be a magnesium deficiency anyway. To correct this, add dolomite limestone, which contains both calcium and magnesium carbonate, or add epsom salts (magnesium sulfate). Magnesium is a highly ionizable salt; therefore, watch the amount. Be sure to use the CEC and know what it means. Sandy soils will give a low CEC.

WILEY ROACH: Question for Bryson James: Would one application of 13-13-13 give enough phosphorus and potassium in bark:sand to be adequate for one season?

BRYSON JAMES: It is possible to apply all at one time if enough is put on. Soluble salts have no influence on CEC. Humus and organic matter have 3 to 4 times as much effect. Clay also has a high CEC. A good CEC range for bark:sand is 6 to 11. It is possible to add the nutrients when mixing soil, although this will probably not provide enough potash for the long term. A good fertilizer ratio to use is 3½ to 4 to 1 to 1.

WILEY ROACH: So if 13-13-13 is added to soil it might be necessary later on to go back and add potash and nitrogen.

BRYSON JAMES: That is correct.

FRED MAY: Is a pH of 6 to 6.5 ideal for azaleas?

BRYSON JAMES: No, it is a good range for general growing. 5.5 is probably as high as is practical with bark. The balance of ions is more important. Because of the high CEC of bark, it is not practical to adjust the pH.

METHODS USED TO APPLY FERTILIZER TO CONTAINERS AT GOOCHLAND NURSERIES

R.E. "ED" BROWN

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All of our container-grown plants are fertilized with dry fertilizer applied by hand. Water soluble fertilizer is used on our liners.

We machine pot all of our 1 gallon and 3 gallon containers and hand pot 7 and 15 gallon containers.

We buy our potting mix already prepared. This consists of three parts local peat, one part builders' sand, and two parts cypress shavings; 110 lbs Hy-cal lime, 70 lbs dolomite, 72 lbs Perk minor element mix and 5 lbs chlordane are added to an 18 yard load of the potting mix. Fertilizer is applied to one gallon containers by using a plastic teaspoon, which holds ½ ounce of 6-6-6 or Osmocote. The first application is made within a few

days after potting, using a 6-6-6 formulation containing minor elements. The nitrogen is all derived from organic material. The 6-6-6 is used as a starter because no fertilizer containing nitrogen, phosphorus or potash is added to our potting mix. This application is made after plants are placed in the beds.

The second fertilizer application is made within 2 to 3 weeks using Osmocote 19-6-12, 3 to 4 month formulation. We have found Osmocote becomes available by the time the 6-6-6 is depleted. Again we use the ½ ounce plastic teaspoon.

Three gallon containers are fertilized first with 6-6-6, second with Osmocote using the same time spacing of applications as with the one gallon containers. Fertilizer for 3 gallon containers is measured using a plastic top from a gallon acid jug available from a lab adjoining the nursery. The top measures 1¼ inch diameter by 1¼ inch deep and holds approximately 1½ ounce of 6-6-6 or Osmocote. We form a handle for convenient use with a 12 gauge galvanized wire wrapped around the top and twisted out to a length of 15 to 18 inches.

Seven gallon containers are hand potted, placed on trailers for transporting to the field and fertilized. The same materials and timing are used, but 2 measures are applied each time. This equals 3 ounces per container per application.

Fifteen gallon containers are handled in the same way as the 7 gallon using 4½ ounces of 6-6-6 for the first application, and 4½ ounces of Osmocote for the second. Timing is the same as for smaller containers.

Ordinarily the third, fourth and fifth applications of Osmocote are applied in the same manner as described above. Sometimes a small additional amount is added to each container because of heavier root formation and top growth.

Plants showing a deficiency in minor elements are given an application of Vertagreen Minor Element Mix, professional formulation 791[1] according to directions of manufacturer.

A water soluble material, Millers Nutri Leaf 60, is used to fertilize liners. The solution is run through our mist heads from our stationary spray tank with a pump attached for fertilizing. This application is started as soon as some roots are showing and continued every two weeks until the plants are well rooted. At this time a light application of Osmocote is broadcast over the bed.

