Annual Report September 1996

HDC PC 86
Year 3 - 1995

Bedding Plants: Investigation of cultural methods for controlling height

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Commenced: February 1995
Completed: October 1995

Key Words: Phosphate, Watering Regime, Bedding Plants, Plug Stage, *Petunia, Begonia,* Geranium, *Impatiens*, Pansy, *Ageratum, Antirrhinum, Lobelia,* Growth Control

HORTICULTURE RESEARCH INTERNATIONAL

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Period of investigation:	February 1995 - October 1995
Date of issue of report:	September 1996
No. of pages in report:	107
No. of copies of report:	9
This is copy no. 3:	Issued to Horticultural Development Council

CONTRACT REPORT

Bedding Plants: Investigation of cultural methods for controlling height

HDC PC 86
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AUTHENTICATION

I declare that this work was done under my supervision according to the procedures described herein and that this report represents a true and accurate record of the results obtained.

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CONTENTS

1. RELEVANCE TO GROWERS AND PRACTICAL APPLICATION

1.1 APPLICATION

A range of bedding plant species were grown to evaluate the use of restricted phosphate to control the growth of seed raised plug plants. In addition, the use of high phosphate liquid feeds was examined with a view to promoting plant growth, whilst two separate watering regimes were applied during growing-on: standard practice and a 'dry' watering regime.

Restricting the levels of available phosphate in the growing media from sowing successfully achieved control of growth in a number of bedding plant species. For the majority of species a rate of 0.3 g/l single superphosphate was adequate to allow plant establishment in the plug whilst restricting plant growth from becoming 'leggy'. High phosphate feeds applied 7-10 days prior to transplanting negated any plant 'check' and aided plant removal from the plug tray and establishment in the final container. Plants produced in plugs using lower rates of phosphate - 0.3 g/l - 0.6 g/l single superphosphate - were generally regarded as being of better quality at marketing as a result of being more compact in their habit.

The 'dry' watering regime during growing achieved on average a 10-30% reduction in final plant height, and potential savings in water use were identified. However, further work is required to produce detailed guidelines for grower use.

1.2 SUMMARY

This year's trial has again demonstrated the potential which exists for plant growth to be controlled through the restriction of available phosphate. In 1994, trial work examined a wide range of phosphate treatments, ranging from no added phosphate up to 3 g/l single superphosphate (SSP) in the growing media for seed raised bedding plant plugs. Plant growth was reduced at the lower phosphate treatments, < 1 g/l SSP. Thus this year's trial aimed to assess a further range of phosphate levels: zero phosphate, 0.3 g/l, 0.6 g/l, 0.9 g/l and 1.2 g/l single superphosphate. In contrast to the trial work in 1994, the phosphate treatments were only applied in the plug stage of production and plug plants were pricked off directly into a commercial proprietary growing media, Levington M2. However, prior to transplanting a number of plants were fed using a high phosphate liquid feed to observe the effects on plant growth. During growing on, two watering regimes were employed, a standard watering regime as per normal commercial practice and a 'dry' watering regime which allowed plants to reach near to wilting point before re-watering lightly overhead. These treatments mirrored those used in the 1994 trial (HDC Report PC86). Finally, a number of new species were evaluated this year: *Ageratum, Antirrhinum, Lobelia, Begonia* and *Geranium*, in addition to *Petunia, Impatiens* and Pansy which were also grown in 1994.

1.2.1 OBJECTIVES

- To evaluate a further range of low phosphate levels and examine their effect on plant growth in the plug stage of bedding plant production.

- To examine a range of bedding plant species and establish if there are any species specific effects for the treatments assessed.

- To investigate the use of high phosphate liquid feed applied to plants in plugs immediately prior to pricking off in comparison to transplanting into a standard growing media without the use of high phosphate liquid feed.

- To assess the long term effect of treatments on the 'shelf-life' and subsequent garden performance of each species.

1.2.2 METHODOLOGY

Start Material

Seeds for the trial were purchased from Colegraves Seeds Ltd.

Species

Lobelia erinius cv Crystal Palace
Viola x. wittrockiana (Pansy) cv F1 Turbo Yellow with Blotch
Impatiens walleriana cv F1 Accent Salmon
Petunia hybr. cv. F1 Express Blue
Ageratum cv F1 Blue Champion
Antirrhinum cv Coronette Yellow
Begonia semperverons cv F1 Olympia Red
Geranium cv F1 Century Scarlet

Treatments

Levels of phosphate used during plug stage

(Single superphosphate (SSP) g/l)

1. 0 g/l
2. 0.3 g/l
3. 0.6 g/l
4. 0.9 g/l
5. 1.2 g/l

Nutritional regime used during plug stage

i. Plants fed with high phosphate liquid feed, 10:52:10 (N:P:K) prior to pricking off into standard growing media (Levington M2).

ii. Plants pricked directly off into standard media (Levington M2) without prior high phosphate liquid feed.

Watering regime during growing-on

A. Standard commercial practice, i.e. watered frequently as deemed necessary, not allowed to wilt.

B. 'Dry' regime in which plants were allowed to dry back until flaccid before watering lightly overhead.

Cultural Details

All seed was hand sown in 286 plug trays (20 x 20 x 20 mm) using Bulrush fine peat amended as follows:

Product	grammes per litre substrate
Ammonium Nitrate	0.4
Potassium Nitrate	0.75
Fritted Trace Elements 255	0.4
Calcium Carbonate (99.99%)	3.0
Plus wetting agent (Aquagro) at recommended rate	

Plus single superphosphate at specified rate in treatments - see page 3.

A base temperature of 20°C was maintained throughout propagation. Upon emergence, the species *Ageratum, Lobelia*, Pansy and *Antirrhinum* were transferred to glasshouse with day/night temperature set point of 12°C and a venting set point of 14°C. Species *Petunia*, *Begonia*, Geranium and *Impatiens* were transferred to an identical compartment and grown on at 16°C day/night and venting at 18°C.

All plug plants received liquid feed as follows:

Product	kg/100 litres
Ammonium Nitrate	2.95
Potassium Nitrate	3.40

Dilute 1:200 to give 75N:75K mg/litre

The liquid feed was applied by hand lance overhead at every watering.
After transplanting in the growing-on stage this was increased to 150N:150K.

The high phosphate liquid feed was applied using 10:52:10 N:P:K (proprietary liquid feed). This was applied by overhead hand watering to each treatment requiring high phospate feed prior to pricking off.

Records were taken at transplanting stage when plants could be easily 'pulled' by hand from the plug tray. Plants were transplanted into double six polystyrene boxes, with a cell size of 367 x 225 x 65 mm using Levington M2 growing media. Plants were grown under either a 'standard' or 'dry' watering regime until marketing when final plant growth assessments were recorded.

1.3 RESULTS - SUMMARY

1.3.1 Effect of phosphate treatments at the plug stage

- As in 1994, there was no effect of phosphate treatments on seed germination.
- Plant growth/height increased generally in proportion to the phosphate treatments applied. Plant height and plant fresh weight increased at the higher phosphate treatments, whilst percentage dry matter content was reduced.
- At the lower phosphate treatments, 0, 0.3 g/l and 0.6 g/l SSP, plant growth could be seen to halt as the phosphate reserve became exhausted, and characteristically on some species leaves 'drooped' e.g. *Impatiens, Antirrhinum* and Pansy.
- At the highest phosphate treatment, 1.2 g/l SSP, with the largest plants, foliage colour was slightly paler, particularly with the plants grown at the higher temperature regimes.
- Rooting was significantly reduced at zero phosphate, prior to liquid feeding with a high phosphate feed.
- High phosphate liquid feed 'boosted' plant growth across all phosphate treatments, and both plant fresh weight and rooting increased.

1.3.2 Effect of phosphate treatments on growing on

- There were no significant differences in plant height, but plant spread (diameter) was increased at the lower phosphate treatments - indication of a better balanced compact plant.
- The number of days from pricking off until marketing was reduced where plug plants had been liquid fed with high phosphate liquid feed prior to pricking off.
- Flowering score recorded at marketing showed that plants which had not been fed with high phosphate liquid feed prior to pricking off had a higher flowering score. (Flowering score represented not only the presence/number of open flowers but also the 'potential' flowering of the plant.)
- Plant fresh weight was generally higher at the lower phosphate treatments, 0.3 g/l-0.9 g/l SSP, but in the absence of statistical analysis its significance cannot be confirmed.

- There were no significant differences in plant percentage dry weight.

- Plant quality was reduced at 0, 0.9 and 1.2 g/l SSP treatments recorded at marketing.

1.3.3 Effect of watering regime on growing on

- Plant growth was generally reduced under the 'dry' watering regime. Plant height and plant spread were reduced across phosphate treatments.

- Plants at the lowest phosphate level, zero, failed to establish under the 'dry' watering regime.

- Plant fresh weight was reduced whilst plant percentage dry matter increased under the 'dry' watering regime. Plant growth appeared much 'harder'.

- Overall plant quality between the two watering regimes was similar, but those grown under the 'dry' regime were slightly smaller in size and hence may not be perceived as good quality by the customer, particularly in *Lobelia*.

- Further measurements to quantify the 'dry' watering regime were based on tensiometer readings; watering occurring at 80/120 hPa (plant wilting point - based on observation).

1.3.4 Shelf-life and garden performance observations

- Plants grown at the lower phosphate treatments, 0.3 g/l and 0.6 g/l SSP, were more compact and were less liable to handling damage at marketing and also at planting out.

- Since plants were more compact it was possible to increase the number of plant boxes held on a Danish trolley, in terms of the number of shelves per trolley.

- Plants grown under the 'dry' watering regime had an increased tolerance to 'drought' whilst in shelf-life, whereas the larger plants grown under the standard watering regime suffered greater flower and leaf damage/loss, but this was not thought to be commercially significant.

- In garden performance assessments, the plant species Pansy and *Ageratum* grown at 0.3 g/l and 0.6 g/l SSP treatments remained smaller in size throughout the 12 week assessment.

- *Antirrhinum* grown at the lower phosphate levels, 0.3 g/l and 0.6 g/l SSP were more compact with better branching at the base and were of better quality in the garden performance assessments.

- There were no significant treatment differences for *Petunia, Lobelia* or *Impatiens*.

1.4 CONCLUSIONS

- A rate of between zero-0.6 g/l single superphosphate can be used successfully to control plant growth in a range of bedding plant species.

- The plant species *Impatiens, Petunia*, Pansy and *Antirrhinum* responded particularly well to this treatment method.

- The plant species Geranium (which has a larger seed size and thus is thought to have a greater reserve of phosphate) does not respond well to this treatment.

- It is recommended to feed plugs with a high phosphate feed 7-10 days prior to pricking off to encourage root development and assist the operation of pricking off/transplanting.

- Plants produced at lower phosphate levels, 0.3 g/l and 0.6 g/l SSP, remained more compact throughout production and hence plant quality at marketing and shelf-life was improved.

- The use of a 'dry' watering regime was again demonstrated as a practical measure which can be used to control plant growth, and there was an indication that it improved plant tolerance at marketing and in shelf-life.

2 EXPERIMENTAL SECTION

2.1 INTRODUCTION

Plant growth regulators are one of the most commonly used methods of controlling the height of pot and bedding plants to produce high quality, compact plants for marketing. The high chemical input concerns growers and customers alike. Cost of chemicals, and their application in the future with regard to legislation means several alternative methods are being investigated to reduce plant height, specifically, the use of temperature and lighting manipulation.

Manipulation of nutrition (phosphate) and the use of water stress on plants has formed the basis for research at Efford in 1993 and 1994 (HDC Project PC86). The use of controlled phosphate as a means of height control has proved effective, with additional effects on flowering being recorded. In addition, height control using water stress during the growing on phase has been demonstrated, with early attempts to quantify a regime which growers can adopt. The encouraging results in 1994 lead to more detailed assessment of the level of phosphate which achieves greatest height control in the plug stage, and subsequently applying phosphate rich feeds in the plug and growing on stage, with the aim to switch growth 'on and off'. Use of these techniques needs further development and evaluation in order to provide growers with the required information on a wide range of bedding plant species.

Performance during the growing on stage in the module can affect subsequent establishment on planting out. The use of 'water stress' is thought to aid toning of plants and to increase shelf-life at the point of sale, and garden performance. Increasingly, the consumer is demanding a high quality product, with an ability to withstand adverse conditions in the garden. Work is necessary to fully define a 'dry regime' which is acceptable to, and can be managed by the growers.

As with all trials, shelf-life/garden performance was included to observe any favourable or detrimental effects of earlier production treatments.

2.2 OBJECTIVES

- To evaluate a further range of low phosphate levels and examine their effect on plant growth in the plug stage of bedding plant production.

- To examine a range of bedding plant species and establish if there are any species specific effects for the treatments assessed.

- To investigate the use of high phosphate liquid feed applied to plants in plugs immediately prior to pricking off in comparison to pricking off into a standard growing media without the use of high phosphate liquid feed.

- To assess the long term effect of treatments on the 'shelf-life' and subsequent garden performance of each species.

2.3 MATERIALS AND METHODS

Year: 1995

2.3.1 Site

Seeds were sown in the propagation area of 'H' Block at HRI Efford. Once the first true leaves had fully expanded, the seedlings were transferred to two compartments of 'Q' Block and grown on the floor upon wooden slats to avoid lateral movement of phosphate due to leaching.

2.3.2 Start Material

Seeds for the trial were purchased from Colegraves Seeds Ltd.

2.3.3 Species

Lobelia erinius cv Crystal Palace
Viola x. wittrockiana (Pansy) cv F1 Turbo Yellow with Blotch
Impatiens walleriana cv F1 Accent Salmon
Petunia hybr. cv. F1 Express Blue
Ageratum cv F1 Blue Champion
Antirrhinum cv Coronette Yellow
Begonia semperverons cv F1 Olympia Red
Geranium cv F1 Century Scarlet

2.3.4 Treatments

Levels of phosphate used during plug stage

(Single superphosphate (SSP) g/l)

1. 0 g/l
2. 0.3 g/l
3. 0.6 g/l
4. 0.9 g/l
5. 1.2 g/l

Nutritional regime used during plug stage

i. Plants fed with high phosphate liquid feed, 10:52:10 (N:P:K) prior to pricking off into standard growing media (Levington M2).

ii. Plants pricked directly off into standard media (Levington M2) without prior high phosphate liquid feed.

Watering regime during growing-on

A. Standard commercial practice, i.e. watered frequently as deemed necessary, not allowed to wilt.

B. 'Dry' regime in which plants were allowed to dry back until flaccid before watering lightly overhead.

2.3.5 Experimental design and layout

The experiment layout within each compartment is illustrated in Appendix I, pages 43 to 45. Phosphate treatments were replicated twice and laid out in a randomised manner within each species block. After transplanting and growing on the watering regime was divided in each compartment.

Preliminary observation with limited replication.

8	species
x	
5	phosphate levels
x	
2	replicates
--	
80	
x	
2	nutritional regimes

160	
x	
2	watering regimes during growing on

320	plots in total

Plot size: 20 plants recorded from centre of each plug tray (plug stage)
12 plants recorded from double-six growing tray (growing on)

2.3.6 Cultural Details

All seed was hand sown in 286 plug trays (20 x 20 x 20 mm) using Bulrush fine peat amended as follows:

Product	grammes per litre substrate
Ammonium Nitrate	0.4
Potassium Nitrate	0.75
Fritted Trace Elements 255	0.4
Lime as Pure Calcium Carbonate (99.99%)	3.0
Plus wetting agent (Aquagro) at recommended rate	

Plus single superphosphate at specified rate in treatments.

See Tables 21a and 21b, Appendix II page 46 for analysis of growing media at sowing.

A base temperature of 20°C was maintained throughout propagation. Upon emergence, the species *Ageratum, Lobelia*, Pansy and *Antirrhinum* were transferred to glasshouse compartment with day/night temperature set point of 12°C and a venting set point of 14°C. Species *Petunia*, *Begonia*, Geranium and *Impatiens* were transferred to an identical compartment and grown on at 16°C day/night and venting at 18°C. See Appendix III for crop diary, pages 48 to 55.

All plug plants received liquid feed as follows:

Product	kg/100 litres
Ammonium Nitrate	2.95
Potassium Nitrate	3.40

Dilute 1:200 to give 75N:75K mg/litre

The liquid feed was applied overhead using a hand lance at every watering.
After transplanting in the growing-on stage this was increased to 150N:150K.

The high phosphate liquid feed was applied using 10:52:10 N:P:K (proprietary liquid feed). This was applied by overhead hand watering to each treatment requiring high phospate feed prior to pricking off. Analysis of the applied feed, 10:52:10 N:P:K is given in Table 22, Appendix II, page 47.

Records were taken at transplanting stage when plants could be easily 'pulled' by hand from the plug tray. Plants were transplanted into double six polystyrene boxes, with a cell size of 367 x 225 x 65 mm using Levington M2 growing media (analysis given in Table 22, Appendix II, page 47). Plants were grown under either a standard or 'dry' watering regime until marketing when final plant growth assessments were recorded.

Biological control agents employed throughout the course of the study included:

Amblyseius cucumeris	for	Western Flower Thrips
Phytoseiulus persimilis	for	Two Spotted Spider Mite
Aphidius colemani	for	Aphids
Aphidoletes aphidimyza	for	Aphids
Encarsia formosa	for	Glasshouse Whitefly

No chemical pesticides were necessary.

