Another chemical germination inhibitor, coumarin, can be used on seeds that do not have a light requirement to induce a light requirement. Cold temperatures can also remove some forms of chemical inhibition by possibly slowing production of enzyme inhibitors and allowing normal development to proceed.

Some modern concepts in removing dormancy problems lie in the field of genetics whereby selective breeding programmes are instituted using low dormancy species crossed with high dormancy species. Offspring should have a dormancy period similar to the geometric neon between the parental dormancy periods.

REFERENCES

Allard "Principles of Plant Breeding"
Greulach "Plant Functions and Structures"
Hartmann & Kester "Plant Propagation: Principles and Practices"
Sager & Ryan "Cells Hereditary"

OBJECTIVES AND RESEARCH METHODS IN THE ROOTING OF APPLE CUTTINGS

D.S. TUSTIN

Department of Horticulture
Massey University, Palmerston North

This paper is a progress report outlining research methods at Massey University being used in the study of the physiology of root initiation of cuttings. While this work is being conducted on apple rootstock hardwood cuttings, the methods used and perhaps the results obtained, will have relevance and application in the propagation of other plants by cuttings.

The prime objective of this research is to investigate why two cultivars of the same plant species, have a widely differing ability to form adventitious roots when treated and planted as cuttings. By using apple rootstocks there is the added advantage that if we can get cuttings of apple rootstocks to grow successfully, then it is a much easier and less laborious task than raising rootstocks by the traditional methods. Apple rootstocks are useful research plants for several reasons. Firstly, workers at East Malling have described a system of propagation of hardwood cuttings which has had some success. Also preliminary studies on rootstocks have resulted in obtaining two rootstocks, one which roots readily, the other one very poorly.

The East Malling recommendations for propagating apple rootstock hardwood cuttings are: dipping the base of the cutting in a 50% alcohol solution of 2,500 ppm IBA for ten seconds and then planting in a heat bed with a temperature of 21-25^{0}C at the cutting base. In our preliminary experiments we have found that 'M.M. 106' will give virtually 100% of the cuttings rooted, while 'E.M. 12' gives only 0 to 10% rooting.

Therefore, we have two vastly different responses which lend themselves very well to studying the factors which either cause the cutting to form roots or conversely prevent it from forming roots. Since establishing the differences in root initiation between 'M.M. 106' and 'E.M. 12' we have studied both rootstock's responses to root initiation from a period from late autumn through until early spring, coinciding with bud break and renewed growth of the stock plants. Since plant hormonal levels and interactions are supposed to control plant growth and development, one of the main parts of the experimental work is involved in the study of relative levels of the various hormonal promoters and inhibitors, within the two rootstocks and also interactions between these hormones. It is hoped that this study will help reveal some of the factors involved in the co-ordinated control of root initiation. As well as this, we intend to study the mechanism involved when the auxin, IBA, is applied to cuttings of each cultivar, since there is some factor involved which is operating in 'M.M. 106,' but does not seem to be in 'E.M. 12'.

Figure 1 shows the results of root initiation trials with the two rootstocks for cuttings taken for a period from autumn (April) through early spring. It is quite evident from this, that the treatments we are subjecting the cuttings to, are by no means the only limiting factors involved in root initiation. It is at this stage we must analyse the internal growth promoters and inhibitors of the respective rootstocks.

In conjunction with the root initiation trials, stem tissue samples are taken at each of the sampling dates and these are analysed for hormonal content within the two rootstocks. In the same experiment, samples of tissue from the bases of cuttings which have been on the heat bed for three weeks are taken. This is at the stage when root initiation processes should be just getting under way and so the hormonal balances within the plant which is going to form roots are assumed to be in a condition conducive to root initiation. A comparison of the hormonal levels from 'M.M. 106' and 'E.M. 12' may show large differences which can be correlated with the degree of root initiation obtained.

