planted. Young plants should be irrigated when necessary for the first season.

With the advancement of rooting hormones and different propagation techniques, there will be more and more breakthroughs in rooting tree species. As operating costs rise, nurserymen are constantly striving for more resourceful means of production. New ideas and the necessity of lower costs will open many doors for rooting flowering and shade trees.

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LIME AND LIME SOURCES IN CONTAINER NURSERY PRODUCTION

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The topic of lime and lime sources is one that has confronted nurserymen throughout nursery history, especially since the advent of container production in soilless and bark mixes.

In container production, the standard practice has been to add a certain quantity of lime to the mix, either for pH adjustment, or to supply calcium and magnesium, or for both reasons. There are a number of products available to growers that will fill the need when a lime source is desired (10).

It is my intention to focus on several sources of lime, the merits and disadvantages of each, and also to present some of the findings from an O.M. Scott and Sons research project this past spring.

It is important to know what calcium and magnesium are and what they do for the plant. The element calcium is required for active cell division, formation of cell walls, transport of carbohydrates and amino acids, and formation of roots.

A deficiency of calcium results in a stunted plant and restricted leaves. Some plants show a paleness at the leaf margins and curling leaves. This is most noticeable in broad-leaved plants. Three sources of calcium are:

1. Calcium hydroxide ($Ca(OH)_2$), hydrated lime, is very soluble and will raise the pH rapidly. It may also be caustic to young plants and seedlings.
2. Calcium carbonate ($CaCO_3$) is the material found in ground limestone, or HiCal. It is also found in dolomitic lime. It is a safe form of lime with no caustic action.
3. Calcium sulfate ($CaSO_4$), gypsum, will add calcium without affecting the pH.

The element magnesium is one of the elements required for the production of chlorophyll. A deficiency will soon lead to a reduction in the rate of photosynthesis. It also has an effect on the transport of phosphorus.

Symptoms of magnesium deficiency generally show up in the older leaves as a light "V"-shaped margin in the leaf with the rest of the leaf remaining green. However, some plants will develop a red or bronze color on the older leaves. In fact, this condition was referred to as "bronzing disease" until it was found that a lack of magnesium was the cause (2,3,5,7). Two sources of magnesium are:

1. Epsom salts ($MgSO_4$).
2. Magnesium limestone, or magnesium carbonate ($MgCO_3$). This is the material that is found in dolomitic lime, and in dolomite. True dolomite is a substance that is mined and contains 50% calcium carbonate and 50% magnesium carbonate. Dolomitic lime contains dolomite, with some additional calcium carbonate (2,3,5,7,8).

In addition to helping satisfy the needs of the plant for these two elements, liming the potting mix performs another important function, which is the reduction in the amount of hydrogen ions. When roots grow, they give off carbon dioxide (CO_2), which combines with water and releases hydrogen. Also, when bark and organic materials break down, hydrogen ions are produced. The hydrogen not only lowers the pH but it also displaces elements on the bark and on the plant root. The hydrogen ions block the uptake of desirable elements. The calcium and magnesium displace the hydrogen and allow for the uptake of the desirable elements (6,9).

With the knowledge that both calcium and magnesium are important to the production of healthy plants, the selection of a source of those two elements becomes important.

A grower has a choice of two types of material: bulk lime or bagged lime. The bulk lime consists of calcium, limerock, and other impurities. In some parts of the country this is the same material that is the subsurface for paved interstate highways. This material does not add a great quantity of calcium and very little magnesium. Also, it does not have a lot of staying power, hence the plants become deficient in those elements in a short period of time. The advantage of this material is that it does not cost a lot.

When selecting a brand of bagged lime, a grower has a number of sources to consider. Brands include:

1. James River Dolomitic Lime; available throughout the U.S. Southeast.
2. Docito Dolomitic Lime; available in Alabama, Mississippi, Louisiana, and Texas.
3. Hi-Cal Vitalime, and Soil Doctor; available in Florida.
4. Rockydale; available in North Carolina.
5. Reveille Dolomitic Lime; available throughout the U.S. Southeast.