2.3.7 Assessments

Plug stage

At the plug stage immediately prior to transplanting full plant growth assessments were made. These included:

Plant height (mm)
Plant quality (1-3, 3 = best)
Fresh weight (g)
Percentage dry matter content
Leaf tissue and growing media analyses
Photographs of treatment comparisons for each species

Maturity

At maturity (marketing stage) further assessments were made. These included:

Plant height (mm)
Plant quality (1-3, 3 = best)
Flowering score (1-3, 3 = most flowers)
Growing media and leaf analyses for one species (*Petunia*)
Photographs of treatment comparisons for each species

Garden performance

Six plants from each plot were planted outdoors in a prepared soil bed, and observations on plant establishment and quality recorded over a 3 month period.

2.3.8 Statistical Analysis

Statistical analysis was limited as the size of the trial did not allow for complete replication of all treatments throughout the trial. Phosphate treatments in the plug stage were replicated and fully randomised within each block. At maturity, comparisons could be made between treatments within each species. Where possible data records were analysed using Standard Analysis of Variance (ANOVA). The degrees of freedom (d.f.), standard error (SED) and least significant difference to 5% (LSD) on which the significance tests were based are presented in the tables where appropriate to aid interpretation of the results. Statistical terms referred to are:

SED = The standard error of the difference when comparing two means in that column of data.

A statistical term easier to interpret:

LSD 5% = The least (minimum) difference when comparing two means within a given column that is required for the means to be statistically different.

N.S. = Not Significant.

3. RESULTS

3.1 *Ageratum* F1 'Blue Champion'

3.1.1 Transplanting

Records of plant growth are given in Table 23, Appendix IV, page 56 and treatment comparisons are shown in colour plate 1, Appendix IX, page 92.

There were significant differences in plant height between each phosphate treatment level with the exception of 0.9 g/l and 1.2 g/l SSP(Table 1).

Table 1: Record of plant height at transplanting stage

Treatments single superphosphate g/l	**0**	**0.3**	**0.6**	**0.9**	**1.2**
Height (mm)	6.6	11.4	14.8	16.2	17.8

SED (d.f. = 4) = ±	1.073
LSD (5%) = ±	2.980

Plant height rapidly increased with the application of 10:52:10 N:P:K liquid feed.

Plant fresh weight was higher at phosphate levels between 0.6 g/l and 1.2 g/l SSP, at approximately 2.8 g, whilst plants were much smaller at 0.3 g/l, and at zero phosphate plants had germinated but made minimal further growth. As percentage dry weight, plants at 0.3 g/l and zero phosphate had the highest figures at 20% and 18.2% respectively.

Records of growing media analysis at transplanting are given in Appendix V, Tables 31 and 32, page 64, whilst leaf analysis records are given in Appendix VI, Tables 47 and 48, page 72.

Growing media analyses showed depletion of phosphorus in all treatments, whilst levels of nitrogen and potassium were generally higher at the lower phosphate treatments, zero - 0.6 g/l.

The level of phosphorus in the leaf tissue was higher in 0.9 g/l SSP and corresponded with slightly higher phosphate levels in the growing media at this treatment. Levels of phosphorus were low in all other treatments, particularly at 0.3 g/l and zero phosphate.

Leaf tissue analysis after the application of phosphate liquid feed showed rapid increase in levels of elements taken up into the plant, shown by the increased levels of phosphorus. Levels of

nitrogen and potassium dropped at the higher level treatments 0.6-1.2 g/l SSP as a result of rapid plant growth.

3.1.2 Maturity

Plant growth records are given in Tables 63 and 64, Appendix VII, page 80.

Plant height was reduced where plants had been grown under a 'dry' watering regime (Table 2), on average across phosphate treatments by 13%.

Table 2: Plant Height (mm) at Marketing

Watering regime	Treatment level single superphosphate (g/l) 0	0.3	0.6	0.9	1.2
Standard	75.7	125.8	126.7	125.4	129.2
Dry	28.3	95.0	132.5	130.8	124.2
Standard +	-	105.4	102.9	105.4	94.6
Dry +	-	86.2	89.2	84.2	90.4

NB: '+' = plants which received supplementary phosphate feed in the plug stage.

Plant height was considerably smaller in zero phosphate treatment, where plants had failed to establish particularly under the 'dry' watering regime, where plant death occurred.

Table 3, plant height:width ratio provides an indication of plant habit. With the exception of plants in zero phosphate which had a more compact habit, plants were all similar in their growth and habit.

Table 3: Plant Height:Width ratio* at Marketing

Watering regime	Treatment level single superphosphate (g/l) 0	0.3	0.6	0.9	1.2
Standard	0.66	0.91	0.85	0.89	0.85
Dry	0.59	0.84	0.89	0.85	0.88
Standard +	-	0.90	0.93	0.83	0.86
Dry +	-	0.84	1.1	0.91	0.94

NB: '+' = plants which received supplementary phosphate feed in the plug stage.
* A high height-to-width ratio indicates an upright habit, whilst a low height-to-width ratio indicates a broad habit.

Flowering score was generally higher in the 'dry' watering regime, probably as a consequence of water stress 'forcing' plants into flower earlier, although the quality of these plants was reduced.

Plant fresh weight records reflected closely the trends seen in plant height, with slightly heavier plants recorded at 0.9 g/l SSP in the 'standard' watering regime, and across treatments plants were heavier where no supplementary phosphate had been given in the plug stage. Percentage dry weight was increased under the 'dry' watering regime.

3.2 *Antirrhinum* F1 'Coronette Yellow'

3.2.1 Transplanting

Records of plant growth are given in Table 24, Appendix IV, page 57 and treatment comparisons are shown in colour plate 2, Appendix IX, page 93.

Plant height was significantly reduced at zero phosphate, whilst plant height increased at higher phosphate levels with a maximum of 28 mm at 0.9 g/l SSP (Table 4). Plant fresh weight was also greatest at 0.9 g/l SSP, with similar fresh weights recorded at 0.6 g/l and 1.2 g/l SSP, at 4.5 and 4.4 g respectively. At 0.3 g/l SSP plant growth was reduced, with a fresh weight of 2.9 g and characteristically the leaves on the young seedlings turned downwards vertically. Percentage dry weight was highest at zero phosphate at 30%, where plants remained very small.

Table 4: Record of plant height at transplanting stage

Treatments single superphosphate g/l	**0**	**0.3**	**0.6**	**0.9**	**1.2**
Height (mm)	8.3	20.4	24.6	28.0	27.3

SED (d.f. = 4) = ±	0.769
LSD (5%) = ±	2.134

Records of leaf tissue analysis are given in Tables 49 and 50, Appendix VI, page 73 and growing media analysis in Tables 33 and 34, Appendix V, page 65.

Leaf tissue analysis showed that slightly higher phosphorus levels were recorded at 0.9 g/l and very similar to those at 1.2 g/l. At lower treatment levels, phosphorus levels were depleted, and below those recommended for normal growth (Metcoff, 1992). Levels of nitrogen were all below recommended levels. Applications of 10:52:10 N:P:K liquid feed greatly boosted leaf phosphorus levels, whilst nitrogen and potassium levels were reduced as a consequence of sudden increase in plant growth.

Growing media analysis showed that levels of nitrogen and potassium became lower as the phosphate treatment level increased. The application of phosphate feeds exacerbated the reduction in nitrogen and potassium as plant growth increased, whilst levels of phosphate increased.

3.2.2 Maturity

Records of plant growth are given in Tables 65 and 66, Appendix VII, page 81.

Plant height was reduced on average by 16% under a 'dry' watering regime (Table 5). Where plants had received phosphate liquid feed prior to transplanting, their final height was smaller in comparison to plants directly pricked off under the standard watering regime. Under the dry watering regime plant maturity was delayed which led to these plants becoming taller.

Table 5: Plant Height (mm) at Marketing

Watering regime	Treatment level single superphosphate (g/l) 0	0.3	0.6	0.9	1.2
Standard	104.5	136.7	151.7	147.5	153.3
Dry	76.7	140.8	108.7	117.5	140.0
Standard +	-	112.1	125.8	147.5	130.8
Dry +	-	153.3	162.1	159.2	162.5

NB: '+' = plants which received supplementary phosphate feed in the plug stage.

Final plant height was reduced at the lower phosphate treatments 0.3 g/l and zero phosphate. Plant quality was deemed higher at 0.3 g/l SSP as a result of the more compact growth(Table 6).

Table 6: Plant Height:Width ratio* at Marketing

Watering regime	Treatment level single superphosphate (g/l) 0	0.3	0.6	0.9	1.2
Standard	0.83	1.03	1.09	1.05	1.11
Dry	0.84	0.98	0.84	0.83	0.98
Standard +	-	0.79	0.94	0.99	1.04
Dry +	-	1.03	1.09	1.05	1.08

NB: '+' = plants which received supplementary phosphate feed in the plug stage.
* A high height-to-width ratio indicates an upright habit, whilst a low height-to-width ratio indicates a broad habit.

Plant fresh weight was considerably higher where plants had been grown with a 'standard' watering regime, and without prior phosphate liquid feeding. Similarly, fresh weight was lower at the lower level phosphate treatments of 0.3 g/l and zero phosphate.

3.3 *Begonia* F1 'Olympia Red'

3.3.1 Transplanting

Plant growth records are given in Table 25, Appendix IV, page 58 and treatment comparisons are shown in colour plate 3, Appendix IX, page 94.

Plant height increased in relation to the increase in phosphate levels. Plants at zero phosphate were significantly smaller than those in other treatments, whilst plants at 1.2 g/l and 0.9 g/l SSP were significantly larger than those at 0.6 g/l, 0.3 g/l or zero phosphate (Table 7).

Table 7: Record of plant height at transplanting stage

Treatments single superphosphate g/l	**0**	**0.3**	**0.6**	**0.9**	**1.2**
Height (mm)	1.5	11.8	14.4	26.8	28.0

SED (d.f. = 4) = ±	1.400
LSD (5%) = ±	3.887

Plant fresh weight increased in line with phosphate levels, with weight greatest at 0.9 g/l SSP. The use of phosphate liquid feeds rapidly boosted plant growth in all treatments with the exception of zero phosphate treatment, which remained extremely small. Plant uniformity was better at 1.2 g/l SSP.

Leaf tissue analysis results at transplanting are given in Tables 51 and 52, Appendix VI, page 74.

The analysis confirmed that phosphate levels were below the recommended levels for expected normal growth (Metcoff, 1992). The use of high phosphate liquid feeds greatly increased the phosphorus levels in all treatments, although potassium levels dropped at 0.9 g/l and 1.2 g/l SSP treatments.

Growing media analyses at transplanting are given in Tables 35 and 36, Appendix V, page 66. These confirmed the exhaustion of phosphate at both 0.3 g/l and zero phosphate, whilst levels were slightly raised at 0.6 g/l SSP and above. Levels of potassium and nitrogen were generally higher at the lower phosphate treatments, zero - 0.6 g/l SSP. The application of high phosphate feeds quickly boosted phosphate levels in all treatments.

3.3.2 Maturity

Plant growth results are given in Tables 67 and 68, Appendix VII, page 82. Plants grown at zero phosphate with or without the application of phosphate feeds failed to thrive and soon perished before they could establish after transplanting.

Plant height was typically increased at both 0.3 g/l and 1.2 g/l SSP under the standard watering regime as a consequence of their delayed maturity (by 3 weeks) in comparison to the other treatments. Similarly, plants grown under a 'dry' watering regime were similar or taller in height in comparison to plants grown in a standard watering regime for the same reason (3 week delay). There was little difference in height between the treatments 0.6 g/l and 0.9 g/l SSP (Table 8).

Table 8: Plant Height (mm) at Marketing

Watering regime	Treatment level single superphosphate (g/l) 0	0.3	0.6	0.9	1.2
Standard	22.5	130.8	70.8	77.1	73.3
Dry	-	55.8	73.7	102.1	108.3
Standard +	-	105.8	60.8	65.8	123.7
Dry +	-	83.3	94.6	92.1	96.7

NB: '+' = plants which received supplementary phosphate feed in the plug stage.

Plant fresh weight was seen to increase with rising phosphate levels, with the exception of treatment 0.3 g/l SSP which produced consistently heavier plants but this was again attributable to the later maturity of plants in these treatments.

Table 9: Plant Height:Width ratio* at Marketing

Watering regime	Treatment level single superphosphate (g/l) 0	0.3	0.6	0.9	1.2
Standard	0.60	0.97	0.70	0.78	0.75
Dry	-	0.81	0.85	0.99	0.94
Standard +	-	0.98	0.66	0.67	0.92
Dry +	-	0.95	0.95	0.84	0.88

NB: '+' = plants which received supplementary phosphate feed in the plug stage.
* A high height-to-width ratio indicates an upright habit, whilst a low height-to-width ratio indicates a broad habit.

Plant width/height ratio was extremely variable across treatments (Table 9). In general plant habit was more compact at the lower phosphate treatments 0.3-0.6 g/l SSP. Plant appearance suffered under the 'dry' watering regime, with plants becoming quite 'glossy' with a 'hard' appearance. Overall plant quality was better in the higher phosphate treatments, 0.6 g/l SSP and above. Flowering was improved in all cases where plants had received supplementary phosphate in the plug tray before transplanting. A comparison of treatments is shown in colour plates 9 and 10, Appendix IX, page 100 and 101.

There was no consistent difference in percentage dry weight between treatments with the exception of 0.3 g/l and 1.2 g/l SSP where percentage dry weight was higher under the 'dry' watering regime.

3.4 Geranium F1 'Century Scarlet'

3.4.1 Transplanting

Records of plant growth are given in Table 26, Appendix IV, page 59 and treatment comparisons are shown in colour plate 4, Appendix IX, page 95.

Plant height was significantly reduced at zero phosphate in comparison to all other treatments, whilst plant height at 0.3 g/l SSP was significantly greater than at 0.6 g/l SSP and produced the tallest plants from any treatment (Table 10).

Table 10: Record of plant height (mm) at transplanting stage

Treatments single superphosphate g/l	**0**	**0.3**	**0.6**	**0.9**	**1.2**
Height (mm)	31.8	80.0	70.7	75.4	79.0

SED (d.f. = 4) = ± 2.400
LSD (5%) = ± 6.664

Plant fresh weight was greatest at 1.2 g/l SSP at 22.6 g, although weights were similar at 0.3 g/l, 0.6 g/l and 0.9 g/l SSP, all near to 20 g. Fresh weight was lowest at zero phosphate.

The application of 10:52:10 N:P:K liquid feed greatly boosted plant growth, and plant height and fresh weight increased in all phosphate treatments.

Records of leaf tissue analysis are given in Tables 53 and 54, Appendix VI, page 75 and growing media analysis in Tables 37 and 38, Appendix V, page 83.

With the exception of zero phosphate, phosphorus levels were all above the minimum level regarded for normal growth. This indicated that seed Geraniums possibly have a greater phosphate reserve within the seed embryo. Phosphate levels in the growing media were also higher in comparison to other species trialled. As would be expected applications of phosphate feed quickly increased phosphorus levels in both the growing media and leaf tissue.

3.4.2 Maturity

Results are given in Tables 69 and 70, Appendix VII, page 83.

There were no consistent differences in plant growth between treatments, although plants grown in the 'dry' watering regime were approximately a week later to reach marketing stage. Similarly, plants grown in the zero phosphate treatment were also later to reach marketing stage.

All plants grown were deemed to be marketable, but plant quality was superior between 0.3-0.6 g/l SSP grown with a 'standard' watering regime, or between 0.9-1.2 g/l SSP when grown under a 'dry' watering regime. Flowering was slightly earlier in the 0.6 g/l SSP treatment.

3.5 *Impatiens* F1 'Accent Salmon'

3.5.1 Transplanting Stage

Results are given in Table 27, Appendix IV, page 60 and treatment comparisons are shown in colour plate 5, Appendix IX, page 96.

Plant height was significantly smaller at zero phosphate, whilst the tallest plants were produced at 0.9 g/l SSP (Table 11).

Table 11: Record of plant height at transplanting stage

Treatments single superphosphate g/l	**0**	**0.3**	**0.6**	**0.9**	**1.2**
Height (mm)	12.1	51.2	57.0	61.6	60.4

SED (d.f. = 4) = ± 5.746
LSD (5%) = ± 15.953

Plant fresh weight was greatest at 1.2 g/l SSP (15.1 g), whilst percentage dry matter was highest at zero phosphate (20%).

The application of 10:52:10 N:P:K liquid feed rapidly boosted plant growth particularly between the treatment levels zero phosphate - 0.9 g/l SSP where an increase in fresh weight of 100% was recorded after a period of 10 days. Plant height similarly increased with the use of high phosphate liquid feeds.

Leaf tissue analysis results are given in Tables 55 and 56, Appendix VI, page 76. These showed a decline in phosphorus levels as the phosphate treatment levels dropped. At 0.6 g/l SSP and above, levels of phosphorus were within the normal range, whilst at 0.3 g/l and zero phosphate, levels of phosphorus were depleted. The application of phosphate liquid feed quickly caused leaf phosphorus levels to rise, whilst nitrogen and potassium levels fell, particularly at the higher phosphate treatment levels as a result of increased plant growth.

