cuttings readily produce roots of their own just above the graft union after the top of the understock has been removed.

For propagators in northern regions it is not easy to follow this method of propagation. It is often impossible to gather conifer cuttings during the most favorable time because of deep snow and low temperatures. Where such conditions exist, one can make large cuttings of the easy-to-root varieties before the onset of bad weather and place them under mist and at low temperatures until the scions can be gathered. In the meantime, the cuttings will have produced callus or even be rooted to some extent. The scions can then be grafted on them. Such cuttings, even when kept all winter, need little greenhouse space—much less than potted stock.

In conclusion we recommend the following:

1. Timing. Taking the cuttings at the most favorable time (winter) to assure quick rooting.
2. Select an easy-to-root variety which also has the tendency to develop a good root system.
3. If large, long scions are used in grafting, we prefer the side-tongue graft because it makes a very solid union.
4. Good drainage of the grafting boxes and the use of a medium that drains easily is most important.
5. Bottom heat (70°F) is essential.

MODERATOR BRIGGS: Our next speaker is from Fremont, California, near San Francisco. Don Dillon, of Four Winds Growers, will talk to us on his citrus propagation procedures, Don:

SIMULTANEOUS GRAFTING AND ROOTING OF CITRUS UNDER MIST

DONALD DILLON
Four Winds Growers
Fremont, California

In order to simultaneously root and graft citrus successfully it is necessary to have the right climatic environment. All of our propagation is from mother-plant twigs; these mother plants are grown in the open air, without shelter from the elements. Having the right type of wood is essential. However, the simultaneous graft healing and understock rooting is done under controlled hot-house conditions.

An ample supply of the right hardened-off shoots of new growth are a "must" in successful twig grafting. Both scionwood and rootstock wood must be available simulaneously at the proper time. We grow our own original mother plants, both for rootstocks and for scions.

Our selections and methods are based on "research," if you will pardon our usage of this word with this definition —

"If one appropriates another man's idea, that is stealing; but if you combine the ideas of many experts along with your own, that is research." We should confess plagarism in "twig-grafting." Dr. F. F. Halma and fellow member, Ted Frolich, both of UCLA, really taught us their methods. Ted not only grafts two twigs, he often sandwiches them 3 or 4 high in his researching.

We hold to this belief — to secure identical results and keep on producing identical results, we must use identicals — both rootstock and scion. While the specific scion strains are generally well known and recognized, this does not hold true with rootstocks. Citrus seedling rootstocks are quite variable. That is why we use shoots of rootstock mother plants, not seedlings, in our propagation. Most of our scion varieties are progeny of one mother tree of the variety. To a lesser degree, this is true of our rootstocks. Our objective is to have every twig-graft, both rootstock and scion, the progeny of a specific mother plant. Conditions change, however; the development of nucellar strains are causing the abandonment of old-line strains. The California citrus industry now is committed to a long-range program of producing indexed, disease-free trees.

In grafting and rooting citrus simultaneously, our propagators go into our mother blocks and cut twigs of scion wood and understock, using the last growth cycle. Leaves are retained on both scion and stock. When the twigs are grafted and ready to be flatted these plants are, on the average, 12 inches long. Our propagators gather their own wood each morning; never is the wood allowed to dry out. The twigs are always kept moist and when they are brought into our propagating room they are dipped into a fungicide solution containing ½ cup P.C.N.B. and 2½ cups of Captan (40% wettable powder) in 20 gallons of water.

After the preceding preparations have been made, our propagators start making their grafts. The cut for the splice graft is ½ to ¾ inches long at about a 30° angle. After the graft has been made, it is tied with a rubber band. The grafted twigs are put back under mist. After making the grafts, our propagators dip the plants into the fungicide again before "stumping" them. The cut on the base of the plant is made square, dipped into a "hormone" and flatted up.

The "hormone" we use is from a formula given to us by Mr. O. A. Matkin, head of the Soil and Plant Laboratory, Inc., Orange, California. At one time we used Hormodin No. 3, or indolebutyric acid in a liquid formulation. The hormone we are now using consists of:

1.0 gram indolebutyric acid
25.0 grams fermate
99.0 grams talc

We find this to be cheaper and it works just as well, if not better than, the hormone preparations previously used.

During the course of the day, if any twig is dropped or has fallen to the floor, it is always put back through the fungicide before it is returned to the working bench. Flats used to carry or hold plants while flatting or when grafting, and containers used for the hormone are dipped in fungicide before being put away for the day. All excess hormone is thrown away every day.

Our grafting room is maintained in a state of "kitchen cleanliness." Access is limited to people who work there. At the end of each day's work, the grafting room is thoroughly cleaned. All prunings and left-over wood are discarded. The mist case in which twigs and completed twig-grafts are held during the day is scrubbed, using 16 ounces of 25% Clorox in 2½ gallons of water. The table and counter tops, which are covered with vinyl linoleum, are scrubbed with the same solution. All tools are cleaned and stored in lined drawers. The floor is scrubbed, even the windows are washed daily. When all this is completed we can go home.

Hot-House Propagation Operation

We have adopted the U. C. system for container-grown plants, as discussed in University of California Manual 23, as the foundation of our growing operation. We are convinced that mother blocks of clean planting stock are essential for a sound growing operation. This is the first principle to support the production of quality nursery stock. The second principle is proper soil treatment. We use a modified U. C. soil mix, in that we use redwood sawdust instead of peat moss. The soil mix is an essential part of our operation. The last principle is proper sanitary practices. We make a real effort here also. All of these practices are necessary. They are goals. We recognize that in some of our practices we are a little short and that constant improvement is necessary. In this work we are regularly assisted by Mr. Matkin, one of the authors of Manual 23.

