sume that our system is not particularly up to date. There are no sit-ins or interference with the people whose signs are on the door, so I assume we failed there but we'll attempt to improve things as time goes on.

We hope ladies and gentlemen that you have an enjoyable and profitable meeting in a professional sense and in a human sense. Thank you very much.

MODERATOR FLEMING: Thank you Dr. Huntley. The first speaker this morning is Dr. H. A. J. Hoitink from the Ohio Agricultural Research and Development Center. Dr. Hoitink came from the Netherlands to McGill University in Canada where he obtained his Masters degree and then he proceeded to Wisconsin for his Ph. D and then to Ohio where he is now. Dr. Hoitink's subject this morning involves the relationship of pathology to plant propagation.

DISEASE CONTROL DURING PROPAGATION[1]

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Plant diseases affect the lives and well-being of so many individuals that the most popular interest in them concerns the means by which they may be prevented. Control of disease is the ultimate purpose of a distinct science of plant pathology. Many disease control practices originated by empirical "cut-and-try methods" long before the true nature of disease was understood.

Disease control measures may be divided into two major groups: 1) prophylaxis and 2) immunization. Prophylaxis implies the protection of the host from exposure to the pathogen, from infection or from the environmental factors favorable to disease development. Immunization refers to improvement of resistance of the host to infection and to disease development.

In the propagation of plant material from cuttings or tissue cultures, prophylaxis is the major approach to disease control since comparatively little is known about disease resistance in ornamentals. Disease control in this area, therefore, can be considered under three subgroups: a) exclusion, b) eradication, and c) direct protection.

Exclusion is still a major means of disease control. It concerns measures designed to keep the disease organism (pathogen) from coming in contact with the host plant. *Sanitation* is of prime importance. Greenhouses should be fumigated with formaldehyde annually. Wooden benches, pots, cans and other containers should be painted with copper-

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naphthenate. Workbenches, floors in the headhouse and propagation house should be washed weekly or bi-weekly with a compound such as LF-10. Tools, aprons, etc. should be dipped in a similar product. Water used should be from municipal systems or from wells, since farm ponds may contain *Pythium* spp. and other pathogenic fungi.

Eradication consists of measures concerned with the elimination of the pathogen after it has become established in the host. Diseased cuttings or leaves should be removed daily from greenhouses. Mere deposit in a waste container is not sufficient since sporulation and spore-discharge may occur, as frequently such containers are in moist areas. Containers should be emptied daily.

The most important means of pathogen eradication is steam sterilization. Steam, at 100 C, was first used for soil treatment in 1888. Since that time it has become well known that severe disease losses may result when a pathogen is accidentally introduced into steam sterilized soil. In addition, a high degree of post steaming toxicity to seedlings and cuttings has often been observed. Yet the use of various forms of steam is probably the most reliable greenhouse disease control method employed at the present time.

Olsen and Baker (1968) and Colbaugh and Ellett (1968) have made significant contributions to the solution of both recontamination and toxicity of sterlized soils. These authors recommend aerated steam for the elimination of plant pathogens from cultural media without destroying some of the natural soil-borne antagonists. The reduced treatment temperature of aerated steam (140-160 F) also virtually eliminates toxicity problems.

The central idea of the air-steam concept is that pathogens are generally less resistant to unfavorable conditions such as heat, than are saprophytes. This is analogous to pasteurization of beer, milk or wine, to free these products from human pathogens without completely sterilizing the product. The performance of a commercially available continuous flow soil pasteurizer which uses steam-air mixtures for heat treatment of soil is presently being investigated by Colbaugh and Ellett in the Department of Plant Pathology at The Ohio State University.