Growing media analysis results, shown in Tables 39 and 40, Appendix V, page 68, show the comparison of nutrient levels before and after the application of 10:52:10 N:P:K liquid feed. Levels of phosphorus quickly rose to above 30 mg/l in all treatments.

3.5.3 Maturity

Results are given in Tables 71 and 72, Appendix VII, page 84.

Plant height was similar between treatments 0.3 g/l to 1.2 g/l SSP (Table 12). The watering regimes produced quite variable effects, with little difference in height between plants grown at 0.6 g/l SSP under either a 'standard' or 'dry' watering regime. In contrast plants grown at 0.9 g/l SSP were approximately 35% shorter in the 'dry' watering regime.

Table 12: Plant Height (mm) at Marketing

Watering regime	Treatment level single superphosphate (g/l) 0	0.3	0.6	0.9	1.2
Standard	51.8	128.3	114.6	133.3	122.5
Dry	25.7	107.1	117.1	87.9	110.4
Standard +	86.7	114.2	132.1	120.0	121.2
Dry +	105.0	112.1	111.2	102.5	97.1

NB: '+' = plants which received supplementary phosphate feed in the plug stage.

Overall plant quality was deemed best for plants at 0.3 g/l SSP under the 'dry' watering regime where plant growth remained more compact (Table 12). Flowering action also appeared slightly earlier in this treatment.

Table 13: Plant Height:Width ratio* at Marketing

Watering regime	Treatment level single superphosphate (g/l) 0	0.3	0.6	0.9	1.2
Standard	0.25	0.99	1.01	1.03	0.98
Dry	1.11	1.11	0.89	0.92	0.96
Standard +	0.70	0.94	1.09	1.05	0.95
Dry +	0.91	0.88	1.15	1.00	1.15

NB: '+' = plants which received supplementary phosphate feed in the plug stage.

* A high height-to-width ratio indicates an upright habit, whilst a low height-to-width ratio indicates a broad habit.

Percentage dry weights were considerably higher where plants had not received supplementary phosphate in the plug stage, across phosphate treatments. Percentage dry weight was slightly increased under 'dry' watering regime.

3.6 *Lobelia* 'Crystal Palace'

3.6.1 Transplanting Stage

Results are given in Table 28, Appendix IV, page 61 and treatment comparisons are shown in colour plate 6, Appendix IX, page 97.

Plant height was significantly reduced at zero phosphate, and also at 0.3 g/l SSP in comparison to the other treatment levels (Table 14).

Table 14: Record of plant height at transplanting stage

Treatments single superphosphate g/l	**0**	**0.3**	**0.6**	**0.9**	**1.2**
Height (mm)	4.7	18.3	22.3	22.6	21.9

SED (d.f. = 4) = ±	1.439
LSD (5%) = ±	3.996

Plant fresh weight was greatest at 1.2 g/l SSP, and was lower at each other phosphate treatment level. Percentage dry matter was highest at zero phosphate (18.3%). The application of high phosphate feed promoted rapid plant growth and increases in both plant height and fresh weight were recorded.

Records of leaf tissue analysis are given in Tables 57 and 58, Appendix VI, page 77 and growing media analysis in Tables 41 and 42, Appendix V, page 69.

Leaf tissue analysis confirmed phosphorus levels in line with phosphate treatment levels - lower at zero phosphate and highest at 1.2 g/l SSP. There was little difference in the levels of nitrogen, whilst potassium levels were lower at zero phosphate and 0.3 g/l SSP. Applications of high phosphate liquid feeds boosted levels of phosphate in the leaf tissue, whilst nitrogen and potassium levels became lower.

Growing media analysis results reflected the increase in plant growth as levels of potassium and nitrogen dropped in all treatments whilst levels of phosphorus rose quickly.

3.6.2 Maturity

Records of plant growth are given in Tables 73 and 74, Appendix VII, page 85.

There were no consistent trends in plant growth between treatments. Final plant height was similar across phosphate treatments and was reduced slightly under the 'dry' watering regime. Plant maturity was also slightly delayed in the 'dry' watering regime, by approximately 1 week.

Quality of plants was generally good, but was poorer at zero phosphate where plant growth was more uneven.

Flowering was slightly advanced in the 'dry' watering regime, whilst in the standard watering regime plants which had received supplementary phosphate liquid feed prior to transplanting were slightly more floriferous.

Plant fresh weight was greatest under the standard watering regime. There were no consistent differences between the two watering regimes on percentage dry matter.

3.7 Pansy F1 'Turbo Yellow with Blotch'

3.7.1 Transplanting

Plant growth results are given in Table 29, Appendix IV, page 62 and treatment comparisons are shown in colour plate 7, Appendix IX, page 98.

Plants were significantly smaller in height between treatments 0 g/l and 0.3 g/l single superphosphate (Table 15). At levels above 0.6 g/l SSP plants were slightly taller, but these differences were not significant statistically.

Table 15: Record of plant height at transplanting stage

Treatments single superphosphate g/l	**0**	**0.3**	**0.6**	**0.9**	**1.2**
Height (mm)	7.7	16.4	28.9	30.3	26.1

SED (d.f. = 4) = ± 2.577
LSD (5%) = ± 7.156

Similar trends were seen in both fresh and dry weight, with lowest figures at zero phosphate with the highest recorded weights at 0.9 g/l SSP. Commercially the best results were obtained using 0.3 g/l SSP which produced good quality, 'stocky' plants and prevented stretching within the plug tray.

The application of high phosphate feeds rapidly boosted plant growth. At the lower phosphate treatments of zero phosphate and 0.3 g/l SSP, fresh and dry weight greatly increased, by 80% and 42% respectively. Plant height had increased by 40% and 25% respectively to 12.7 mm and 21.8 mm. At the higher phosphate treatments above 0.6 g/l SSP, although plant growth had increased, the additional growth was not as great as at zero phosphate or 0.3 g/l SSP.

Leaf tissue analysis clearly showed that without the application of phosphate liquid feeds, phosphate was the limiting factor for growth (Tables 59 and 60, Appendix VI, page 78). Levels of phosphate were quickly replenished with the use of 10:52:10 N:P:K liquid feed. Media analysis (Tables 43 and 44, Appendix V, page 70) showed that phosphorus levels in all treatments were very low, but recovered after using 10:52:10 N:P:K liquid feed.

3.7.2 Maturity

Results are given in Tables 75 and 76, Appendix VII, page 86.

Plant height was reduced on average by 35% where plants had been grown under a 'dry' watering regime, and the greatest effect was visible on 0.9 g/l and 1.2 g/l phosphate treatments, likely to be as a result of potentially more vigorous growth at these treatments (Table 16).

Table 16: Plant Height (mm) at Marketing

Watering regime	Treatment level single superphosphate (g/l) 0	0.3	0.6	0.9	1.2
Standard	93.7	162.9	145.0	180.0	192.9
Dry	77.0	95.0	108.7	109.2	95.4
Standard +	105.0	91.2	107.2	130.4	128.7
Dry +	111.7	78.3	111.4	94.2	95.0

NB: '+' = plants which received supplementary phosphate feed in the plug stage.

Plant height was generally greater where plug plants had received no supplementary phosphate prior to transplanting. This is thought to be attributable to the fact that plants which received supplementary phosphate as liquid feed in the plug tray were more mature upon transplanting and produced a more compact plant at marketing. Similarly, plants which had been grown in plugs with low levels of phosphate zero-0.6 g/l SSP were more compact in their habit (Table 17).

Table 17: Plant Height:Width ratio* at Marketing

Watering regime	Treatment level single superphosphate (g/l) 0	0.3	0.6	0.9	1.2
Standard	0.68	0.88	0.76	0.87	0.98
Dry	0.72	0.73	0.77	0.81	0.76
Standard +	0.75	0.79	0.89	0.90	0.90
Dry +	0.80	0.71	0.83	0.84	0.80

NB: '+' = plants which received supplementary phosphate feed in the plug stage.
* A high height-to-width ratio indicates an upright habit, whilst a low height-to-width ratio indicates a broad habit.

Flowering appeared more floriferous at 0.6 g/l SSP and above. Quality was good across all treatments, although the smaller plant size under the 'dry' watering regime necessitated a lower quality score. Plant fresh weight was greater under the standard watering regime in comparison to the 'dry' watering regime, and was greater at the high phosphate treatments 0.9 g/l and 1.2 g/l SSP. Percentage dry weight did not vary widely between treatments except for slightly higher percentage dry weight for plants grown in the 'dry' watering regime.

3.8 *Petunia* F1 'Express Blue'

3.8.1 Transplanting Stage

Results are given in Table 30, Appendix IV, page 63 and treatment comparisons are shown in colour plate 8, Appendix IX, page 99.

Plant height was significantly increased in relation to increase in the phosphate treatment, with the exception of 1.2 g/l SSP which was not significantly larger than 0.9 g/l SSP (Table 18).

Table 18: Record of plant height at transplanting stage

Treatments single superphosphate g/l	**0**	**0.3**	**0.6**	**0.9**	**1.2**
Height (mm)	3.1	15.2	28.9	34.9	35.8

SED (d.f. = 4) = ± 2.019
LSD (5%) = ± 5.606

Plant fresh weight was greatest at 1.2 g/l SSP (9.7 g) and was lower at each phosphate treatment; 0.9 g/l (9.5 g), 0.6 g/l (8.1 g), 0.3 g/l (4.9 g/l) and zero phosphate (0.14 g). Percentage dry matter was greatest at zero phosphate (14.29%) and at 0.3 g/l SSP (12.24%) whilst lowest at 0.6 g/l SSP (6.17%).

Plant growth rapidly increased after the application of 10:52:10 N:P:K feeds with visual increase in plant growth recorded as increased plant height and fresh weight.

Leaf tissue analysis results are given in Tables 60 and 61, Appendix VI, page 79. These show that phosphorus levels in all treatments were below the normal recommended range (0.5-1.2% P). Levels of nitrogen and potassium were also slightly below the normal range.

The application of phosphate feeds quickly promoted plant growth and the levels of phosphorus in the leaf tissue increased in all plants. Levels of both nitrogen and potassium were reduced as a result of the boost in plant growth particularly at the higher phosphate treatment levels of 0.9 g/l and 1.2 g/l SSP.

Media analysis results are given in Tables 45 and 46, Appendix V, page 71. Phosphate levels were depleted in the treatments zero phosphate to 0.6 g/l SSP. The application of 10:52:10 N:P:K feeds quickly increased the phosphorus levels in the growing media.

3.8.2 Maturity

Results are given in Tables 76 and 77, Appendix VII, page 87.

Plant height was considerably reduced under the 'dry' watering regime, by 22% on average across the phosphate treatments (Table 19). The tallest plants were generally produced in treatments 0.3 g/l or 0.6 g/l SSP, although their habit was more compact. As such plant quality was usually better in these treatments (Table 20).

Table 19: Plant Height (mm) at Marketing

Watering regime	Treatment level single superphosphate (g/l) 0	0.3	0.6	0.9	1.2
Standard	126.0	242.5	181.7	161.7	148.7
Dry	-	172.1	117.9	111.7	129.6
Standard +	235.8	154.2	195.4	110.8	165.8
Dry +	98.3	122.1	129.6	140.8	134.2

NB: '+' = plants which received supplementary phosphate feed in the plug stage.

Table 20: Plant Height:Width ratio* at Marketing

Watering regime	Treatment level single superphosphate (g/l) 0	0.3	0.6	0.9	1.2
Standard	0.85	1.37	1.19	1.17	0.98
Dry	-	1.31	0.89	0.98	1.07
Standard +	1.37	1.16	1.52	1.05	1.38
Dry +	0.97	0.77	1.24	1.20	1.29

NB: '+' = plants which received supplementary phosphate feed in the plug stage.
* A high height-to-width ratio indicates an upright habit, whilst a low height-to-width ratio indicates a broad habit.

Flowering was more floriferous in treatments 0.3 g/l - 0.6 g/l SSP and plants grown under standard watering regime were better than those grown under a' dry' watering regime. Plant fresh weight was considerably higher for plants grown in a standard watering regime.

Both leaf tissue and growing media samples were taken from all treatments at marketing. Results for leaf analysis are given in Tables 83 to 86, Appendix VIII, page 88 and 89, and results for growing media analysis in Tables 79 to 82, Appendix VIII, pages 90 and 91.

Leaf analysis results showed that all plants had nutrient levels within the normal range of values (Metcoff, 1992). Levels of nutrients were generally higher in plants grown under 'dry' watering regime.

4. DISCUSSION

This year's trial has again demonstrated the potential which exists for plant growth to be controlled through the restriction of available phosphate. In 1994, trial work examined a wide range of phosphate treatments, from no added phosphate up to 3 g/l single superphosphate in the growing media for seed raised bedding plant plugs. Plant growth was reduced at the lower phosphate treatments, < 1 g/l. This year's trial aimed to assess a further range of phosphate levels; zero phosphate, 0.3 g/l, 0.6 g/l, 0.9 g/l and 1.2 g/l single superphosphate. In contrast to the trial work in 1994, the phosphate treatments were only applied in the plug stage of production and plug plants were pricked off directly into a commercial proprietary growing media, Levington M2. However, prior to transplanting a number of plants were fed using a high phosphate liquid feed to observe the effects on plant growth. During growing on, two watering regimes were employed, a standard watering regime as per normal commercial practice and a 'dry' watering regime which allowed plants to reach near to wilting point before re-watering lightly overhead. These treatments mirrored those used in the 1994 trial. Finally, a number of new species were evaluated this year: *Ageratum, Antirrhinum, Lobelia, Begonia* and Geranium in addition to *Petunia, Impatiens* and Pansy which were also grown in 1994.

The results from this year's work have confirmed that by restricting the levels of phosphate available, plant growth can be controlled. With the exception of Geranium, all species in this years work responded to the treatments; in general terms plant size in the plug was reduced as the phosphate levels were reduced. In the case of Geranium, plant growth was not too dissimilar at treatments above zero phosphate. It is possible that due to the larger seed size of Geranium, its phosphate reserve is higher than most other species and this negated the effect of the phosphate treatments applied.

Leaf tissue samples and growing media analysis taken immediately prior to transplanting confirmed that phosphorus levels were the limiting factor for plant growth. Levels of nitrogen and potassium were typically within the recommended range, particularly at the lower phosphate treatments. Seeds germinated successfully in all treatments and over a period of time plant growth rate could be seen to gradually slow and then stop, first in the lower phosphate treatments and then also at the higher treatment levels. In a number of species, *Ageratum* and Pansy, but particularly *Antirrhinum* and *Impatiens* the cotyledons were characteristically held vertically on the young seedlings.

Impatiens proved again to be very responsive to the phosphate treatments and even at 0.3 g/l growth of the young plug plants could become stretched. The best control over growth was afforded with the zero phosphate treatment where plants could be held successfully without loss in quality due to plants stretching. In *Petunia*, Pansy, *Antirrhinum* and *Lobelia* the rate of 0.3 g/l SSP single superphosphate proved to be most satisfactory allowing plants to become established in the plug before the depletion of phosphate halted plant growth.

This technique is not recommended for Geranium as at any other rate other than zero phosphate very little control of plant growth was achieved, whilst plants at zero phosphate were deemed to be of poorer quality. Also, although the technique worked well on *Begonia* and control of plant growth was demonstrated, *Begonia* is not thought to be a species which would require growth control in this manner.

The use of high phosphate liquid feeds (e.g.10:52:10 N:P:K) in the plug stage before pricking off proved advantageous in promoting plant growth at the lower phosphate treatments. The effect was to 'un-lock' plant growth and allow rapid development of both roots and foliage. From a practical point of view, it is recommended to begin feeding plug plants with a phosphate feed about 7-10 days prior to transplanting. This will aid both 'pulling' from the plug module and also help to avoid any check in plant growth at transplanting. This technique was used successfully on all species grown. However, some species, notably *Impatiens*, were strongly rooted without prior liquid feeding with phosphate and could be easily transplanted.

The trial this year did not continue the phosphate treatments during growing on, but used a standard growing media, Levington M2. However, effects were still seen from the earlier phosphate treatments applied in the plug tray, particularly for plants which had not received supplementary phosphate liquid feed in the plug stage. Typically, the lower phosphate treatments, 0.3 g/l and 0.6 g/l SSP produced higher quality plants as a result of plants being more compact in their habit and therefore less liable to stretch in the tray. Both the species *Petunia* and *Impatiens* were more compact at marketing where plug plants had been grown at lower levels of phosphate, 0.3 g/l and 0.6 g/l. Similar results were obtained with *Ageratum* and *Lobelia*. The use of phosphate liquid feeds prior to transplanting was more beneficial with *Begonia* and *Lobelia*, which otherwise failed to establish as rapidly after transplanting from the lower phosphate treatments.

During growing on, clear differences were observed between the watering regimes. The 'dry' watering regime kept plants smaller and restricted their growth. In some species flowering was slightly earlier in plants grown 'dry'; *Petunia, Lobelia* and *Ageratum* are examples. Dependent upon plant species the final height of plants in the 'dry' watering regime was reduced by between 10-30%. Further attempts were made to quantify the watering regime used, and using a tensiometer it was observed that watering usually occurred at between 80-120hPa. *Petunia* responded very favourably to the 'dry' watering regime whereas the species *Lobelia, Begonia* and *Impatiens* became a little uneven in their growth.

