Project title:	**Nursery stock propagation: nutrition of rooted cuttings in modular trays**
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Project Leader:	**Margaret Scott, HRI Efford**
Report:	**Interim report (Year 1-2 of first phase of work)**
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GROWER SUMMARY

Headline

- Phosphate, applied in a liquid feed programme, has potential for manipulation of cutting growth, either applied after rooting to enable pinching for primary branch framework in the modules, or a few weeks before potting to plugs which have been held for varying periods, to promote root:shoot activity and aid establishment and early growth.

Full results will not be available until Phase 2 of the work, currently underway, is completed. The Final Report, due early 2004, will contain the full results, discussion, financial benefits and guidelines for practical implementation, of both Phases of the work. Consequently, this Interim Report presents a summary of main results from Phase 1 of the work.

Background

Quality cuttings with active root:shoot growth establish and grow away faster, with greater uniformity within batches of material, than harder, starved material, and this is reflected in the final grade-out at marketing. Ideally, cuttings should be potted-on shortly after propagation while still in active growth, and able to benefit from a full growing season. Inevitably, however, delays occur due to pressure on potting timetables, lack of space for growing on, or as markets demand more scheduled batch production, and rooted cuttings can be held for varying periods of time before potting. In these circumstances, maintenance of cutting quality becomes an important consideration. Two methods of nutrition are routinely used; liquid feeding after rooting, or incorporation of controlled release fertiliser (CRF) in the rooting media. With the majority of HNS propagation now in modular trays, mini granule CRF is necessary to achieve a more even distribution between cells, and these are now only available in a 3-4 month formulation before supplementary feeding is required.

Earlier MAFF (now DEFRA) work at HRI Efford in the 1980's had looked at use of liquid feeding after rooting, and showed that a routine N:K_20 feed maintained quality without excessive growth occurring. Inclusion of phosphate promoted root and shoot development, which could become overcrowded and lose quality if not potted on in time. This has led to this work to see if phosphate can be used to trigger root:shoot growth, when applied shortly before potting, where cuttings held over an extended period, having been maintained until then with an N:K_20 feed programme, with the objective of improving establishment and early growth, thus overcoming problems of overcrowding early on.

The earlier MAFF work also showed that incorporation of CRF in the rooting media produced benefits of earlier growth compared with liquid feeding after rooting, and reduced the problems of waterlogging when trying to liquid feed over the winter. This early flush of growth, as a result of using CRF, would be of benefit for stopping back to produce the early branch framework in the plug stage.

The focus of the programme of work is two-fold:

- Role of phosphate in manipulating triggering growth

- Systems of nutrition

Work covers both late summer and winter propagation periods, and will provide building blocks of information to help develop nutrient regimes for maintaining cutting quality and/or triggering activity, to provide the best possible start to the production cycle, even if cuttings have to be held for extended periods pre-potting.

Phase 1 of the work (1998-2001) has been completed, with main results reported here in summary format.

Phase 2 of the programme (2001-2003) is still in progress, with the final report, incorporating full results, together with discussion, financial benefits, and guidelines for practical implementation from both Phases of the programme is due early 2004.

Summary of Results

PHASE 1

Objectives

1. To examine the use of phosphate to induce root/shoot activity shortly before potting, in order to improve establishment.

2. Compare methods of nutrition for maintaining quality of rooted plugs (Liquid feeding v CRF).

3. Determine the importance of trace element additions during propagation (Winter propagation only).

4. Compare rooting in a peat:bark and coir:bark rooting media (Winter propagation only).

5. Monitor whether a nutrient charged zeolite has potential to replace CRF in the rooting media (Summer propagation only).

1. ROLE OF PHOSPHATE

Investigation of whether application of phosphate later in a liquid feed programme promotes root/shoot activity prior to potting, for cuttings held in modular trays over an extended period.

Summer strike (late August 1998) - *Azalea* 'Rose Greeley', *Weigela florida* 'Variegata'

Rate of feed applied after rooting (ppm)						**N : $P_2 0_5$: $K_2 0$ +**		**additional $P_2 0_5$ applied six weeks before potting**
A	0	:	0	:	0			
B	50	:	0	:	50			
C	50	:	25	:	50			
D	50	:	50	:	50			
E	50	:	0	:	50	+	25	} Applied 6 weeks
F	50	:	0	:	50	+	50	} before potting at
G	50	:	0	:	50	+	100	} fortnightly
H	50	:	0	:	50	+	200	} intervals
J	50	:	25	:	50	+	100	} Applied 6 weeks
K	50	:	25	:	50	+	200	} before potting
L	50	:	25	:	50	+	400	} every fortnight

Cuttings rooted in a 50:50 peat:fine pine bark mix.

