to be allergic to Terrachlor so therefore we eliminate the Terrachlor from the fungicidal dip and use only the Mortons Soil Drench on this variety. We have three different types of houses that we use in rooting most varieties of ground covers. These are quonset type plastic houses, conventional greenhouses and saran shade houses.

Our quonset type plastic houses are used for the greatest varieties of cuttings. These are houses 24 ft. wide and 96 feet long and 7 feet high at the center. Each house holds 700 flats. All are benched and equipped with mist systems. Our mist nozzles are Nylon Econ O Mist Nozzles placed 3 feet apart on the line. Timers are standard 5 minute interval timers. We have a 6 foot wide cement walk down the center of each house so that we can very quickly remove the rooted flats from the houses by running our electric trucks equipped with special racks for holding flats right through the house; also much of the planting is done on tables placed in this wide isle. We cover the houses with 4 mil polyethylene in November and leave them covered until April or May at which time we remove the poly and cover the houses with saran shade cloth. Heating is by natural gas unit heaters. We do not at present use any bottom heat although some varieties would root somewhat quicker, particularly during the winter months, if we had bottom heat available. In our area we find that the natural heat from the sun is sufficient to give us all the daytime heat we need except for rare periods of short duration. Most all the heating done is at night.

We do plant most of our Ivy, Iceplant and other succulent types of plants in our saran shade house. Again we follow the same procedure described earlier in making the cuttings, dipping and sticking etc. The main difference is that these flats of cuttings are allowed to sit in the open under the saran to root. In the case of Ivy cuttings we place the flats of cuttings in the beds and then cover the entire bed with sheets of polyethylene, they are left covered until they are rooted. We find it necessary to check under the polyethylene only once a week to be sure plants have not dried out. During cool weather many beds are watered only once or twice during the period they are covered, which is about 30 days. When the beds of Ivy cuttings are rooted we remove the poly covers and leave the flats right in the beds they were originally placed to finish their growing. When they have reached saleable size they are loaded directly from this same bed into the truck that will deliver them.

We, as most growers, have gone through our periods of trial and error. One troublesome occurrence we had some time ago was that in a house of cuttings of the same variety, we would have flats here and there that would appear to be burned, some would be a whole flat, others might be only a few rows of plants in the flat. After a great deal of checking we found that some of the women were not removing all of their cuttings from the fungicidal dip. When they place a batch of cuttings into the dip they would remove most of them and stick them but there were a few that remained in the bottom of the tub. These cuttings that remained in the fungicide too long were the ones that were burning.

Should fungus disease occur in flats of cuttings we have found that drenching the flats with a solution of Terrachlor and Morton Soil Drench has been reasonably successful in stopping it. We have also used Shell 345 with a fair degree of success.

At the present time we are experimenting with mist containing nutrients. Some advantage seems to be possible on varieties such as Verbenas and Chrysanthemums in that plants retain a better color and become saleable quicker. We have not noticed any appreciable speed up in rooting however.

BEDDING PLANT PRODUCTION

HENRY ISHIDA
Union Nursery (Gardena, California)

We are primarily producers of bedding plants. We use the U. C. system of soil propagation. Soil is mixed in 2 transit type concrete mixers and steam sterilized in the mixers. One basic soil mix is used throughout the nursery. Soil is dispensed into flats through a vibrator type of dispenser.

All up to date methods of moving and handling flats are utilized as handling is one of the largest items of expense.

We use conventional greenhouses, plastic houses and saran shade houses for growing. One innovation on our saran houses, we have them rigged so that the saran in 20′ strips can be quickly taken down. This eliminates the necessity of moving the flats and saves much labor.

Accurate production and sales records are kept so that production may be closely regulated to the season.

Pest control is contracted to a specialist, who comes once a week to keep everything under control. Weeds are controlled using weed oil sprayed on through 3 gallon Hudson sprayers. An automatic clock controlled sprinkler system has been installed through much of the nursery. This has been quite successful and eliminates most of the hand watering.

Feeding is done on a constant basis through the water system. Supplemental feeding is made as necessary. Blood meal is applied to much of this material prior to delivery to sustain it while on the dealer's bench.

DISCUSSION

QUESTION: Why is more direct seeding not done to eliminate the cost of transplanting?

MR. ISHIDA: Because the economics do not work out. Too much space is tied up over too long a period of time. Also seeds do not germinate uniformly and uniform growth is difficult to maintain.

QUESTION: Why are prices on bedding plants in other areas outside southern California lower than those in California, when production methods in southern California are more efficient?

MR. ISHIDA: Growers in other areas are not aware of their actual costs. Most grow other crops and only produce bedding plants for a short period in spring. Probably their other crops are subsidizing the bedding plants.

Discussion on the influence of light on the growth of bedding plants was held. Mr. Norton of Seattle stated that research was under way in their area to see what could be done by artificial light to improve the quality. They have so many periods of cloudv or overcast days that it can affect the quality of the plants. No results are ready for publication at this time. New light sources are being developed and probably much information will be available in the future. Much research on this subject needs to be done.

Air pollution was discussed briefly and is a real problem, affecting many plants. Dr. Spaulding of the University of California stated many lawn grasses are adversely affected by smog.

Discussion of the benefits of additional CO_2 to greenhouses was mentioned. It is too early to make any definite statements at this time although some benefits are thought to occur. Economical systems need to be available.

GROWING BEDDING PLANTS

I. E. EDWARDS

Edwards Nursery (Visalia, California)

We grow about 40,000 flats of bedding plants and ground covers. The soil mix essentially is a U. C. mix—8 parts sand—2 parts peat—2 parts fir bark, plus additives. Starting pH is approximately 6½. Our water contains some lime and magnesium so the pH naturally goes up. All mixes are steamed to 190° F. Nitrogen is added before steaming. Ammonium Nitrate is fed using a Smith measure mix after transplanting.

Our houses are plastic, mostly poly and some mylar. All are heated with suspended blowers. Houses are designed so that most of the condensation goes outside. All growing houses are drive thru using Electric trucks.

Seed Storage: Pansy, Viola, Larkspur and most perennials are stored in a refrigerator at approximately 40°F. Others are at room temperature and refrigerated in summer. Getting back to soil mixes, our seed soil is essentially the same as the planting mix except no bark is used.

Due to our dry climate, moisture at germination is our big problem especially in the fall. Most of the critical seed are sown in furrows made by using a lath. Sterilized sand is used for seed cover. We have found Calendula must be kept very wet until germination.

QUESTION: How do you control drip in plastic houses?

MR. EDWARDS: Houses have a 6-12 pitch. At the plate line there is ¾″ opening to allow the condensation to run through and drip off at the eave line outside.

QUESTION: How do you cover seed flats?

MR. EDWARDS: We cover seed flats with sterilized sand and sterilized muslin. Begonias are covered with plastic and muslin.

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A SELECTION OF PLANTS FROM THE NORTHWEST:
New, Unusual or Worthy of Wider Use

BRUCE BRIGGS
Briggs Nursery
Olympia, Washington

Plant	Description	Method	Time	Medium	Remarks
Berberis thunbergii 'Roseglow'	Pink variegation, glowing effect. Introduced in Holland — probably will be patented in America	Softwood cutting	June-July	Sand	Same as *B. thunbergii*
Cornus nuttali 'Goldspot'	Variegated sport of *nuttali*	Grafting or budding			Same as other dogwoods
Cotoneaster 'Saldam'	*C. dammeri* x *C. henryi*. Long leaf, creeping evergreen. Red berries	Softwood cutting	July-September	Sharp sand or perlite	Use overhead mist
Cotoneaster x *watereri* 'Pendula'	Weeping form. Large glossy leaf and red berry. Lends well to espalier	Softwood cutting	July-September	Sharp sand or perlite	Use overhead mist
Daphne cneorum 'Ruby Glow'	Larger and deeper pink bloom; fuller, more compact growth	Cutting	August-September semi-hard	Sharp sand Needs good drainage	Wood from plants grown under dry conditions roots better
Ilex crenata 'Mariesi'	Fastigiate form. Slow growing	Softwood cutting	Early	Sharp sand	Same as other *Ilex crenata*
Kalmia latifolia (Dexter strain) 'Ostbo #5'	Red flower. Larger bloom and better foliage	Cutting	Semi-hard cutting	40% sand—60% peat	Difficult to root; use closed case
Photinia 'Fraseri'	Brighter new foliage tips. Free of mildew	Soft tip cuttings	Almost anytime	Sand, peat or perlite	Roots easily. Improved with mist
Prunus laurocerasus "new dwarf form"	Recently introduced from Canada. Growth similar to *V. davidi*	Cutting	August-November	Sand, peat or perlite	No special problem
Prunus laurocerasus 'Otto Luyken'	Darker green; more upright and compact than Zabelianna	Cutting	August-November	Sand, peat or perlite	No special problem

Plant	Descripton	Method	Time	Medium	Remarks
Cotinus coggygria (Syn. *Rhus cotinus*) 'Royal Purple'	Purple foliage and bloom	Softwood cutting	Early June	Large coarse sand; good drainage necessary	Roots fairly well under mist; loss great in transplanting and overwintering
Abies balsamea 'Nana'	Dwarf fir; similar in growth to a nest spruce	Cuttings	Winter (December)	Sand	Slow to root; do not disturb until well rooted
Abies lasiocarpa var. *arizonica* 'Compacta'	Intense blue	Graft			Use Noble fir for understock
Pseudotsuga menziesii (Syn. *P. douglasii*) 'Fletcheri'	Prostrate blue form	Graft			Use Douglas fir understock
Cedrus deodara 'Albospica'	White flecked. Slower growth	Graft			Cuttings are being tried
Chamaecyparis lawsoniana		Cuttings	Winter	Sharp sand or perlite	
'Lycopodiodes'	Dwarf globe, twisted foliage				
'Silver Moon'	Dwarf, silver variegation; Introduced by Goddard				
'Goddardi'	Golden obovate form; Introduced by Goddard				
'Golden Shower'	Similar to above; slightly more silver. Introduced by Briggs				
Chamaecyparis obtusa		Cuttings		Sharp sand or perlite	
'Coralliformis'	Threadlike foliage				
'Nana Kosteri'	Dwarf, irregular, layered effect				
'Lycopodioides'	Heavy, clublike folaige				
'Mariesii'	Dwarf, silver variegation; threadlike				
'Tonii'	Golden variegation on tips. Medium compact				

Plant	Description	Method	Time	Medium	Remarks
Chamaecyparis pisfiera 'Filifera nana aurea'	More dwarf form; deeper color	Cutting	Winter	Sharp sand or perlite	
Picea glauca 'Echiniformis'	Dwarf globe form of Albertiana	Cutting	Winter	Sand	Same as Albertiana
Picea pungens glauca		Cutting	Winter	Sand	Mist might be helpful
'Nana'	Dwarf form of Blue Spruce	Cutting			
'Globosa'	Dwarf globe form of Blue Spruce	Graft			
'Hoopsii'	Bright silver blue				
Pinus sylvestris 'Fastigiata'	Blue, heavy needle, fastigiate form	Field: top graft-side, veneer or saddle	August-September		This method has been successful for John Spaan in the soutrern part of Washington. 2-3 inch scions. Heavy flow of sap makes quick union. No wax or cover used over rubber.
Thuja occidentalis 'Hetza midget'	Dwarf globe. Smaller, better color than Little Gem	Cuttings	Winter	Sand	
x *Mahoberberis miethkeana*	*Berberis* x *Mahonia.* Dark green. glossy foliage. Unright to 6 feet.	Cutting	Early summer	Sharp sand	Mist is helpful

NEW PLANT MATERIALS FOR THE WEST AND SOUTHWEST

Don K. Sexton,
Monrovia Nursery Company
Azusa, California

I have been asked to discuss some plants being introduced to the nursery trade in the southwest by Monrovia Nursery Company.

Seven plants have been selected, all of them low-growing shrubs except one. Four are Junipers. Hardiness zones referred to are those used in the U.S.D.A. Plant Hardiness Map, running in degrees below zero. Zone 6 is from -10° to 0° and the other zones are in ten-degree steps so that zone 2 is from -50° to -40°.

The first of these shrubs is *Cotoneaster horizontalis* var. *perpusilla* or Ground Cotoneaster. It is a lower growing plant than the species, to about 3 feet, and has a distinct two-ranked habit of branching. This semi-evergreen shrub with pinkish flowers and red berries in fall has smaller leaves than *C. horizontalis* which turn red in fall also. It is useful as wall covering, on banks, and in rock gardens, growing well in any soil. Cold tolerance to zone 4.

Genista germanica var. *prostrata* is another bank or ground cover and the mature growth is so spiny that the plant is an effective barrier even to animals. This evergreen shrub has small entire leaves with compound spines in the axils and hairy branchlets. The yellow flowers are borne on 1 to 2-inch racemes at the ends of the shoots.

Nandina domestica var. *nana* 'Dwarf' is a very dwarf compact mound form of this familiar shrub. The leaves are three-parted, each stem holding 2 to 3 leaflets which are much broader than in the species and turn a more evenly deep red color in the cooler months. Hardy to zone 6.

Juniperus sabina 'Broadmoor' is intermediate in size between *J. horizontalis* and *J. sabina* var. *tamariscifolia*. At first prostrate, it mounds to 30 inches and reaches a diameter of 12 feet. The foliage is a soft gray-green color. Hardy to zone 3.

Juniperus sabina 'Buffalo' is spreading and similar to 'Broadmoor' in size, but a bright green color. Both of these originated in Russia. Will stand the cold of zone 2.

Juniperus horizontalis 'Webberi' is a very low mat forming bank or ground cover. It has heavy foliage with a rich green color which changes to purple or pum in the colder months. This Juniper is also useful in the foreground of a border and as an accent plant for upright types of conifers. It is hardy to zone 4.

Juniperus chinensis 'Robusta Green' has an informal upright habit of growth and is deep bluish-green in color. The heavy-textured foliage is on dense tufted branches. It is slow growing and requires no pruning. 'Robusta Green' is especially useful as a specimen, in a planter box, or in an intermediate shrub planting and is hardy to zone 4.

NEW GROUND COVERS

HENRY ISHIDA
Union Nursery, Inc.
Gardena, California

In order to gather this list of 'new' ground cover. I followed the advice of Mr. Boddy, and contacted other people. In discussing this list with our Los Angeles County Farm Advisors Mr. Maire and Mr. Piatt, and also with Mr. Jim Perry and Mr. Carl Zangger of Perry's plants, who considered the authorities on this subject. It was interesting to find that there are actually only a very few new ground covers introduced, that is from the standpoint of a new breed or sport. Incidentally, I tried to persuade Mr. Boddy into having Mr. Zangger give this paper, but was turned down since Carl had to moderate a panel on an earlier program. It seems that what may be considered new in one locality may be due to the introduction of a relatively old variety from another area. Or, in some cases, the reintroduction of an old variety to a new generation of people. This probably is due to the recent interest in the use of ground covers in landscaping, and we notice the interest spread geographically into different areas.