This technique of restricting phosphate is both an easy and effective tool which can be used by growers. Potentially it can reduce wastage as a result of plants becoming too tall or over mature in the plug tray before transplanting. If tall plants are transplanted often their final quality is poor and handling damage can be greater. Although no detailed assessments were made as part of this trial there maybe some additional benefits with reduced phosphate levels whereby a slightly 'harder' plant is produced, which may be at less risk from pest and disease attack.

From a production point of view, restricting phosphate levels in the growing media enables significant control of plant growth. Subsequently growth can be maintained or increased by supplementing phosphate through applied liquid feeds. Where all the phosphate is applied in the growing media at sowing/potting, this is not an option. Control is then dependent on the use of chemical plant growth regulators, or controlled watering regimes and in some instances the use of temperature manipulation through DIF/DROP. In simple terms this technique of controlled phosphate deficiency allows growers to be in more control of crop growth.

5 CONCLUSIONS

- A rate of between zero-0.6 g/l single superphosphate can be used successfully to control plant growth in a range of bedding plant species.

- The plant species *Impatiens, Petunia*, Pansy and *Antirrhinum* respond very well to this treatment.

- The plant species Geranium (which has a larger seed size and thus is thought to have a greater reserve of phosphate) does not respond well to this treatment.

- It is recommended to feed plugs with a high phosphate feed 7-10 days prior to pricking off to encourage root development and assist the operation of pricking off.

- Plants produced at lower phosphate levels, 0.3 g/l and 0.6 g/l SSP, remained more compact throughout production and hence plant quality at marketing and shelf-life was improved.

- The use of a 'dry' watering regime was again demonstrated as a practical measure which can be used to control plant growth, and there was an indication that it improved plant tolerance at marketing and in shelf-life.

6 FUTURE WORK

- This trial has clearly shown that by the manipulation of nutrition plant growth can be 'controlled' and improvement in plant quality is possible. In the context of this trial only phosphate (phosphorus source) was examined as a tool to control growth. Strategic research is required to examine in more detail the role of a much wider range of nutritional elements in plant development.

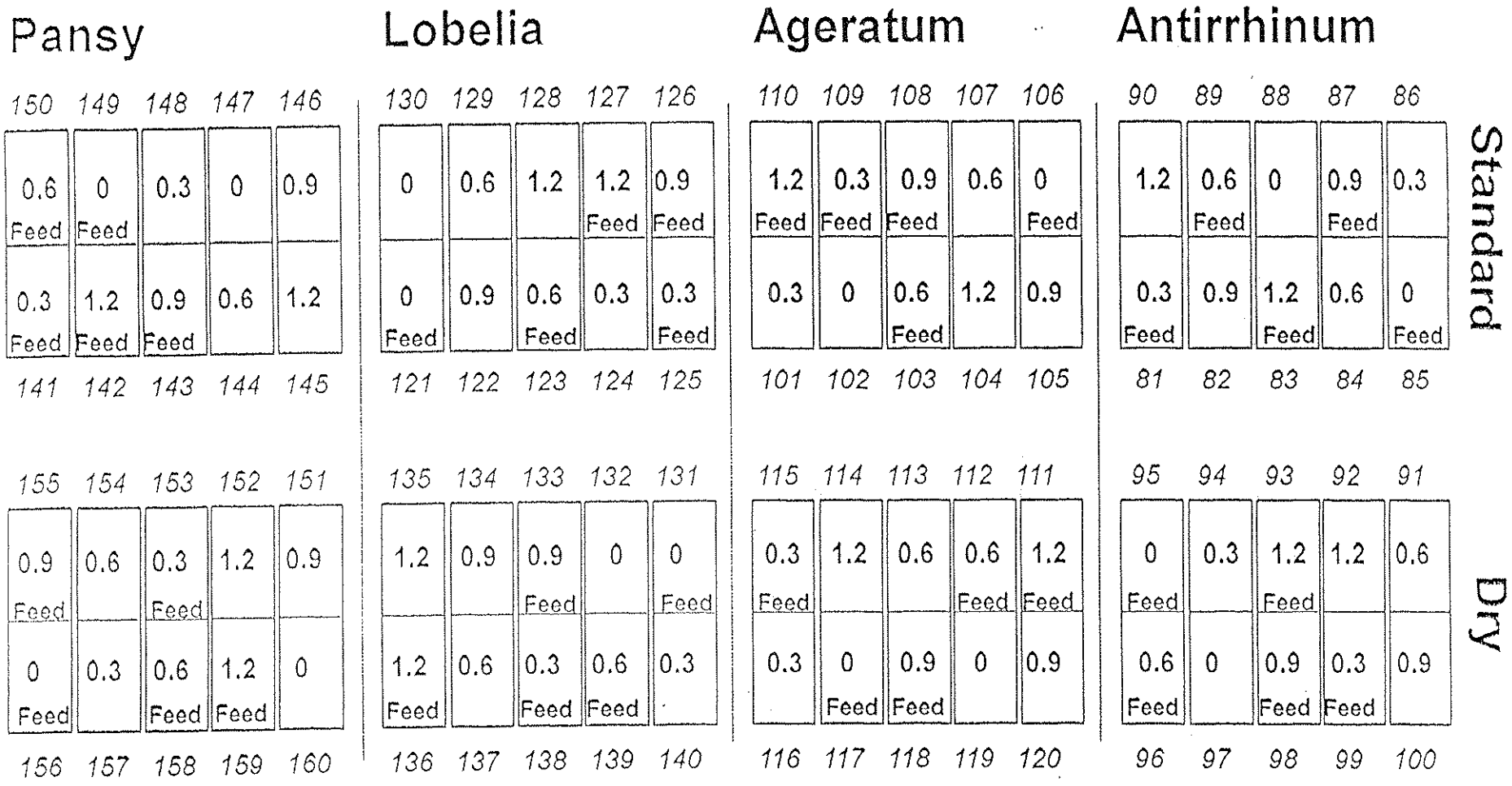
- With the use of liquid fertilizers, the method and timing of application is important in the plug stage to maximise their effectiveness and eliminate waste/runoff. Further strategic/ applied research needs to examine more closely the best way in which nutrients can be supplied to plants grown in small module units.

- The practice of 'growing dry' has been demonstrated as a practical method which can be used to control plant growth. Further research is required to quantify these methods and develop guidelines for a range of plant species so that these techniques can be more accurately applied by growers.

APPENDICES

N

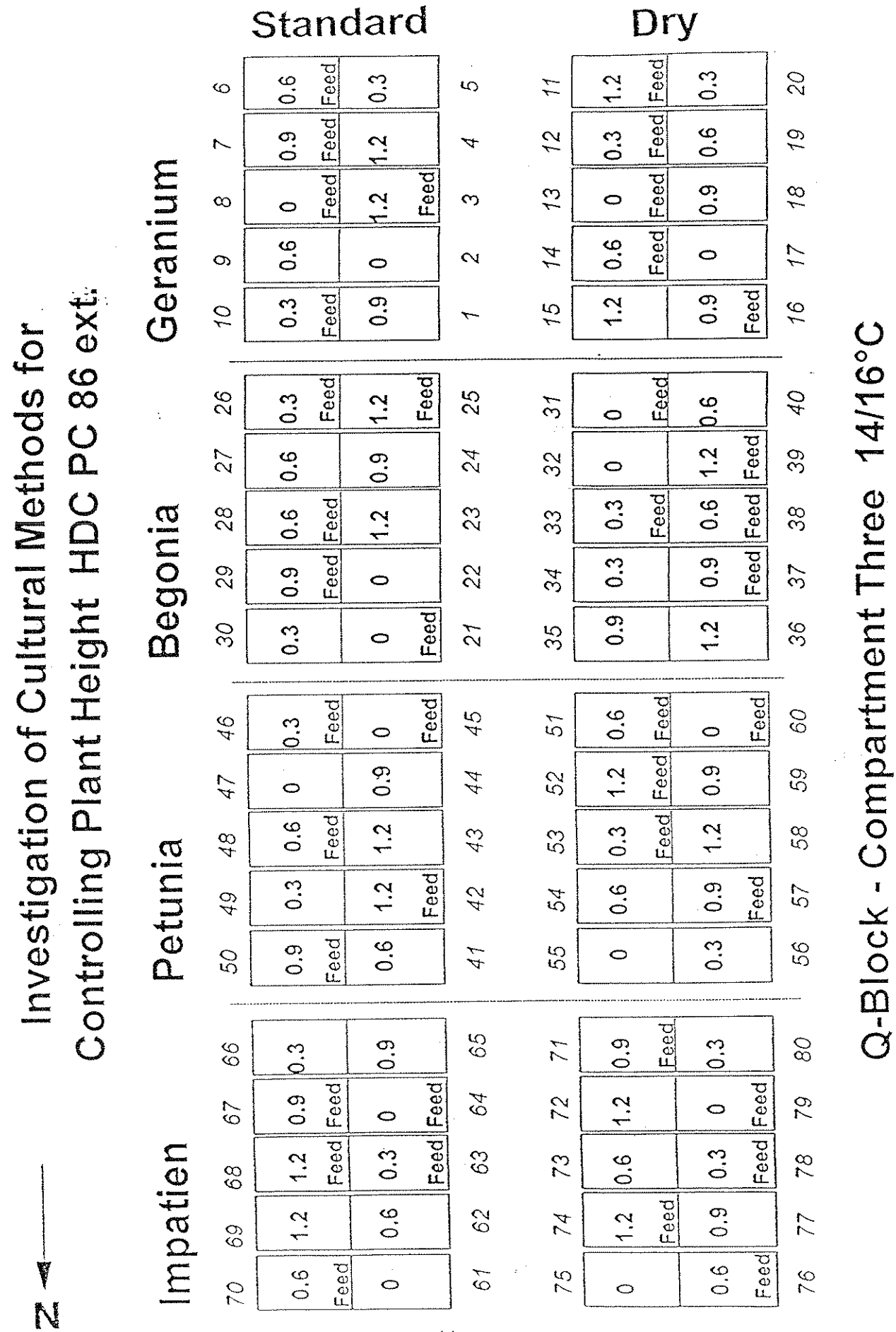
Investigation of Cultural Methods for Controlling Plant Height HDC PC 86 ext.



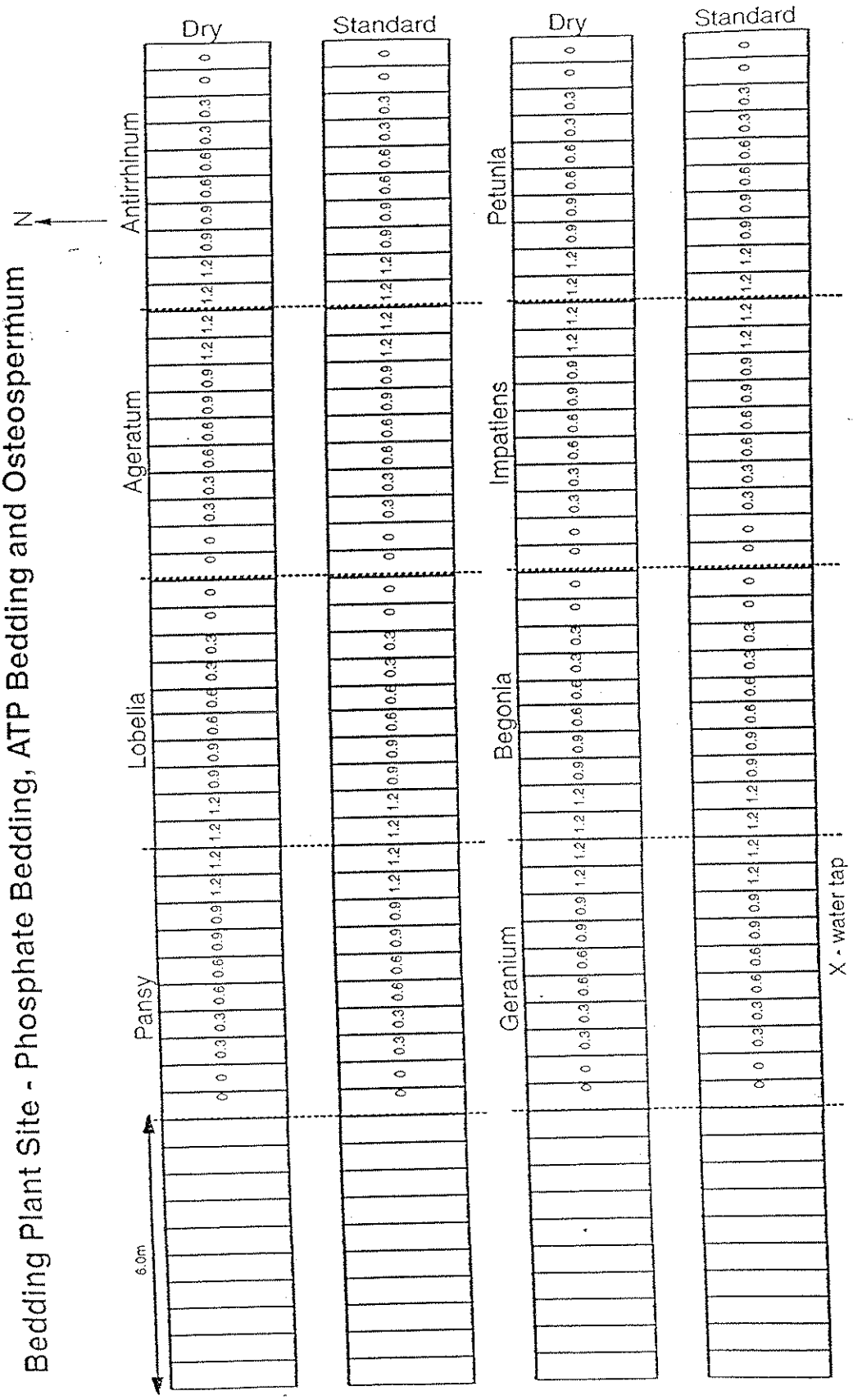
Q-Block - Compartment Two 10/12°C

No.81-160 = plot nos.

APPENDIX I **Trial Layout**



APPENDIX I **Trial Layout**



Each block, 6 plants across the bed with 2 rows, total 12 plants 30 cm spacing.
Room for guard plants either side at bed edge i.e 2 rows of 8 plants.
Guards can be from the same treatment (half-box)
(Zero - feed treatments will probably not be planted out for each species)

APPENDIX II

Table 21a: Media Analysis at Sowing

Replicate 1		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Bulk Density	g/ml	0.246	0.258	0.253	0.251	0.279
pH		6.1	5.8	5.8	5.7	5.4
Conductivity	μs	219 (1)	240 (1)	276 (1)	314 (2)	365 (2)
Nitrate (as N)	mg/l	129 (4)	124 (4)	128 (4)	124 (4)	133 (5)
Ammonium (as N)	mg/l	38.6 (7)	39.2 (1)	42.1 (1)	41.2 (1)	62.2 (2)
Potassium	mg/l	142 (3)	143 (3)	149 (3)	154 (3)	170 (3)
Calcium	mg/l	39	57	82	112	149
Magnesium	mg/l	15 (3)	21 (3)	29 (4)	39 (5)	43 (5)
Phosphorus	mg/l	<1 (0)	14 (3)	31 (5)	57 (7)	66 (7)
Iron	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/l	0.44	0.32	0.86	1.35	0.95
Manganese	mg/l	0.05	0.06	0.08	0.11	0.11
Copper	mg/l	0.02	0.02	0.02	0.02	0.02
Boron	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01

Table 21b: Media Analysis at Sowing

Replicate 2		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Bulk Density	g/ml	0.270	0.289	0.288	0.287	0.302
pH		5.8	5.7	5.5	5.5	5.3
Conductivity	μs	207 (1)	245 (1)	292 (1)	328 (2)	417 (3)
Nitrate (as N)	mg/l	119 (4)	136 (5)	134 (5)	131 (5)	143 (5)
Ammonium (as N)	mg/l	47.9 (1)	54.1 (2)	46.6 (1)	48.0 (1)	54.2 (2)
Potassium	mg/l	133 (3)	160 (3)	162 (3)	166 (3)	186 (4)
Calcium	mg/l	37	62	83	114	187
Magnesium	mg/l	12 (2)	20 (3)	26 (4)	34 (4)	49 (5)
Phosphorus	mg/l	<1 (0)	12 (3)	26 (4)	48 (6)	67 (7)
Iron	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/l	0.68	0.28	0.35	0.22	0.88
Manganese	mg/l	0.07	0.04	0.06	0.07	0.29
Copper	mg/l	0.02	0.02	0.02	0.02	0.02
Boron	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01

APPENDIX II

Table 22: Media and feed analysis for pricking off

		10:52:10 N:P:K liquid feed	Fison's Levington M2 Growing media
pH		6.8	5.7
Conductivity	μs	677	406 (4)
Nitrate (as N)	mg/l	9	122 (4)
Ammonium (as N)	mg/l	44.2	87.3 (2)
Potassium	mg/l	44	143 (3)
Calcium	mg/l	67	89
Magnesium	mg/l	2	94 (7)
Phosphorus	mg/l	84	82 (8)
Iron	mg/l	0.02	<0.01
Zinc	mg/l	0.10	0.24
Manganese	mg/l	0.02	0.21
Copper	mg/l	0.03	0.10
Boron	mg/l	0.01	<0.01
Sodium	mg/l	12	-
Chloride	mg/l	22	-
Sulphate (as S)	mg/l	1	-