Liquid feed applied after rooting at weekly intervals, until triggering treatments started, when treatments E-L were applied fortnightly, but with N:$K_2 0$ increased to 100 ppm to achieve similar application of N and $K_2 0$ across all treatments.

Results

***Azalea* 'Rose Greeley'**

- As to be expected, cuttings which received no maintenance feed gradually starved and lost vigour.

- A maintenance feed of N:$K_2 0$ held a darker foliage colour than other treatments, while limiting new extension growth, thus avoiding overcrowding. This, however, reduced the potential for multiple stops in the plug tray.

- Application of phosphate in the maintenance feed, following rooting, boosted both root and shoot growth, with effects more marked as rate of P increased. With *Azalea* this response to P was accompanied by a paling - yellowing of foliage, especially at the higher rate of 50 ppm $P_2 0_5$, and linked to a marked increase in % P in the foliage.

- The P triggering treatments were deliberately delayed until cuttings had been held in the modules for 12 months, in order to see if they would respond to treatment after being held for such an extended period.

- There was an immediate and marked response to the phosphate triggering treatments, with a flush of new growth obvious within 10 days of applying treatments. This effect was particularly marked with the material which had not received phosphate during the maintenance period (Plate 1a & 1b), though there was still an advance in growth from application of P pre-potting where material had received a 25 ppm $P_2 0_5$ maintenance feed while being held in the module tray. This triggering of growth was also accompanied by an increase in shoot number. Maximum response to treatment in terms of growth and increased shoot number occurred at the 100 - 200 ppm $P_2 0_5$ triggering treatment. However, as seen in the maintenance phase, application of increased rate of P was linked to a marked yellowing of foliage, and at the higher rates some foliage necrosis (Plate 3a). Again foliage analysis showed a marked increase in P uptake as rate of application increased.

- P triggered cuttings were potted into 90 mm pots in a standard peat based mix, 6 weeks after treatments started, and within 2-3 weeks foliage from even the yellowest treatments had 'greened' up and were continuing to grow away strongly.

- The P triggered plants established and grew away faster than those which had not received any supplementary P pre-potting, though with the flushing habit of growth of this species, the apparently starved and less advanced cuttings at potting gradually caught up (Plate 2).

- A few plants failed to establish satisfactorily in all treatments receiving supplementary P in either the maintenance or triggering phases of growth, and was most marked where cuttings had received the 50 ppm $P_2 0_5$ treatment during the maintenance period (Plate 3a & 3b).

- P triggering was no substitute for early or timely potting (Plate 3c). However, where material had been held for varying periods in the modules, then P applications pre-potting offers a means of triggering cutting activity and consequent improvement in establishment and early growth post potting.

***Weigela florida* 'Variegata'**

- Results with *Weigela* followed a similar pattern to those observed in *Azalea,* though there was no problem of foliage chlorosis with this species.

- *Weigela* did not appear to take up additional P into the foliage in response to increasing rates of application until levels of 200 and 400 ppm were applied during the P triggering phase.

Winter Strike (mid November 1998) *Juniperus communis* 'Repanda'
Viburnum tinus 'Eve Price'

Treatments were similar to those outlined for the summer strike.

Results

***Juniperus communis* 'Repanda'**

- 1998/99 proved a particularly difficult season for propagation and Juniper cuttings suffered a severe delay in rooting, and root establishment in the plug was also extremely slow after rooting started. Consequently no treatments were possible during 1999 and maintenance treatments started March 2000.

- Despite the delay in starting maintenance feeds, Juniper response was marked, following a similar pattern to that observed with *Azalea.* Thus only a small increase in growth was observed where the N:K_20 feed was applied, though colour was better in these trays compared to the unfed cuttings (Plate 4b)

- Application of P in the maintenance feed produced a marked increase in growth, and at 50 ppm P_20_5 cuttings were twice the size of those in the unfed trays (Plate 4a).

