lightweight, tarpaper containers 2¼″ x 2¼″ x 8″. These are placed side by side in old lemon storage boxes. The seed is planted in the soil and then covered with peat moss to keep them moist for sprouting.

When the seedlings are 15″ to 18″ high they are separated, tip-grafted and then placed back into boxes. The tarpaper pots give us some trouble as they break down readily and the roots grow through them; we are now experimenting with some plastic pots that could be stapled together and then re-used.

The trees are tip-grafted from 6″ to 10″ above the seed by making a long sloping cut on the seedling with a sharp knife and then selecting scion wood of approximately the same size and making a corresponding cut on it, leaving 1 to 2 buds. This scion piece is usually from 1½″ to 2″ in length. The cut surfaces are bound together firmly with budding tape or budding rubber. The top of the scion is treated with Tre-Seal to prevent loss of moisture.

The grafted trees are kept under high humidity and subdued light until the buds break and start growing. The tape is removed when the graft is healed; this is approximately 3 to 4 weeks after growth has started and is 6 inches long, or longer. Constant suckering of the seedling and scion is necessary.

Up to this point, very little cost has gone into the care and growing as little space has been taken and little material used. Now repotting is done and the trees are shifted into larger containers. For the larger container we are using pressed paper pots that can be buried when planting so that there is no disturbance to the roots. We are still experimenting with other containers. The paper containers are good but they tend to rot out on the bottom before they are ready for planting; however, they are still quite satisfactory.

MODERATOR TEAGUE: I would now like to introduce Mr. E. F. Frolich, who is well known to all plant propagators in southern California. He is with the Department of Agricultural Sciences — Plant Nutrition — University of California, Los Angeles. He will discuss both citrus and avocado propagation. Ted —

ROOTING CITRUS AND AVOCADO CUTTINGS

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Many varieties of citrus will make satisfactory trees on their own roots (1). Nurserymen have grown Meyer lemon and Rangpur lime as rooted cuttings for many years. There are own-rooted trees of Navel and Valencia orange, Eureka and Lisbon lemon, Dancy tangerine, Bearss lime, and Marsh

grapefruit in California, some now over 30 years old. Contrary to the view held by many nurserymen, citrus trees grown from cuttings are not necessarily dwarf. Experience has shown that the sweet oranges, such as Washington Navel and Valencia, Marsh grapefruit, Dancy tangerine and Bearss lime, make trees of about the same size as standard budded trees of the same variety. Eureka Lemon in its early years is vigorous but tends to be short-lived. Lisbon lemon makes a vigorous tree but is very subject to fungus attack. Navel orange on its own roots also has exhibited a greater incidence of fungus trouble on the roots than has Valencia as a rooted cutting. We can say that citrus trees grown from cuttings reach the same size as trees of the same variety budded on one of its own seedlings. Cutting-grown citrus trees are not as well-anchored in their early years as are trees on seedling rootstocks because the former lack a taproot.

The speed with which citrus cuttings form roots varies both with the different species and the age of the clone. Cuttings from seedlings, as in nearly all other plants, root more readily than cuttings from old cultivars. They tend also to send roots down in a more nearly vertical direction as opposed to the more horizontal growth produced by the latter. The acid citrus, such as limes, lemons, and citron root most readily. Mandarins and kumquats are slowest to root, grapefruit and sweet oranges lie in between.

The most satisfactory cutting material is the last flush of growth that has hardened but not yet started a new flush. The greatest number of cuttings of this type would be available in early summer following the spring flush. Cuttings are generally made 3 to 6 inches long and of a single flush. The size is not critical; cuttings 2 feet long can be rooted. The important thing is that some leaf area be maintained. In general the more leaves functioning the heavier will be the rooting. Cuttings should be kept moist at all times during handling to keep the leaves turgid.

Some citrus species benefit from treatment with a rooting hormone. Indolebutyric acid at 8,000 ppm in talc is most generally used. Equally good results can be had with IBA as a quick-dip at around 3,000 ppm. The acid citrus gives a much greater response to the hormone treatments than do oranges, grapefruit, or mandarins.