APPENDIX III

Crop Diaries: No supplementary phosphate

	Antirrhinum 'Coronette Yellow'			Ageratum 'Blue Champion'		
	wk	**date**	**days**	**wk**	**date**	**days**
sown	5	01.02.95 no covering		7	16.02.95 no covering	
radicle emergence (99%)	6	04.02.95	3	8	19.02.95	3
emergence with cotyledons expanded & horizontal (95-98%)	6	07.02.95	6	8	23.02.95	7
Started feeding - plugs 1:1 NK (75 ppm N) EC1035 μS	8	23.02.95	22	9	01.03.95	13
Transferred from H prop to H north 12°C day (vent 14°C) 12°C night	9	04.03.95	31	10	05.03.95	17
Transferred from H north to Q3 direct growing-on treatments 10°C day (vent 12°C) 10°C night	11	13.03.95	40	11	15.03.95	27
growing-on M2 compost double sixes	11	13.03.95	40	11	15.03.95	27
commenced water regimes	11	17.03.95	44	11	18.03.95	30
Started feeding - double sixes 150-60-150 EC1500 μS pH 6.5	14	06.04.95	64	14	06.04.95	49

APPENDIX III

Crop Diaries: With supplementary 10:52:10 N:P:K phosphate liquid feed

	Antirrhinum 'Coronette Yellow'			Ageratum 'Blue Champion'		
	wk	**date**	**days**	**wk**	**date**	**days**
Transferred from H prop to H north 12˚C day (vent 14˚C) 12˚C night	9	04.03.95	31	10	05.03.95	17
Started feeding - plugs (high phosphate feed) 10-52-10	11	15.03.95	42	11	16.03.95	28
Transferred from H north to Q3 plug tray treatments 10˚C day (vent 12˚C) 10˚C night	14	03.04.95	61	15	10.04.95	53
growing-on M2 compost double sixes	14	03.04.95	61	15	10.04.95	53
commenced water regimes	14	07.04.95	65	15	14.04.95	57
Started feeding - double sixes 150-60-150 EC1500 μS pH 6.5	17	26.04.95	84	18	02.05.95	75

APPENDIX III

Crop Diaries: No supplementary phosphate

	Begonia 'Olympia Red'			Geranium 'Century Scarlet'		
	wk	date	days	wk	date	days
sown Base heat 20°C	4	24.01.95 no covering 1/plug cell		4	24.01.95 vermiculite covering medium black polythene	
radicle emergence (99%)	5	04.02.95	11			
emergence with cotyledons expanded & horizontal (95-98%)	6	09.02.95	16	4 5	27.01.95 02.02.95	3 9
Started feeding - plugs 1:1 NK (75 ppm N) EC1035 μS	8	23.02.95	30	8	20.02.95	27
Cycocel - 465 ppm Chlormequat 46.5% 1.0 ml l^{-1} First application				8	24.02.95	31
Transferred from H north to Q1 direct growing-on treatments 16°C day (vent 18°C) 16°C night	12	23.03.95	58	9	03.03.95	38
growing-on M2 compost double sixes	12	23.03.95	40	9	03.03.95	38
commenced water regimes	13	28.03.95	63	10	08.03.95	43
Started feeding - double sixes 150-60-150 EC1500 μS pH 6.5	15	12.04.95	78	13	01.04.95	67
Cycocel - 465 ppm Chlormequat 46.5% 1.0 ml l^{-1} Second application Third application				11 12	14.03.95 22.03.95	49 57

APPENDIX III

Crop Diaries: With supplementary 10:52:10 N:P:K phosphate liquid feed

	Begonia 'Olympia Red'			Geranium 'Century Scarlet'		
	wk	**date**	**days**	**wk**	**date**	**days**
Transferred from H prop to E8 plug tray treatments 16°C day (vent 18°C) 16°C night	12	23.03.95	58	9	04.03.95	39
Started feeding - plugs (high phosphate feed) 10-52-10 (50 ppm N)	12	24.03.95		10	06.03.95	41
Cycocel - 465 ppm Chlormequat 46.5% 1.0 ml l^{-1} Second application				11	14.03.95	49
Transferred from E8 to Q1 plug tray treatments	14	06.04.95	72	12	20.03.95	55
growing-on M2 compost double sixes	14	06.04.95	72	12	20.03.95	55
commenced water regimes	13	11.04.95	77	12	24.03.95	59
Cycocel - 465 ppm Chlormequat 46.5% 1.0 ml l^{-1} Third application				12	22.03.95	57
Started feeding - double sixes 150-60-150 EC 1500 μS pH 6.5	17	24.04.95	90	15	13.04.95	79

APPENDIX III

Crop Diaries: No supplementary phosphate

	Petunia 'Express Blue'			Impatiens 'Accent Salmon'		
	wk	date	days	wk	date	days
sown Base heat 20°C Compost	6	07.02.95 no covering		4	25.01.95 vermiculite covering medium	
radicle emergence (99%)	7	13.02.95	6			
emergence with cotyledons expanded & horizontal (95-98%)	7	16.02.95	9	5 6	02.02.95 06.02.95	8 12
Started feeding - plugs 1:1 NK (75 ppm N) EC1035 μS	9	01.02.95	22	8	20.02.95	26
Transferred from H prop to Q1 direct growing-on treatments 16°C day (vent 18°C) 16°C night	11	13.03.95	34	10	06.03.95	40
growing-on M2 compost double sixes	11	13.03.95	34	10	06.03.95	40
commenced water regimes	11	17.03.95	38	11	12.03.95	46
Started feeding - double sixes 150-60-150 EC1500 μS pH 6.5	14	04.04.95	56	14	04.04.95	69

APPENDIX III

Crop Diaries: With supplementary 10:52:10 N:P:K phosphate liquid feed

	Petunia 'Express Blue'			Impatiens 'Accent Salmon'		
	wk	date	days	wk	date	days
Transferred from H prop to E8 plug tray treatments 16°C day (vent 18°C) 16°C night	11	13.03.95	34	10	06.03.95	40
Started feeding - plugs (high phosphate feed) 10-52-10 (50 ppm N)	11	14.03.95	35	10	06.03.95	40
Transferred from E8 to Q1 plug tray treatments 16°C day (vent 18°C) 16°C night	14	04.04.95	56	12	20.03.95	55
growing-on M2 compost double sixes	14	04.04.95	56	12	20.03.95	55
commenced water regimes	14	08.04.95	60	12	25.03.95	60
Started feeding - double sixes 150-60-150 EC1500 μS pH 6.5	17	24.04.95	76	15	12.04.95	78

APPENDIX III

Crop Diaries: No supplementary phosphate

	Lobelia 'Crystal Palace'			Pansy F1 'Turbo Yellow with Blotch'		
	wk	date	days	wk	date	days
sown Base heat 20°C Compost	5	30.01.95 no covering 6/plug cell		6	10.02.95 vermiculite covering fine	
radicle emergence (99%)	6	06.02.95	7			
emergence with cotyledons expanded & horizontal (95-98%)	6	09.02.95	10	7	17.02.95	7
Started feeding - plugs 1:1 NK (75 ppm N) EC1035 μS	8	23.02.95	24	9	01.03.95	19
increased plug feed 1:1 NK (100 ppm) EC1166 μS	11	15.03.95	44	11	15.03.95	33
Transferred from H prop to H north 12°C day (vent 14°C) 12°C night	9	04.03.95	32	10	05.03.95	23
Transferred from H prop to Q3 direct growing-on treatments 10°C day (vent 12°C) 10°C night	11	14.03.95	42	12	24.03.95	33
growing-on M2 compost double sixes	11	14.03.95	42	12	24.03.95	33
commenced water regimes	12	20.03.95	48	13	29.03.95	38
Started feeding - double sixes 150-60-150 EC1500 μS pH 6.5	14	06.04.95	65	15	10.04.95	50

APPENDIX III

Crop Diaries: With supplementary 10:52:10 N:P:K phosphate liquid feed

	Lobelia 'Crystal Palace'			Pansy F1 'Turbo Yellow with Blotch'		
	wk	**date**	**days**	**wk**	**date**	**days**
Transferred from H prop to H north plug tray treatments 12˚C day (vent 14˚C) 12˚C night	9	04.03.95	32	10	05.03.95	23
Started feeding - plugs (high phosphate feed) 10-52-10 (50 ppm N)	11	16.03.95	44	12	24.03.95	42
Transferred from H north to Q3 plug tray treatments 10˚C day (vent 12˚C) 10˚C night	15	10.04.95	69	15	11.04.95	60
growing-on M2 compost double sixes	15	10.04.95	69	15	11.04.95	60
commenced water regimes	15	14.04.95	73	15	15.04.95	64
Started feeding - double sixes 150-60-150 EC1500 μS pH 6.5	18	01.05.95	89	18	01.05.95	79

APPENDIX IV

Plant Growth Assessments at Transplanting

Table 23: *Ageratum* **'Blue Champion'** (figures are a mean of 20 plants)

Treatments SSP g/l	Plots	Stage[1]	Plot Uniformity[2]	Fresh Wt (g)	Dry Wt (g)	% DM	Height (mm)
0	102/119	1	2	0.11	0.02	18.18	6.65
0	106/117	1	1.5	*	*	*	5.70
0 + F	106/117	2	1	0.84	0.03	3.57	8.60
0.3	101/116	1	1.5	1	0.2	20.00	11.65
0.3	109/115	1	1.5	*	*	*	11.10
0.3 + F	109/115	2	2	6.9	0.98	14.20	23.55
0.6	107/113	1	1.5	2.6	0.3	11.54	16.75
0.6	103/112	1	1.5	*	*	*	12.80
0.6 + F	103/112	2	2	6.95	1.25	17.99	26.80
0.9	105/120	1	1.5	3	0.2	6.67	17.70
0.9	108/118	1	1.5	*	*	*	14.80
0.9 + F	108/118	2	2	10.49	1.77	16.87	32.85
1.2	104/114	1	1.5	2.7	0.3	11.11	18.20
1.2	120/111	1	2	*	*	*	17.45
1.2 + F	120/111	2	2	8.97	1.39	15.50	33.85

1 Stage 1 = at plug stage, stage 2 = approx. 3 weeks later after receiving high phosphate liquid feed (+F)

2 Uniformity (1, 2, 3) = poor, average, good

* No record for these plots/assessments

APPENDIX IV

Plant Growth Assessments at Transplanting

Table 24: *Antirrhinum* **'Coronette Yellow'** (figures are a mean of 20 plants)

Treatments SSP g/l	Plots	Stage[1]	Plot Uniformity[2]	Fresh Wt (g)	Dry Wt (g)	% DM	Height (mm)
0	88/97	1	2	0.1	0.03	30.00	8.20
0	85/95	1	2	*	*	*	8.40
0 + F	85/95	2	1	0.77	0.03	3.99	11.30
0.3	86/94	1	2	2.9	0.5	17.24	20.00
0.3	81/99	1	1	*	*	*	20.75
0.3 + F	81/99	2	3	9.38	1.18	12.58	33.00
0.6	84/91	1	2	4.5	0.4	8.89	23.25
0.6	89/96	1	2	*	*	*	26.00
0.6 + F	89/96	2	2	12.96	1.81	13.97	42.10
0.9	82/100	1	2	5.2	0.5	9.62	27.30
0.9	87/98	1	2	*	*	*	28.70
0.9 + F	87/98	2	2	12.6	1.69	13.41	47.00
1.2	90/92	1	2	4.4	0.4	9.09	26.05
1.2	83/93	1	2	*	*	*	28.50
1.2 + F	83/93	2	2	11.82	1.57	13.28	47.75

1 Stage 1 = at plug stage, stage 2 = approx. 3 weeks later after receiving high phosphate liquid feed (+F)

2 Uniformity (1, 2, 3) = poor, average, good

* No record for these plots/assessments

APPENDIX IV

Plant Growth Assessments at Transplanting

Table 25: *Begonia* 'Olympia Red' (figures are a mean of 20 plants)

Treatments SSP g/l	Plots	Stage[1]	Plot Uniformity[2]	Fresh Wt (g)	Dry Wt (g)	% DM	Height (mm)
0	22/32	1	1	0.06	0.01	16.67	1.35
0	21/31	1	1	*	*	*	1.65
0 + F	21/31	2	1	0.17	0.07	41.18	3.45
0.3	30/34	1	1	5.87	0.5	8.52	11.70
0.3	26/33	1	1	*	*	*	12.00
0.3 + F	26/33	2	1	25.44	1.15	4.52	33.95
0.6	27/40	1	1	7.64	0.6	7.85	16.40
0.6	28/38	1	1	*	*	*	12.45
0.6 + F	28/38	2	1	34.7	1.29	3.72	42.70
0.9	24/35	1	2	13.69	0.8	5.84	26.55
0.9	29/37	1	2	*	*	*	27.15
0.9 + F	29/37	2	2	47.79	1.66	3.47	58.00
1.2	23/36	1	2.5	12.7	0.6	4.72	27.70
1.2	25/39	1	2.5	*	*	*	28.35
1.2 + F	25/39	2	2.5	48.27	1.69	3.50	54.90

1 Stage 1 = at plug stage, stage 2 = approx. 3 weeks later after receiving high phosphate liquid feed (+F)

2 Uniformity (1, 2, 3) = poor, average, good

* No record for these plots/assessments

APPENDIX IV

Plant Growth Assessments at Transplanting

Table 26: **Geranium 'Century Scarlet'** (figures are a mean of 20 plants)

Treatments SSP g/l	Plots	Stage[1]	Plot Uniformity[2]	Fresh Wt (g)	Dry Wt (g)	% DM	Height (mm)
0	8/17	1	2	8.9	1.1	12.36	33.25
0	8/13	1	2	*	*	*	30.40
0 + F	8/13	2	3	14.1	1.7	12.06	49.80
0.3	5/20	1	3	20.6	1.7	8.25	77.90
0.3	10/12	1	2	*	*	*	82.15
0.3 + F	10/12	2	2.5	31.9	3.9	12.23	93.90
0.6	9/19	1	2	20.5	1.6	7.80	71.75
0.6	6/14	1	2	*	*	*	69.60
0.6 + F	6/14	2	2	33.4	3.9	11.68	89.60
0.9	1/18	1	2	20.6	1.7	8.25	73.45
0.9	7/16	1	3	*	*	*	77.35
0.9 + F	7/16	2	2.5	35.1	4.4	12.54	92.75
1.2	4/15	1	2	22.6	1.6	7.08	79.55
1.2	3/11	1	2	*	*	*	78.55
1.2 + F	3/11	2	2.5	36	4	11.11	106.95

1 Stage 1 = at plug stage, stage 2 = approx. 3 weeks later after receiving high phosphate liquid feed (+F)

2 Uniformity (1, 2, 3) = poor, average, good

* No record for these plots/assessments

APPENDIX IV

Plant Growth Assessments at Transplanting

Table 27: *Impatiens* 'Accent Salmon' (figures are a mean of 20 plants)

Treatments SSP g/l	Plots	Stage[1]	Plot Uniformity[2]	Fresh Wt (g)	Dry Wt (g)	% DM	Height (mm)
0	61/75	1	3	1	0.2	20.00	11.80
0	64/79	1	3	*	*	*	12.35
0 + F	64/79	2	3	4.5	0.4	8.89	19.90
0.3	66/80	1	2	12.3	0.9	7.32	51.85
0.3	63/78	1	2	*	*	*	50.50
0.3 + F	63/78	2	1	22.7	1.6	7.05	70.50
0.6	62/73	1	2	14.1	0.9	6.38	55.00
0.6	70/76	1	2	*	*	*	59.00
0.6 + F	70/76	2	1	28.5	1.9	6.67	86.80
0.9	65/77	1	2	13.5	0.9	6.67	58.95
0.9	67/71	1	2	*	*	*	64.25
0.9 + F	67/71	2	1	26.3	0.9	3.42	86.35
1.2	69/72	1	2	15.1	0.9	5.96	67.90
1.2	68/74	1	2	*	*	*	52.85
1.2 + F	68/74	2	2	20.6	1.6	7.77	73.40

1 Stage 1 = at plug stage, stage 2 = approx. 3 weeks later after receiving high phosphate liquid feed (+F)

2 Uniformity (1, 2, 3) = poor, average, good

* No record for these plots/assessments

APPENDIX IV

Plant Growth Assessments at Transplanting

Table 28: *Lobelia* **'Crystal Palace'** (figures are a mean of 20 plants)

Treatments SSP g/l	Plots	Stage[1]	Plot Uniformity[2]	Fresh Wt (g)	Dry Wt (g)	% DM	Height (mm)
0	130/132	1	2	0.6	0.11	18.33	4.90
0	121/131	1	2	*	*	*	4.50
0 + F	121/131	2	1	3.19	0.42	13.17	16.15
0.3	124/140	1	2	4	0.3	7.5	18.50
0.3	125/138	1	2	*	*	*	18.15
0.3 + F	125/138	2	2	11.45	1.85	16.16	35.55
0.6	129/137	1	2	4.7	0.5	10.64	20.70
0.6	123/139	1	2	*	*	*	23.95
0.6 + F	123/129	2	2	12.58	1.96	15.58	41.45
0.9	122/134	1	3	5.4	0.5	9.26	23.00
0.9	126/133	1	2	*	*	*	22.30
0.9 + F	126/133	2	3	11.72	1.9	16.21	38.50
1.2	128/135	1	2	5.7	0.5	8.77	23.10
1.2	127/136	1	2	*	*	*	20.80
1.2 + F	127/136	2	2	12.53	1.93	15.40	37.40