Data obtained from the analysis of stem samples has shown some interesting trends, in the relative levels of plant hormones in the two rootstocks. The main inhibitor in higher plants, abscisic

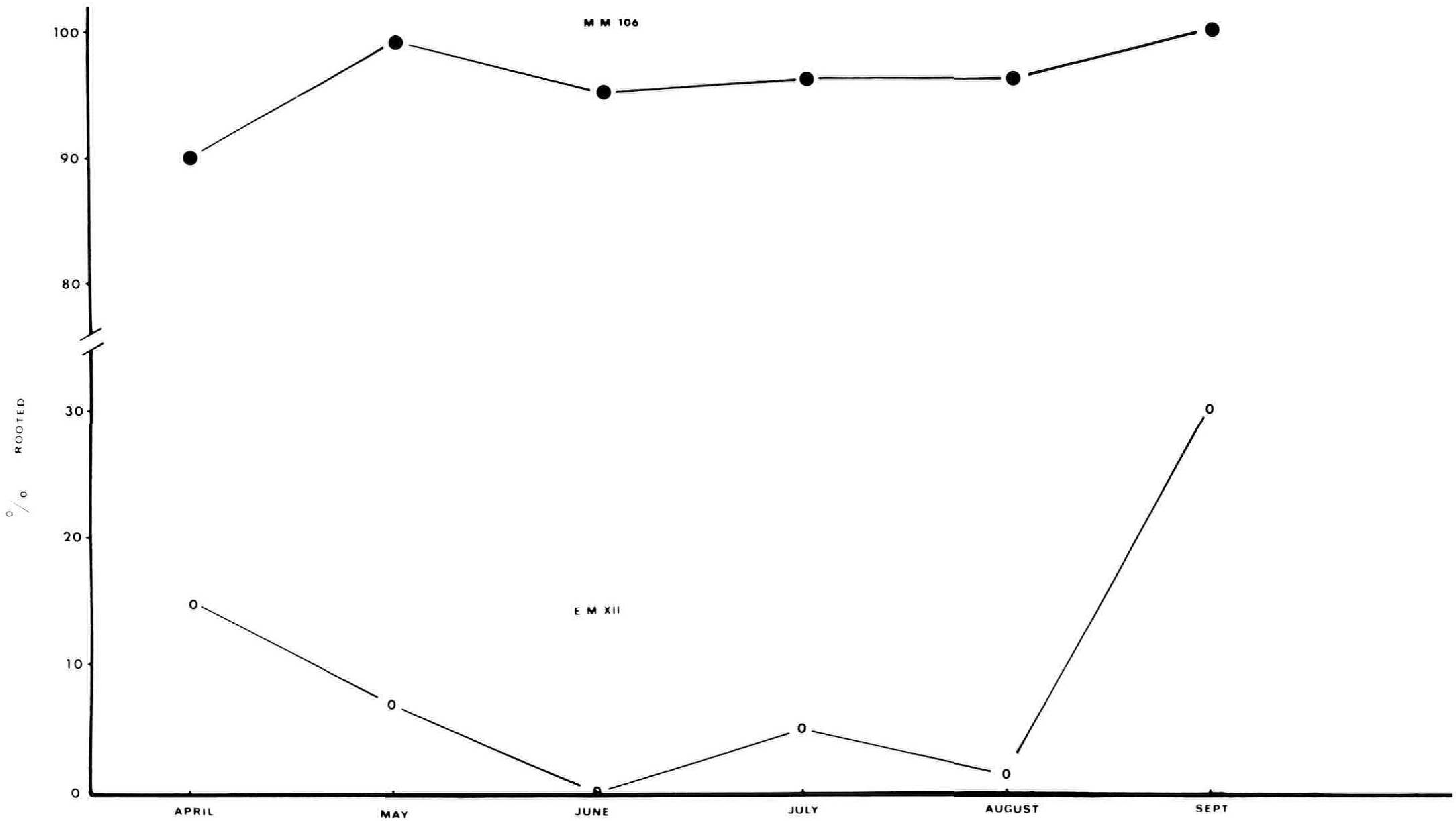

Figure 1. Comparison of root initiation responses of "M.M. 106' and 'E.M. 12' apple rootstock hardwood cuttings.

acid, has shown a considerable increase in level in both rootstocks as they enter dormancy as would be expected. In samples which were taken from the heat bed after three weeks, the level of this inhibitor had decreased dramatically in both 'M.M. 106' and 'E.M. 12'. Since this decrease in level occurs in both rootstocks, it seems that ABA is not directly involved in the root initiation process but leads to postulation that with its rapid decrease in the cuttings, the tissue has undergone a change from a dormant condition to one which is potentially capable of renewed growth. Therefore, if the rootstocks are in a potentially active state after several weeks on the heat bed, the limiting factor which will determine whether root initiation will occur, may be growth promoter levels.

