MODERATOR MAIRE: Thank you very much, Karl Opitz and Lloyd Joley, for that very interesting presentation on propagation of pistachio

Now, to continue; Bob Gonderman is here from the Los Angeles State and County Arboretum. He has been doing some experimental work with certain rather difficult-to-root plants and we are lucky to have him. I am sure that Bob will have some interesting things to report. So, here is Dr. Bob Gonderman from the Los Angeles State and County Arboretum in Arcadia:

## STUDIES WITH CUTTINGS OF DIFFICULT-TO-ROOT PLANTS

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In attempts to root cuttings of difficult-to-root plants, a number of variations of lesser-known methods have been tried. I have had some moderate success in rooting cuttings of pines, oaks, and eucalyptus, and perhaps our methods may enable propagators to produce better landscape plants more easily and cheaply.

Vegetative propagation of desirable clones is becoming more and more practical as we apply our present knowledge to old rooting problems and learn to benefit from past experiences, such as we may learn at this meeting. Our mission-oriented research has permitted a few publications, so some of you already know of some of my work.

We may think of rooting as the result of expression of the interaction of root promoting and inhibiting factors metabolized within the plant itself. Production and concentration of such factors may be investigated by taking cuttings at various growth stages—before, during, or after a flush of growth. With the assistance of my class members, we have rooted several reportedly difficult plants during their spring flush of growth. Usually these have been single experiments; they are not reported until enough repetitions have been made.

It is conceivable that rooting inhibitors may be leached from the plants if they are easily soluble. My early trials in this regard have yielded only promises so far. While leaching, we could at the same time infuse the cuttings with phenolic or proteinaceous substances for possible promotion of endogenous auxin production.

Another approach is to gather cuttings when the root promoting effects are highest. One of the physiologically favorable times appears to be during the spring growth season. Our class members taking

cuttings at this time have obtained rooting with the following plants within a five week period. *Rhapiolepis, Ilex cornuta,* jujuba, loquat, *Templetonia, Abutilon, Metasequoia,* sun azalea, crape myrtle, *Carissa,* and *Bauhinia. Platanus, Ceanothus,* avocado and *Eucalyptus* took longer. These were mostly one time trials, with some repetitions carried on each year since 1969. None of this work has been reported up to this time

Timing of obtaining cutting material of various species may be of vital importance. With *Osmanthus fragrans aurantiacus* we found cuttings rooted only in spring and fall with no rooting in summer or winter. Trials with *Hymenosporum flavum* showed rooting to peak in early spring with few cuttings rooting the rest of the year. Interestingly, when endogenous auxin activity is highest, these often root best without exogenous hormones, and high concentrations of added auxin have decreased rooting.

Juvenility has been clearly recognized as a major factor in difficult-to-root plants We are attempting an approach in this area. We are working with 100 year old pine trees that are smog resistant. These are not only hard to find but it is difficult to obtain adequate satisfactory cutting wood. We are retaining the few cuttings that rooted and using them as "juvenile" stock plants and are hoping to obtain ease of rooting from cuttings taken from these due to the juvenility factor.

Also the position on conifer trees from which cuttings are taken suggests some juvenile effect. Reportedly cuttings taken from lateral ramets of lower ortets root more readily.

An important consideration is the great variation in Douglas fir trees Here the propagator needs to maintain records of parent trees and then use only the best rooters among them.

Several ideas which may have a beneficial influence on rooting will be briefly suggested. While I have used them, no specific data has been extracted on their overall value.

(1) Use of a penetrant carrier as dimethyl sulfoxide to carry rooting hormones into the vascular system of the cutting. This material has been useful in waxy, resinous, woody types of cuttings but has been of little value in other cases.

(2) Give cuttings as much light as they can use without inducing wilting. My own mist system is in full sun with natural photoperiod.

(3) Relatively high bottom heat and low foliar temperature seems to be worth consideration. After various trials and accidents, no ill effects have been seen, but rather an apparent enhancement of rooting has been obtained with several varieties and species.

