Control Of Woody Root Systems Using Copper Compounds

Ian Gordon
Department of Plant Production, University of Queensland Gatton College, Lawes 3434 Australia

INTRODUCTION

Nursery production of woody plants has traditionally been a field-based production system. Undercutting or transplanting of plants during the production system has enabled the nursery producer to develop a well-shaped root system with no circling or other root distortions.

In many countries container plant production has become a dominant production technique for woody plants. In the case of the Australian nursery industry container plant production has become the norm. A container production system has many operational and marketing advantages over field production. The climate of Australia is more conducive to the production of woody plants in containers. The lack of any real winter dormancy over most of the country is a major factor in this country-wide trend to container plant production of woody plants.

Although the climate of northern Europe still encourages large-scale field production of woody plants, there appears to be an increasing move into container production. This is particularly noticeable at the propagation stage with large-scale commercial propagation of seed- and cutting-propagated plants being produced in small multicelled containers (Morgan, 1995).

The propagation stage is the most crucial stage in commercial nursery production and if root distortions are created on the plants during propagation the plants can be seriously affected later in their life, often long after they have left the nursery. The shape and volume of many multicelled propagation containers may be responsible for the development of root distortions and it is the aim of this paper to explore means by which the nursery producer can minimise the extent to which root system distortion will develop during nursery production of plants in containers.

THE NATURE OF THE PROBLEM

In a paper presented at the New Zealand Region annual conference in 1994, I outlined the types of root distortion problems that occur in nursery container production and the main reasons why these distortions occur (Gordon, 1995).

PREVENTION OF ROOT DISTORTION

There are three main strategies that can be used to reduce or eliminate the degree of root distortion which occurs with small plants in nursery containers:

1) **Avoid Leaving Young Plants in Nursery Containers for Too Long.** Keeping plants in the nursery for excessive periods of time inevitably leads to severe root binding. This is a serious operational problem for many nurseries and it requires a serious decision to destroy plants with badly spiraled roots, rather than to pot them up

into a larger container size. Potting plants with spiraled roots does not solve the problem; it merely masks the problem.

2) **Use Nursery Containers Which Are Designed to Minimise or Eliminate Spiraling of Roots.** There have been many examples of nursery containers which have been designed specifically to redirect the growth of roots so that spiraling does not occur. Containers which are designed to deflect the roots downwards and out through the container base so that air pruning of roots can occur are probably the most popular. Some containers also allow root development through slots in the side walls.

   There is no doubt that if these containers are used properly they will result in a major improvement to the quality of the root systems of woody plants. The real problem is that most nursery producers are reluctant to use these types of containers. Some of the reasons given are: "they are too expensive", "they don't fit our production systems", "our customers don't like them", "our staff don't like them", or "we can't grow a good quality plant in them". Whatever the reasons, most nurseries refuse to use these types of containers. This means that the customer is not getting the quality root systems which they should. It is also the reason why we are seeing this third option becoming a potentially viable one for the nursery industry.

3) **Use Chemical Compounds to Control the Young Developing Roots.** Most early work on evaluating the effect of copper compounds was carried out in the U.S.A. and Canada and was primarily concerned with coniferous forestry species such as pines and spruce (Beeson and Newton, 1992). Early problems focussed on how to apply the compounds to nursery containers. The most common method of application now in use is to incorporate the copper compound into a latex or acrylic paint and to paint or spray the compound onto the inside wall of the nursery container.

   Subsequently, a number of researchers have evaluated the technique with a wide range of woody ornamental trees and shrubs. Furuta et al. (1972), working in California, demonstrated that the technique could be used on many ornamental trees, including *Eucalyptus* species. Struve (1990), working at Ohio State University incorporated copper treatment of containers into a wider tree production system called "The Ohio Production System" (OPS). This system enables nurseries to produce tree whips to a plantable size in containers in 1 year compared to the 3 to 5 years normally required for conventional field production.

FORMULATIONS OF COPPER

A number of different formulations of copper have been assessed by different researchers. Copper carbonate was the formulation used by most early researchers but many forms of copper will produce similar root inhibition. However, copper hydroxide now appears to be the most widely used compound. Copper hydroxide is the active constituent of the registered fungicide Kocide™. It is manufactured by the

Griffin Chemical Company of Valdosta, Georgia, U.S.A. This company is currently marketing a product in the U.S.A. under the trade name of Spin Out^{TM} which consists of 7.1% copper hydroxide in a latex paint solution.

Spin Out^{TM} has now been registered in a number of countries—Australia, New Zealand, and some from Europe—for use as a root-controlling compound. The basic material consists of copper hydroxide incorporated in a latex paint. In some countries bulk supplies of the liquid preparation are sold for incorporation onto the inside surfaces of containers by the individual nursery producer.

The Griffin Chemical Company, which markets the product, is now offering a number of other options including polystyrene propagation containers with copper impregnated into the walls, pre-sprayed growing-on containers, flexible polyester growing bags with copper impregnated, and woven weedmat materials with copper incorporated to prevent root growth out through the base of containers. It is likely that we will see a wider range of pretreated products become available and these will certainly provide a greater convenience to the individual nursery producer.

In South Africa a similar product is available and is marketed under the trade name Prune^{TM}. This product was initially developed as a coating for polystyrene speedling type trays to prevent root growth in between the polystyrene beads of the trays. Root growth into the spaces between the beads of used trays makes seedling extraction very difficult and dipping of the trays into a solution of this compound eliminates the problem.

Prune^{TM} is now registered in Australia for root control in containers and is now becoming widely used by forestry nurseries and seedling producers, but I am not aware of any intent to market this product in Europe at this stage.