Another point that was discussed is, how long can a plant be called new after introduction. In the bedding plant industry where seed companies offer new introductions annually, a new plant or variety may be classified as new for only one or two years. But in the case of ground covers where new introductions are relatively rare, it raises a question as to what can be called new.

Following is a list of plants for your consideration.

If there are any questions regarding any new or old ground covers, I'll be very happy to refer you to Mr. Zangger, who is sitting in the back, who I'm sure will be very happy to answer them for you.

Scientific Name	Common Name	Propagation
Ajuga crispa	Bronze giant ajuga	Cuttings, division
Archtostaphylos edmundsii	Manzanita	Cuttings
Baccharis pilularis		Cuttings
Hybrid bermuda *grass*	'Sunturf', 'Tifgreen', etc.	Stolons
Duchesnea indica	Native strawberry Indian mock berry	Cuttings, division, seed
Gazania splendens	New colors, 'Fiesta Red' 'Burgundy red' 'Pink hybrid'	Cuttings, division

Gazania uniflora leucoleana	New colors Orange White Bronze	Cuttings, division
Hypericum repens	Dwarf St. Johnsworth	Cuttings
Lantanas	New colors	Cuttings
Lysimachia nummularia	Moneywort	Cuttings, division
Mazus reptans		Cuttings, division
Osteospernum fruticosus	Trailing African daisy	Cuttings
Potentilla verna		Cuttings
Santolina virens	Green santolina	Cuttings
Teucrium chamaedrys prostratum	Prostrate germander	Cuttings
Verbena peruviana	New color in hybrids Red, white, pink, rose, purple, burgundy, candystripe	Cuttings

GRAFTING EVERGREENS

JOHN C. SNYDER
Extension Horticultural Specialist
Washington State University
Pullman, Washington

My main interest has been in grafting deciduous fruit trees. Because of my experience with techniques which, for the most part, are in general use, Mr. Knut Lunnum, Extension Forestry Specialist, Washington State University, prevailed upon me to help him graft some evergreens. At least, to Mr. Lunnum's knowledge, some of the grafting techniques used in horticultural crops are used to a very limited extent in evergreens. As I describe these techniques, I shall include some limited experience in grafting evergreens and suggest instances in which I think horticultural grafting techniques can be applied to evergreens.

Success in horticultural grafting depends very much upon the condition of the material and how expertly the operations are carried out. I assume the same situation applies to evergreen grafting and that possibly evergreens may be somewhat more exacting in their requirements. In horticultural grafting, failures are due mainly to failing to follow the basic principles. I trust that pointing out some of the mistakes and suggesting techniques for avoiding them will help those interested in evergreen grafting.

Gazania uniflora leucoleana	New colors Orange White Bronze	Cuttings, division
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Time of Grafting

Occasionally you hear a grafter say, "I am not particular when I do the grafting". In our area we have a very successful grafter who says that any time after about March 1, and up to the time the trees are well leafed out is satisfactory. He sees no greater success during any one part of this period than another. Following our major freeze of 1955, we had a good opportunity to compare different times of grafting. In the springs of 1956 and 1957, when most of the repair grafting was done, some started in early March and others grafted as late as June. We also have some peach growers who insist that February is the ideal time for grafting peaches. They insist that after the last of March is too late, and January is almost as good as February. It is difficult to pick out one time that is better than all others for grafting the different kinds of tree fruits. The nearest approach to an all around satisfactory time is immediately prior to or just as root activity starts. The Douglas fir grafting which I did was done before visible bud swelling was apparent. This appears to be a satisfactory time. With ponderosa pine, however, I understand better success is obtained by waiting until the growth of both stock and scion is about half completed.

The Scionwood

Our experience in grafting fruit trees confirms the general opinion that the scionwood should be dormant and unshrivelled. This is true even though, in 1957, some apple growers in our area took scionwood from trees after growth had started and placed it directly on nearby trees. There was very little delay between the time the wood was cut and when it was put on. It may be surprising but success from this procedure was very credible. This situation is not unlike that of ponderosa pine.

Some grafters fail to use fully developed scionwood. Wood of good average vigor, grown in good sunlight appears to be better than weak or very succulent wood. Water sprouts can be used but normal twig growth is preferable. The central two-thirds of a 12 or 14 inch scion stick is better than either the tip or the butt of the stick.

For most fruit trees one-year-old wood is preferable to older wood. This doesn't mean that two- or even three-year-old wood will not grow. One of our walnut grafters prefers two-year-old wood.

Most of our fruit tree grafters shorten their scions to about three buds. If wood is scarce they shorten them even more. These same grafters seldom ever use terminal wood. There are some, however, who use much longer wood and seem to actually prefer terminal wood. Using terminal wood does not seem to cut down the number of takes. Short scions seem to produce more wood and come into fruiting a little later. It would seem that if early fruiting is not essential and vigorous growth is not objectionable, short scions have an advantage. In the Douglas fir grafting I did, I used short scions, some of which were terminal and some were sections. Success was better with the terminal scions.

I understand that February is a good time for collecting Douglas fir scions and that dipping the butt ends in paraffin as they are being collected is a good practice. Similarly, scionwood taken from the top five whorls of a mature tree produces trees with an upright growth habit, whereas those taken from lower whorls produce more spreading growth.

Cutting the Scion

Few things in grafting are more important than a sharp knife and using it properly. It has been my experience that amateur grafters often fail to develop a technique for making good cuts when shaping the scion.

A beginer should first understand how to hold the scion stick and the knife, and then learn how to move the hand and arm as he grips the knife. With these principles well understood, and some whittling practice, anyone can develop skill with which he can make perfect cuts rapidly and with ease.

There are several different kinds of grafts which I think have a place in evergreen grafting. I shall mention a few of them.

The Cleft Graft

To prepare to cut the wedge, hold the scion stick firmly in the left hand with the butt end pointing toward you and about 3 inches of the butt extending out of the left hand. Grip the knife firmly in the right hand but don't choke down on the blade. The position of the knife in the hand is fixed and rigid. As you make the cut, the hand and the knife do not change their positions in relation to each other. There is no finger movement. The whole arm moves.

To make the first cut, place the butt end of the scion stick between the thumb of the right hand and the blade of the knife with the basal bud of the scion on the top or exposed side of the stick. With one smooth movement of the right hand, make a straight cut that is 1½ inches long by the time it comes to the center of the stick. This means that the wedge, when the cutting stroke is completed, is somewhat longer than 1½ inches. The cut surface should be straight as though you made it with a carpenter's plane. When making this cut the thumb simply serves as a supporting guide for the scion stick as the knife slides. The thumb never changes its position in relation to the knife. It always moves just as fast as the knife; you never cut your thumb.

To cut the other side of the wedge turn the scion counterclockwise almost 180 degrees and make a similar cut on the other side of the scion. Turning it less than 180 degrees, possibly 165, makes one side of the wedge thicker than the other. With practice this and the previous cut can be made in single strokes. As you complete the second cut, the tip of the wedge need not come to a feather edge. Actually it is better if it does not. As pointed out earlier, the wedge of the average-sized scion should be about 1½ inches long and slightly thicker on one side than the other.

Making the cleft — the cleft is made with a grafting tool or similar device by splitting through the middle of the stub. Actually the splitting should be as much or more cutting than splitting. How far the cleft should extend into the stub depends upon the diameter of the stub. For stubs an inch or less in diameter an inch is enough. For stubs 2 inches or more in diameter it should be 2 or 3 inches long.When preparing to make the cleft, its direction is determined almost automatically by the smoothness and shape of the stub. But if there is a choice, there is an advantage in splitting the stub so the cleft extends radially toward the center of the tree rather than perpendicular to this direction. Then there is an inside or top scion which usually becomes better anchored than one on the bottom of the cleft.

As pointed out earlier, the cambium layers of both the stock and scion form a paper-thin cylinder of cells which lie inside the bark and outside the sapwood. This very thin layer of cells is not in the wood and it is not in the bark. It is between the two.

The fact that the cambium layer is paper-thin and that it lies only between the sapwood and inner bark requires precise manipulation to make contact between scion cambium and stock cambium.

Inserting the cleft graft scion — The first step is to open the cleft. Drive the wedge of the grafting tool in far enough to open the cleft far enough to accommodate the scion wedge. In general, it is well not to open the cleft any more than necessary. When inserting the scion, push the scion down into the cleft until only about ⅛ inch of cut surface at the top of the scion wedge is exposed. To insert the scion, it may be necessary to spring the cleft open slightly more by applying pressure to the grafting tool handle. Slant the top of the scion outward from parallel to the grain of the stock slightly to insure contact. In this way the cambium layer of the scion crosses that of the stock. Try to make them cross at approximately ¼ inch below the shoulder of the stub. When the scion is in place it should be very tight.

Veneer or bark graft

.. This graft is a surface graft. The scion is fit against the surface of the sapwood. It is not set in a cleft or notch cut into the wood. In contrast with the cleft graft, in which the stock is split and the scion is set in the wood, the veneer graft involves only the bark area of the stock. As the graft grows it forms a veneer covering over the stock. This graft is used for many special situations such as bridging over injured areas.

In general, the scion is shaped into a one-sided wedge 1½ to 2 inches long. This wedge exposes a complete elliptical circle of cambium cells near the edge of the cut surface of the wedge. To make contact these cells are placed flush against stock sapwood on which cambium cells remain as you loosen the bark. The cambium cells which adhere to the sapwood thus come in contact with this circle of scion cambium cells. Obviously the contact with this graft is very generous compared with that of the cleft graft.

There are several different ways of inserting the scion. The most common method is to make two vertical and parallel slits in the stock bark as far apart as the thickness of the scion. These slits should be almost as long as the one-sided wedge of the scion. Holding the scion up against the stock where you want to set the scion and using it as a guide helps to cut a tongue of bark as wide as the diameter of the scion. It is well not to make it any wider than necessary.

To insert the scion beneath the strip of bark, first, loosen the tip of the bark. It sometimes helps to clip off the heel of the scion, thus giving it a sharp, two-sided wedge point. Cut the scion to the desired length, usually three buds, and slide it down so that all but about 1/8 inch of its cut surface is covered. As you slide the scion into place, the scion forces the stock bark loose and the freshly exposed cambium cells of the stock make contact with cambium cells of the scion. Allowing the tongue to remain in place and slipping the scion under it is much better than pulling the tongue of bark loose ahead of time. Contact is made while all cut surfaces are fresh and juicy.

The side graft

The side graft scion is the same as the cleft graft scion except that the wedge is somewhat shorter (3/4 inch long) and both sides of the wedge are of the same thickness. The scion need be no more than three buds long. To insert the scion, spring the stock branch enough to open the crack you cut in it. Insert the scion at a slight angle, starting it at one side of the crest of the crack rather than at the crest, and directing the point of the scion so you get as much contact as possible. While the branch is still in a bent position tap or force the scion in well so it is tight. Insert the scion far enough so that approximately 1/8 inch of the cut surface of the wedge is exposed. Sometimes a loose flap of bark lays over the scion. Trim it off. Otherwise it interferes with waxing and adds no functional cambium contact. This graft, when well-made, provides cambium contact in four places. Release the stock branch and cut it off 2 or 3 inches from the graft unless other grafts are to be made farther out. As the branch springs back it pinches the scion and holds it very firmly in place. No nailing or binding is necessary; just waxing. Coat the graft thoroughly, using all precautions to be sure that the seal is complete and will last. Give special attention to chinking wax into cracks that otherwise may be missed. Coat the end of the stock where you cut it off as well as the tip of the scion.

Fitting Scion and Stock Together

Most grafters are quite aware that cambium layers are thin and delicate. To fit the cambiums of scion and stock together requires precision. Because the cambiums are highly susceptible to drying they dare not be exposed to drying air. Although a small amount of contact between the two cambiums will suffice, more is better. Because of this fact, cutting the scion with smooth, straight cuts and then fitting them together with extreme care adds up to more takes.

Wrapping and Nailing the Graft

Once the scion and stock are fitted together, they must be held in contact position until they knit. Nailing is by far the most common method of maintaining contact in horticultural grafts. There are some grafters, however, who insert veneer graft scions without either nailing or binding the grafts. They do this with surprising success when the bark of the stock is thick. To me it seems that with evergreens, wrapping works better than nailing.

When the scion is very small in diameter, driving a thin nail through it sometimes seriously damages it. In such instances, wrapping the graft is preferable to nailing it. Commonly, used wrapping materials are paper grafting tape, electricians' tape, masking tape and gummed cloth tape. Wrapping provides very satisfactory contact and does not injure the scion. For most of the evergreen grafting I did I used masking tape. When wrapping certain types of grafts—whip grafts, for example—care must be made not to move the scion out of position. This is a fairly common error.

Waxing the Graft

Once the graft is fitted together and wrapped or nailed, it is ready for waxing. Without waxing, cut surfaces are susceptible to drying air and decaying organisms. To preserve the delicate and exposed surfaces until scion and stock can knit, the graft must be covered with a complete seal. There are numerous sealing compounds. If they are to weather satisfactorily, they must neither crack nor wash off. In the evergreen grafting I did, I used a tree healing material. Because it gets very hard I prefer one of the regular grafting compounds.

One of the most common mistakes in waxing is to fail to see that all cut surfaces are well covered. As a rule it is well to check the grafting the following day and cover any cracks that may have opened. In general, it is not economical to be scotch with the wax. Personally, I like to use cold brush wax, but many grafters prefer and get excellent results with hand wax.

AERATED STEAM TREATMENT OF SOIL — ITS PRINCIPLES AND APPLICATION

CARL M. OLSEN
Department of Plant Pathology
University of California
Berkeley, California

Aerated steam treatment of soil is basically a transfer of heat from the boiler fuel to the soil. Variables such as soil moisture, compaction, and volume, affect the penetration and volume of steam required to heat the soil.

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Steam moves through the soil in an advancing front. If it is introduced beneath the surface of the soil, an egg-shaped heated area will be produced around the point of injection. The temperature in the center will be that of the incoming steam and will be progressively less with increasing distance from the input. The temperature gradient or front may be as narrow as ¼ inch. Aerated steam moves through the soil as a water vapor-saturated air mixture and condenses on the nearest cold soil particle releasing its heat to that soil particle.

When pure steam and a particular quantity of air are mixed, a temperature less than that of pure steam (212°F) will result. For instance, if 12.3 lb. of air are mixed with 1 lb. of steam, a temperature of 120°F will result; 6.5:1 yields 140°F, 3.4:1 yields 160°F, and 1.5:1 yields 180°F.