The most misused control measure perhaps is the use of fungicides. Almost all fungicides that are presently available have a *protective* effect only and are not effective after disease onset. Dexon and Terrazole can be excellent for the prevention of *Phytophthora, Pythium* and other water molds. Our experience has been, however, that these products only delay the appearance of some diseases, e.g. Phytophthora wilt of Rhododendron. During propagation, however, *Pythium* and *Phytophthora* were prevented by monthly drenches with Dexon. Terraclor is a soil drench that gives excellent control of Rhizoctonia damping-off and it can be used quite successfully in pro-

pagation. The proper dosage depends on several factors; quite frequently phytotoxicity occurs under dry conditions. Furthermore, the use of wetting agents in fertilizer applications probably affects the rate at which Terraclor should be used. Morsodren, Pano-drench and other mercury-containing drenches are excellent for the control of Fusaria. No phytotoxicity was observed when Morsodren was applied to Rhododendron beds at 3 oz/100 gal. On Taxus cuttings rooting was 30% below the control.

In recent years *Cylindrocladium* has become a serious problem during propagation under high moisture conditions. *Cylindrocladium* can cause 30-80% losses on Rhododendron, azalea, Dianthus and several other seedlings or cuttings. Horst and Hoitink showed that none of the commercially available fungicides tested would control this disease. A new systemic fungicide Benlate, also known as Dupont-1991, gave 100% control of this disease during propagation and when applied to liners.

Fungicides in general, however, do not cure disease. These products only prevent disease.

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MODERATOR FLEMING: Thank you Dr. Hoitink. Are there any questions at this time?

GUS MEHLQUIST: The Rhododendrons you've shown as examples are all of the *R. ponticum* or azalea series; have you tested these fungicides on any of the 32 or 33 other series of Rhododendrons? I feel this is very important since we have problems in the *R. ponticum* series which we do not have in the other series and vice versa.

H. HOITINK: No we have not.

ARIE RADDER: On *Rhizoctonia* you recommend Terraclor; I've been using oxy-quinoline sulphate and found it quite satisfactory used as drench; have you compared this material?

H. HOITINK: No, I have not, the reason I mention this new fungicide is that it is effective against many more fungi than just Rhizoctonia.

CASE HOOGENDOORN: How can I control a black spot on my Rhododendrons? The cuttings look clean when I put them in the bench but 2-3 weeks later they start to turn yellow and drop their leaves.

JIM WELLS: Case, I believe Zineb or Parzate sprayed on the plants as a preventative spray in May or June will correct this but you must get at it early.

H. HOITINK: Dithane works equally as good as Zineb for blackspot, it might be better to go to Dithane because we think it helps control die-back also.

MODERATOR FLEMING: Our next speaker is Dr. R. K. Horst of Cornell University. He spent 5 years doing tissue culture work for Yoders Bros. and though he's not doing much of this now at Cornell, his subject is "Modern Propagation with Tissue Culture."

MODERN PROPAGATION WITH TISSUE CULTURES

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It is fashionable today in modern day research (both animal and plant investigations) to relate research projects in some manner to tissue culture. Most of the interest in tissue culture has centered around the increased concern of mankind for the answers to the complex question of the cause and cure of cancer. Cancer or malignant tumors is one of the most feared diseases of man. Tissue culture has served as a means of studying the ways in which tumor-type growths develop and ways in which these types of growths can be retarded or inhibited. Tumor cells, on dividing, produce tumor cells regardless of whether one is dealng with plant or animal cells; however, the conversion to normal tissue growth from callus-type tissue growth has been done with certain plant tissues (4, 10, 11). It is the implication and importance of this type of technique which we want to consider in relation to the propagation of plant materials.

We want first to define what we mean when we talk about plant tissue culture. The organization and differentiation of cells into a specialized complex may be termed a tissue or more simply, a tissue is a group of organized cells. Meristematic tissue is often used in tissue culture work. This is a region of the plant where active cell division is occurring, such as the terminal bud of a plant. It is not always essential to use meristematic tissues. Pith tissues have been used with some success and this tissue is found in the center portion of the stem. Theoretically, one could use any tissue of the plant because each cell contains the genetic code for that particular plant. In order to simplify our discussion we will discuss only the use of meristematic tissues for tissue culture.

The terminal meristem is deeply imbedded within a terminal bud. Leaves grow around the very small meristem and tightly enclose it in a sterile-type growth environment. When