Cuttings can be rooted in any equipment that will maintain a high humidity and a fairly good light intensity, either a closed case or a mist system. Mist systems are less satisfactory with the slower rooting varieties because of excessive leaching which will occur over a period of time. Bottom heat at a minimum of 75° F. is beneficial; on some citrus, such as calamondin, temperatures around 85° F. minimum may be desirable.

Twig-grafting (1), a method sometimes used, employs two or more cuttings grafted together. Two cuttings will give

a desired rootstock-scion combination, three cuttings a combination of rootstock, scion, and interstem. Select material that is nearly the same diameter at the graft. At least one leaf on each piece is essential. A splice graft is generally used, making diagonal cuts ½" to ¾" inches long. Tying is done with raffia, plastic, or rubber. We have found a regular #16 stationer's rubber band to be satisfactory. It is not necessary to seal the cuts because the humid conditions used will keep them from drying out. Unions at the graft should heal in 3 to 4 weeks. Healing of the unions, unlike rooting, is nearly the same for all species. Rooting time depends on the piece at the base and is little affected by the scion (2). Citron may root in less than two weeks, some mandarins may take as long as 6 months. We have grafted 10 pieces end to end to demonstrate how readily the grafts heal even though no roots are present.

Avocados are rarely grown as rooted cuttings. Avocados grown from cuttings are more difficult to handle for the first few years than those on seedling rootstocks. Since most varieties are difficult and expensive to produce as cuttings, the method is limited to growing trees for certain experimental uses. Young seedlings (3) and a few old cultivars such as Ganter, Scott, and Zutano can be rooted by ordinary methods in either a closed case or under mist. Cuttings of the Fuerte variety have been rooted in small numbers the same way but not consistently (4). Most commercial varieties, however, require a special etiolation process in order to produce roots (5). For the varieties that are difficult to root, it is necessary to produce a shoot with a base that has developed in the dark and a top that has grown in the light. We generally graft the desired variety onto a seedling growing in a small container. We generally use a one-quart can, because experience has shown that shoots from plants in large containers do not root well. After the graft is well established and has made some growth, we cut back to buds near the base of the shoots. When these buds show signs of growth. we put the whole plant into a dark room at about 75° F. and let new shoots grow about 3 inches. The plant is then brought into the light and the bases of the shoots are covered with some material such as vermiculite to keep them dark. The tips are allowed to grow in the light. When 3 or more leaves have reached maturity, the shoots can be detached near the base and rooted in conventional propagating equipment. The shoots can also be rooted by removing a ring of bark near the base and covering the area with some moist material as in air layering. We prefer detaching the cuttings because in our experience we can use the stock plants more times than when we girdle. Girdling seems to weaken the root system much more than does detaching shoots.

Treatment of avocado cuttings, either etiolated or green, with normal concentrations of rooting hormones does not

seem to help. At higher concentrations we get tissue damage but again with no improvement in rooting.

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MODERATOR TEAGUE: Thank you. Ted. Next we will hear from Mr. Paul Moore, University of California, Riverside, who will continue the discussion on citrus propagation. Paul:

PROPAGATION AND GROWING CITRUS NURSERY TREES IN CONTAINERS

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The field propagation of citrus nursery trees is an old practice. Successful nursery techniques are well established and reasonably standardized throughout the citrus producing areas of the world. Until recent years, citrus nurserymen have shown but little interest in growing their trees in containers. Orchardists have been equally hesitant about planting container-grown stock. However, within the last decade, certain developments related to nursery tree certification, land and labor availability, automation, and transportation costs have generated a new interest in container-growing systems for citrus.

For many years, the University of California, Citrus Research Center, has been growing trees in containers for research purposes. Thousands of such trees have been planted in our orchards and have performed as well as field-grown nursery trees. The consequence of our favorable experiences was a decision to discontinue our field nurseries in favor of container growing. Some of the advantages which led us to this decision are listed below:

Advantages:

1. *Standardized soils*
   Soil mixes can be standardized for physical and nutrient characteristics. Flexibility in selecting mixes tailored for specific needs is also possible.
2. *Pest-free soils*
   Steam sterilization or pasturization guarantees freedom from soil-borne diseases, pests and weeds.