The advantages of aerated-steam soil treatments at 140°/30 min. are many. The four main advantages are:

1. All pathogens are killed by treatments of 140°/30 min.
2. The recontamination hazard is greatly reduced. Treatment at 140-160°/30 min. does not kill all the soil microorganisms, but does kill the pathogens. The great numbers of saprophytes that remain luxuriate in growth and act antagonistically against any organisms accidentally introduced after treatment. If this introduced organism is a pathogen, as is very likely in areas of intensive culture such as nurseries, the resulting disease will be restricted to only a few plants. In contrast, steam treatments at 212° will kill nearly all microorganisms, resulting in a 'biological vacuum'. The introduced pathogen will then grow rampant, resulting in a high incidence of disease.
3. Plant growth is better in soils treated at this temperature than at 212°F, due to reduced phytotoxicity. Most soils produce phytotoxic materials when treated at 212° with pure steam, and these result in reduced plant growth.
4. Only half the quantity of steam is required at 140° than at 212°, since the soil is heated only half as high.

Several ways of obtaining aerated steam have been devised. A steam venturi is suitable for use with a steam vault containing soil in flats, pots, etc. It consists of a large, carefully designed tube fitted with a steam nozzle at the closed end. The steam expands rapidly after passing through the nozzle and entrains a given amount of air from a side opening due to the partial vacuum created. Aerated steam is released through the open end of the tube and into the vault chamber. In normal operation, pure steam is introduced into the vault and mixes with the air normally present inside, producing a richer and richer mixture and resulting in a temperature rise. After soil temperatures of about 130° are attained, a second steam line fitted with one or more venturis is turned on. The temperature inside the vault continues to rise, but will not exceed that of the incoming aerated steam. Venturis are suitable for use only where static pressure will be constant and not exceed ⅛ lb.

A second common means of obtaining aerated steam is with a fan. Only vane-axial or compression (paddle wheel) fans are suitable. They must be engineered to operate against a static pressure of at least ⅓-½ lb. A very successful application of the use of fans in aerated steam treatments involves forcing the mixture into a plenum chamber 4-6 in. high for distribution under a layer of soil. This design consists of a large rectangular box, 4-6 inches deep with an opening at one side, to which the fan housing can be coupled. A perforated plate or heavy mesh supported on vertical pipes or a grid comprises the top. A water drain is commonly provided to clear out condensate. On top of the plenum a soil bin can be constructed, or the plenum can be made to fit into the bottom of a truck or trailer body. Bulk soil is loaded into the treatment chamber onto the perforated plate or mesh. The steam line opening into the outlet at the fan housing, is turned on and the air temperature in the plenum will rise. When the bottom of the soil layer reaches about 140°, the fan is turned on and the steam volume adjusted to maintain the correct temperature or ratio of air and steam. The soil surface can then be covered with a plastic tarp or suitable lid, but it should not be air tight. At least one grower has the top of his plenum box fitted with a large pipe to recirculate the aerated steam back through the fan, and in this case the lid should be tight fitting. The life of the fan may be reduced due to corrosion, but this is offset by the greater uniformity in soil heating. A means of mechanical loading and unloading should be provided. Several of these plenum units can be set up that operate from one portable fan unit.

The Thomas method of steaming raised benches also lends itself to aerated steam treatment. The perforated pipe running the length of the bench should be large enough to handle the increased flow of aerated steam. Aluminum irrigation pipe has been used for this purpose with great success. The aerated steam can be supplied by a portable fan unit that can be wheeled into position at the end of each bench. As with successful steam treatments, cracks or holes in the bottom of the benches are essential. These allow the escape of air in the cold soil, rather than trap it in pockets in the soil which therefore heat slowly.

Aerated steam provides a means of treating soil so that all pathogens are killed, and it allows the antagonistic effects of residual microflora to operate. Better plant growth is evident in treatments at 140°/30 min. due to reduced plant toxicity of the soil, and the cost of treatment is reduced. Aerated steam treatments have proved to be a valuable commercial nursery practice. It should be pointed out that the 30 min. treatment period should not begin until the coldest soil has reached the treatment temperature.

A number of seeds have been treated experimentally for the eradication of seed-borne pathogens. Several advantages of these treatments over hot-water treatments have become evident: (1) often increased seed germination results, (2) there is less moisture uptake, and (3) rupture of the seed coat and mucilage production (stock seed) are reduced. The control of certain seed-borne pathogens has been very successful and this method warrants further use.

AUTOMATIC ONE-GALLON CONTAINER IRRIGATION

WILLIAM M. TOMLINSON
Select Nurseries
Brea, California

Hand watering has been the oldest and most widely used method of irrigation of container plants in wholesale nurseries. Due to the ready availability and reliability of stoop labor in the past, it was possible to proceed this way in our irrigation practices from the time of the Babylonians four thousand years ago until recently.

Today, however, we find labor is pricing itself too high for this type of work, and is not constantly available. If you will notice by the slide (SLIDE) the girl is hand watering. She does not look like she is paying much attention to her work, so therefore we are going to have spotty watering of the containers. When this happens, we are sure to get spotty plant growth. (SLIDE) Here we see the some girl turning off the water faucet. She has had to drag a heavy hose throughout the area and back to the hydrant. Notice that while she is turning the water off she is also washing three or four plants out of the containers, due to the fact that she is not paying any attention to her water hose.

Why should we automate a sprinkler system? I feel that there are three main points which should be brought into any discussion on automated sprinkler systems: One, the reliability of labor; two, proper irrigation techniques; and three, the cost of labor.

In the discussion of reliability of labor we all know what problems have arisen during the past year in the unionization of nurseries. Suppose on a day when the temperature is 110°F and you are relying on manual labor for irrigating your plants, your workers decide to go out on strike. This would be the fastest way I know to bankruptcy. Relying wholly on manual labor for irrigating plants leaves any nurseryman in an extremely vulnerable position.

Another point which we should consider in the manual irrigation of plants is that if a person becomes ill, we must either replace him or have someone else do his job. If we have someone else try to fill in for him, we are faced with the problem of people hurrying over their own watering to do other worker's jobs . . . thus again, we have a condition whereby the plants are receiving inadequate irrigation. In this day and age, when everyone wants a forty hour week (and recently I heard of a company in Orange County going on a thirty-five hour week) is less moisture uptake, and (3) rupture of the seed coat and mucilage production (stock seed) are reduced. The control of certain seed-borne pathogens has been very successful and this method warrants further use.

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- it becomes harder and harder for us to obtain labor that will work sixty, seventy or even eighty hours per week. When weather conditions dictate that we must water, we *must* have a reliable source of labor. We all know how hard it is to get people to work on Saturday, Sunday and holidays. However, I feel that when we are dependent on manual labor for irrigating one-gallon cans, this is a "must".

The next point is proper irrigation. Perhaps some of your people stay out all night, or they are having problems at home with the wife or girl friend . . . what happens? They come to work, and instead of concentrating on giving the plants proper irrigation, they are thinking only of their own problems. When this happens, a plant may get irrigated or it may not . . . we are at the mercy of the whims of labor . . . if they are happy, they may do a good job, but if they are not happy, we have real problems.

In our part of the country we may have a beautiful day with a temperature of about 70° F. and in two or three hours have an extremely windy condition, with a temperature of 100 to 110°F. We call this our "Santa Ana" winds. If we rely on manual labor to do our irrigation, it would be almost an impossibility to keep the plants irrigated properly. We would have to put everyone from the office and from the propagation areas in the field, give them hoses, and tell them to start watering! You can imagine the havoc this would create! It would probably be easier to take the loss from the wind than it would be to have inexperienced people irrigating the plants.

A plant, to be properly irrigated, should be irrigated when the soil reaches 50% moisture reservoir capacity. When a container such as a one-gallon can is filled with soil and is thoroughly saturated, and the excess moisture is allowed to drain away, we have a condition which we call field capacity, or that the soil has reached or is in a state of 100% moisture reservoir capacity. When this moisture reservoir capacity reaches 50%, this is when the plants should be irrigated. If the soil is irrigated before this 50% moisture reservoir capacity is reached, we will have a condition where there is lack of oxygen in the soil. This not only upsets our plants' growth, but it may also induce certain bacterial diseases which may ultimately kill our plants. In reverse, if we irrigate when the moisture reservoir capacity is extremely low, the plant may go into a wilting condition which it may never come out of, or permanent damage to the plant tissues may result. So, you see it is extremely important that the plants are irrigated at the proper time. Normally, the type of labor we are able to afford for this type of nursery work, are not adequately trained or qualified to make this type of decision.

In the irrigating of one-gallon container plants the discussion of cost always arises. We have made a fairly complete study of this factor, and have found that if we are paying our manual labor $1.35 per hour including benefits, and if they are working eight hours a day, they are able to irrigate 150,000 one-gallon containers per day at a cost of 2c per can per year. Normally, however, our one-gallon containers are spaced out, and this brings the cost up to as high as 8c per can per year for irrigation. I wish to bring up the fact that in this cost figure pumps. pressure tanks, and adequate piping system have not been figured in. This is because we must already have this equipment installed before we can be in the nursery business.

Next, I would like to discuss the cost of the manual sprinkler system. In my opinion, a manual sprinkler system is a basic sprinkler system in which a Rainbird sprinkler or some other type of sprinkler is connected to our water hydrants into an existing manual system. We must have a reliable person to turn our sprinklers on and off and he must have sufficient knowledge to understand proper irrigation practices. Of course, with this type of labor we must pay higher wages than we do the people we use for manual watering. In ammortizing the cost of our sprinkler system over a ten year period and figuring in our labor, we have arrived at a cost of ½c per one-gallon can per year. This is a tremendous drop in cost in comparison to our manual watering system. However, we still are at the mercy of labor. If they are doing a good job, our plants will receive proper irrigation, but if they do not show up for work or become ill, we still have a problem on our hands.

I would next like to discuss an automatic sprinkler system. By this term I am not referring to a sprinkler system that is operated by a time-clock and comes on at a predetermined time. In my opinion an automatic sprinkler system is one which is so set up that when 50% of our soil moisture reservoir capacity has been reached, the sprinklers will automatically turn on and will automatically turn off when the proper irrigation is completed. In this type of system we must have a tensiometer, time clocks, hydraulic valves, and numerous tubing and fittings. However, after this type of equipment has been properly installed and is ammortized over a ten year period we arrive at a cost of only 9/100 of a cent per one-gallon can per year.

Here you see a man turning on a manual sprinkler system. He must be extremely conscious of when the sprinkler was turned on, so that he will not over water or under water the plants, and, as I said previously, we must have an extremely conscientious person. (SLIDE) Here you see a man turning off our manual irrigation system and getting squirted in the face. It seems the sprinkler swung around just when he was least expecting it... what happens? He either must go home to change his clothes, or stay and be miserable the rest of the day... and chances are he will have a "cold" tomorrow so that he may not return to work for two or three days. These are just a few of the factors that can affect our manual sprinkler systems. When we get into a discussion of a fully automatic sprinkler system, we must have some type of instrument that will tell us when 50% of our soil moisture capacity has been reached. We therefore must use a tensiometer. A tensiometer is an instrument which has a porous tip, usually made of some type of porous ceramic material which allows water to flow in and out of it. This is connected to tubing which acts as a reservoir and connected to this tubing is a vacuum guage. When this instrument is inserted into the soil, water flows in or out of it according to our moisture in the soil, creating a vacuum which registers on the guage. If this instrument is placed in a saturated soil it reads zero, as there is no "pull" on the instrument. As the soil dries out through evaporation and through the root action of the plants, moisture flows out of the instrument, creating a vacuum and thus giving us a reading on the dial. Basically, you might say that this instrument acts the same way as plant's roots.

A tensiometer includes 9 porous tips, metal tubing which is connected to a vacuum guage, and glass tubing which acts as a reservoir for the instrument.

The actual instruments we are using at SELECT NURSERIES are in the root zone of the one-gallon container. A wire is connected from it to our time clock. A plastic cover over the dial on the instrument helps to keep the sun rays and excessive moisture out of the instrument.

We have numerous banks around our nursery, and the irrigation of these banks is also controlled by tensiometers. In our banks there are two tensiometers. One gives us a reading at six inches, while the other instrument gives us a reading at fourteen inches. Thus, when our banks need irrigation, it is done completely automatically. Our time clock is made by Rainbird Sprinkler Systems, and has numerous features which we find are a "must" for any type of automatic sprinkler system. This particular clock has eleven different stations which can be regulated from five minutes to one hour or more. When we irrigate, we like to do some leaching, and we found from laboratory information that the proper length of time to irrigate our one-gallon containers is 55 minutes. When the tensiometer in the field reaches 50% moisture soil capacity, the signal is relayed to this time-clock, which in turn works the hydraulic valve. The hydraulic valve is connected to a short piece of copper tubing which acts as a shock absorber. As the valve turns on, the initial surge and pressure would rupture plastic tubing if it were connected directly to the valve. However, with this short length of copper tubing, this problem does not exist. Plastic tubing in turn is connected to the copper tubing and is run completely back to our time clock. We designed our automatic system in such a way that if we ever need water in the field, we can turn a petcock on our hydraulic valves which would over-ride our tensiometers and time clock. The only time when we desire this feature is when our plants are initially canned. Our first irrigation is always done with manual labor, as we wish to give the plants a thorough soaking. However, after the initial manual irrigation, as long as the plants are in our nursery, they are never again manually irrigated.

All of our banks are automatically irrigated when 50% of the moisture capacity has been reached. Our pilot automatic watering system covers approximately 200,000 one-gallon containers and approximately 10,000 two-gallon containers. We have had this system in operation for over ten months, and have had no problems with it. So far as I know, this was the first commercial installation of a completely automatic sprinkler system in the world.

Here is a picture of some of the two-gallon cans which are automatically irrigated. Please take particular note of the extreme evenness of growth which I feel is due to the fact that the plants are receiving a very uniform amount of water, and that they are irrigated when they should be. We grow over two million one-gallon container plants per year at SELECT, and are currently making plans to convert all of our one-gallon irrigation systems over to this type of automatic sprinkler system. There is a wonderful feeling to be able to take off on a holiday or a weekend, knowing that when the plants need water, they will receive it, and at a cost far less than ever before, and at a rate of application that is even and proper for the plants.