We have found that these methods are adaptable to our

[1] Vertagreen Minor Element Mix 791, contains the following percentages of minor elements: Mg, 9.17; Mn, 2.32; Cu, 0.24; Zn, 0.69; Fe, 3.50; S, 2.00; B, 0.06; chelated Fe, 0.23; Mo, 0.002.

production system and enable us to produce high quality plants.

METHODS USED TO APPLY FERTILIZER TO CONTAINERS AT TOM DODD NURSERIES

TOM DODD, III

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The objective of our fertilization program is to provide the proper nutrients at the proper levels in the least expensive manner. There are several problems with containers that make it necessary to modify standard fertilization methods. One major problem is the soil medium itself. We normally use two parts milled pine bark and one part German peat moss for the majority of our ericacious plants and add sand for other container ornamentals. The nutrients available initially in the peat and bark medium are not adequate for optimum plant growth. We, therefore, must add nutrients as required. The other major problem is leaching. With containerized stock, irrigation practices are different because more water is used to wet this self-contained environment properly, and we observe considerable leaching. Thus, we have a loss of many nutrients and depression of soil pH.

In attempting to overcome these problems economically, we divide our program into three basic methods: 1. Premix the medium and the nutrients. 2. Side dress. 3. Apply by injector.

Let us look first at our pre-mix procedure: Initially, the two (or three) medium components are mixed by a front-end loader. As they are mixed the second time, dolomite, nutrients, and trace elements are added. We sometimes also add chlordane at this stage. The mixture is then turned at least five more times before it is delivered to the potting machines or to the potting wagons for use. There are certain drawbacks to this procedure that will be pointed out later. All of our soil medium is mixed with dolomite at a rate of 6 pounds per cubic yard. For most of the azaleas we add either Osmocote 18-6-12 at 10 pounds per cubic yard, or Osmocote 18-5-11 at 12 pounds per cubic yard, and one ounce of Peters FTE 503. For *Ilex* and other ornamentals we add Scotts 24-9-9 Premix plus minors at a rate of 3.5 pounds per cubic yard to the two-bark, one-peat, and one-sand mixture. For *Ilex* liners we lessen the rate to 2 pounds per cubic yard. For our azalea liners and some of our native species, we add only dolomite to a one-bark, one-peat mixture and add food by top dressing or with the injector system.

that we have 100 tubes for each week of 6 weeks. On 3 square feet of shelf holding the 100 tubes we obtain 6.3 divisions per tube. One division is used for replacement into fresh stage 2 medium. These numbers give us a production of 500 plus plantlets per week.

The Pretransplant Step and Establishment in Soil. The plantlets are rooted in stage 3 containers in 2 to 3 weeks and then moved into the outside world. The plantlets are placed in trays containing 72 cavities holding medium of 1/3 sand, 1/3 peat and 1/3 loam. The cavity is 2 inches square and 2¼ inches deep. After placing in the moist soil the plantlet is watered well and covered for 5 to 6 days with a near clear plastic dome. After the dome is removed, they remain in the glasshouse under 10,000 lux (1,000 foot-candles) for 3 weeks. These plants develop a superior root system in this period of time and are then transferred to a 6 inch container for growing onto a finished product.

Six months after the plantlets come out of the lab (5 months from the liner stage), we have 18-inch finished plants.

SETTING UP A TISSUE CULTURE SYSTEM

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Plant tissue culture is the placing of excised plant cells, tissues or organs in an artificial environment for the purpose of controlling the development of the explant. Plant tissue culture is pertinent to those in commercial horticulture as a method of achieving rapid vegetative multiplication. Shoot tip or shoot apex culture is the usual method; however, other tissues such as bulb scales, leaf parts, petioles, and embryos are also often used.

Plant tissue culture is not a new science as Haberlandt was the first to place leaf tissues into a nutrient solution for observation in 1902. Successful embryo cultures were achieved in 1904 by Manning. In 1934 White succeeded in culturing tomato roots, which display unlimited growth. These cultures are still being maintained; 1934 was also important due to the discovery of the auxin, indoleacetic acid. Gautheret and Nobecourt in France, and White in the United States, all reported the indefinite culture of callus on an artificial medium. Van Overbeek in 1941 reported the control of differentiation into embryos or callus with coconut milk treatments, and in 1946 Ball obtained