Incoming water for the mist beds, either clear or fertilized, passes through Monarch, 100 mesh strainers. We use normally-open solenoid valves since we have found it is better to have continuous water on the twig-grafts than none at all in the event of a power failure. We use General Electric silicone cables for bottom heat. Each bench has it's own HSC-5 thermostat, pilot light, and circuit breaker.

Our timer was inspired by discussions and papers we heard at the first Western Region, Plant Propagators' meeting at Asilomar in 1960. We use a 24-hour clock to control two six-minute timers. The pins on the 24-hour clock can be set for 15-minute intervals, and the 6-minute clocks at any 5-second intervals. By proper placing of the pins, any combination of mist duration and interval can be programmed. Like other propagators, our controls must allow great flexibility yet provide a high degree of reliability. By the use of relays, the 24-hour clock prevents the chance of continuous misting in the event that the 6-minute clock were to stop for the night in an open (misting) position.

We have recently added a 1¼ H.P. 3600 R.P.M. motor and pump to increase our mist line pressure to 140 P.S.I. A 120-gallon tank under air pressure maintains even pressure. This increases nozzle velocity and creates smaller droplets. These absorb more heat and tend to hang in the air longer. This allows us to reduce the mist duration and increase the mist intervals. We use a Monarch No. 3.0, 120°, oil-burner type nozzle. These would produce 3 gallons of water per hour if allowed to run continuously. They are also fitted with 100 mesh screens. Our lines are ⅜-inch copper tubing. We use Imperial fittings. Our ten benches have individually controlled water lines which are mounted on the ceiling rafters. The lines are located along the front edge of the bench with the nozzles pointing down. Any drip falls in the aisle. Benches are raised, 36 feet long, 3 feet wide. Heating cables are buried in 3 inches of gravel, covered with hardware cloth. After treating the wire mesh and wood benches with copper naphthenate, empty 18 x 18 inch flats are placed on the bench and filled with rooting media. We use coarse grind vermiculite of the type used for insulation fill. The twig-grafts are dipped in hormone and stuck.

When the mist is on it is impossible to see the other end of the greenhouse—40 feet away. Small droplets will still be in the air when the next cycle begins. While this seems like an excessive amount of water, please keep in mind that until the graft has healed, the scion has no contact with the moisture in the rooting media. It is suspended in mid-air, supported by the understock and has no other contact except the atmosphere around it.

When the graft union has fully healed and the understock rooted, the bottom heat and the mist line are turned off. Sometimes, though the plants are rooted, we must wait until the graft has healed. The flats are left to harden off for a period of several days to two weeks, depending on variety. We do not use peat or other types of pots. The roots are straight and uncoiled. Trees are planted directly into one-gallon cans, bare-root.

It is our aim to produce good-tasting, full-sized fruit on a dwarf tree whose ultimate size has been controlled by the interaction of rootstock and scion. These trees are produced from carefully selected twigs, grafted under kitchen-clean sanitary conditions, then rooted and healed simultaneously under conditions of intermittent mist.

MODERATOR BRIGGS: Our next speaker has a little different problem, one which may be a lot more difficult than the others. To tell you about this is Dr. Holger Brix, formerly of Denmark. He acquired his early education there but came to the United States where he got his doctorate at Texas A and M University. He is now with the Forest Research Laboratory Victoria, B. C. Dr. Brix.

ROOTING OF DOUGLAS FIR CUTTINGS BY A PAIRED-CUTTING TECHNIQUE

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A study of rooting of Douglas fir cuttings was undertaken two years ago because vegetative propagation of Douglas fir by grafting had not been entirely satisfactory. In recent years much overgrowth of rootstock by the scion has become apparent resulting in poor growth and eventual death of the tree. A barrier to translocation of assimilate from the plant top to the root seems to develop at the graft union and leads to starvation of the rootstock.

Chemical treatments have not been consistently successful in rooting Douglas fir cuttings from mature trees. Other workers have found, as we have, that indolebutyric acid (IBA) will induce rooting in cuttings from old trees but the results can not consistently be replicated in other years and with other trees. Mechanical aids, such as wounding, have not improved the results. On the other hand, cuttings from seedlings of Douglas fir root fairly readily even without chemical treatments. It, therefore, seemed worth testing whether cuttings from old trees could be induced to root by grafting cuttings from young trees onto them.

At the end of March, 1966, 60 cuttings from mature trees (80-100 years old) and 60 cuttings from 5-year-old Douglas fir seedlings were grafted together in pairs. Hereafter, for convenience, these are referred to as "old" and "young" cuttings, respectively. Only the last annual shoots were used and they were cut to a length of about 3 inches. The cuttings were side-grafted for a length of about 1 inch at the base of the stem and held together by elastic bands. The basal ends were cut flush after grafting. This is referred to as butt grafting. The paired cuttings were set with the base in 50 ppm IBA for 24 hours and thereafter placed in a rooting bench with perlite and kept under intermittent misting. The graft union was completely buried in the rooting medium. After 17 days in the bench the union between the paired cuttings was sufficiently strong to permit removal of the elastic bands. Since the basal growth of the cuttings is considerable, the bands are removed as soon as possible to avoid constriction.

During the first 2 months in the bench 17 pairs rooted; after 3½ months 28 pairs had roots and 54 pairs had roots