FRIDAY AFTERNOON SESSION

FIELD TRIP TO UNIVERSITY OF CALIFORNIA AT DAVIS AND TO CALIFORNIA STATE FORESTRY NURSERY

The following projects were shown:

Selection of nematode resistant fruit tree rootstocks

— C. J. Hansen

Peach and other fruit tree rootstocks are being tested for resistance to two species of root knot nematodes, *Meloidogyna incognita* and *M. javanica*. The species of nematodes are kept in separate containers and the populations are built up by growing tomatoes for about 5 months. The seedlings or cuttings to be tested are then grown for about 5 months, after which time they are measured and the roots graded for number of galls. If galls are present, they are also examined to see if the nematodes are reproducing on the roots.

Germination of dormant peach seeds

— William Lipe, graduate student

Seeds of peach and many other temperate-zone deciduous plants are dormant when ripe and require stratification before they will germinate. Removal of seed coats of peach seeds and exposure to about 68°F. can result in the production of normal seedlings without stratification. This shortened treatment would be of value to the plant breeder by shortening the time, perhaps by a year, required to evaluate progeny.

Two factors appear to be involved in the dormancy of these peach seeds: (a) the inhibition of germination by the seed cover- and (b) physiological dwarfing controlled by germination temperature. How seed coats inhibit germination is being investigated. Possible chemical inhibitors are extracted, and an attempt is being made to identify such inhibitors and to determine what changes they undergo during stratification.

Root initiation on cuttings — Dr. K. Ryugo

Hartmann, Hansen and Griggs of the Pomology Department have found that while Old Home cuttings rooted easily when treated with indolebutyric acid, the percentage of Bartlett cuttings, similarly treated, was relatively much smaller. Mr. Fadl, an Egyptian graduate student, and Dr. Hartmann are assessing various factors which might be contributing towards the relative ease or difficulty of rooting of Old Home and Bartlett cuttings. Concurrently, Ryugo and Fadl have exchanged buds of Old Home and Bartlett to test their thesis that the buds of the former produced more or less inhibitors than the latter clone. Buds and leaves collected at different times of the season are being bio-assayed for growth inhibitors and accelerators to ascertain whether or not their balance can be correlated with the behavior of the stocks. Attempts will be made to relate these findings to the rest period of the buds.

Tissue culture — Dr. Dale Kester

Tissue cultures are small pieces of plant growing without roots or stems in artificial media containing minerals, sugar, vitamins and growth substances. This contains napthaleneacetic acid, kinetin, vitamin B1, choline and 1-cysteine. Cultures are started as small pieces of callus smaller thn a match head, which will grow to about the size of a nickel in six weeks. They are then cut up to start new cultures. Under such conditions, tissue can be kept alive indefinitely. This technique is being used to investigate noninfectious almond bud-failure, a serious, hereditary disorder in certain almond varieties. Studies are also being initiated to investigate differences between easy-to-root and hard-to-root almond, peach, and peach-almond hybrids and to study the incompatibility reaction in almond/plum graft combinations.

PRODUCTION OF VIRUS-FREE MATERIAL

DR. GEORGE NYLAND
University of California, Davis
DR. A. C. GOHEEN
U. S. Dept. of Agriculture

Obtaining and maintaining virus-free sources of our common varieties of fruit trees and grapes are cooperative endeavors by the University of California, United States Department of Agriculture, and the California Department of Agriculture.

Plant pathologists of the University and the United States Department of Agriculture obtain clean stocks by field selection and indexing and where necessary by heat treatment. The Foundation Plant Materials Service maintains the clean stocks in foundation plantings and makes them available to growers, and the California Department of Agriculture supervises registration and certification programs.

Standard host ranges are used to index grapes and stone fruit varieties. The 8 known viruses of grapes can be detected on 5 indicator varieties and some 20 or 25 stone fruit viruses can be detected on 8 indicator varieties. Visual inspection and selection also are important parts of the procedure.

Heat treatment can be used to free infected varieties of grapes and fruit trees of viruses. Plants in pots are placed in the heat treatment room and held at 100°F. With grapes new shoot tips are removed at desired times. Clean shoots can be obtained from fanleaf, yellow mosaic, and veinbanding vines after 28 days, and from leafroll vines after 56 days. With stone fruits, dormant buds are removed from the heated plants after treatment for 2-6 weeks depending on the virus involved. Four viruses of grape and more than 15 viruses of fruit trees have been inactivated in living plants by heat treatment. Recently we have also inactivated at least 1 virus in rose.

Virus-free vines and trees make superior planting stock and yield more fruit of better quality.

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MAINTENANCE AND DISTRIBUTION OF VIRUS-DISEASE FREE PROPAGATING MATERIALS

DR. CURTIS ALLEY
Foundation Plant Materials Service
University of California
Davis, California

The Foundation Plant Materials Service of the University of California maintains a Foundation Orchard and Vineyard of varieties that have been indexed and found to be virus-disease-free by Plant Pathologists of the University of California and the California Department of Agriculture. Propagation wood from these sources is distributed to nurseries and growers who are participating in this program, state agencies, foreign countries, and to growers and nurseries in general.

The screenhouse area is used to maintain the various stone fruit tree varieties in isolation. In addition, there is a small Foundation-orchard that was planted this spring in which will be grown two trees of each variety to serve as a source of bud-wood and graftwood.

Adjacent to the screenhouse are the liner beds in which registered Mahaleb and Mazzard seedlings are grown. The small liners are grown for distribution to nurseries as lining-out-stock; the orchard size liners are raised for growers. About 2 miles west of the isolation screenhouse, is the Foundation vineyard, in which the standard rootstocks, table, raisin and wine varieties are maintained. Material is distributed to nurseries and growers.

REGISTRATION AND CERTIFICATION

STANLEY MATHER
California State Department of Agriculture

Growers may use plant materials furnished by the University's Foundation Plant Materials Service for the propagation of nursery stock in accordance with regulations for registration and certification adopted by the State Department of Agriculture. These regulations are formulated when clean propagating sources are developed and when specific procedures are needed to maintain the virus cleanliness of the nursery stock and its identity. In the Department of Agriculture, methodology studies for the certification of nursery stock are carried on by the Bureau of Plant Pathology and procedures so developed are written into regulations which are administered by Nursery Service. The registration and certification programs are optional and self-supporting through fees collected to cover the Department's cost of indexing, testing, inspection, and supervision required by the regulations.

The development and operation of these programs exemplify the cooperation that exists in California between the workers of the University of California, the U. S. Department of

MAINTENANCE AND DISTRIBUTION OF VIRUS-DISEASE FREE PROPAGATING MATERIALS

DR. CURTIS ALLEY
Foundation Plant Materials Service
University of California
Davis, California

The Foundation Plant Materials Service of the University of California maintains a Foundation Orchard and Vineyard of varieties that have been indexed and found to be virus-disease-free by Plant Pathologists of the University of California and the California Department of Agriculture. Propagation wood from these sources is distributed to nurseries and growers who are participating in this program, state agencies, foreign countries, and to growers and nurseries in general.

The screenhouse area is used to maintain the various stone fruit tree varieties in isolation. In addition, there is a small Foundation-orchard that was planted this spring in which will be grown two trees of each variety to serve as a source of budwood and graftwood.

Adjacent to the screenhouse are the liner beds in which registered Mahaleb and Mazzard seedlings are grown. The small liners are grown for distribution to nurseries as lining-out-stock; the orchard size liners are raised for growers. About 2 miles west of the isolation screenhouse, is the Foundation vineyard, in which the standard rootstocks, table, raisin and wine varieties are maintained. Material is distributed to nurseries and growers.

REGISTRATION AND CERTIFICATION

STANLEY MATHER
California State Department of Agriculture

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Agriculture, and the State Department of Agriculture. This cooperative effort has resulted in the development of registration and certification programs for citrus, deciduous fruit trees, grapevine, and strawberry plant nursery stock.

There are now 120 nurserymen and growers participating in these programs. The term "California Certified" will identify to the agricultural industry nursery stock which is the best available from a pest cleanliness standpoint.

FRIDAY EVENING SESSION

Moderator: Dr. Dale Kester

PLANT PROPAGATION IN THE YEAR 2000

J. P. NITSCH
Laboratoire du Phytotron
Gif-sur-Yvette (S. et O.), France

Perhaps one does not often realize that the year 2000 is only thirty-six years ahead. It's not a very long time and, probably, that year will be no different than the year before and the year after. So we can look at the year 2000 as an ordinary year and can compare it with other ordinary years that have passed before. If we do this, we can look back in history and see what happened in the last thirty or forty years. We then observe that the discoveries which were made thirty or forty years ago are now being applied to the field of plant propagation.

Looking Back

For example yesterday, Dr. Snyder told you that plant growth hormones were discovered about thirty years ago. In fact, no one knew for sure what the substances were chemically until 1934, exactly 30 years ago, when Kogl, Haagen-Smit and Erxleben found that indoleacetic acid was active in plant growth. It was also in 1934 that Prof. Went found that they stimulate the rooting of pea stems. It was then shown very rapidly that, indeed, many auxins were very active in promoting the rooting of cuttings.

I can give you another example. Almost a hundred years ago Julius Sachs, a German plant physiologist, studied the nutrition of plants. He wanted to know what the soil furnishes the plant in order to make it grow. He tried to make solutions which would replace the soil. He and other workers, for example, Prof. Hoagland here in California, determined which chemical elements were essential for plant growth and which ones were unnecessary. The result of this work is that it is possible

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Perhaps I can remind you of another discovery that was made by botanists about thirty or forty years ago and which has now found application in the field of plant propagation. This is a work of Prof. Knudson of Cornell on the germination of orchid seed. Before that time it was very hard to grow orchids. One had to get slips from plants which had been collected in the wild during expeditions in Central America or Asia. To multiply them was very slow. It was especially difficult to germinate the seed which are very tiny. People had developed theories that, in order to germinate, these seeds needed a symbiotic fungus. One had to isolate this fungus and then inoculate it in the medium on which the seeds were to germinate. Knudson showed that this was not necessary. Seeds could be germinated in a test tube without any fungus on a completely synthetic medium, containing mineral salts and sugar. Once this fact was established it opened the door for the production of a large number of orchids and new hybrids.

Thus some of the techniques which are used today in the field of plant propagation on an industrial scale spring from the careful work of scientists which was done thirty to forty years ago.

Looking Ahead

The same source which has been the origin of the fields we are exploiting today will continue to produce new ones in the future. Thus, in order to have some idea of what possibilities will exist in the year two thousand one should look for the new things which plant physiologists are discovering at the present time.

Orchid Growing

I have mentioned the orchid field. In this connection I would like to say a few more words about orchids. First of all, even though it is now possible to germinate orchid seed rather easily, it is difficult to get uniform seedlings from seeds and it takes a long time—five to seven years between the time you sow the orchid seed and the time you see the first flower. It is also not easy to get very outstanding hybrids; growers say that, in the case of Cymbidiums, they may have to grow about a thousand seedlings in order to get two or three that are really outstanding. It would be very useful to be able to multiply these two or three oustanding plants very quickly and get rid of all the rest. Well, this has been rather difficult up to now because once you have such a plant, you can make one division every year or so, and get two or three plants every year. One doesn't build up a stock of excellent plants very quickly that way and, what is worse, during the course of this slow process, plants get infected with virus. This is the case, for example, with *Cymbidium Alexanderi* "Westonbirt", a choice variety which is completely infected.

In recent years pathologists and physiologists have developed means of getting rid of viruses. One of them is heat treatment. This can be tricky because one has to heat the plant enough to kill the virus but not too much, to avoid killing the plant. Thus, with certain species this technique is very difficult. Another means of getting rid of viruses in plants is to grow parts which are normally devoid of virus. Such a part is the apical meristem, the very tip of the shoot, which is enclosed in the small leaves and not larger than the head of a pin. One sterilizes the tip of the plant with something like "Chlorox" and then dissects carefully away all the young leaves to get to the growing point. The latter is excised under aseptic conditions using splinters of razor blades that have been welded onto a handle. It is planted in a test tube on a suitable medium like Knudson's number three medium. There the tip develops slowly and forms a rooted plant which is virus free. This technique is used for carnations, dahlias, etc. It can also be used for orchids. Dr. Morel, for example, has developed this technique and has been able to free many strains of orchid from virus. He also has been able to multiply these virus-free plants vegetatively. The growing point which has been regenerating in sterile culture to form a protocorm-like tissue can be cut into 4 pieces every month. If each piece is subcultured and again divided into four after a month, then the stock of choice plants can be raised to several millions per year in the form of protocorms which can then be grown to full-sized plants. This may take several years, but at least one is sure that, in the end, he will have several millions of top choice specimens.

The rooting of cuttings

Synthetic auxins enhance very much the production of roots on many cuttings. It has been found, however, that species which root poorly naturally also root poorly (although slightly better) with hormone treatments. This is because compounds other than auxins are involved in the induction of root promordia. At the present time research is directed towards the study of the chemicals which enhance the auxin effect and which are called "synergists".

At least three groups of auxin synergists are known at the present time. One of these includes reducing substances with SH groups, such as glutathione. Another group is made of terpenoids, like vitamin E, vitamin K, vitamin H and some of the unknown natural terpenoids which Dr. Hess is working on right now. The third and important group is composed of some of the phenolic substances which are so abundant in plants. Phenolics in plants may be either synergists or inhibitors of auxin action. We already know what the chemical configuration of the "phenol" has to be for a compound to be synergistic. We know that it is necessary to have *ortho*-diphenols like chlorogenic acid or caffeic acid, and not monophenols like *para*-coumaric acid which would be inhibitory. We know that flavonoids like quercetin are very good synergists, whereas other flavonoids like naringenin are inhibitory. We also know that most of the anthocyanins are very good synergists of auxin action. Synergists may be used more and more in the future in order to improve rooting mixtures. Actually natural synergists exist already in plants, and their level and their identity is regulated by the environment. For example under long days more flavonoids of one type can be produced than in short days. Work in progress at the present time is centered along the effect of the red and the far-red light on the production of endogenous synergists and, also, the effect of temperature and other factors on the production of synergists by the plant itself. You know that the environment is very important for success in the rooting of cuttings. The next slide will indicate this by showing a result which was obtained by Dr. Waxman at Cornell some years ago with the rooting of red dogwoods. What was found was that under long days (18 to 24 hrs.) there were more roots produced than under short days (9 hrs.). This was true both when the stock plants had been kept under long days before the cuttings were rooted and the cuttings themselves were exposed to long days. Such results show why certain planting dates are important for success in plant propagation.