BENEFITS OF COPPER TREATMENT

Redistribution of Roots Within Container. The primary effect of the copper treatment is the prevention of root circling within the container. At the point where the root tip comes in contact with the container wall, the root tip ceases growth. Secondary lateral root growth develops from further back and when these laterals reach the container wall they are also inhibited or "pruned" by the copper.

Overall root distribution within treated containers is quite different to untreated containers. In an untreated container, most of the roots will be located on the outside of the ball of media in the interface area between media and container wall. This type of root distribution is relatively inefficient as most water and nutrients are located within the volume of media in the pot. With treated containers, the young feeder roots tend to be located within the container media volume rather than on the outside and this leads to more effective utilisation of water and nutrients from the growing media. A number of researchers have reported a greater total amount of growth on plants in treated containers and it is likely that this improved utilisation of water and nutrients is the principal reason.

In trials carried out at HRI Efford in England during 1994 and 95 a number of ornamental woody plant species were propagated from cuttings stuck in plug trays with and without a coating of copper. It was established that the plants from the treated trays were much easier to extract and that they had a much denser root system with fewer emergent roots. (Scott, 1995)

These plants were then potted into treated and untreated 9-cm liner pots and grown on. Again it was found that the plants from treated pots had a much greater density of root of a more fibrous nature compared to the plants in the untreated pots.

Longer Shelf Life for Plants in Small Containers. Probably the main reason why we experience serious problems with woody plants grown in small nursery containers is that frequently the seedlings remain in the containers for far too long before planting out or potting on. This may not be the fault of the nursery producer as factors such as availability of water for planting, weather conditions, and land preparation may contribute to this problem.

Plants grown in copper-treated containers will not experience the extensive root-circling problems experienced in untreated containers. This means that the plants can be held in treated containers for much longer before planting out without root distortion problems occurring.

Prevention of Root Growth Through the Base of Containers. In many nurseries container plants are grown on ground level beds with a capillary sand base. Root growth through the drainage holes of the container into the sand layer beneath the pot is frequently a problem. Where this rooting through occurs a large proportion of the young feeder roots develop outside of the container and are lost during order assembly. Work carried out at HRI Efford (Scott, 1995) determined that SpinOut™ greatly reduced the amount of rooting through in most species tested.

Many other nurseries use closely woven weedmatting as a surfacing material over sand or gravel beds and root growth downwards through the weedmat can also be a serious problem. HRI Efford has also shown that a copper compound applied to the surface of the weedmat will also markedly restrict the number of roots growing through the weedmat (Scott, 1995). Similar work carried out by the Forestry Authority Research Division, Midlothian, Scotland, has confirmed this ability for copper to inhibit root growth through woven weedmatting (Morgan, 1995).

Better Root Establishment After Planting in the Field. Burdett (1978), working with lodgepole pine in Canada, demonstrated that roots which were inhibited by copper treatment in the nursery container would resume growth once the plant was planted into a field position. This means that the natural pattern of root development will occur after these treated plants are planted out. As the root system grows outwards and downwards in the natural pattern, the root system will provide greatly improved anchorage compared to untreated root systems with distortions present.

It also means that the root system is better able to seek water and nutrients and that results in faster establishment after planting out. Many other researchers have confirmed that plants with copper-treated root systems have faster rates of establishment after planting out compared to plants with untreated root systems.

Increased Survival After Planting Out. McDonald et al. (1981) compared the survival rate of ponderosa pine planted into a forest location from copper-treated containers and from containers which had varying patterns of holes for air pruning to occur. Survival of plants which had been exposed to copper treatment was 93%, while survival of plants from air pruning containers was 39%.

CONCLUSION

It is clear from the work of a number of researchers that the use of copper for woody-root-system control is an effective substitute for the various air pruning systems outlined earlier in this paper. As more formulations of copper are registered, its popularity with nursery producers will increase.

The most significant current barrier to its use by nurseries is that it has to be applied to containers in the nursery. This constitutes another step in the plant-production process and an additional cost to the producer and many nursery producers will be reluctant to use the products for this reason. There is undoubtedly an opportunity here for the pot manufacturers to follow the lead of the Griffin Chemical company in the U.S.A. and supply pretreated containers directly to the nursery producer. The additional convenience of purchasing pre-treated containers may make acceptance of this process by nursery producers more likely.

LITERATURE CITED

Beeson, Jr., R.C. and **R. Newton.** 1992. Shoot and root responses of eighteen south eastern woody landscape species grown in cupric hydroxide-treated containers. J. Environ. Hort. 10(4):214-217.

Burdett, A.N. 1981. Box-pruning the roots of container-grown tree seedlings. Proc. *Canadian containerised tree seedling symposium. Ministry of Natural Resources.* Ontario. Canada.

Furuta, T., W.C. Jones, W. Humphrey, and T. Mock. 1972. Chemically controlling root growth in containers. Calif. Agric. 26:10-11.

Gordon, I. 1994. Control of woody root systems using copper compounds. Comb. Proc. Intl. Plant Prop. Soc. 44:416-424.

McDonald, S.E., R.W. Tinus, and **P. Reid.** 1981. Proc. Canadian Containerised tree seedling symposium. Ministry of Natural Resources. Ontario. Canada.

Morgan, J.L. 1995. SpinOut™ performance trials. Forestry Authority Research Division, Midlothian, Scotland.

Scott, M. 1995. The use of SpinOut™ to control the root structure of container grown nursery stock. HRI Efford.

Struve, D.K. 1990. Container production of hard-to-find or hard-to-transplant species. Comb. Proc. Intl. Plant Prop. Soc. 40:608-612.