from the 15th of April to the 1st of May showing new growth of 4 to 8 inches.

LARRY CARVILLE: So the amount of new growth depends upon the genus and species.

RALPH SHUGERT: Yes. Our weather is very dark in December, January, and February, but when the days lengthen and the sky opens up in the spring the plants just take off.

DIRECT STICKING OF CUTTINGS IN GRO-PLUGS®

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Abstract. Many deciduous cuttings can be directly stuck into Gro-Plugs® and successfully rooted. This method greatly reduces stress encountered in transplanting the rooted cuttings into the field or container.

At the 1980 IPPS Eastern Region meeting we reported on the practical application of Gro-Plug® systems in growing ornamentals (1). That report primarily dealt with seedling-grown conifers. This report will give our experience in directly sticking softwood cuttings into Gro-Plugs®. This system allows us to overcome the problems of a short season here in northeastern Wisconsin and still transplant softwood cuttings out to the field or container the same season. We have used this system on many species and cultivars of *Berberis, Cornus, Cotoneaster, Euonymus, Lonicera, Physocarpus, Potentilla, Ribes, Rosa, Spiraea, Salix*, and *Weigela*.

CUTTING WOOD

Selection. Selection of proper cutting wood material is of paramount importance. The art of exactly when to take a cutting must be left to the individual propagator and the environment in which he is working. Cuttings should be taken only from true-to-name mother plants.

Cutting preparation. We take our cuttings in June as early as the wood is ready. The cutting wood is watered with Physan 20 at the rate of one tsp. per gal. of water. The wood is then rinsed with fresh water. We make the cuttings with two or more nodes and approximately 3 to 5 inches in length. The basal cuts are made ¼" below a node and the lower leaves are stripped off. The tops are pruned, in the case of shrubs, to force lateral growth.

STICKING

Media. We use our regular growing medium containing (by volume) Canadian peat moss, coarse perlite, and coarse vermiculite, (2:1:1). The medium is amended with calcium nitrate, treble superphosphate, potassium nitrate, calcium carbonate, dolomite limestone 80-90, GU-49, and Micromax. The formulation of our medium was previously described (1). We use ½ the recommended rates of GU-49 and Micromax. The pH of the medium is adjusted to 5.5 at equilibrium by using ½ our standard increment of calcium carbonate and dolomitic lime as described previously (1). The medium is pre-moistened to an optimum level for root initiation during the batch-mixing process.

Trays. The trays we use are our 73-cell groove tubes (1). Twelve of these trays fit our pallet rack. Two people can then easily handle a pallet rack which contains 876 cells.

Treatment and insertion. After the cuttings are made, they are dipped for one second in a 1,000 IBA quick-dip. They are then given a second dip into a powder containing 10% Benlate/Captan dust (2:1) in talc. We have found that the separation of the IBA and fungicide has been beneficial in our softwood program. The cuttings are inserted approximately 1 in. in the cell. We use 1 to 3 cuttings per cell depending on the item. Some types of cuttings may require the use of a dibble in forming a hole. Our reasonable expectancy for production is 4 trays per hour per person when making and inserting 1 cutting per cell and 2.5 trays per hour per person when inserting 3 cuttings per cell.

ROOTING CULTURE

Structure. After sticking the cuttings, the individual trays are placed on pallet racks in a polyhouse. A white opaque poly covering (approximately 50% shade) is used for approximately ⅔ the length of the house but excluding the bottom 4 ft on each side. The entire house is then covered with a 50% Saran shade. This results in approximately 75% shade under the poly, and good side ventilation. The poly prevents rain from waterlogging the medium. The ⅓ of the house covered with only the 50% Saran cloth is used in the first step of hardening off.

Humidity control. Since a growing medium is being used, rather than a rooting medium, precautions must be taken to prevent the medium from becoming waterlogged. In the past we have used the standard intermittent mist system, but with a great deal of manual control. Under the brightest conditions we would use a maximum of 2 seconds every 6 minutes.

Truly, humidity control is an art and must be constantly monitored by the propagator. Under cloudy, cool conditions no mist is used. The pH of the mist water has been adjusted by the use of sulfuric acid to 6.0 ± 0.2. Presently we are looking at a fogger or a boom mister as a replacement.

Integrated pest management (IPM). IPM begins with sanitation and good housekeeping. We apply fungicides every 7 to 14 days depending upon conditions. We use a Captan and Benlate mixture, or Dithane with a spreader-sticker, or Bravo without a spreader-sticker. They are applied on a rotating basis. After rooting has begun we add Malathion to each application. The crop is monitored for aphids, white flies, and root rot. Pentac, Resmethrin, and Banrot are used, respectively.

HARDENING-OFF CULTURE

Timing and structure. When visible rooting begins after 2 to 4 weeks, we start the hardening-off process. The first step is to move the pallet racks to the one-third of the polyhouse which has only 50% shade. They remain in this area a maximum of 3 weeks. They are then taken outside into the direct sun, where they will remain for an additional 1 to 3 weeks before going to the field or container operation.

Humidity. One of the key factors to successfully hardening off these plants is humidity control. Again, it is an art and must be closely monitored by the propagator. In the shade area the propagator will mist the plants by hand depending on weather conditions. This will also vary by species and cultivar. Once the rooted cuttings reach the outside, they will be misted only the first two or three days if conditions require. At that point they are subject to whatever humidity the weather conditions provide.

Fertilization and pest control. Fertilization begins with the amendments we have added to our medium. We begin a liquid N, P, and K application as soon as the cuttings reach the shade hardening-off area. This is done through an injector system where the pH of the water is first adjusted by sulfur acid to pH 6.0 ± 0.2. The liquid fertilizer contains 150 ppm N, 88 ppm of phosphorus and 130 ppm of potassium. Considerably less phosphorus may be satisfactory for other growers. The plants are fertilized each time they are watered. Integrated pest management continues throughout the hardening off process.

TRANSPLANTING

Containers. By mid-July we are able to transplant the fast-rooting items directly into containers. The plugs are carefully removed from the trays so as not to break the plug. There is little or no stress in transplanting and a constant fertility pro-

gram is continued. In our container operation we use a 100% hardwood bark medium. Most of the items are put into 2-gal. containers and by July or August of the following year they are ready for sale.

Field. The faster rooting items are ready for transplanting to the field in early August. The slower items are planted by the end of August. By the time the plants are transplanted to the field, they have developed a very solid root system and quickly become established. The plants are mulched with bark or wood chips to prevent heaving. By the following fall they will be excellent heavy liners.

SUMMARY

Disadvantages. This system does require more rooting space. Since the medium is a growing medium rather than a rooting medium care must be exercised to prevent it from becoming water-logged.

Advantages. Many deciduous softwood cuttings can be successfully direct stuck and rooted in Gro-Plugs®. This system greatly reduces the stress in transplanting and hastens establishment of the rooted cutting in the field or container. As a result, it helps to overcome the difficulty of our short growing season and eliminates over-wintering storage problems of rooted cuttings. Further, the system is very flexible as small amounts of plants can be easily grouped for special environmental requirements.

LITERATURE CITED

1. Pinney, T.S. Gro-Plug® systems and their practical application in growing ornamentals. *Proc. Inter. Plant Prop. Soc.* 30:312-318.

ROBERT EASTMAN: A comment on the depth of your tubes and the problem of roots occasionally growing up. We are using tubes with a minimum depth of 3½ inches and we have never had that problem.