Control of the environment

The environment has also an important role in the *growth* of the woody plant. The next slide shows two seedlings of *Weigela florida* of the same age. Probably you don't even see one of them because it is so small. They were sown on the same soil, given the same amount of sunlight (10 hours), yet one is about 2 feet tall after 2 months and the other less than ½ inch. The difference is not due to soil, nor photosynthesis nor temperature as these factors were the same for both plants. The only difference was that the large plant received an additional illumination of low intensity light (50 ft.c.) for 8 hrs. every day. The next slide shows that one can get similar results with seedlings of *Picea glauca* var. *albertiana;* on a fourteen-hour day growth quickly stops, but it keeps going on a twenty-four-hour day, so that one can get a Christmas tree much faster by giving extra light,provided that the temperature is high enough. All these effects are due to the fact that, under long days, the apical meristem produces leaf primordia which develop immediately into leaves. Under short days, on the contrary, they develop into scales instead, growth is arrested, and the plant becomes dormant. This knowledge is important not only if one wants to get quick growth, but also if one wants to prepare plants for winter. A plant which is growing actively is very tender and will freeze, whereas it will withstand cold weather if it has become dormant soon enough. Probably people will realize more and more the importance of having an adequate temperature and daylength control in their greenhouses. It may become a paying proposition, for example, to condition the stock plants in order to keep them in a state in which the cuttings will root easily. It may also become practical to induce dormancy in certain plants before shipping them. The next slide will show the Gif supergreenhouses. These are air-conditioned greenhouses with different day and night temperatures. In addition, they are equipped with metallic curtains which are rolled outside during the day and which automatically unfold at the proper time to cover the whole roof of each greenhouse compartment. At the same time, vertical partitions rise in order to close the sides, including doors. A completely light-tight box is thus produced. Genuine phytotrons also are developing in all parts of the world. In them one can even replace sunlight with artificial light. Under these conditions, one can grow all plant species at any time of the year. We have had spectacular results with very large sunflowers which flowered perfectly, even though they never saw any natural light, or with plants of South African deserts, such as *Stapelia flavirostris* which were grown from seed on our glass wool medium.

Bottom mist

Let us go back for a minute to the subject of rooting cuttings of woody plants. I would suggest that instead of having the overhead mist we change to bottom mist. The point which has always bothered me about overhead misting is that one gives a lot of water to the leaf. Now trees and shrubs are not aquatic plants. Their leaves like to grow in air, not in water. In fact, when too much water is given, it leaches nutrients out of the leaf. Actually what do we want? We want to prevent wilting of the leaves and also to provide a humid atmosphere at the basal end of the cutting for roots to develop. If we could make some sort of perforated rubber sheet or embed cuttings in a plastic foam so that mist could be applied from the under side, to the bottom inch or so of the cuttings, I think this would give better results with species which take a long time to root. We could even heat the mist to the right temperature as bottom heat is very important. Thirdly, one could also add nutrients to this bottom mist. All these features might constitute an improvement over the overhead misting technique which is in use at the present time.

The use of cytokinins

Also, in addition to the basal hormone dip which we use for cuttings, we might have, in the future, dips for the tops. In order to produce a good rooting system, cuttings generally need to have healthy leaves on them. Thus it is important to keep these leaves healthy and green. We know now that there are substances which are capable of keeping leaves healthy and green. The next slide will illustrate this. It is a slide which Prof. A. C. Leopold of Purdue University kindly sent me and which shows very dramatically the effect of one such substance in keeping leaves green. One leaf of this cutting of French bean was treated with a synthetic cytokinin called benzyadenine, the other leaf being left untreated. The cutting was put in water and left there for a week or so. At the end of that time, the treated leaf was still healthy and green while the other had turned yellow. It is possible that cytokinins will become useful in keeping green the leaves on cuttings and allow them, therefore, to function in the manufacturing of whatever substances are needed for root formation.

While I am on this subject, may I also mention the possibility of keeping flowers from wilting by the application of cytokinins. They might make flowers last longer, especially in heated apartments.

Tower greenhouses

In order to industrialize the production of potted plants rather drastic changes will have to be made in greenhouses. In this connection, the tower greenhouse which has been devised by the firm Ruthner (Obere Donaustrasse 49, Vienna 2, Austria) may be a forerunner of a type of greenhouse of the future. As you can see from the slides which have been kindly lent by the Ruthner Co., a glass or plastic tower stretches the available space vertically into a third dimension. In this tower, a chain goes up and down, up and down again, and on that chain the pots hang. Looking into the tower upward, one gets the extraordinary sight of all these pots hanging in the air. The result is that the plants get maximum illumination from the sun. The chain moves slowly with the pots, so that the latter go through the whole volume of the greenhouse. As they go down and pass through a certain zone, they can be watered automatically. Such a system produces very uniform plants and eliminates the effect of any pockets of dead air. It takes full advantage of the natural light, which is often limiting luring winter in Northern climates.

Flower-inducing compounds

Turning to other things which may develop later on into practical applications, I must mention the work which is being done now in various laboratories about flower-inducing compounds. It would be nice to grow plants in greenhouses to the desired size, then spray some hormone and get everything into bloom. Actually, this dream has become true at least in one instance, that of the pineapple. The next slide shows a field of pineapple plants in Hawaii. This row has not been treated. This one has been treated with naphthaleneacetic acid. Pineapples are short-day plants which initiate flowers during the fall and winter. The fruits develop during the following spring all at the same time. A large labor force is needed to harvest them, but there is not enough work to do for all these people during the rest of the year. By applying naphthaleneacetic acid and similar compounds, it is now possible to induce flowering in one field after the other and thus to spread the harvest over the entire year.

The next slide will show an interesting result obtained in my laboratory by Dr. Harada with some Japanese chrysanthemums. These, I should hasten to say, are *not* short-day chrysanthemums, but they require a cold treatment in order to flower. It was found that when these chrysanthemums are subjected to cold, a new growth substance appears in the growing point. This new growth substance has been extracted and used to treat other chrysanthemums of the same variety: it caused their flowering under non-inductive conditions. This substance turned out to belong physiologically to the class of gibberellins. In fact, a treatment with gibberellic acid gave the same effect. There are several gibberellins known, which are active in triggering off flowering in a good number of long-day and of cold-requiring species. Other compounds, such as the new dwarfing chemicals, may stimulate flowering in azaleas or holly. Thus Dr. Marth at Beltsville has reported that a drenching spray of "Phosfon" (1.5 gram per liter) applied to rooted holly cuttings in July produced flowers and a crop of berries the following year.

Seeds with long-lasting germinating capabilities

You know very well that seeds, some of them at least, lose their germinating capacity after a short time. On the other hand physiologists have been working on the factors which stimulate or inhibit germination. Thus it was found that one variety, "Grand Rapids", germinates readily at 57°F. but not at 85°F., if maintained in total darkness. What is worse, after having been kept moist for a day or two at 85°F. in the dark and dried again, such seeds do not germinate at 57°F. anymore. The heat treatment in the dark has induced a dormant condition. Now it would be wonderful if one could induce a long-lasting dormancy in seeds. One could then store them for twenty years, and they would still be as good as the first year. Incidentally, the trick to get Grand Rapids lettuce seeds to germinate after the 85°F. treatment is to give them a little light; they then germinate readily. Quite a few years ago when the Japanese were occupying Manchuria, they discovered in a lake which was drying up, seeds of *Nelumbo* (lotus) in a deep layer of earth. According to the geologists these seeds might have been a thousand years old, and yet they germinated perfectly. Therefore, longevity of seeds can be very long in certain species. In the soil many seeds keep their ability to germinate for a long time. When we will know all about the tricks a seed uses in order to stay viable and yet dormant, even though the soil becomes moist, then we will be able to devise powerful means of storing viable seeds for long periods of time.

Vegetative embryos

Talking about seeds, I would like to mention some exciting news in this field. In 1959 a German plant physiologist, Dr. Reinert, was growing in test tubes callus cultures derived from the root of a carrot. In the course of the experiment, he put these cultures on various media. He observed that some of the cultures behaved differently from the usual pattern and produced little carrot shoots with leaves. Investigating the matter further, he found that the culture mass was full of embryos. In the tissues were embedded what, under the microscope, looked exactly like carrot embryos with cotyledons, roots and buds. Yet there had been no flowers, no pollination. He tried to collect his notes and find out on what media these particular tissues had been grown, but apparently it was difficult to repeat the experiment and find exactly which factors had been responsible for the formation of the embryos. This year Halperin and Wetherell of the University of Connecticut published a paper showing that, in the case of the wild carrot, one could take any piece of the root, the stem, or even the petiole of a leaf and get embryos formed from it in tissue culture. The recipe is to grow the tissues first on a medium containing a strong auxin, such as 2-4-D, and a phytokinin, then to transfer them to a similar medium but without any auxin. The cultures produced hundreds of embryos. These embryos could be germinated, transplanted into soil and grown to maturity, forming normal carrot plants. Perhaps you don't fully realize the importance of this discovery but you will, if you think of animal instead of plant tissues, even human ones. It is possible, at the present time, to grow in the test tube pieces of human tissues, like pieces of skin and other parts. In fact, there are growing in several laboratories cultures of tissues from people who died years ago. Just think that these could now be stimulated to differentiate embryos, and you will have an idea of what has been achieved with carrots. For the plant propagator, this result could mean what I mentioned with the orchid at the beginning: these vegetative embryos are a means to produce plants exactly alike that from which they have been derived.

Bottled Flowers

In closing this presentation, which is not as much science fiction as it sounds, may I just mention a discovery which has been made at the Phytotron at Gif. It is the formation of flowers in test tubes and bottles, as shown in the next slide. If a piece of chicory root is planted in a test tube, under certain conditions which we are studying presently, it will produce a bud which gives rise to a flower. Such a production of flowers has also been obtained on pieces of tobacco stem grown in flasks on artificial nutrients. Other species will be grown in this way in the future, even roses perhaps. At that time then, one will be able, truly, to buy "Four Roses" in a bottle for Saturday night.

On this happy thought let me end my talk about the year 2000. Thank you very much.

DARA EMERY: What was the name of the cytokinin?

DR. NITSCH: The one I mentioned for keeping leaves green was benzyladenine. I think it is now produced commercially. You can get it from the Shell Company; ask Dr. J. Van Overbeek, Shell Agricultural Research Center, Modesto, California.

CHARLES LUGER: Would the cytokinin be of use right now in the spraying of cuttings?

DR. NITSCH: It is at your own risk, but you could try the chemicals now available, although better ones may be developed. A little word of warning: be sure to treat all the leaves that you want to keep on the cutting, because, if you treat only one leaf or two, these treated leaves not only will remain green, but will deplete the food from the other leaves, causing the untreated ones to become yellow faster.

CROCKER TEAGUE: I would like to know what concentration of gibberellic acid you use to produce flowering?

DR. NITSCH: Which flower are you referring to? Chrysanthemum? Well, actually 0.05 mg were applied to the growing point in a lanolin paste. You could obtain similar results with sprays containing about 100 milligrams per liter.

BREEDING NEW FRUITS AND NUT CROPS

DALE E. KESTER
University of California
Davis, California

The Department of Pomology in the California Agricultural Experiment Station has had an active program in fruit and nut breeding for many years. The various aspects of these breeding programs include:

a. Maintenance of collections of species, varieties and breeding materials although there is no attempt to maintain a complete collection.

b. Development and evalution of new varieties with emphasis on commercial orcharding.

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b. Development and evalution of new varieties with emphasis on commercial orcharding.

c. Study of genetics and inheritance of the fruit and nut species.

Most of the work involves seedling growing but some work is starting in induction of mutations. With the establishment of the radioactive cobalt source on the campus, more work is contemplated. However, there is some doubt as to whether potential usefulness of this method is as great as conventional methods. Probably it will be useful in particular types of plants or in achieving specific objectives.

My own work deals mostly with almond breeding and I would like to tell you something about our efforts relative to the production of hybrids between peach and almond. One of our objectives is to transfer self-fertility from peach to almond; another is to use the F1 hybrid for rootstocks. The F1 hybrid is uniform, vigorous, and involves possible useful characteristics, such as nematode resistance and resistance to lime-induced chlorosis, depending upon the particular combination of parents.

Methods of production have not been developed to commercial usefulness. Vegetative propagation is variable depending upon the individual clone. Tests have shown that the almond parent is literally impossible to root by soft or hardwood cuttings; the peach parent can be rooted by softwood cuttings under mist and to some extent by hardwood cuttings; but the hybrid offspring seedlings tested have shown a range of from poor to good rooting.

Seed propagation may be possible through controlled cross-pollination. To date it has not been achieved in high proportion through hand pollination in our tests.

The F2 hybrid population is very heterozygous and seedlings are extremely variable. These could not be used as rootstocks but might be useful for other purposes.

We have also produced more complicated hybrids mostly involving backcrosses to almond. Some individual clones of these are being considered for their ornamental value. Potentially valuable characteristics for which we have selected include double flowering, vigor, fruitlessness, and some degree of resistance to peach leaf curl.

(Slides were used to illustrate this material)

PRODUCTION AND PROPAGATION OF ROOTSTOCKS

CARL J. HANSEN
Professor of Pomology
University of California
Davis, California

I will limit my remarks to some of the vegetative methods of propagation that we are using for fruit tree rootstocks.

In the June, 1963 issue of the "Plant Propagator" Dr. H. T. Hartmann, Dr. W. H. Griggs and I published an article de-

c. Study of genetics and inheritance of the fruit and nut species.
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My own work deals mostly with almond breeding and I would like to tell you something about our efforts relative to the production of hybrids between peach and almond. One of our objectives is to transfer self-fertility from peach to almond; another is to use the F1 hybrid for rootstocks. The F1 hybrid is uniform, vigorous, and involves possible useful characteristics, such as nematode resistance and resistance to lime-induced chlorosis, depending upon the particular combination of parents.

Methods of production have not been developed to commercial usefulness. Vegetative propagation is variable depending upon the individual clone. Tests have shown that the almond parent is literally impossible to root by soft or hardwood cuttings; the peach parent can be rooted by softwood cuttings under mist and to some extent by hardwood cuttings; but the hybrid offspring seedlings tested have shown a range of from poor to good rooting.

Seed propagation may be possible through controlled cross-pollination. To date it has not been achieved in high proportion through hand pollination in our tests.

The F2 hybrid population is very heterozygous and seedlings are extremely variable. These could not be used as rootstocks but might be useful for other purposes.

We have also produced more complicated hybrids mostly involving backcrosses to almond. Some individual clones of these are being considered for their ornamental value. Potentially valuable characteristics for which we have selected include double flowering, vigor, fruitlessness, and some degree of resistance to peach leaf curl.

(Slides were used to illustrate this material)

PRODUCTION AND PROPAGATION OF ROOTSTOCKS

CARL J. HANSEN
Professor of Pomology
University of California
Davis, California

I will limit my remarks to some of the vegetative methods of propagation that we are using for fruit tree rootstocks.

In the June, 1963 issue of the "Plant Propagator" Dr. H. T. Hartmann, Dr. W. H. Griggs and I published an article describing methods of rooting Old Home and Bartlett pears for use in areas where pear decline is a problem.