1 Stage 1 = at plug stage, stage 2 = approx. 3 weeks later after receiving high phosphate liquid feed (+F)

2 Uniformity (1, 2, 3) = poor, average, good

* No record for these plots/assessments

APPENDIX IV

Plant Growth Assessments at Transplanting

Table 29: **Pansy 'F1 Turbo Yellow with blotch'** (figures are a mean of 20 plants)

Treatments SSP g/l	Plots	Stage[1]	Plot Uniformity[2]	Fresh Wt (g)	Dry Wt (g)	% DM	Height (mm)
0	147/160	1	2	0.33	0.24	72.73	8.25
0	149/156	1	2	*	*	*	7.25
0 + F	149/156	2	2	1.61	0.41	25.47	12.70
0.3	148/157	1	2	2.28	0.78	34.21	16.80
0.3	141/153	1	2	*	*	*	16.00
0.3 + F	141/153	2	2	5.12	1.27	24.80	21.85
0.6	144/154	1	2	4.74	1.19	25.11	25.30
0.6	150/158	1	2	*	*	*	32.45
0.6 + F	150/158	2	2	11.36	2.66	23.42	36.05
0.9	146/151	1	2.5	6.84	1.59	23.25	30.40
0.9	143/155	1	2.5	*	*	*	30.30
0.9 + F	143/155	2	2.5	10.32	2.18	21.12	33.70
1.2	145/152	1	2.5	5.73	1.21	21.12	26.95
1.2	142/159	1	2.5	*	*	*	25.25
1.2 + F	142/159	2	2.5	9.42	2.25	23.89	29.70

1 Stage 1 = at plug stage, stage 2 = approx. 3 weeks later after receiving high phosphate liquid feed (+F)

2 Uniformity (1, 2, 3) = poor, average, good

* No record for these plots/assessments

APPENDIX IV

Plant Growth Assessments at Transplanting

Table 30: *Petunia* **'Express Blue'** (figures are a mean of 20 plants)

Treatments SSP g/l	Plots	Stage[1]	Plot Uniformity[2]	Fresh Wt (g)	Dry Wt (g)	% DM	Height (mm)
0	47/55	1	3	0.14	0.02	14.29	3.35
0	45/60	1	2	*	*	*	2.85
0 + F	45/60	2	1	1.6	0.1	6.25	9.85
0.3	49/56	1	2	4.9	0.6	12.24	17.60
0.3	46/53	1	2	*	*	*	12.85
0.3 + F	46/53	2	2	17.57	1.23	7.00	36.30
0.6	41/54	1	2	8.1	0.5	6.17	31.95
0.6	48/51	1	2	*	*	*	25.85
0.6 + F	48/51	2	1	25.78	1.89	7.33	56.20
0.9	44/59	1	2	9.5	0.6	6.32	34.70
0.9	50/57	1	2	*	*	*	35.10
0.9 + F	50/57	2	2	26.66	2.05	7.69	57.85
1.2	43/58	1	2	9.7	0.7	7.22	36.35
1.2	42/52	1	2	*	*	*	35.35
1.2 + F	42/52	2	2	23.62	1.81	7.66	61.10

1 Stage 1 = at plug stage, stage 2 = approx. 3 weeks later after receiving high phosphate liquid feed (+F)

2 Uniformity (1, 2, 3) = poor, average, good

* No record for these plots/assessments

APPENDIX V

Growing Media Analysis at Transplanting

Table 31: *Ageratum* F1 'Blue Champion' (no supplementary phosphate)

		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Bulk Density	g/ml	0.357	0.395	0.390	0.375	0.479
pH		5.9	6.0	6.0	6.0	6.1
Conductivity	µs/20C	166 (1)	98 (0)	114 (0)	101 (0)	101 (0)
Nitrate (as N)	mg/l	80 (3)	31 (2)	30 (2)	11 (4)	16 (1)
Ammonium (as N)	mg/l	21.9 (1)	2.5 (0)	6.8 (0)	3.0 (0)	3.8 (0)
Potassium	mg/l	96 (2)	60 (2)	67 (2)	46 (1)	53 (2)
Calcium	mg/l	27	21	23	26	19
Magnesium	mg/l	7 (1)	4 (0)	5 (0)	4 (0)	3 (0)
Phosphorus	mg/l	<1 (0)	<1 (0)	3 (0)	5 (1)	3 (0)
Iron	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/l	0.18	0.15	0.25	0.17	0.26
Manganese	mg/l	0.07	0.04	0.04	0.03	0.03
Copper	mg/l	0.08	0.09	0.13	0.12	0.12
Boron	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01

Table 32: *Ageratum* F1 'Blue Champion' (with supplementary phosphate liquid feed)

		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Bulk Density	g/ml	0.297	0.439	0.413	0.448	0.389
pH		5.8	6.1	6.1	6.1	6.2
Conductivity	µs/20C	311 (2)	50 (0)	40 (0)	35 (0)	39 (0)
Nitrate (as N)	mg/l	117 (4)	10 (0)	<1 (0)	4 (0)	7 (0)
Ammonium (as N)	mg/l	5.5 (0)	0.4 (0)	<0.1 (0)	<0.1 (0)	0.1 (0)
Potassium	mg/l	184 (4)	25 (1)	20 (0)	14 (0)	11 (0)
Calcium	mg/l	60	20	14	16	22
Magnesium	mg/l	14 (2)	3 (0)	2 (0)	2 (0)	3 (0)
Phosphorus	mg/l	96 (8)	22 (4)	15 (3)	10 (2)	10 (2)
Iron	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/l	0.37	0.25	0.20	0.11	0.19
Manganese	mg/l	0.17	0.03	0.02	0.03	0.02
Copper	mg/l	0.08	0.07	0.04	0.07	0.05
Boron	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01

APPENDIX V

Growing Media Analysis at Transplanting

Table 33: *Begonia* **'F1 Olympia Red' (no supplementary phosphate)**

		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Bulk Density	g/ml	0.448	0.402	0.402	0.374	0.349
pH		5.5	5.8	5.9	5.8	6.2
Conductivity	µs/20C	265 (1)	159 (1)	188 (1)	148 (0)	131 (0)
Nitrate (as N)	mg/l	151 (5)	71 (3)	85 (4)	52 (3)	42 (2)
Ammonium (as N)	mg/l	0.9 (0)	1.0 (0)	1.3 (0)	1.6 (0)	1.5 (0)
Potassium	mg/l	155 (3)	110 (3)	128 (3)	89 (2)	83 (2)
Calcium	mg/l	101	42	59	45	44
Magnesium	mg/l	27 (4)	10 (2)	14 (2)	10 (2)	9 (1)
Phosphorus	mg/l	<1 (0)	<1 (0)	6 (1)	11 (2)	11 (2)
Iron	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/l	0.29	0.13	0.16	0.18	0.31
Manganese	mg/l	0.89	0.01	0.02	0.39	0.35
Copper	mg/l	0.09	0.09	0.08	0.09	0.10
Boron	mg/l	0.08	0.25	0.05	<0.01	<0.01

Table 34: *Begonia* **'F1 Olympia Red' (with supplementary phosphate liquid feed)**

		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Bulk Density	g/ml	0.368	0.378	0.352	0.334	0.325
pH		5.4	5.6	5.7	5.6	5.8
Conductivity	µs/20C	278 (1)	119 (0)	110 (0)	106 (0)	119 (0)
Nitrate (as N)	mg/l	135 (5)	41 (2)	31 (2)	24 (1)	26 (2)
Ammonium (as N)	mg/l	0.8 (0)	0.4 (0)	0.8 (0)	2.0 (0)	0.2 (0)
Potassium	mg/l	178 (4)	77 (2)	67 (2)	55 (2)	52 (2)
Calcium	mg/l	116	48	50	52	68
Magnesium	mg/l	26 (4)	10 (1)	10 (1)	10 (1)	11 (2)
Phosphorus	mg/l	70 (7)	53 (6)	56 (7)	59 (7)	64 (7)
Iron	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/l	0.27	0.32	0.33	0.28	0.27
Manganese	mg/l	0.08	0.05	0.05	0.06	0.06
Copper	mg/l	0.05	0.05	0.06	0.07	0.05
Boron	mg/l	<0.01	<0.01	<0.01	<0.01	0.08

APPENDIX V

Growing Media Analysis at Transplanting

Table 35: *Antirrhinum* 'F1 Coronette Yellow' (no supplementary phosphate)

		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Bulk Density	g/ml	0.286	0.319	0.294	0.305	0.357
pH		5.8	5.8	5.8	5.7	5.9
Conductivity	µs/20C	238 (1)	129 (0)	127 (0)	115 (0)	109 (0)
Nitrate (as N)	mg/l	123 (4)	50 (2)	37 (2)	18 (1)	13 (0)
Ammonium (as N)	mg/l	28.1 (1)	1.9 (0)	3.1 (0)	2.7 (0)	3.2 (0)
Potassium	mg/l	139 (3)	76 (2)	65 (2)	50 (2)	43 (1)
Calcium	mg/l	48	33	32	33	33
Magnesium	mg/l	12 (2)	7 (1)	6 (1)	6 (1)	7 (1)
Phosphorus	mg/l	<1 (0)	<1 (0)	1 (0)	5 (1)	7 (1)
Iron	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/l	0.14	0.14	0.17	0.09	0.14
Manganese	mg/l	0.12	0.07	0.05	0.05	0.04
Copper	mg/l	0.07	0.08	0.08	0.09	0.10
Boron	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01

Table 36: *Antirrhinum* 'F1 Coronette Yellow' (with supplementary phosphate liquid feed)

		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Bulk Density	g/ml	0.399	0.320	0.313	0.328	0.314
pH		6.0	6.0	5.8	5.7	5.8
Conductivity	µs/20C	203 (1)	58 (0)	74 (0)	72 (0)	75 (0)
Nitrate (as N)	mg/l	73 (3)	3 (0)	3 (0)	2 (0)	2 (0)
Ammonium (as N)	mg/l	40.5 (1)	0.5 (0)	1.0 (0)	0.9 (0)	1.3 (0)
Potassium	mg/l	131 (3)	22 (0)	34 (1)	36 (1)	35 (1)
Calcium	mg/l	39	17	29	30	31
Magnesium	mg/l	9 (1)	2 (0)	4 (0)	4 (0)	4 (0)
Phosphorus	mg/l	51 (6)	10 (2)	17 (3)	20 (4)	25 (4)
Iron	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/l	0.39	0.32	0.75	0.26	0.24
Manganese	mg/l	0.12	0.03	0.05	0.05	0.06
Copper	mg/l	0.09	0.13	0.16	0.20	0.22
Boron	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01

APPENDIX V

Growing Media Analysis at Transplanting

Table 37: Geranium 'F1 Century Scarlet' (no supplementary phosphate)

		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Bulk Density	g/ml	0.462	0.291	0.333	0.321	0.371
pH		5.6	5.6	5.7	5.7	5.9
Conductivity	µs/20C	156 (1)	146 (0)	167 (1)	125 (0)	177 (1)
Nitrate (as N)	mg/l	76 (3)	53 (3)	54 (3)	19 (1)	31 (2)
Ammonium (as N)	mg/l	0.2 (0)	4.4 (0)	10.3 (0)	2.4 (0)	1.1 (0)
Potassium	mg/l	91 (2)	65 (2)	76 (2)	38 (1)	56 (2)
Calcium	mg/l	42	43	57	46	90
Magnesium	mg/l	15 (3)	15 (3)	20 (3)	15 (3)	27 (4)
Phosphorus	mg/l	<1 (0)	4 (0)	13 (3)	9 (2)	23 (4)
Iron	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/l	0.33	0.11	0.32	0.12	0.09
Manganese	mg/l	0.06	0.06	0.06	0.05	0.06
Copper	mg/l	0.06	0.06	0.06	0.05	0.06
Boron	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01

Table 38: Geranium 'F1 Century Scarlet' (with supplementary phosphate liquid feed)

		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Bulk Density	g/ml	0.411	0.361	0.329	0.301	0.308
pH		5.7	5.6	5.6	5.5	5.8
Conductivity	µs/20C	104 (0)	110 (0)	129 (0)	134 (0)	122 (0)
Nitrate (as N)	mg/l	39 (2)	29 (2)	29 (2)	22 (1)	18 (1)
Ammonium (as N)	mg/l	1.0 (0)	1.2 (0)	1.4 (0)	1.7 (0)	1.3 (0)
Potassium	mg/l	49 (1)	38 (1)	42 (1)	36 (1)	30 (1)
Calcium	mg/l	36	40	57	67	74
Magnesium	mg/l	11 (2)	13 (2)	17 (3)	21 (3)	18 (3)
Phosphorus	mg/l	40 (5)	37 (5)	47 (6)	50 (6)	57 (7)
Iron	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/l	0.14	0.28	0.23	0.28	0.42
Manganese	mg/l	<0.01	0.12	0.12	0.25	0.33
Copper	mg/l	0.12	0.12	0.15	0.10	0.13
Boron	mg/l	0.15	0.02	<0.01	<0.01	<0.01

APPENDIX V

Growing Media Analysis at Transplanting

Table 39: *Impatiens* 'F1 Accent Salmon' (no supplementary phosphate)

		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Bulk Density	g/ml	0.349	0.391	0.340	0.372	0.380
pH		5.8	6.2	6.1	6.0	6.1
Conductivity	µs/20C	167 (1)	21 (0)	24 (0)	28 (0)	115 (0)
Nitrate (as N)	mg/l	80 (3)	4 (0)	<1 (0)	2 (0)	<1 (0)
Ammonium (as N)	mg/l	0.7 (0)	<0.1 (0)	<0.1 (0)	0.2 (0)	0.1 (0)
Potassium	mg/l	110 (3)	46 (1)	53 (2)	42 (1)	38 (1)
Calcium	mg/l	48	16	20	24	33
Magnesium	mg/l	17 (3)	3 (0)	6 (1)	6 (1)	6 (1)
Phosphorus	mg/l	<1 (0)	1 (0)	4 (1)	6 (1)	8 (2)
Iron	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/l	0.07	0.11	0.12	0.11	0.12
Manganese	mg/l	0.05	0.02	0.02	0.03	0.02
Copper	mg/l	0.05	0.12	0.12	0.09	0.08
Boron	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01

Table 40: *Impatiens* 'F1 Accent Salmon' (with supplementary phosphate liquid feed)

		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Bulk Density	g/ml	0.335	0.322	0.284	0.353	0.329
pH		5.9	5.9	5.9	5.7	6.0
Conductivity	µs/20C	104 (0)	61 (0)	69 (0)	77 (0)	73 (0)
Nitrate (as N)	mg/l	34 (2)	5 (0)	5 (0)	6 (0)	6 (0)
Ammonium (as N)	mg/l	1.0 (0)	1.5 (0)	1.1 (0)	1.8 (0)	1.1 (0)
Potassium	mg/l	67 (2)	37 (1)	37 (1)	36 (1)	36 (1)
Calcium	mg/l	26	16	20	25	25
Magnesium	mg/l	8 (1)	4 (0)	5 (0)	6 (1)	5 (1)
Phosphorus	mg/l	37 (5)	34 (5)	33 (5)	44 (6)	40 (5)
Iron	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/l	0.19	0.22	0.23	0.42	0.27
Manganese	mg/l	0.35	0.22	<0.01	<0.01	<0.01
Copper	mg/l	0.14	0.19	0.15	0.17	0.15
Boron	mg/l	0.23	0.03	<0.01	<0.01	<0.01

APPENDIX V

Growing Media Analysis at Transplanting

Table 41: Pansy 'F1 Turbo Yellow with Blotch' (no supplementary phosphate)

		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Bulk Density	g/ml	0.432	0.478	0.442	0.416	0.480
pH		6.0	6.2	6.2	6.1	6.2
Conductivity	µs/20C	169 (1)	117 (0)	112 (0)	110 (0)	111 (0)
Nitrate (as N)	mg/l	82 (4)	41 (2)	36 (2)	32 (2)	39 (2)
Ammonium (as N)	mg/l	21.1 (1)	5.6 (0)	11.5 (0)	4.6 (0)	4.9 (0)
Potassium	mg/l	115 (3)	96 (2)	72 (2)	73 (2)	78 (2)
Calcium	mg/l	31	23	24	26	25
Magnesium	mg/l	8 (1)	6 (1)	6 (1)	6 (1)	5 (0)
Phosphorus	mg/l	<1 (0)	<1 (0)	1 (0)	3 (0)	1 (0)
Iron	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/l	0.24	0.19	1.05	0.28	0.09
Manganese	mg/l	0.33	0.20	2.32	0.20	0.20
Copper	mg/l	0.05	0.14	0.16	0.17	0.08
Boron	mg/l	0.04	<0.01	0.20	0.06	<0.01

Table 42: Pansy 'F1 Turbo Yellow with Blotch' (with supplementary phosphate liquid feed)

