understand how hormones influence plant growth and development and use them wisely.

LITERATURE CITED

1. Bidwell, R. G. S. 1974. Plant Physiology. Macmillan, New York
2. Bleasdale J. K. A. 1973. Plant Physiology in Relation to Horticulture. Macmillan, London
3. Canny M. J. 1981. A systems approach to the control of plant development. Abstracts, XIII International Botanical Congress, Sydney
4. Criley R.A. and P.E. Parvin 1979. Promotive effects of auxin, ethephon and daminozide on the rooting of *Protea neriifolia* cuttings. *Jour. Am. Soc. Hort. Sci.* 104:592-596
5. Hartmann, H. T. and D. E. Kester 1975. Plant Propagation: Principles and Practices. 3rd ed. Prentice-Hall, Inc., Englewood Cliffs, New Jersey
6. May P. B. 1984. Preparation of liquid hormones. *Proc. Inter. Plant Prop. Soc.* 34:70-74.
7. Metzger J. D. and J. A. D. Zeevaart 1980. Identification of six endogenous gibberellins in spinach shoots. *Plant Physiol.* 65:623-626
8. Noggle G.R. and G. J. Fritz 1983. Introduction to Plant Physiology. Prentice-Hall, Inc., Englewood Cliffs, New Jersey
9. Pharis R. P. and C.C. Kuo 1977. Physiology of gibberellins in conifers. *Can. Jour. For. Res.* 7:299-325
10. Salisbury F. B. and C. Ross 1978. Plant Physiology. Wadsworth, Inc., Belmont, Calif.
11. Vanderhoef L. N. and R. R. Dute 1981. Auxin-regulated wall-loosening and sustained growth in elongation. *Plant Physiol.* 67:146-149
12. Wightman F 1983. Plant auxins and their role in the regulation of growth and development. *Abst 23rd Ann. Meeting, Aust. Soc. Plant Physiol.* May, 1984

AVOIDING PROBLEMS IN SEEDLING AND BUDWOOD SELECTION IN CITRUS

IAN S. TOLLEY

Box 2

Renmark, South Australia

There are many criteria that can be used to select good propagation material. For everyone I might suggest, there will be many more you can add which are of a specific nature to the plants you are propagating.

Let me use two examples to illustrate the difference between areas of decision and happenstance in propagation.

Seedlings for citrus come from a wide range of seed sources, many of which were, and still are, chosen for their ease of growing by the propagator, but not necessarily the best material needed by the end user.

An example is the use of Rough lemon as a rootstock. It is a proven poor performer in the field, and has long since been supplemented by much improved rootstocks, but it is still being used today. It is marvelous stock to propagate but should not the main aim be to reflect the needs of the end user?

If seed is the product then great care needs to be exercised to harvest it fresh from the tree to avoid soil contaminants. Heat treatment has to be done accurately and an understanding of the requirements of fungicide protection is also necessary to provide an ongoing repetitive production of reliable seed.

There is always a chance that mistakes will occur but if good records are kept, then when they do occur, they can be more easily traced and analysed. This improves the service to the end user.

Many seed sources are fortunately true to type, exhibiting an acceptably high proportion of nucellar uniformity. Culling processes in these stages are not difficult *but beware if seed has been taken from seedling trees and mixed.* How then can you tell which plant is true to type or which is zygotic?

If you are producing seed for your own use or for sale, then propagate a line of vegetatively produced mother plants from your best selection, and be assured that future grafting and selection of seed or cuttings will be uniformly achieved.

For example, in the citrange group of hybrid rootstocks Troyer and Carizo are popular selections. We find it essential to cull at least 30 to 40% to achieve visual uniformity and reduce to an acceptable level the chance that the end user may have a seedling stock which does not have the performance characteristics expected of the particular clone.

Once the scion has been budded to the particular seedling it is doubtful if anyone will know if the combination is faulty, and the grower may well blame his management for the poor growth performance, never knowing that it may well have been an initial lack of culling by the original propagator.