The method for Old Home consisted of taking the cuttings in late October and treating them with IBA (100 ppm for 24 hrs. or 2000 ppm quick dip). Following treatment the cuttings were stored for about 3 weeks in moist peat moss at 70° F. and then planted in the nursery. About 72% of the cuttings rooted.

The Bartlett pear would not root satisfactorily by the method used for Old Home. It was necessary to take the Bartlett cuttings in late November and hold them upright in peat moss over bottom heat, but with the tops exposed to winter chilling conditions, for 3 weeks before planting. Best rooting was obtained with bottom heat of 75°F. and an IBA treatment of 150 ppm. About 47% of the cuttings rooted.

The method used for the Bartlett pear also showed good results in 1964 with some of the English apple rootstocks. Up to 63% rooting was obtained with some of the clones when IBA was used at the rate of 100 ppm. We will repeat the work next year.

We would like to propagate some of our root-knot nematode resistant peach and peach-almond rootstocks by means of hardwood cuttings but the methods we developed for pears do not work. In some cases, up to about 65% of the cuttings produced roots, but only from 2 to 13% survived in the nursery, (45 ppm 24 hour-soak and 4000 ppm IBA-quick dip).

This year we treated hardwood cuttings of 25 nematode resistant peach selections with IBA (4000 ppm quick dip) and IBA plus a dip in 50% Captan. The cuttings were planted directly in the nursery row. In all the 25 selections the IBA plus Captan gave better results than the IBA alone. The average survival was 22% for the IBA and 67% for the Captan and IBA. The cuttings were taken from young trees so the rooting was probably better than if they had been taken from old trees. However, the Captan apparently helped to make the cuttings grow, so we plan to try more of it at various concentrations.

All the species of fruit trees that I have mentioned can be propagated with the use of IBA and intermittent mist, but this method requires more labor and equipment than in the case of hardwood cuttings. However, I told you on your field trip to Davis that we find softwood cuttings very useful in our root-knot nematode resistant rootstock trials.

I am sure that we will continue to use seedlings for rootstock purposes in many cases, but more vegetative methods will be used in special cases as we perfect them.

WALNUT ROOTSTOCK

E. F. SERR, *Pomologist*
University of California, Davis California

The standard and generally used rootstock for commercial walnut orchards in California during the period from 1910 to 1950 was the Northern California Black Walnut, *Juglans hindsii*. Since 1950 there has been increasing interest in Paradox hybrids (mainly *J. hindsii* x *J. regia*) and a few plantings have been made on *J. regia* in districts where Blackline (delayed incompatibility) is an overridding problem in mature orchards.

The reasons for favoring Paradox over *J. hindsii* in some areas are usually: (1) greater vigor and faster growth especially in mountain districts and on poorer soils and in replant situations; (2) greater tolerance of root lesion nematodes (*Pratylenchus vulnus*) ; (3) greater tolerance of high lime content in soil, excess water, or very heavy soil texture; (4) resistance to crown rot (*Phytophthera cactorum*). There is considerable evidence indicating better average uptake of zinc, phosphorus and iron by the Paradox than *J. hindsii roots*. On the other hand, Paradox roots seem on the average somewhat more susceptible to attack by crown gall (*Bacterium tumefaciens*) and oak root fungus (*Armillaria mellea*), and are just as subject to Blackline development at the unions in mature trees as are *J. hindsii* rootstocks.

There is a need for clonal propagation of Paradox rootstocks because: (1) it is difficult to get enough first generation (F_1) Paradox hybrids to meet demands, due to yearly fluctuations in percentage of natural hybrids found in seedlings from *J. hindsii* trees which have been selected as seed trees because of the usually good percentage of hybrids found among their seedlings and because of their average good vigor; (2) there are known to be marked fluctuations between Paradox clones in vigor, root lesion nematode resistance, and timber value and some clones also seem probably resistant to oak root fungus. Some Paradox clones have been propagated vegetatively in U.C. nurseries at Davis during the past twelve years, mainly for use in test plantings.

Various methods of clonal propagation of Paradox walnuts have been tried. These are listed below with brief notes on methods, results, and time required.

Trench layerage — The desired rootstock clones are budded or grafted into nurse stocks and grown for one year in the nursery row. Resulting trees are planted almost horizontal, then whitewashed and staked down in the bottom of a trench about six inches deep. Soil is filled in gradually as shoots grow from the horizontal stems. There is great variation among clones regarding numbers of roots produced. Roots grow mainly from the parent stem and seldom from the upright shoots. This gives odd shaped root systems. Usually two years are required after planting grafted trees in a horizontal position before sufficient root develop to allow digging and cutting parent stem into sections, with roots and an upright shoot as close together as possible. These must normally be replanted and grown in the nursery row another year before planting in the orchard.

Halma-Frolich method (developed first for avocado rootstocks) — Clones are budded or grafted on nurse stocks growing in cans. They are cut back and placed in a warm dark chamber in late winter after chilling requirements are met. Etiolated shoots develop quickly. When these are 12 to 18 inches long the individual shoots are girdled near their base by removal of a ring of bark about one-eighth inch wide. This area is then wrapped with woolen yarn to prevent rapid regrowth of bark. A collar of roofing paper or wood extending well above the girdles is placed around the plant resting on top of the soil in the can and filled with a rooting medium such as vermiculite. The plants are then placed in the greenhouse and rooting medium kept moist. Shoots soon turn green and roots develop above the girdles. Individual rooted shoots can be cut off and planted in the nursery the following winter. Orchard plantable stocks are produced in two years after girdling etiolated shoots.

Piece root grafting — Plantable rootstocks with a good root system can be produced in one year if root pieces are available. Best results were obtained with root pieces nine inches or more in length on which scions of the same clone were whip-grafted. There was 50% survival with grafts made March 31, using roots and scions held in cold storage, and planted directly in the nursery, covered even with the tops of the scions.

Hardwood cuttings — We have had best results by starting in late December or January. Cuttings are given a 24 hour basal soak in 225 ppm IBA, then packed upright in lug boxes in damp peat moss with only the top third exposed. The boxes are placed over the bottom heat source which holds the temperature at about 75° F. at the base of the cuttings. The hot bed is in an open sided shed where normal winter temperatures hold the exposed buds dormant. After four weeks, all cuttings are examined individually at weekly intervals during the following four week period. Those which show actual roots beginning to develop (not just callus tissue) are potted in Aiken loam soil in peat pots. They are then placed in the greenhouse or over a heat source in the open shed with the temperature of the soil around the roots held preferably at about 65° F. They are transferred to the lathhouse for hardening in late April (if held in greenhouse previously) and planted out in the nursery row after danger of frost is ended and soil warms in early May. Plantable rootstock trees can be produced in one year by this method with most of the Paradox clones we have tried but some clones will not produce roots.

In some districts of California, especially in the vicinity of the San Francisco Bay, as well as in most of the walnut producing areas of Oregon and in France, delayed failure at the union (Blackline) has been a serious problem. It causes death of the tops of mature Persian walnut trees propagated on several common species of black walnut and Paradox and Royal hybrids. It can be avoided by using *Juglans regia* itself as the rootstock, but in California this species is subject to attack by oak root fungus (*Armillaria mellea*). In Oregon the prevalence of an apparently different so-called "fir strain" of this fungus, generally less injurious to walnuts, and possibly other factors, have made oak fungus, less important than Blackline in the main producing areas and use of Manregian, a variety of *J. regia* from Manchuria, as a seed parent for rootstocks is recommended. Efforts to root cuttings of this variety have been unsuccessful so far.

In California the so-called "oak strain" of *Armillaria mellea* predominates in most walnut districts and causes such serious losses to orchards on *J. regia* rootstocks that growers in most cases have continued to use the Blackline resistant *J. hindsii* or Paradox stocks. Neither of these stocks is entirely immune to *Armillaria* attack, but *J. hindsii* is highly resistant and Paradox seem variable. Tests of individual clones of Paradox are in progress.

Tests at Davis of effects of using weak growing clones of several species and hybrids of *Juglans* as interstocks between *J. regia* tops, and Paradox hybrid rootsocks have shown two of the clones of *J. nigra* and three of *J. ailantifolia cordiformis* to be decidedly dwarfing. Dwarfed trees produced several times as many flowers, both pistillate and staminate, as comparable normal trees of the similar age.

SATURDAY MORNING SESSION

October 17, 1964

FIELD TRIP TO OKI NURSERIES, INC., SACRAMENTO.
Group Leader — George C. Dobbins.

IBM: INVENTORY AND ACCOUNTING

LOWELL E. SHERMAN
Oki Nursery, Inc.
Sacramento, California

Oki Nursery, in the fall of 1963, was approached by IBM concerning the possible installation of data processing equipment. After many hours of consultation and research into the operation of our wholesale nursery business, IBM determined that an installation would be economically realistic. The actual installation of IBM equipment was made in late December 1963 with a date of January 10, 1964 set as the target date to be operational.

IBM designs and builds each system to the needs of each customers. For this reason, installation can be painful until the 'bugs' are worked out of a system. We did suffer such a period and did not become fully operational until February 10, 1964.

As part of the research prior to the installation, it was determined that one of the areas of information most lacking in the nursery industry was sales analysis. It is from sales analysis that you are able to program production from propagation to finished product. With this in mind, the accumulation of information for sales analysis became an important by-product of our projected operation. As it has turned out, most of our hopes and expectations for our system have been realized, although more time has been needed to make conversions than we had anticipated.

This gives you some history of our system and the fundamental reason why we converted to IBM. In this afternoon's presentation by Mr. John Parr of IBM, you will hear of our future hopes and expectations for automating accounting and inventory procedures. From here on, I will only be concerned with what we have done and are doing, with data processing with regards to accounting and inventory.

Before proceeding to specific jobs and how we are doing them, let me explain that data processing uses as an entry method into the system, an IBM card. This card with its numerous, small, retangular punched holes, is familiar to most of you. These cards are a basis for all transactions recorded by the machine and actually become history of what transpired. Each hole in the card represents either an alphabetic or numeric character. To process these cards, we have installed three pieces of equipment:

1. #403 Accounting Machine — This is the brains and the heart of the operation, doing all of the actual accounting and calculation.
2. #82 Card Sorter — This piece of equipment allows us to sort the IBM cards into any numerical or alphabetical sequence.
3. #526 Printing Summary Card Punch — This machine is our entry to the system by punching the holes in the cards. It is also hooked up to the #403 to automatically punch summary cards.

In establishing our system, it was essential to set up two sets of files from which to work.

1. Name and Address File — Each account was assigned a number and a set of cards punched with information concerning that account.
2. Item File — Each item in our inventory was assigned a number and a stack of cards punched with this information.

We are presently performing the following operations on our equipment:

1. Order Writing — A hand written order is received from our salesmen on our IBM numerical order sheet and a deck of IBM cards is pulled from the file to correspond with this order. From these cards, the #403 writes an order copy.
2. Label Writing — A rerun of these same cards produces labels which we use in our fields to assemble orders.
3. Invoice Writing — After delivery of the order, another rerun of the same deck of cards produces a completed and fully extended invoice. Also produced is a summary punched, accounts receivable card.
4. Accounts Receivable Accounting — An accumulation of the accounts receivable summary punched cards is made, and these as a group, make up our accounts receivable. As payments are made, cards are removed from this file and only outstanding items are kept in this file.
5. Inventory Updating — By processing the item cards after they've been used for invoicing, we are able to keep an up to date inventory of what we have in stock.
6. Sales Analysis — By again processing the item cards we are able to break down our sales in any manner we wish; by salesmen, by area, by tape of account, by item, by location or any other conceivable way.

All of these jobs mentioned are inter-related and are a result of sales. They are all dependent on the individual item card. Presently, we are performing all of these jobs with the exception of inventory updating. We currently are setting up files for this operation and should be in full operation with this by October 30. One side light of this is that we've just completed a fiscal inventory and used the #403 to do the calculating involved. I estimate that we have saved 40 to 50 hours of labor in doing our inventory in this manner.

In the planning stage for November, is a conversion of payroll to the machine. When this is done, we will not only be able to do payroll much faster and more accurately, but we will have a good set of labor costs. Also in the planning stage, but some months away, is machine-operated accounts payable.

What are our conclusions regarding IBM data processing for the nursery industry?

1. We are no different than other industries — we have a product to produce and sell, and our accounting and related chores can be done with data-processing.
2. Our present size of operation is such that we feel we are approximately breaking even, cost wise, comparing manual operation to data processing. The advantage is that we have ample room for expansion without increasing our machine or labor costs. Further growth of our company will be the payoff.
3. The accuracy of the equipment is 100%. There is no error. This has made each of us at Oki Nursery increase our own accuracy and efficiency.

We at Oki have found the last year most challenging and interesting in making this conversion to IBM. It has made us change our thinking and to come up with new concepts of operation. In doing so, we are proud that we are the first nursery to entirely convert to IBM data-processing.

PROPAGATION PROCEDURES USED BY OKI NURSERY PROPAGATION DEPARTMENT

EDWIN S. KUBO
Oki Nursery, Inc.
Sacramento, California

Collection of Cuttings

1. Use sharp shears
2. Use clean polythylene sheets to collect cutting material.
3. Protect the cutting wood against direct sunlight when working in the open.
4. Take cutting wood to propagation shed as often as necessary to prevent desiccation.

Cutting Procedures

1. Wash cutting wood on rack as soon as it is brought in from the field.
2. Keep cutting wood moist with mist until time of use.
3. Use sharp shears or knife to make the cuttings.
4. Length of cuttings are 3 - 4 inches long.
5. Dip finished cuttings for 10 minutes with Morton's Soil Drench C at the rate of 1 tsp. per 5 gallons of water.

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6. Cuttings are placed in a wire bottom box after treated and drained.
7. Cuttings are treated with Hormodin powder 1, 2, 3, or the quick dip method using I.B.A. crystal with 50% alcohol.
8. Sterilized rooting medium is used for sticking cuttings.
9. Types of rooting media:
   a. Perlite 100%
   b. Perlite 75%
      Peat Moss 25%
   c. Propagation grade sand 100%
10. All tools are disinfected *twice* daily with 1 quart of 37% commercial formaldehyde diluted with 5 gallons of water.
11. Cutting benches and floors are also washed with the formaldehyde solution.
12. Rubber gloves are worn whenever any chemical is handled.

Liner Planting Procedure

1. The rooted cuttings or seedlings must be well hardened off before planting in pots.
2. Rooted cuttings are washed with Morton's Soil Drench C solution after they are lifted from the flats.
3. Soil must be sterilized before using.
4. Soil moisture content must be checked before rooted cuttings or seedlings are planted in the pots.
5. Irrigation interval is determined greatly by temperature and humidity.
6. All tools are sterilized wtih formaldehyde solution — 1 quart to 5 gallons of water.
7. Benches where liners are placed must be washed and sprayed with one part 8% copper naphthenate with five parts of paint thinner solution after each crop.