(4) The pH of the rooting medium is reportedly optimum at about 5 to 6. Perlite has little buffering capacity and its prolonged use may cause a salt accumulation. Peat is usually added in summer. In

winter, less water is required and peat is omitted. With a small mist flow to carry salts away, we have had no appreciable problems with perlite.

(5) Lastly, propagation by tissue culture is an approaching possibility, though there is yet much to be known. Most of you know the merits of dividing promeristems under aseptic conditions to obtain propagules of desirable clones in large numbers. A variation of this method which may be faster and easier for some of you is the use of sterile sections of twig tips. Which medium and which hormone, and their concentrations, are problems which will be worked out with time. Probably one should start with a simple nutrient solution but complex media, as that of Murashige and Skoog, should yield response from a wider range of species.

Using the above techniques, I have been able to root cuttings of *Pinus pinea, P. palustris, P. roxburghii, Quercus agrifolia, Q. leucotricha, Eucalyptus ficifolia, E. gunnii* and a few others.

Not all attempts to achieve rooting of difficult plants have resulted in success, but trials which are evaluated lead the way to increased rooting percentages with less time and effort involved. It is hoped that some of these suggestions will work for you in the interests of producing better plants for more people to use.

MODERATOR MAIRE: We have a few minutes before coffee break for a couple of questions for Dr. Gonderman.

HAROLD ELZINGA: Who is the distributor for DMSO?

BOB GONDERMAN: You can get it from Van Waters and Rogers, Baker Chemical—chemical suppliers of that sort. It is not expensive.

HAROLD ELZINGA: What concentrations?

BOB GONDERMAN: I use a range—sometimes 100 parts per million, sometimes 1000 ppm— with the quick-dip method, normally.

MODERATOR MAIRE: Thank you very much, Bob Gonderman. We appreciate your being with us and giving us a most interesting talk. This will end this part of the morning session.

MODERATOR BRIGGS: Now, first on our propagation panel we have Ted Frolich, Dept. of Agricultural Sciences, University of California at Los Angeles. Ted has been on our program many times before. He has worked with citrus and other sub-tropicals. Ted is going to talk on the use of screens in the bottom of flats. This can involve two things: drainage, or modifying the growth of the root system. Next on our panel will be Dieter Lodder who originally came from Ger-

many. He started with Monrovia Nursery; now he is at Armstrong Nursery He is the supervisor of propagation there and will be talking on propagation of lilacs. Ken Inose is with K & Y Nursery, Gardena, California. He will be talking on pumice as a rooting media. Then from Canada we planned to have with us Walt Van Vloten, but Walt didn't make it; he did send along his propagator, Harold Elzinga, again from Canada. And then Bob King from California Propagation Co. at Sepulveda. He again will be talking on something that we're all concerned about—the relationship in propagation between light, temperature, aand humidity. So, basically, this is what we will have this morning on our panel Ted, would you take over from here and talk on the screen bottom flats? Thank you.

## THE USE OF SCREEN BOTTOM FLATS FOR SEEDLING PRODUCTION

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Seedlings of many plants produce pronounced tap roots in their initial stage. This is especially characteristic of materials from arid and semi-arid areas such as the southwest of the United States and parts of Australia, South Africa, and the Mediterranean region. When transplanting from the seed flat to pots, it is necessary with these materials to drastically reduce the size of the root system in order to avoid bending of the roots. This very often results in loss of the seedling

One way to overcome this problem is by root pruning the seedlings prior to the transplanting operation. In the past this was sometimes done by using a material toxic to roots in the bottom of the flat. Copper was most commonly used, either as a screen laid in the bottom of the flat, or by coating the flat heavily with copper naphthenate. This is effective in killing the growing point of the taproot, but there is a danger of getting an excess of copper into the seedlings, which could lead to various nutritional disturbances.

In the College of Agriculture at UCLA, screen bottom flats are used for starting seedlings of plants native to the Nevada desert. These flats are built of one-inch thick redwood for the sides and discarded Saran screen for the bottoms. This screen is the grade usually used to give about 50% shade. To support the Saran a piece of 2" x 4" mesh turkey wire is used. The depth of the flat is determined by the size of the container to be used in the transplanting. A flat 1¼" deep is about right for transplanting to 2¼" peat pots. The flats are raised above