		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Bulk Density	g/ml	0.353	0.317	0.325	0.361	0.300
pH		6.1	6.4	6.3	6.2	6.3
Conductivity	µs/20C	100 (0)	45 (0)	40 (0)	48 (0)	48 (0)
Nitrate (as N)	mg/l	29 (2)	5 (0)	5 (0)	8 (0)	9 (0)
Ammonium (as N)	mg/l	0.2 (0)	0.2 (0)	<0.1 (0)	0.2 (0)	<0.1 (0)
Potassium	mg/l	71 (2)	20 (0)	12 (0)	12 (0)	16 (0)
Calcium	mg/l	26	13	17	25	23
Magnesium	mg/l	6 (1)	2 (0)	3 (0)	4 (0)	4 (0)
Phosphorus	mg/l	10 (2)	6 (1)	6 (1)	11 (3)	9 (2)
Iron	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/l	0.25	0.28	0.20	0.50	0.34
Manganese	mg/l	0.04	0.04	0.02	0.03	0.03
Copper	mg/l	0.11	0.07	0.04	0.05	0.04
Boron	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01

APPENDIX V

Growing Media Analysis at Transplanting

Table 43: *Petunia* 'F1 Express Blue' (no supplementary phosphate)

		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Bulk Density	g/ml	0.275	0.283	0.303	0.490	0.515
pH		5.8	5.8	6.0	5.9	6.2
Conductivity	µs/20C	239 (1)	114 (0)	104 (0)	98 (0)	95 (0)
Nitrate (as N)	mg/l	123 (4)	45 (2)	32 (2)	13 (0)	9 (0)
Ammonium (as N)	mg/l	30.1 (1)	2.2 (0)	7.0 (0)	6.8 (0)	5.4 (0)
Potassium	mg/l	133 (3)	64 (2)	54 (2)	49 (1)	58 (2)
Calcium	mg/l	42	28	24	20	21
Magnesium	mg/l	11 (2)	6 (1)	4 (0)	5 (0)	3 (0)
Phosphorus	mg/l	<1 (0)	<1 (0)	3 (0)	9 (2)	8 (2)
Iron	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/l	0.10	0.17	0.09	0.16	0.21
Manganese	mg/l	0.14	0.07	0.03	0.03	0.03
Copper	mg/l	0.07	0.07	0.08	0.09	0.11
Boron	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01

Table 44: *Petunia* 'F1 Express Blue' (with supplementary phosphate liquid feed)

		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Bulk Density	g/ml	0.507	0.425	0.389	0.421	0.393
pH		5.6	5.6	5.7	5.6	5.7
Conductivity	µs/20C	134 (0)	105 (0)	63 (0)	63 (0)	60 (0)
Nitrate (as N)	mg/l	41 (2)	24 (1)	4 (0)	3 (0)	2 (0)
Ammonium (as N)	mg/l	13.6 (0)	12.4 (0)	1.4 (0)	1.0 (0)	0.9 (0)
Potassium	mg/l	83 (2)	52 (2)	10 (0)	12 (0)	7 (0)
Calcium	mg/l	38	32	31	35	34
Magnesium	mg/l	8 (1)	7 (1)	5 (1)	6 (1)	6 (1)
Phosphorus	mg/l	57 (7)	63 (7)	48 (6)	51 (6)	49 (6)
Iron	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/l	0.32	0.30	0.26	0.24	0.21
Manganese	mg/l	0.09	0.07	0.05	0.07	0.10
Copper	mg/l	0.08	0.09	0.14	0.11	0.10
Boron	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01

APPENDIX V

Growing Media Analysis at Transplanting

Table 45: *Lobelia* 'Crystal Palace' (no supplementary phosphate)

		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Bulk Density	g/ml	0.317	0.490	0.427	0.419	0.401
pH		5.7	6.3	6.2	6.1	6.3
Conductivity	µs/20C	213 (1)	82 (0)	62 (0)	80 (0)	82 (0)
Nitrate (as N)	mg/l	118 (4)	16 (1)	6 (0)	6 (0)	7 (0)
Ammonium (as N)	mg/l	2.8 (0)	1.3 (0)	1.0 (0)	1.3 (0)	1.2 (0)
Potassium	mg/l	131 (3)	48 (1)	30 (1)	26 (1)	29 (1)
Calcium	mg/l	63	16	15	28	28
Magnesium	mg/l	19 (3)	2 (0)	4 (0)	5 (1)	5 (0)
Phosphorus	mg/l	<1 (0)	<1 (0)	1 (0)	4 (1)	5 (1)
Iron	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/l	0.27	0.11	0.11	0.17	0.14
Manganese	mg/l	0.11	0.02	0.02	0.03	0.02
Copper	mg/l	0.09	0.09	0.09	0.08	0.09
Boron	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01

Table 46: *Lobelia* 'Crystal Palace' (with supplementary phosphate liquid feed)

		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Bulk Density	g/ml	0.318	0.364	0.309	0.366	0.353
pH		6.3	6.1	6.0	5.8	6.2
Conductivity	µs/20C	38 (0)	40 (0)	45 (0)	55 (0)	51 (0)
Nitrate (as N)	mg/l	4 (0)	<1 (0)	<1 (0)	<1 (0)	<1 (0)
Ammonium (as N)	mg/l	<0.1 (0)	<0.1 (0)	<0.1 (0)	<0.1 (0)	<0.1 (0)
Potassium	mg/l	19 (0)	16 (0)	17 (0)	18 (0)	14 (0)
Calcium	mg/l	11	18	24	27	28
Magnesium	mg/l	2 (0)	2 (0)	4 (0)	4 (0)	4 (0)
Phosphorus	mg/l	14 (3)	10 (2)	12 (3)	14 (3)	11 (3)
Iron	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/l	0.16	0.25	0.21	0.27	0.21
Manganese	mg/l	0.01	0.03	0.06	0.06	0.03
Copper	mg/l	0.04	0.04	0.05	0.05	0.04
Boron	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01

APPENDIX VI

Foliage Analysis at Transplanting

Table 47: *Ageratum* 'F1 Blue Champion' (no supplementary phosphate)

		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Nitrogen	%	3.77	3.10	3.77	3.15	3.25
Phosphorus	%	0.065	0.136	0.241	0.535	0.294
Potassium	%	1.72	3.09	3.31	3.59	3.53
Calcium	%	2.110	1.428	1.749	1.833	1.836
Magnesium	%	0.540	0.358	0.391	0.412	0.379
Manganese	mg/kg	243.11	132.09	129.28	115.32	124.91

Table 48: *Ageratum* 'F1 Blue Champion' (with supplementary phosphate liquid feed)

		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Nitrogen	%	5.32	2.25	1.72	1.61	1.54
Phosphorus	%	1.323	1.064	0.900	0.552	0.650
Potassium	%	2.87	2.24	1.63	1.38	1.54
Calcium	%	2.063	2.421	2.274	2.043	2.115
Magnesium	%	0.521	0.446	0.425	0.426	0.405
Manganese	mg/kg	152.17	204.93	149.33	87.33	99.74

APPENDIX VI

Foliage Analysis at Transplanting

Table 49: *Antirrhinum* 'F1 Coronette Yellow' (no supplementary phosphate)

		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Nitrogen	%	3.39	2.61	3.47	2.92	2.83
Phosphorus	%	0.053	0.085	0.197	0.311	0.291
Potassium	%	2.36	2.56	3.51	3.03	2.82
Calcium	%	3.275	1.331	1.478	1.449	1.299
Magnesium	%	0.670	0.411	0.518	0.466	0.434
Manganese	mg/kg	331.09	124.84	95.96	85.17	77.23

Table 50: *Antirrhinum* 'F1 Coronette Yellow' (with supplementary phosphate liquid feed)

		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Nitrogen	%	4.60	2.19	2.17	1.95	1.90
Phosphorus	%	2.010	1.104	1.077	0.954	0.872
Potassium	%	3.69	2.52	2.16	1.92	1.89
Calcium	%	2.377	2.754	2.571	2.505	2.289
Magnesium	%	0.676	0.609	0.546	0.491	0.450
Manganese	mg/kg	292.28	252.22	181.99	163.42	134.48

APPENDIX VI

Foliage Analysis at Transplanting

Table 51: *Begonia* 'F1 Olympia Red' (no supplementary phosphate)

		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Nitrogen	%	1.90	3.26	3.89	4.00	3.64
Phosphorus	%	0.036	0.158	0.330	0.415	0.415
Potassium	%	0.83	2.66	3.33	4.56	4.34
Calcium	%	2.064	1.163	1.387	1.073	1.237
Magnesium	%	0.542	0.563	0.584	0.651	0.694
Manganese	mg/kg	140.21	147.75	151.30	146.45	130.04

Table 52: *Begonia* 'F1 Olympia Red' (with supplementary phosphate liquid feed)

		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Nitrogen	%	2.84	3.31	3.27	3.13	3.04
Phosphorus	%	0.982	1.159	0.910	0.641	0.696
Potassium	%	1.51	3.23	3.03	2.65	2.81
Calcium	%	2.091	1.256	1.190	1.040	1.164
Magnesium	%	0.523	0.625	0.570	0.526	0.604
Manganese	mg/kg	130.15	141.43	112.89	113.47	105.54

APPENDIX VI

Foliage Analysis at Transplanting

Table 53: Geranium 'F1 Century Scarlet' (no supplementary phosphate)

		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Nitrogen	%	2.77	3.95	4.46	3.71	4.02
Phosphorus	%	0.081	0.330	0.546	0.519	0.653
Potassium	%	3.24	4.80	5.54	4.76	4.92
Calcium	%	0.998	1.524	1.777	1.364	1.608
Magnesium	%	0.252	0.441	0.483	0.389	0.481
Manganese	mg/kg	301.87	199.20	180.08	208.50	156.26

Table 54: Geranium 'F1 Century Scarlet' (with supplementary phosphate liquid feed)

		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Nitrogen	%	3.34	2.54	2.67	2.58	2.14
Phosphorus	%	0.805	0.450	0.659	0.644	0.608
Potassium	%	4.29	3.06	3.00	2.90	2.65
Calcium	%	1.678	1.331	1.524	1.471	1.402
Magnesium	%	0.421	0.410	0.397	0.363	0.340
Manganese	mg/kg	223.51	169.36	130.43	158.81	121.77

APPENDIX VI

Foliage Analysis at Transplanting

Table 55: *Impatiens* 'F1 Accent Salmon' (no supplementary phosphate)

		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Nitrogen	%	3.69	3.52	4.12	3.34	2.83
Phosphorus	%	0.091	0.192	0.356	0.449	0.478
Potassium	%	2.47	3.40	3.89	3.70	3.55
Calcium	%	2.648	2.931	3.515	3.287	3.308
Magnesium	%	1.898	0.552	0.708	0.655	0.547
Manganese	mg/kg	143.99	142.68	147.41	174.62	139.34

Table 56: *Impatiens* 'F1 Accent Salmon' (with supplementary phosphate liquid feed)

		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Nitrogen	%	4.98	3.05	2.96	2.82	2.29
Phosphorus	%	1.392	1.403	1.260	1.198	1.241
Potassium	%	4.22	3.20	3.23	3.09	2.91
Calcium	%	2.859	3.070	3.166	3.034	3.292
Magnesium	%	0.847	0.570	0.616	0.588	0.519
Manganese	mg/kg	131.51	144.37	138.69	154.51	119.84

APPENDIX VI

Foliage Analysis at Transplanting

Table 57: *Lobelia* 'Crystal Palace' (no supplementary phosphate)

		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Nitrogen	%	2.45	2.87	2.54	2.50	2.33
Phosphorus	%	0.068	0.126	0.211	0.473	0.498
Potassium	%	1.04	3.25	4.08	4.31	4.33
Calcium	%	1.775	1.029	1.178	1.232	1.238
Magnesium	%	0.302	0.198	0.233	0.238	0.210
Manganese	mg/kg	87.03	88.09	96.15	118.45	106.57

Table 58: *Lobelia* 'Crystal Palace' (with supplementary phosphate liquid feed)

		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Nitrogen	%	3.06	1.71	1.58	1.57	1.54
Phosphorus	%	0.929	1.069	0.930	0.890	0.799
Potassium	%	3.97	2.14	1.94	2.01	1.96
Calcium	%	1.263	1.503	1.630	1.661	1.682
Magnesium	%	0.258	0.257	0.257	0.264	0.238
Manganese	mg/kg	76.51	77.46	96.14	94.58	88.34

APPENDIX VI

Foliage Analysis at Transplanting

Table 59: Pansy 'F1 Turbo Yellow with Blotch' (no supplementary phosphate)

		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Nitrogen	%	2.33	2.77	2.51	2.57	2.71
Phosphorus	%	0.052	0.084	0.131	0.193	0.167
Potassium	%	2.48	2.90	3.07	3.14	3.11
Calcium	%	1.244	0.736	0.659	0.717	0.696
Magnesium	%	4.304	0.910	1.149	1.118	0.772
Manganese	mg/kg	224.29	239.82	192.90	196.69	186.96

Table 60: Pansy 'F1 Turbo Yellow with Blotch' (with supplementary phosphate liquid feed)

		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Nitrogen	%	3.64	1.99	1.70	1.57	1.40
Phosphorus	%	1.018	0.608	0.531	0.640	0.604
Potassium	%	4.01	2.33	2.06	2.13	2.17
Calcium	%	1.323	0.685	0.593	0.659	0.599
Magnesium	%	1.512	0.420	0.317	0.388	0.417
Manganese	mg/kg	313.59	236.69	179.38	181.52	147.02

APPENDIX VI

Foliage Analysis at Transplanting

Table 61: *Petunia* 'F1 Express Blue' (no supplementary phosphate)

		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Nitrogen	%	3.91	3.44	3.66	3.65	3.42
Phosphorus	%	0.054	0.102	0.344	0.470	0.437
Potassium	%	2.15	4.13	6.23	5.48	5.11
Calcium	%	1.726	1.232	1.297	1.379	1.509
Magnesium	%	0.479	0.242	0.315	0.311	0.316
Manganese	mg/kg	121.78	106.82	112.43	99.44	108.79

Table 62: *Petunia* 'F1 Express Blue' (with supplementary phosphate liquid feed)

		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Nitrogen	%	4.57	3.11	3.06	2.40	2.87
Phosphorus	%	0.978	0.856	0.779	0.705	0.777
Potassium	%	5.01	3.98	3.35	3.87	3.20
Calcium	%	1.584	1.348	1.178	1.283	1.404
Magnesium	%	0.450	0.264	0.246	0.265	0.255
Manganese	mg/kg	127.19	98.35	90.87	84.88	96.10

APPENDIX VII

Plant Growth Assessments at Maturity

Table 63: *Ageratum* 'F1 Blue Champion'

Standard regime (mean of 12 plants per treatment)

	Height (mm)	Spread[1] (mm)	Spread[2] (mm)	Flower Score	Quality	Fresh Weight (g)	Dry Weight (g)	% Dry Matter	Recording Date
0	75.71	123.57	105.00	0.29	1.00	45.00	5.20	11.56	15 May
0 + Feed	+	+	+	+	+	+	+	+	All dead
0.3	125.83	151.67	124.58	1.50	1.00	169.30	13.50	7.97	9 May
0.3 + Feed	105.42	130.00	104.17	1.67	3.00	108.40	10.90	10.06	15 May
0.6	126.67	160.00	137.50	1.08	2.00	178.00	15.40	8.65	3 May
0.6 + Feed	102.92	122.92	98.33	1.00	2.00	99.50	9.90	9.95	15 May
0.9	125.42	155.42	126.67	1.42	2.00	177.00	16.00	9.04	3 May
0.9 + Feed	105.42	140.83	114.58	0.92	3.00	108.90	9.30	8.54	9 May
1.2	129.17	168.75	134.58	1.17	2.00	189.60	16.40	8.65	3 May
1.2 + Feed	94.58	115.83	103.33	0.92	2.00	77.20	7.70	9.97	9 May

[1] At widest width
[2] At 90° to [1]

Table 64: *Ageratum* 'F1 Blue Champion'

Dry regime (mean of 12 plants per treatment)

	Height (mm)	Spread[1] (mm)	Spread[2] (mm)	Flower Score	Quality	Fresh Weight (g)	Dry Weight (g)	% Dry Matter	Recording Date
0	28.33	51.67	43.33	0.00	1.00	2.30	0.50	21.74	15 May
0 + Feed	+	+	+	+	+	+	+	+	All dead
0.3	95.00	123.18	104.55	1.36	1.00	94.60	9.40	9.94	9 May
0.3 + Feed	86.25	114.58	90.83	2.00	2.00	73.90	9.10	12.31	15 May
0.6	132.50	165.00	132.92	2.17	1.00	169.60	13.60	8.02	9 May
0.6 + Feed	89.17	90.42	77.50	1.17	1.00	53.10	6.80	12.81	15 May
0.9	130.83	172.92	132.92	2.58	1.00	191.00	15.90	8.32	9 May
0.9 + Feed	84.17	100.42	84.58	1.67	2.00	66.10	8.40	12.71	16 May
1.2	124.17	157.50	125.42	1.58	1.00	164.20	13.40	8.16	9 May
1.2 + Feed	90.42	101.67	90.00	2.25	2.00	67.90	8.50	12.52	16 May