SOILS AND STERILIZATION:
Mixing, Sterilization Methods

JAMES TAKEHARA
Oki Nursery, Inc.
Sacramento, California

1. Initially Oki Nursery was predominantly a bare root and B & B grower with a few acres of container grown stock. The requirements, at that time, for soil of container grown stock was met under the following conditions:
   A. Equipment: Stationary five yard cement mixer and scoop loader tractor.
   B. Sterilization: Methyl Bromide.
   C. Type of soil: U.C. Mix.
2. When Oki Nursery underwent the transition to complete container growing, 50 acres of containers necessitated a greater volume of soil under the U.C. Mix specifications.

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A. The U.C. Soil specifications are the following:
   1. Soil must be uniform.
   2. Soil must be free of weeds and disease.
   3. Soil must be light and pliable.
   4. Soil's basic ingredients must be economically and readily obtainable.
   5. Soil must be free from salinity.
   6. Soil must be usable soon after mixing.

B. Sterilizing methods used by the Oki Nursery to fulfill the above specifications are as follows:
   1. Weed control — methyl bromide for rice hull.
   2. Composting — natural heating within the soil mass.
   3. Steam — liner mix and propagation media.

3. Factors of the mixing method utilized by Oki Nursery are as follows:
   A. *Ingredients*: 50 cubic yards of redwood sawdust treated with nitrogen, 43 cubic yards of rice hull, and 48 cubic yards of washed sand with recommended amount of fertilizers.
   B. *Machinery*: Scoop loading tractors, rotary mixer and screener, and 180° side-to-side swinging conveyor.
   C. *Personnel*: One reliable operator.

4. The preparation of the Liner Mix using U.C. System:
   A. *Ingredients*: $\frac{1}{3}$ cubic yard fine sand, $\frac{1}{3}$ cubic yard fine fir bark, $\frac{1}{3}$ cubic yard ground sphagnum peat moss and recommended amounts of fertilizers.
   B. *Sterilization*: Steam under canvas cover at 140° F. for 30 minutes. Steam is fast, retains beneficial bacteria, and is a by-product of steam energy.

SPECIALIZED EQUIPMENT: CANNING, MATERIAL HANDLING SYSTEMS

DICK OKI
Oki Nursery, Inc.
Sacramento, California

Most of us build or purchase machinery for easier and quicker handling, and for labor saving. We all make mistakes in purchasing special equipment because of the expense involved. A less expensive model will usually be made with cheaper parts.

We here at our nursery, in evaluating equipment, consider life time, labor saved, and taxes. It's a shame our industry isn't large enough for machine manufacturers to build specialized equipment. Most all of our equipment is built here in our shops. All parts we use are new and are readily available at any dealer.

First, I'd like everyone to observe the two-row Pneumatic Canning Machine. At this rate of speed, this crew will plant over 17,000 cans in an eight hour day. Except for the hoppers and pot dies, the parts for this whole machine may be obtained

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This truck was built in our shop. It has a Chevy II, four cyclinder motor with an automatic transmission, Ford front end, and a Jeep rear end.

This spray rig has a Bean pump, a Clark Fork lift, for different heights, and a Bean blower. All the action is controlled from the drivers seat.

We have found air cleaners to be an important factor in the maintenance costs of our gas engines. We have installed paper air filters in most all of our equipment. We also are in the process of changing all of our oil filters to toilet paper filters..

When over hauling the gas engines in our yard equipment, we install cheap cast iron rings.

For those who are planning on building equipment, make sure the parts are available at your local source of supply. Don't use war surplus parts because it's going to cost money when it's time to replace them — machinery won't last forever.

B-I-F FERTILIZER METERING SYSTEM

George Oki
Oki Nursery, Inc.
Sacramento, California

Since Oki Nursery's fertility program is based on the constant feed system, a more dependable fertilizer metering system was needed. The source of water being from a well we have faced a constant problem of sand in our water raising havoc with the positive metering system as used by many injector pumps.

We at Oki Nursery under the advise and counsel of Mr. Fred Petersen of Soil and Plant Laboratories have installed the BIF metering system. This apparatus is a commonly used technical equipment used by many water districts throughout the country to chlorinate drinking water. All component units were of a stock shelf item and only fertilizer was used instead of the chlorinating reagent.

These are the 3 basic pieces of equipment necessary.

a. The transmitter which responds to a differential pressure created by a primary flow element of the "DALL" flow tube and donverts the pressure differential into time impluses proportionate to flow accuracy is $\pm$ 0.1% of maximum flow.
b. The Dall flow tube is a differential producing primary flow metering element to accurately measure water flow.
c. The 1210-05 Duplex Chem-O-Feeder is a duplex head chemical proportioning diaphragm pump of the positive displacement type. It is equipped with a positive dial stroke adjustment on each head and the repeatability of setting is assured by micrometer screw adjustments.

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b. The Dall flow tube is a differential producing primary flow metering element to accurately measure water flow.

c. The 1210-05 Duplex Chem-O-Feeder is a duplex head chemical proportioning diaphragm pump of the positive displacement type. It is equipped with a positive dial stroke adjustment on each head and the repeatability of setting is assured by micrometer screw adjustments.

The advantage of this BIF System are many fold.

1. Ease of operation.
2. Accuracy ± 0.1% of water flow.
3. Versatile, i.e. one head may be used to meter nitrogen, the other potash or otherwise with different proportioning ratio.
4. A second pump may be added to the transmitter to meter for water correction, i.e. sulfuric acid.
5. Minimum maintenance.
6. Installation ease. With the technical staff of BIF only a pipe filter is needed.
7. Cost. The entire installation of the unit is $1500.00 plus piping costs, approximately $100.00.

Since the installation of this equipment we have had more accuracy in the application of either nitrogen or potash since each suction tube of the Chem-O-Feeder is placed directly into a solution of 20-0-0 or potash as delivered from the manufacturer and the dosage is adjusted by the micrometer screw settings. This then eliminates the inaccuracy of mixing various fertility strengths as before. This particular method of fertilizer metering is another endeavor to grow better plants more economically for the ever increasing consumer.

MECHANIZED IRRIGATION FOR NURSERIES

LARRY J. BOOHER, *Extension Irrigationist*
N. W. STICE, *Farm Advisor*
University of California

The production of large numbers of plants in containers has created a problem on how to irrigate and fertilize to assure uninterrupted growth. Plants growing in gallon cans are now irrigated by overhead sprinkler systems, and proportioners are available to inject fertilizers into the irrigation line. Trees growing in 5 and 15 gallon containers are being watered by hand, which is too slow and costly.

The Oki Nursery of Sacramento decided to build a system to irrigate 15 gallon containers and asked for assistance in designing it. They wanted the system to irrigate 12,000 containers from a pump delivering 200 g.p.m. containers to be spaced on 4 foot centers.

The first step was to determine the amount of water needed and the rate of application to uniformly wet the soil mix in the container. Plastic tubing with 1/16 and ⅛ inch inside diameter was tried, but at low pressure the rate of application was too slow. There was no spreading in the coarse soil mix, so the water traveled down from the point of injection and ran out the bottom leaving more than 50% of the soil mix dry. In trials with ⅜ and ½ inch plastic tubing, it was found that a flow of at least 1¼ gallons per minute at low pressure to prevent wash-

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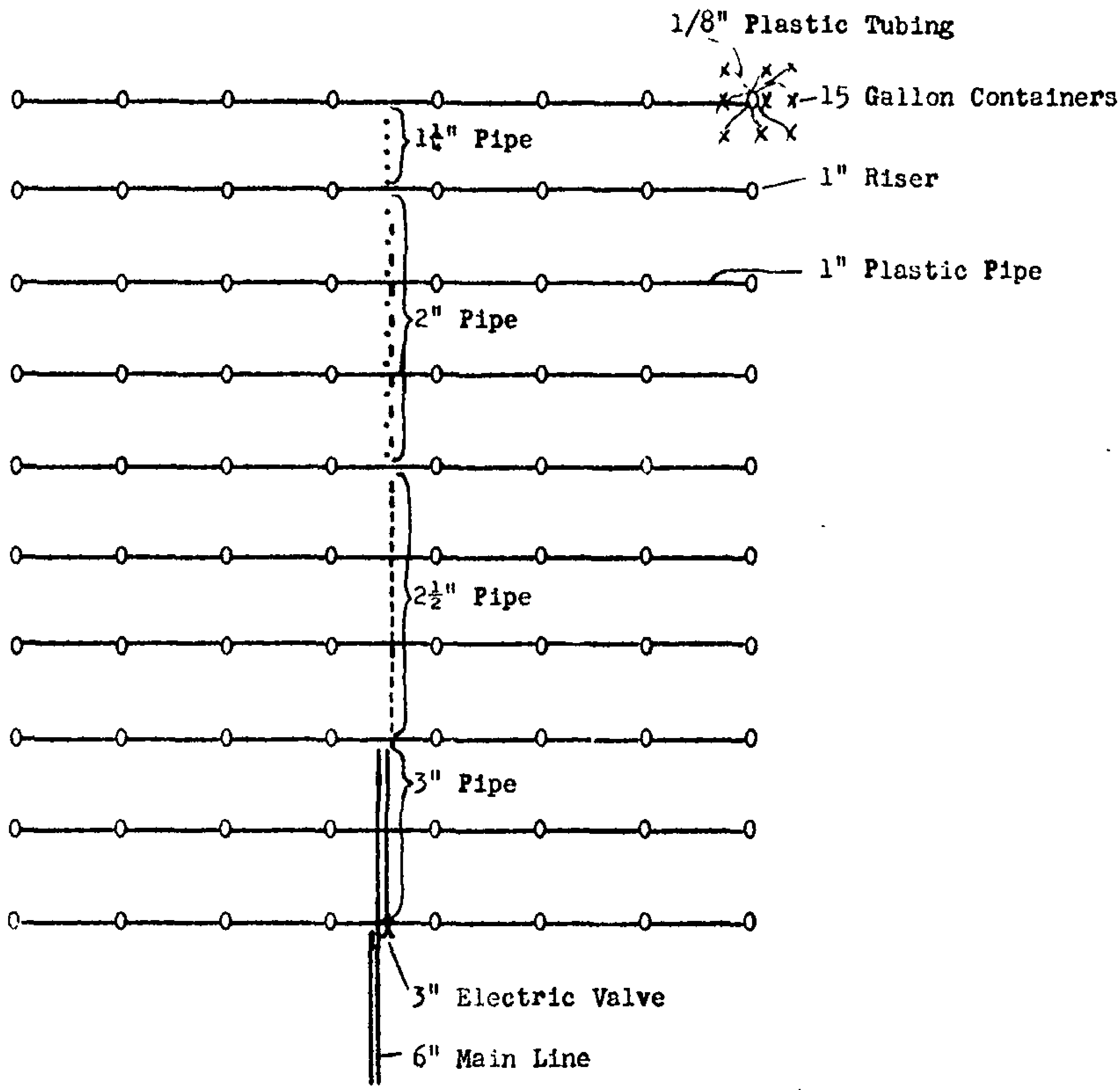
The first design was based on ¾″ galvanized iron pipe risers with four ⅜″ plastic tubes of the same length and without any spreading device at the ends to serve four containers. The 200 g.p.m. would irrigate 160 containers from one valve, and at 1¼ g.p.m. for each tube, it would take four minutes to irrigate them. Before the system could be tested, George Oki, found the Gates Type plastic nozzles were available at low cost and would fit into ¼ inch plastic tubing. They were available with 90° or 180° flat fan spray. Nozzle capacities or flow rates were checked at different pressures and the 90° and 180° were the same.

10 lbs. pressure	0.2 g.p.m.
20 ″ ″	0.36 g.p.m.
30 ″ ″	0.48 g.p.m.
40 ″ ″	0.78 g.p.m.

Both nozzles appeared to be perform best at about 20 lbs. pressure.



A manifold containing nine plastic tubes was then made up by Jim Takehara. The manifold was connected to a hose and 90° and 180° nozzles were inserted in the end of the tubes. These were attached to the sides of containers and tried out at various pressure. The 90° nozzles appeared better than the 180° with less water striking the inside wall of the container.

A system was then installed in an area 96′ X 228′ that would accomodate 1368 containers placed on 4′ centers. Two 3″ electric valves controlled the water supply from a 6″ transit main. All pipe below the valves was rigid plastic graduated down from 3″ - 2½″ - 2″ - 1¼″ - 1″. See attached diagram for pipe details. The risers were 1″ plastic pipe, extending above ground 2′. The 1″ plastic caps were drilled to take nine ⅛ inch plastic tubes 6′ long, all with 90 plastic nozzles at the end. The end of the ⅛ inch tubles containing the nozzles were held in place by drilling a slanting hole through a 1″ X 1″ stake driven into the ground at the outside edge of the containers. (See