It is now universally accepted that auxins, particularly indoleacetic acid (IAA), promote adventitious root initiation. The levels of auxins present in 'M.M. 106' and 'E.M. 12' are being measured in the same tissue samples from which abscisic acid was measured. A large difference in IAA level has been detected between 'M.M. 106' and 'E.M. 12', 'M.M. 106' having a considerably higher level present (Figure 2). If we consider that, with the reduction of abscisic acid in the cutting base and the differing levels of IAA, the balance between these two hormones in 'M.M. 106' is more in favour of root initiation than in 'E.M. 12'; i.e., the proportionally larger quantity of IAA present in 'M.M. 106' would seem more likely to stimulate renewed development within the cuttings. As far as our analyses have progressed, this significant difference in IAA level between the two rootstocks has consistently occurred.

In association with the hormonal analysis of stem tissue we intend to use the mung bean root initiation bioassay for detecting rooting promoters other than IAA. This bioassay was developed by Dr. Charles Hess and has been used to explain differences in rootability of plants despite similar auxin levels. Generally high levels of unidentified promoters — called cofactors — have been found to be present in plants which grow easily from cuttings. By using this technique we may find additional compounds which, in association with IAA, may stimulate root initiation.

At present we are setting up an experiment which will evaluate all the information obtained from the hormonal studies. If 'M.M. 106" has higher levels of hormonal and co-factor promoters, then by grafting a scion of 'M.M. 106' onto 'E.M. 12' rootstock, we might expect some of these promoters to influence the biochemical condition of 'E.M. 12' and improve its behaviour in root intiation. Reciprocal donor grafts — using both 'E.M. 12' and 'M.M. 106' — are to be made and, one month prior to planting as cuttings, the stems will be girdled below the graft union. A record of root initiation trials will be compared with samples taken and