- Response to the P triggering treatments was also marked, the previously unfed trays flushing into growth within 3 weeks of treatments, with an even faster response to treatments where 25 ppm P_20_5 had been applied in the maintenance feed (Plate 4c & 4d). As with *Azalea* and *Weigela,* this triggering of the flush of growth pre-potting improved speed of establishment and early growth.

- There were no signs of chlorosis with the Juniper, even at the higher rates of P applied, and foliage analysis showed little difference in P uptake between the various treatments.

***Viburnum tinus* 'Eve Price'**

This species proved difficult to hold for an extended period in the module trays, starving very quickly at the relatively low rates of nitrogen being applied, and root systems continuously pushing the cutting out of the plug. Consequently, this species was only taken through to the maintenance treatment phase of the trial.

- There was little difference observed between treatments that were unfed, or receiving 50 ppm N:50 ppm K_20 or 50 ppm N:25 ppm P_20_5:50 ppm K_20, all treatments showing signs of N starvation. However, increasing the maintenance P feed to 50 ppm did produce an increase in growth and shoot length, though as with *Azalea*, was accompanied by a significant paling of foliage.

2. SYSTEMS OF NUTRITION

This programme was designed to investigate methods of maintaining cutting quality after rooting where mini CRF granules were incorporated in the rooting medium, as well as comparing incorporation of CRF with liquid feeding after rooting.

Summer Propagation (early September 1998) *Cotoneaster* 'Cornubia'

Rooting media:	50:50 peat:fine bark
Nutrition during rooting:	Nil 0.5 kg/m^3 Osmocote Plus or Multicote mini granules (3-4 months) incorporated.
Maintenance feeds after rooting:	Nil Top dressing with appropriate CRF (30g/m^2) Weekly liquid feed of 50 ppm N:50 ppm K_20

Results

- The cold 1998 season delayed the take for the 'summer' strike.

- Benefits from incorporation of mini CRF granules in the rooting media were clearly demonstrated, with these trays producing a much earlier flush of growth compared to those in unfertilized trays due for liquid feeding after rooting.

- The early flush of growth in the CRF incorporation treatments meant that pinching back to form the primary branch framework was possible in the module tray.

- In this work the Multicote mini granule appeared to be releasing faster than Osmocote, cuttings having a greater amount of growth and a darker foliage. This was confirmed with the company from analyses, though should not have been the case. A repeat of the trials with another batch of material confirmed that it produced similar results to Osmocote mini granules.

- While early response to CRF was good, these trays appeared to start to 'run out of steam' within 3 months of incorporation, requiring supplementary nutrition to maintain quality, if held longer than that.

- With this relatively vigorous species, the top dressing of CRF mini granules proved the most effective treatment in maintaining quality, and indeed producing a faster flush of growth for pinching back to continue improving branch framework.

- Application of the 50:50 N:K_20 liquid feed programme provided sufficient nutrients to maintain foliage colour without excessive growth.

Winter Strike (mid November 1998) *Viburnum tinus* 'Eve Price'

Rooting media	50:50 oeat:fine pine bark 50:50 coir:fine pine bark
Nutrient incorporation in rooting media:	Nil Trace elements @ 300 g/m^3 FTE WM 255 Osmocote Plus mini CRF @ 0.75 kg/m^3 Multicote mini CRF @ 0.75 kg/m^3
Maintenance feeds after rooting:	Nil Top dressing with Osmocote Plus mini CRF @ 30 g/m^2 Top dressing with Multicote mini CRF @ 30 g/m^2 Liquid feed applied weekly after weaning @ 50:50 ppm N:K_20

Results

- There appeared to be a small delay in rooting in the coir based mix at the first record, but 4 weeks later, rooting was similar in both mixes overall.

- Inclusion of trace elements in the rooting media had no obvious effect on rooting or cutting quality.

- A small reduction in rooting occurred in the peat based rooting media where Osmocote mini granules were incorporated, but not in the coir based mix, suggesting that this media had a greater buffering capacity.

- There was a marked reduction in rooting in the peat based mix with Multicote mini granules incorporated, but again this was the faster releasing batch of product as used in the summer strike. In the repeat work, with another batch of product, no reduction in rooting was observed.

- As in the summer strike, the benefit of CRF incorporation in the rooting media in obtaining an early flush of growth was clearly seen.