A further area worthy of intensive effort is to take whatever steps are necessary to achieve rapid, and even more essential, uniform germination. This may entail structural considerations and the use of bottom heat, controlled watering, etc.

But what concerns me more is the treatment of seed prior to sowing. There are many ways to improve this vital area:

1) Improving uniformity — selection of the largest seeds in the batch.

2) Seed coat treatment and removal.

3) Pre-germination.

Any of these will lead to more uniform germination in the shortest period of time, and enable you to improve the selection process of seedlings produced, since you will have removed some of the major variables which undoubtedly contribute ongoing problems to the final stages of a usable plant.

The Selection of Budwood and Cutting Material. This is recognized by most propagators as an important skill developed by experience and training — but how many propagators spend as much time preparing the mother trees or plants for budwood or cutting collection?

How many use leaf analysis as a regular tool to ensure the propagation material is not deficient in one nutrient or another and, as a consequence, blame poor strikes or poor budwood takes on the season?

How many propagators manipulate fertiliser regimes on a seasonal basis to ensure that the primary plant material is in prime condition?

How many are actively training mother plants using techniques which can include leaf removal and hormone spraying to control the quality of the propagation material for the time you wish to propagate?

I have found that when we have poor results in budding it can almost always be traced back to mother trees in poor condition, producing poor budwood.

It is so easy to concern ourselves with the immediate reasons — it was too hot or too cold, or the stocks needed extra water before, during, after the budding, etc.

I suggest, however, that looking into the background may show more productive areas for improving propagation techniques and results. I am sure that most of us share the frustrations of using the best available propagation material at the time. Many times we know it to be second rate but it is all that is available.

In an endeavour to control some of the factors associated with getting the best budwood at the right time we have experimented with growing mother plants in macro-pots. These macro-pots are made with a wire mesh frame, lined with black polythene, placed on small wooden pallets covered with shade cloth. These macro-pots are filled with our standard potting mix. With an irrigation system and a controlled fertiliser program we have achieved a reliable method of controlling growth. We have developed this system over a period of 5 years.

With a spacing of 800 macro-pots per acre one can imagine how little area is required to provide a substantial, if not total, supply of all the propagation material required. The material is on site and ready when you need it.

FROM TISSUE CULTURE TO FOREST TREES

V.J. HARTNEY and E.D. KABAY

CSIRO, Division of Forest Research
Canberra, A.C.T., and
Alcoa of Australia, P.O. Box 172,
Pinjarra, Western Australia 6208, respectively

Abstract. Micropropagation of eucalypts and many other kinds of forest trees is now technically possible. There are several methods available to reduce the cost of producing plants by micropropagation and there is potential for integrating tissue culture techniques into nursery systems developed for seedlings. However, the largest cost in micropropagation is the labour and time entailed with manual subculturing techniques. Automatic, intelligent machine systems could overcome this restriction and revolutionize clonal forestry.

INTRODUCTION

Clonal plantations of forest trees are now a reality in many parts of the world. It is the main method of establishing plantations for species that can be easily propagated vegetatively, like poplars. Even for species that are more difficult to propagate, such as the eucalypts, clonal plantations are being established on a large scale: Brazil plants more than 10,000 ha per annum (3), the Congo over 6,000 ha (6) and France plans 2,000 ha (14). Most of these plantations are established from rooted cuttings of hybrid eucalypts. This development in forestry is not surprising since it enables clones to be planted which are adapted to specific sites or management objectives. Such clones might have been selected for maximum growth or adaptation to harsh environmental conditions such as mining dumps or saline soils. Clonal forestry also allows hybrid vigour to be exploited.

When we examine the methods of propagation of commercial plant species we find that vegetative propagation is the preferred method for most of the high-valued horticultural plants, e.g., perennial fruit crops and ornamentals. However, broad-acre crops, such as annual cereals, forage crops, and vegetables, are usually propagated by seed because each plant