A close look at the label tells a lot about the product although most of them look the same. For example:

1. The Vitalime and Soil Doctor are lower in magnesium than the others.
2. The James River Limestone has the highest magnesium content.
3. The Dolcito, James River, and Rockydale have the finest grinds.

How a grower uses dolomitic lime is also a consideration. Incorporation of lime is by far the most efficient method of achieving the full benefits from the product. The reaction of calcium and magnesium is more rapid and the altering of the pH is also faster than if the lime were applied to the surface. Also, lime that is surface-applied is expensive, not only because of the labor, but because it is slow to react (1).

The research that O.M. Scott and Sons conducted this past spring indicated that several factors were instrumental in determining the quality and suitability of the lime source used.

1. First, the degree of fineness is very important. The finer the grind of the material, the more rapid the response both in terms of availability of the elements in the lime and the response to altering pH. Fineness is measured by the percent of the material that would pass through a 100-mesh screen. A 75% rating is desirable.
2. Second, the percent of calcium carbonate and magnesium carbonate did make a difference. Specifically, when the levels of magnesium in the soil were maintained at optimum, performance was greatly improved for a majority of plants.

The Scott study involved the incorporation of several sources of lime into comemrcial potting mixes along with fertilizer and microelements. This test was conducted in Florida and used mixes that contained over 50% Florida peat. The peat had a pH in the low- to mid-4 pH range. Plant indicators tested included *Dracaena* spp, *Ixora* spp, and "reflexa".

After 6 months, these studies indicated that an increase in the amount of dolomitic lime may be necessary in order to prevent the pH of the mix from dropping out of the range where optimum plant growth can be expected. Lime rates in this type of mix of 15 to 20 lbs/yd^3 may be required. The exception to this would be in a nursery that had either high soluble salts or high sodium levels in the water. Under these conditions, the pH did not increase regardless of the source of lime; pH's were 4.7 to 4.8 at the end of six months. Also, many times when high salts or high sodium are found, high chlorine is also found. The chlorine would be detrimental to many plants. Using 15 to 20 lbs of lime per yd.^{3} in a potting mix that contained mostly pine bark, shavings, or Canadian peat would *not* be recommended, as a significant rise in pH would probably occur.

In presenting information on lime and lime sources, a complicated and involved discussion on pH could be raised. The purpose of this paper has been to point out that, regardless of the importance of pH, the fact remains that plants need adequate amounts of calcium and magnesium. A good quality dolomitic lime with 35 to 40% magnesium carbonate and 45 to 60% calcium carbonate, with 75% of the material able to pass through a 100 mesh screen, would be the most economical source of achieving that end.

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INFLUENCE OF JUVENILITY AND MATURITY IN PROPAGATION

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Importance of juvenility and maturity in propagation. Why are juvenility and maturity important in propagation? In a schematic representation of a 100 year old tree there are three zones of maturation: (1) a juvenile zone at the crown and base of the tree: (2) a transition zone; and (3) a mature zone or region (Figure 1). Any propagules taken from the base of this tree will have juvenile characteristics and be potentially easier to root, regardless of the chronological age of the propagule. The transition zone of the tree is comparable to puberty in humans with both juvenile and mature characteristics. In general, transition zone material will not flower and propagules taken from this region root less readily than juvenile material, yet more readily than mature material. The mature zone is characterized by the ability to flower and set fruit, but frequently there is a drastic reduction in rooting potential. Characteristically, a plant will not express its commercial potential until after it has reached a mature stage. Hence, as propagators we have an interest in learning to manipulate these three physiological stages of growth either to enhance rooting by causing a reversion back to the transition or juvenile condition, or to encourage earlier flowering, fruit bearing, or expression of other desirable mature characteristics by speeding up the maturation process.

Physiological condition vs. chronological age. It is the physiological condition, not the chronological age which determines a plant's capability to form adventitious roots (ARF). A sucker, which may have developed 50 years ago at the base of this 100 year old tree in the juvenile zone, will have a greater chance of rooting than a 5-month-old shoot that has recently developed in the mature region. It is the physiological age, the