- Results from the maintenance feeds were also similar to the summer strike, with the CRF top dressing producing the better quality cuttings, compared to the low rate of liquid feed used as a maintenance programme. With this vigorous species, a higher rate of N would need applying during the maintenance period to match the CRF top dressing and ensure foliage did not become starved. The top dressing was more difficult to apply to these trays where foliage canopy was dense.

3. NUTRIENT CHARGED ZEOLITE OBSERVATION

Zeolite is a natural alumino-silicate mineral with an open framework structure providing a large surface area. Zeolites carry a negative electrical charge which is balanced by positively charged cations loosely held within the open framework, giving the zeolite a highly efficient cation exchange capacity. Clinoptilolite is one of the most widely prevalent and commercially used zeolite, and has been studied world-wide.

It is possible to 'load' zeolite with a full range of nutrients required for growth, theoretically allowing it to be used as a direct replacement for CRFs. Commercial products are becoming available and one such, Ferticult, was looked at in this trial.

Species: *Viburnum tinus* 'French White' (struck late August 1998)

Rooting media:	50:50 peat:fine pine bark
Nutrient charged Zeolite (Ferticult):	5% incorporation 10% incorporation

Results

- Severe scorching and death of a proportion of the cuttings occurred where 10% Ferticult was incorporated.

- Results in the 5% Ferticult mix looked more promising, the majority of cuttings rooting, with only slight scorch occurring on a small proportion of cuttings initially, with the second flush of growth unaffected. The mix maintained a dark foliage colour for in excess of 8 months.

- While results looked interesting, it will be important to trial the use of Ferticult over a much wider range of species. *Viburnum* is a relatively vigorous species and able to use higher rates of nutrients. How safe the Ferticult would be for use in rooting media with more nutrient sensitive species needs further investigation.

Action Points for Growers

- These are interim results, and as such need treating with caution until confirmed from Phase 2 of the work now underway.

- Nevertheless, Phase 1 of the work has demonstrated a number of options for maintaining quality of cuttings held for often quite extended periods in module trays pre-potting.

- Perhaps the most important result is the ability of P to trigger rapid growth in relatively starved, hard or inactive cutting material, when applied around 6 weeks before potting. This enables the cuttings to be held back in the trays by withholding P in a liquid feed programme to prevent overcrowding and loss of quality.

- Rate of P for triggering treatments may well depend on sensitivity of species to phosphate. Rates will be confirmed at the conclusion of the Phase 2 part of the work, though good results were obtained at 100 ppm P applied 6 weeks before potting.

- However, where cuttings are going to be held for an extended period pre-potting, the primary branch framework needs to be formed in the module tray, usually requiring 1-2 pinches at this stage. This can be achieved by incorporation of a mini CRF in the rooting media, producing an early flush of growth prior to 'running out of steam', after which cuttings can be held on an N:$K_2$0 liquid feed regime without further overcrowding, until P triggering is required pre-potting. A further flush of growth can be achieved, however, if required, by adding P to the maintenance liquid feed or applying the CRF mini granules as a top dressing.

- A top dressing of mini granule CRF, @ 30 g/m^2 produced excellent results in promoting a flush of growth and maintaining cutting quality.

- This manipulation of cutting growth and quality will vary with species, and will be able to be fine tuned for greater precision when the results of the second phase of the work are available.

- Whilst P appears able to be used to manipulate cutting growth for material held over long periods, it is no substitute for early or timely potting where this can be achieved.

PHASE 2

The objective of this phase of the work is to confirm results of the first phase for both winter and summer struck cuttings, but only held for a 'normal' period in the modular trays. This programme of work is still ongoing and results will not be available until 2003, with the final report due early 2004. Work includes:

1. Comparison of CRF incorporation v. liquid feed post rooting on cutting quality and branching.

2. Continuation of monitoring the role of P in manipulating cutting growth and quality during the maintenance period.

3. Comparison of P 'triggering' schedules relative to time of application and number of applications required pre-potting, as well as rate of P required.

4. Examination of whether the response to P triggering is affected by the level of N applied.

5. Monitor influence of treatments on speed of establishment once potted on.

6. Develop protocols for manipulation of cutting growth, quality and activity where rooted plugs can be held in module trays for several months before potting.

APPENDIX

Photographs