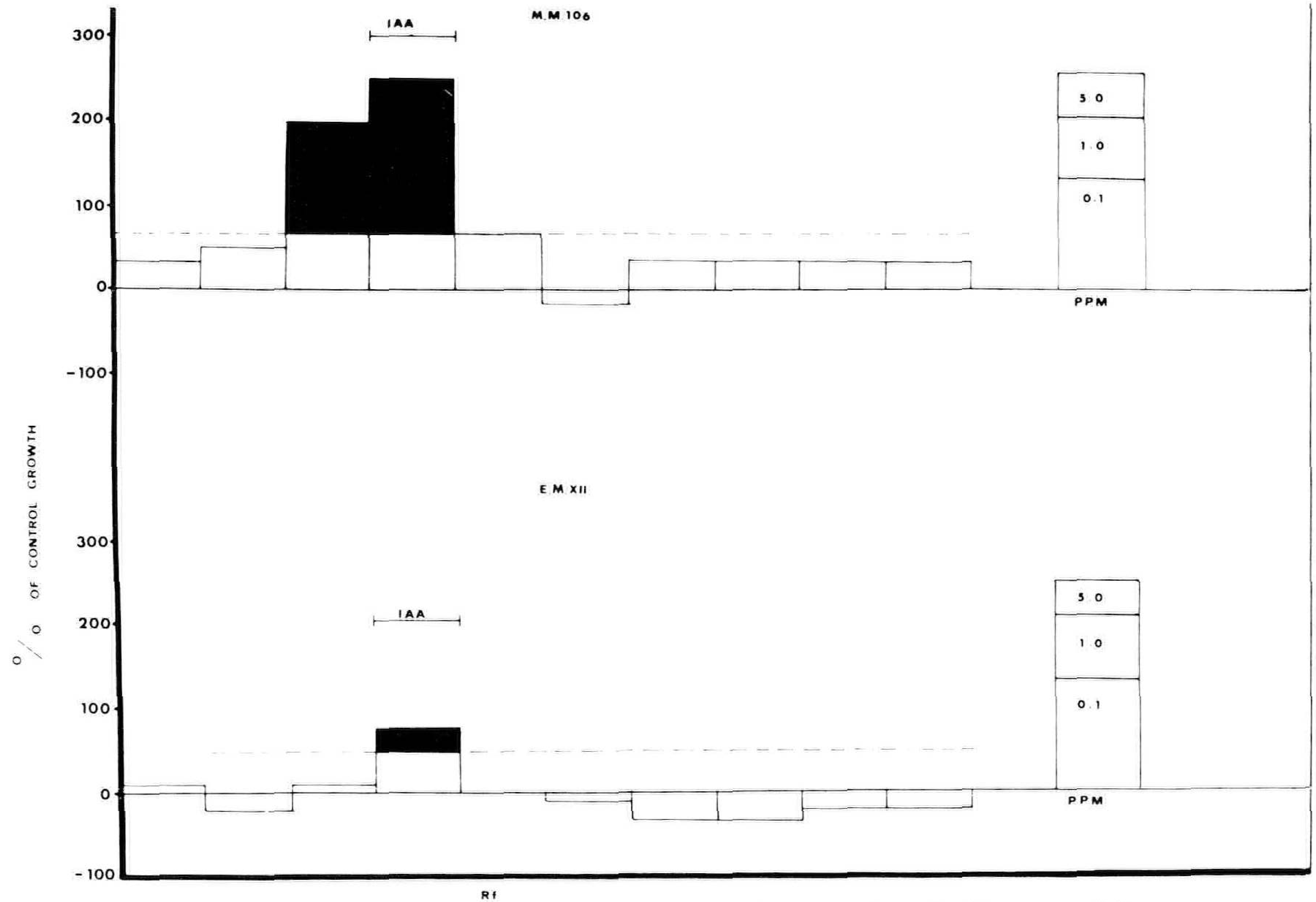

Figure 2. Comparison with growth promoters by oat coleoptile bioassay of the acidic ether fractions of stem tissue samples taken in April.

analysed for hormones and co-factors. This ought to demonstrate some of the limiting factors in root initiation.

The final aspect of research to be done will be a study of the metabolism and breakdown of IAA within the two rootstocks. This will be achieved by using radioactive IAA, which allows easy tracing of breakdown products of IAA. Since 'M.M. 106' roots more readily than 'E.M. 12' we might expect a difference in the metabolism of IAA to occur. A recent research report on this type of study on plum cuttings has suggested that synthetic auxin IBA, when applied as a rooting hormone, does not act as an auxin itself but acts as a protector of IAA and directs IAA to form certain compounds which could be used in the formation of roots. This effect will be investigated to see if a similar system is operating in apple cuttings. If this effect does prove to operate in apples then the importance of IAA levels within the cutting will be highly significant in terms of the ability to form roots. In conjunction with this work, it is hoped to use radioactive IBA to study the influence of this auxin on the system above and to compare the metabolism of IBA and IAA in the cutting base.

RESEARCH ON THE NUTRITION OF CONTAINER-GROWN PROTEACEAE PLANTS AND OTHER NURSERY STOCK

M.B. THOMAS
Department of Horticulture,
Lincoln College, Canterbury, N.Z.

Abstract. The nutrition of six species of plants was examined using peat: perlite (1:1) mixes and slow-release fertilisers in factorial experiments. Most plants responded strongly to nitrogen while there was little response to phosphorus. Medium phosphorus levels proved fatal for *Protea repens* and depressed the growth of *Grevillea rosmarinifolia* particularly when accompanied by high nitrogen. Tomatoes responded to very much higher fertiliser levels than proteaceoks and other shrubs and there was a very strong N x K interaction with tomatoes even though they were grown in winter.

REVIEW OF LITERATURE

Gardeners and nurserymen alike have often found plants in the Proteaceae difficult to grow unless certain requirements are met. Plants may die early and can be particularly difficult to grow in containers; a comparison of their growth response with other nursery plants like camellia, erica and tomato will give an insight into their relative nutritional requirements.

Various reasons have been put forward for losses of proteaceous plants including disease and faults with general culture. Hewett (18) states that attack by the fungus *Phytophthora*