OKI NURSERY IRRIGATION SYSTEM
15 GALLON CONTAINERS ON 4′ CENTERS

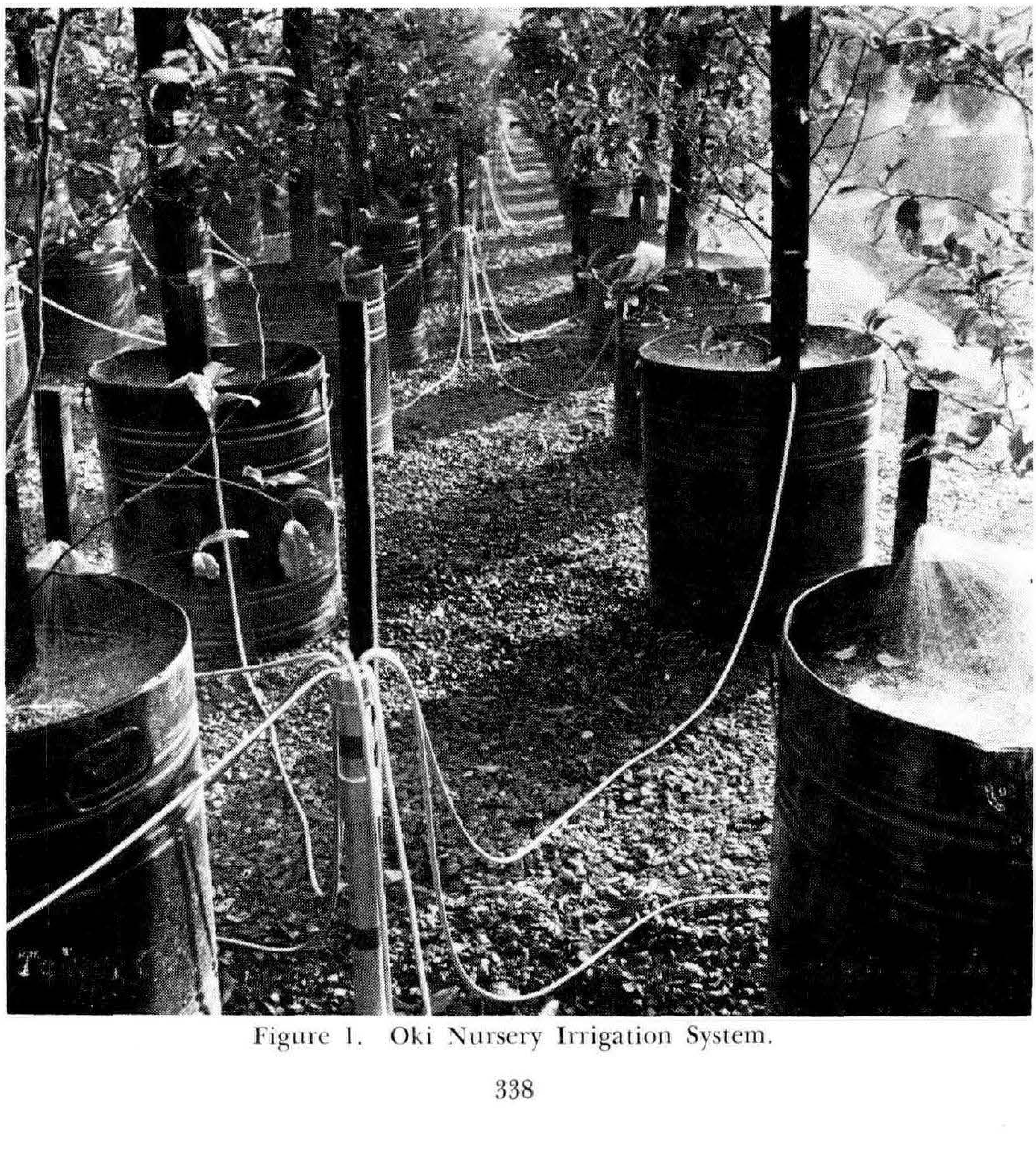


Figure 1. Oki Nursery Irrigation System.

photo). The entire area was graded to drain to the center with a small ditch to a natural drain. It was covered with crushed rock and the containers and plants were then set in place.

The system was then operated until water ran out from the bottom of the containers. After several trials, it appeared that five minutes were sufficient. The nozzles put out .4 inch per hour, so each container received two gallons of water per irrigation. One valve served 648 containers and the other, 720 containers. If each valve is operated for five minutes, a total of 1368 containers can be irrigated in 10 minutes.

Sand traps or filters should be installed to prevent nozzle stoppage. The adhesive used to cement the nine 1/8 inch tubes into the 1″ plastic cap may plug the tubes. Be sure they are open before trying.

SATURDAY AFTERNOON SESSION

MODERATOR: George C. Dobbins

PRODUCTION AND RECORDS

EDWIN S. KUBO
Oki Nursery, Inc.
Sacramento, California

In the 1962 Twelfth Annual Meeting of the International Plant Propagators' Society — Eastern Region, Mr. George Oki spoke on, "Systems and Mechanization in a Container Nursery." Also he briefly mentioned Oki Nursery's record keeping system. Since then, we have had many inquiries from nurserymen from different states about our production record keeping system.

One of the questions asked by nurserymen is as follows: What form does Oki Nursery use to anticipate varieties to grow? We at Oki Nursery use the *Annual Production Schedule.* In this form we have information such as:

1. Variety
2. Method of Propagation
3. Approximate per cent of rooting or germination
4. Approximate amount to cut or seed
5. Best month to cut or plant seeds
6. Alternate month to cut or plant seeds

Another common question asked is how do we determine when to make the cuttings, plant the liners, and plant the galphoto). The entire area was graded to drain to the center with a small ditch to a natural drain. It was covered with crushed rock and the containers and plants were then set in place.

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Another common question asked is how do we determine when to make the cuttings, plant the liners, and plant the gallons? We use our *Crop Projection Sheet* in which for each variety the sales date and quantity needed is first determined; then we work back to determine the liner planting date and the cutting or seeding date.

Some of the other forms used in the production department are as follows:

Cutting Schedule List

The cutting schedule list is used by the propagator as a reminder and a check list as to what season or month the cutting should be taken. Information on this sheet is as follows:

1. Season or month
2. Variety
3. Amount needed
4. Approximate amount to cut
5. Total amount cut

Seeding Schedule List

This form is used as a reminder and a check list to proper timing of seed planting. The time of seed planting is normally determined by the harvesting date of the seed. As a general rule, best germination of seeds is obtained by planting fresh harvested seeds. Items included are:

1. Variety
2. Scheduled sowing months
3. Number of flats to sow
4. Treatments

Propagation by Cuttings

This form is used to record daily activities of our cutting department as to date, what varieties were cut and also quantities that were processed.

Individual Variety Record for Cuttings

This form is used to keep the history of each plant variety. Information gathered on this form is as follows:

1. Botanical Name
2. Cuttings
   Date
   Amount
   Location
3. Liners
   Date
   Amount
   Location
4. Canning
   Date
   Amount
   Location
5. Source of Wood
6. Treatment of Cuttings

7. Growth Regulator
8. Type of media used
9. Percentage rooted
10. Per cent take
11. Miscellaneous remarks

Individual Variety Record for Seeds

The form used for seeds is almost identical to the form used for cuttings.

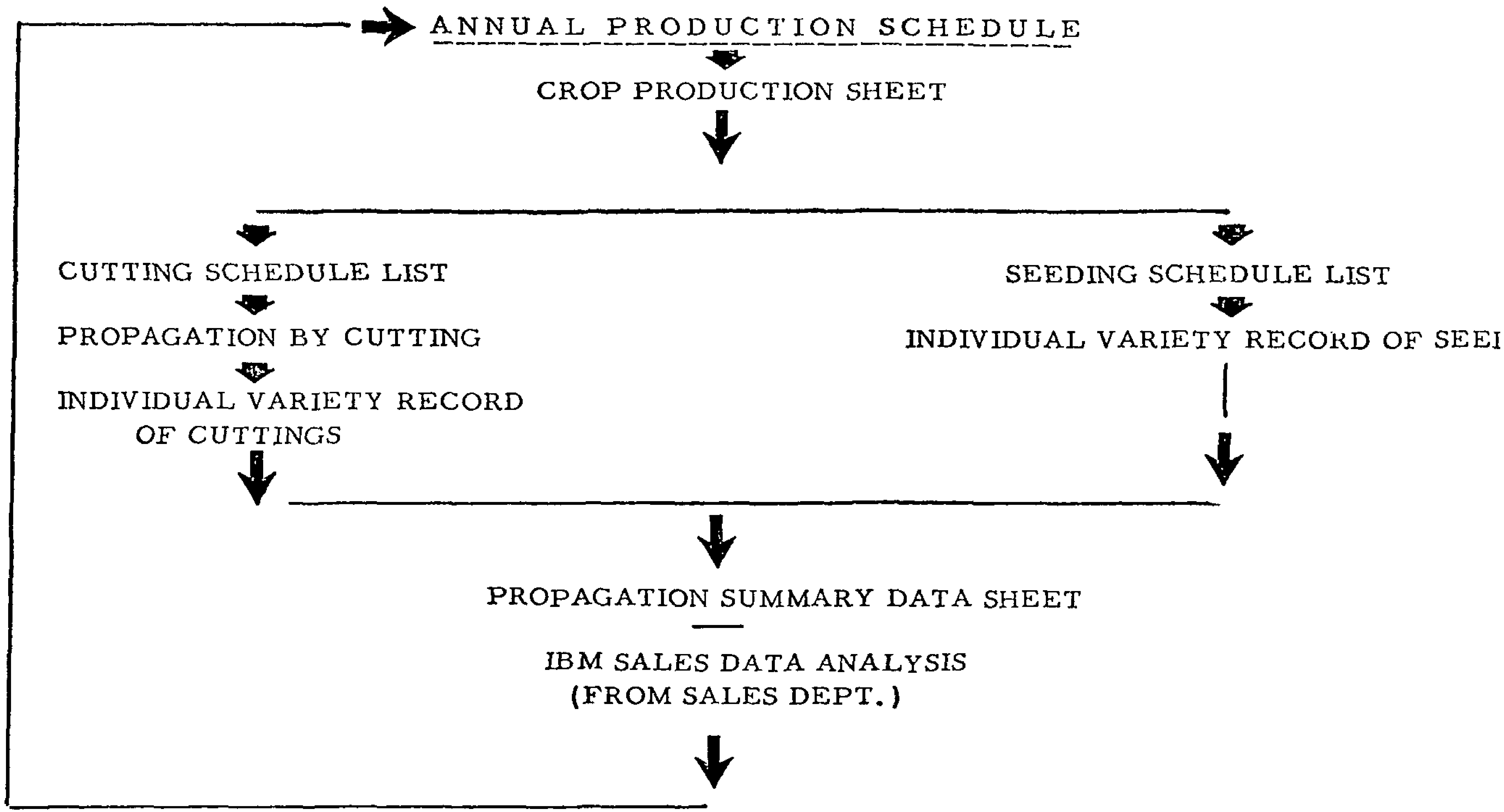
At the end of each season all the individual variety records are reviewed and analyzed as to variety, rooting or germination cycle, rooting or germination per cent, growth regulator or seed treatment, media used, misting or no misting, and miscellaneous remarks.

This information is compared with previous years' performance of each variety and at this time the best known method is determined and used for the following season's Annual Production Schedule.

Our IBM accounting department plays an important role in providing our production department with information such as customer, time of sale, variety, size and quantity. This comes under the heading of *Sales Analysis Data.*

We at Oki Nursery have found that the only logical way to improve our efficency and reduce our cost of production is to keep *comprehensive written records.*

SUMMARY


ANNUAL PRODUCTION SCHEDULE
CROP PRODUCTION SHEET
CUTTING SCHEDULE LIST
PROPAGATION BY CUTTING
INDIVIDUAL VARIETY RECORD OF CUTTINGS
SEEDING SCHEDULE LIST
INDIVIDUAL VARIETY RECORD OF SEEI
PROPAGATION SUMMARY DATA SHEET
IBM SALES DATA ANALYSIS
(FROM SALES DEPT.)

IBM DATA PROCESSING AND THE NURSERY INDUSTRY

JOHN S. PARR
I B M
Sacramento, California

In today's expanding and competitive market place, one of the most significant goals towards which nurserymen are working is optimum production with lowest costs and best inventory levels to meet customer demand. For over a year we have worked closely with Oki Nursery to implement an IBM Data Processing system which is a step toward this important objective.

As Mr. Kubo has told you, he maintains production records on all crops grown at Oki Nursery and during the last year we have been gathering sales data as a result of doing the basic accounting jobs of order writing and invoicing. This first venture into data processing is an important one, for while it is economically performing the routine accounting functions of order writing, invoicing, accounts receivable, accounts payable, it also enables a nursery to gather sales data which can later be used with production records to forecast sales and project production requirements.

The modularity of IBM data processing systems is important here. Oki Nursery entered punched card data processing at a economical level and has been able to meet increased volumes of business without complete modifications of their existing procedures and as we move towards more sophisticated work, the experience which we have had in working with this first system will enable us to move smoothly into a more powerful data processing system.

As I mentioned earlier, that one of the most important goals of the nursery industry today is to obtain optimum production with lowest cost and best inventory levels to meet customer demand. One of the ways in which this is done is through a technique known as linear programming. It is a management science approach to analyzing variable factors in a business. In the nursery business this linear programming technique could be used to forecast sales and at the same time correlate data from prior production records.

Many variables are involved here and in order to properly project the amount of planting required to meet a specific sales objective, it would depend upon many factors, such as mortality rate, climatic conditions, fertilization techniques, soils, and expected growth period. The main objective, of course, is to produce as much as is required to meet the specific sales objective based on all these variable factors and to produce these requirements at the lowest possible cost while maintaining quality.

An example of a system similar to this in use at the present time is Yoder Bros. operating in Ohio, California and Florida. They use an IBM 1401 tape-oriented computer to schedule production of chrysanthemums. In addition, entire farms are under computer control in terms of crop projection.

Inventory problems are being solved every day by non-nursery industries through the use of a program called IMPACT, which is an inventory simulator. All of this experience can be brought to bear by IBM in assisting nurserymen who are interested in data processing as a technique to aid in realizing optimum production control. Because of the power of a computer data processing system, this kind of work could be accomplished while the computer would also be used to take care of all the accounting functions such as order writing, billing, accounts receivable, payroll, accounts payable, and the general ledger.

If we let our imagination be our only limitation, many other applications for this powerful tool are available. Through a technique which IBM calls, Teleprocessing, many locations could have on-line inquiry ability to the central computer system so that via telephone and keyboard inquiry one location could request inventory information, sales data, accounts receivable information, and receive, in seconds, a reply to their inquiry.

We appreciate the opportunity to speak to you today and certainly don't intend to turn this into a sales pitch by any means, but perhaps I can answer some of the questions which may have arisen in your mind as to the kind of support which IBM can lend to its customers in implementing a data processing system. In most major cities, as in Sacramento, IBM maintains a branch office and a staff of sales representatives and systems engineers. These people are all available for guidance and assistance in planning and implementing a data processing system. In addition, the branch offices also act as education centers where your own people can be trained to operate and to program data processing systems. We also maintain regional and district educational centers and an educational program unsurpassed in the data processing industry with classes geared to all levels of customer personnel beginning at the operator level and going all the way up to executive courses geared to presidents and managers of companies.

Technicians in our business known as customer engineers are also housed in a branch office to perform preventative maintenance on the equipment and to answer calls which may arise because of emergency situations. During the past year over 80% of all such emergency calls have been answered in one hour or less. Our objective here is to give each customer the best possible service and the most productive use of his data processing system. All of these services are apart of the package that a customer buys when he leases IBM equipment or purchases it.

Some of you may have further questions and I will be more than happy to speak with you individually following the meeting today. It has been a very interesting and exciting experience to work with Oki Nursery the past year and to find out what a dynamic industry the nursery idustry is. We at IBM are sincerely interested in helping you in any way to meet your business objectives and we feel that data processing as a technique and a tool for management certainly has a place in the nursery industry. I hope that this very brief discussion may have given you some ideas about where data processing's role is in the nursery industry and that we can at some time in the future be of more assistance to you in discussing your own individual needs and requirements.

Thank you very much for your invitation to speak to you today.