[1] At widest width
[2] At 90° to [1]

APPENDIX VII

Plant Growth Assessments at Maturity

Table 65: *Antirrhinum* 'F1 Coronette Yellow'

Standard regime (mean of 12 plants per treatment)

	Height (mm)	Spread[1] (mm)	Spread[2] (mm)	Flower Score	Quality	Fresh Weight (g)	Dry Weight (g)	% Dry Matter	Recording Date
0	104.55	141.36	110.00	0.00	1.00	60.80	6.80	11.18	12 May
0 + Feed	+	+	+	+	+	+	+	+	All dead
0.3	136.67	142.08	122.08	0.00	3.00	134.80	14.10	10.46	27 Apr
0.3 + Feed	112.08	158.75	124.58	0.00	3.00	100.60	9.30	9.24	5 May
0.6	151.67	149.58	129.58	0.00	2.00	166.70	16.20	9.72	27 Apr
0.6 + Feed	125.83	148.75	117.50	0.00	3.00	98.50	11.00	11.17	5 May
0.9	147.50	148.33	131.25	0.00	2.00	159.30	15.60	9.79	27 Apr
0.9 + Feed	147.50	162.08	135.00	0.00	1.00	144.00	13.60	9.44	5 May
1.2	153.33	151.25	125.83	0.00	2.00	182.20	17.60	9.66	27 Apr
1.2 + Feed	130.83	137.08	112.92	0.00	2.00	106.60	11.00	10.32	5 May

[1] At widest width
[2] At 90° to [1]

Table 66: *Antirrhinum* 'F1 Coronette Yellow'

Dry regime (mean of 12 plants per treatment)

	Height (mm)	Spread[1] (mm)	Spread[2] (mm)	Flower Score	Quality	Fresh Weight (g)	Dry Weight (g)	% Dry Matter	Recording Date
0	76.67	104.17	76.67	0.00	1.00	17.90	3.90	21.79	12 May
0 + Feed	+	+	+	+	+	+	+	+	All dead
0.3	140.83	159.58	125.83	0.00	3.00	119.50	11.90	9.96	5 May
0.3 + Feed	153.33	164.17	132.50	0.00	2.00	110.40	12.00	10.87	12 May
0.6	108.75	139.58	119.58	0.00	1.00	94.90	11.80	12.43	27 Apr
0.6 + Feed	162.08	164.58	133.33	0.00	1.00	115.80	12.80	11.05	12 May
0.9	117.50	151.25	129.58	0.00	1.00	111.10	12.50	11.25	27 Apr
0.9 + Feed	159.17	162.50	141.67	0.00	2.00	115.60	13.70	11.85	12 May
1.2	140.00	157.08	128.33	0.00	1.00	133.70	14.10	10.55	5 May
1.2 + Feed	162.50	162.92	139.58	0.00	1.00	113.20	12.30	10.87	12 May

[1] At widest width
[2] At 90° to [1]

APPENDIX VII

Plant Growth Assessments at Maturity

Table 67: *Begonia* 'F1 Olympia Red'

Standard regime (mean of 12 plants per treatment)

	Height (mm)	Spread[1] (mm)	Spread[2] (mm)	Flower Score	Quality	Fresh Weight (g)	Dry Weight (g)	% Dry Matter	Recording Date
0*	22.50	47.50	27.50	0.00	1.00	1.80	0.10	5.56	22 May
0 + Feed	+	+	+	+	+	+	+	+	All dead
0.3	130.83	152.08	116.67	1.83	2.00	410.40	15.50	3.78	22 May
0.3 + Feed	105.83	113.75	100.83	2.25	3.00	294.90	11.90	4.04	22 May
0.6	70.83	115.42	85.00	0.42	1.00	137.30	6.20	4.52	3 May
0.6 + Feed	60.83	108.33	73.33	1.08	2.00	107.40	5.30	4.93	3 May
0.9	77.08	113.75	85.83	0.83	3.00	157.50	6.70	4.25	3 May
0.9 + Feed	65.83	119.58	75.42	1.00	2.00	126.50	6.00	4.74	3 May
1.2	73.33	109.17	85.00	0.75	3.00	148.60	6.70	4.51	3 May
1.2 + Feed	123.75	149.58	117.08	2.50	2.00	408.40	13.70	3.35	22 May

* mean of 2 plants remaining, 10 plants dead
[1] At widest width
[2] At 90° to [1]

Table 68: *Begonia* 'F1 Olympia Red'

Dry regime (mean of 12 plants per treatment)

	Height (mm)	Spread[1] (mm)	Spread[2] (mm)	Flower Score	Quality	Fresh Weight (g)	Dry Weight (g)	% Dry Matter	Recording Date
0	+	+	+	+	+	+	+	+	All dead
0 + Feed	+	+	+	+	+	+	+	+	All dead
0.3	55.83	75.83	60.42	0.08	1.00	74.30	3.90	5.25	22 May
0.3 + Feed	83.33	97.50	77.92	1.42	2.00	154.50	8.30	5.37	22 May
0.6	73.75	95.83	77.08	0.42	1.00	143.20	6.20	4.33	22 May
0.6 + Feed	94.58	110.42	87.92	1.75	2.00	186.90	9.50	5.08	22 May
0.9	102.08	110.83	95.83	1.50	2.00	245.00	11.50	4.67	22 May
0.9 + Feed	92.08	124.58	95.00	1.75	3.00	217.80	11.00	5.05	22 May
1.2	108.33	127.75	102.08	2.17	2.00	263.60	13.00	4.93	22 May
1.2 + Feed	96.67	119.17	97.50	1.58	3.00	236.10	12.30	5.21	22 May

[1] At widest width
[2] At 90° to [1]

APPENDIX VII

Plant Growth Assessments at Maturity

Table 69: Geranium 'F1 Century Scarlet'

Standard regime (mean of 12 plants per treatment)

	Height (mm)	Spread[1] (mm)	Spread[2] (mm)	Flower Score	Quality	Fresh Weight (g)	Dry Weight (g)	% Dry Matter	Recording Date
0	141.67	153.75	125.42	0.00	1.00	159.90	16.70	10.44	11 May
0 + Feed	129.17	142.08	117.50	0.00	2.00	130.30	13.70	10.51	10 May
0.3	165.83	147.92	116.67	0.17	2.00	201.90	20.70	10.25	3 May
0.3 + Feed	140.00	149.58	115.42	0.00	3.00	157.50	16.00	10.16	3 May
0.6	132.50	128.33	112.50	0.08	3.00	142.60	15.60	10.94	3 May
0.6 + Feed	150.00	146.25	114.58	0.00	2.00	155.70	14.80	9.51	3 May
0.9	170.83	163.33	127.08	0.00	2.00	218.70	21.60	9.88	3 May
0.9 + Feed	161.25	151.67	127.08	0.42	1.00	169.50	20.20	11.92	11 May
1.2	137.50	127.08	107.50	0.00	1.00	151.20	15.50	10.25	3 May
1.2 + Feed	122.08	162.92	113.75	0.00	3.00	126.90	15.30	12.06	10 May

[1] At widest width
[2] At 90° to [1]

Table 70: Geranium 'F1 Century Scarlet'

Dry regime (mean of 12 plants per treatment)

	Height (mm)	Spread[1] (mm)	Spread[2] (mm)	Flower Score	Quality	Fresh Weight (g)	Dry Weight (g)	% Dry Matter	Recording Date
0	130.42	134.17	109.17	0.00	2.00	126.20	13.20	10.46	10 May
0 + Feed	143.33	143.75	117.92	0.00	1.00	131.30	15.30	11.65	11 May
0.3	157.92	152.92	130.83	0.08	1.00	181.50	19.20	10.58	11 May
0.3 + Feed	139.17	160.00	115.42	0.25	2.00	143.50	15.10	10.52	10 May
0.6	169.58	155.00	130.42	0.33	1.00	189.90	21.80	11.48	11 May
0.6 + Feed	152.92	157.50	121.45	0.25	1.00	160.00	17.30	10.81	11 May
0.9	131.25	130.42	106.67	0.00	3.00	134.70	15.30	11.36	10 May
0.9 + Feed	130.00	153.75	109.58	0.00	3.00	126.40	15.00	11.87	10 May
1.2	122.50	133.33	113.33	0.00	3.00	127.90	14.80	11.57	10 May
1.2 + Feed	137.50	150.83	116.67	0.00	2.00	141.00	15.50	10.99	10 May

[1] At widest width
[2] At 90° to [1]

APPENDIX VII

Plant Growth Assessments at Maturity

Table 71: *Impatiens* 'F1 Accent Salmon'

Standard regime (mean of 12 plants per treatment)

	Height (mm)	Spread[1] (mm)	Spread[2] (mm)	Flower Score	Quality	Fresh Weight (g)	Dry Weight (g)	% Dry Matter	Recording Date
0	51.82	63.64	45.00	1.09	1.00	16.40	2.70	16.46	12 May
0 + Feed	86.67	138.33	105.00	2.33	3.00	100.90	5.80	5.75	24 Apr
0.3	128.33	146.25	111.67	2.00	1.00	139.00	9.20	6.62	24 Apr
0.3 + Feed	114.17	135.83	107.08	1.83	2.00	110.80	6.80	6.14	24 Apr
0.6	114.58	134.58	92.50	1.75	1.00	118.80	8.20	6.90	24 Apr
0.6 + Feed	132.08	138.33	105.83	1.83	2.00	117.90	7.70	6.53	24 Apr
0.9	133.33	154.58	105.83	1.92	1.00	151.40	9.60	6.34	24 Apr
0.9 + Feed	120.00	128.33	101.67	1.92	2.00	119.80	7.00	5.84	24 Apr
1.2	122.50	138.75	111.25	1.92	1.00	131.70	8.90	6.76	24 Apr
1.2 + Feed	121.25	141.67	113.75	2.08	2.00	134.10	7.60	5.67	24 Apr

[1] At widest width
[2] At 90° to [1]

Table 72: *Impatiens* 'F1 Accent Salmon'

Dry regime (mean of 12 plants per treatment)

	Height (mm)	Spread[1] (mm)	Spread[2] (mm)	Flower Score	Quality	Fresh Weight (g)	Dry Weight (g)	% Dry Matter	Recording Date
0	25.71	25.71	20.00	0.00	1.00	2.20	0.30	13.64	12 May
0 + Feed	105.00	130.83	101.67	2.33	1.00	121.20	6.90	5.69	5 May
0.3	107.08	107.92	86.67	1.50	2.00	82.20	5.10	6.20	25 Apr
0.3 + Feed	112.08	140.83	115.42	2.00	3.00	119.80	7.30	6.09	25 Apr
0.6	117.08	148.33	115.00	2.33	3.00	136.80	8.20	5.99	25 Apr
0.6 + Feed	111.25	110.42	83.75	1.25	1.00	69.00	4.70	6.81	25 Apr
0.9	87.92	105.42	83.75	1.83	1.50	75.30	5.10	6.77	25 Apr
0.9 + Feed	102.50	112.50	91.67	1.83	2.00	77.90	5.30	6.80	25 Apr
1.2	110.42	130.42	98.75	2.08	2.00	104.70	6.40	6.11	25 Apr
1.2 + Feed	97.08	98.75	71.67	1.75	1.00	55.30	3.90	7.05	25 Apr

[1] At widest width
[2] At 90° to [1]

APPENDIX VII

Plant Growth Assessments at Maturity

Table 73: *Lobelia* 'Crystal Palace'

Standard regime (mean of 12 plants per treatment)

	Height (mm)	Spread[1] (mm)	Spread[2] (mm)	Flower Score	Quality	Fresh Weight (g)	Dry Weight (g)	% Dry Matter	Recording Date
0	154.58	185.83	131.25	0.33	2.00	173.10	13.70	7.91	16 May
0 + Feed	152.08	203.33	164.17	0.00	2.00	174.60	12.00	6.87	16 May
0.3	146.67	202.92	158.75	0.00	3.00	158.20	12.20	7.71	3 May
0.3 + Feed	147.50	169.58	123.75	0.17	3.00	144.40	11.00	7.62	16 May
0.6	186.25	216.67	154.58	0.08	2.00	201.70	16.00	7.93	3 May
0.6 + Feed	154.17	164.58	131.67	0.42	2.00	122.60	10.40	8.48	16 May
0.9	172.08	222.92	162.50	0.00	1.00	203.10	15.10	7.43	3 May
0.9 + Feed	145.42	123.33	94.58	1.33	3.00	87.40	9.20	10.53	16 May
1.2	200.83	242.50	173.33	0.00	1.00	240.10	16.40	6.83	3 May
1.2 + Feed	155.00	202.50	125.42	0.67	2.00	126.90	11.20	8.83	16 May

[1] At widest width
[2] At 90° to [1]

Table 74: *Lobelia* 'Crystal Palace'

Dry regime (mean of 12 plants per treatment)

	Height (mm)	Spread[1] (mm)	Spread[2] (mm)	Flower Score	Quality	Fresh Weight (g)	Dry Weight (g)	% Dry Matter	Recording Date
0	84.55	78.18	66.82	0.00	1.00	26.10	3.30	12.64	16 May
0 + Feed	74.09	62.73	53.18	0.00	0.09	22.60	3.10	13.72	16 May
0.3	171.25	174.17	132.08	0.92	2.00	152.60	12.90	8.45	16 May
0.3 + Feed	150.42	135.00	97.08	0.33	3.00	82.00	8.90	10.85	16 May
0.6	155.42	179.17	135.42	2.92	3.00	165.20	15.00	9.08	16 May
0.6 + Feed	153.75	170.42	112.92	1.08	3.00	103.40	9.90	9.57	16 May
0.9	164.58	175.42	117.50	2.33	3.00	146.10	13.10	8.97	16 May
0.9 + Feed	138.75	166.25	106.25	0.67	2.00	97.50	9.80	10.05	16 May
1.2	162.73	183.18	140.00	2.36	0.09	141.50	15.20	10.74	16 May
1.2 + Feed	142.92	153.33	118.33	1.08	3.00	99.40	10.30	10.36	16 May

[1] At widest width
[2] At 90° to [1]

APPENDIX VII

Plant Growth Assessments at Maturity

Table 75: Pansy 'F1 Turbo Yellow with Blotch'

Standard regime (mean of 12 plants per treatment)

	Height (mm)	Spread[1] (mm)	Spread[2] (mm)	Flower Score	Quality	Fresh Weight (g)	Dry Weight (g)	% Dry Matter	Recording Date
0	93.75	153.33	121.25	0.00	2.00	77.60	9.20	11.86	19 May
0 + Feed	105.00	151.25	127.92	0.08	2.00	81.00	9.70	11.98	19 May
0.3	162.92	213.33	155.00	1.25	2.00	175.80	15.00	8.56	17 May
0.3 + Feed	91.25	133.33	97.62	0.83	1.00	71.10	9.00	12.66	19 May
0.6	145.00	218.33	165.83	1.17	2.00	144.50	14.10	9.76	17 May
0.6 + Feed	107.17	138.33	103.75	1.42	3.00	94.10	9.70	10.31	17 May
0.9	180.00	230.45	184.09	1.45	2.00	190.10	16.10	8.47	17 May
0.9 + Feed	130.42	166.25	122.50	1.17	3.00	117.70	11.20	9.52	17 May
1.2	192.92	215.00	178.75	2.33	2.00	190.30	15.60	8.20	17 May
1.2 + Feed	128.75	164.17	121.67	1.67	3.00	113.30	11.40	10.06	17 May

[1] At widest width
[2] At 90° to [1]

Table 76: Pansy 'F1 Turbo Yellow with Blotch'

Dry regime (mean of 12 plants per treatment)

	Height (mm)	Spread[1] (mm)	Spread[2] (mm)	Flower Score	Quality	Fresh Weight (g)	Dry Weight (g)	% Dry Matter	Recording Date
0	77.00	118.50	95.50	0.40	1.00	46.10	5.50	11.93	30 May
0 + Feed	111.67	157.08	121.25	1.00	3.00	117.00	12.00	10.26	30 May
0.3	95.00	150.00	110.83	0.58	2.00	89.20	9.70	10.87	17 May
0.3 + Feed	78.33	132.50	87.50	0.42	2.00	57.90	7.00	12.09	17 May
0.6	108.75	157.92	122.08	1.25	1.00	109.90	13.10	11.92	17 May
0.6 + Feed	111.36	149.55	117.73	1.36	2.00	102.80	12.00	11.67	17 May
0.9	109.17	161.67	107.50	1.25	2.00	105.70	11.60	10.97	17 May
0.9 + Feed	94.17	127.08	96.25	2.25	2.00	81.20	10.10	12.44	19 May
1.2	95.42	142.50	105.83	0.83	1.00	82.80	10.10	12.20	17 May
1.2 + Feed	95.00	139.58	98.33	0.75	2.00	69.30	8.00	11.54	17 May

[1] At widest width
[2] At 90° to [1]

APPENDIX VII

Plant Growth Assessments at Maturity

Table 77: *Petunia* 'F1 Express Blue'

Standard regime (mean of 12 plants per treatment)

	Height (mm)	Spread[1] (mm)	Spread[2] (mm)	Flower Score	Quality	Fresh Weight (g)	Dry Weight (g)	% Dry Matter	Recording Date
0	126.00	166.00	130.00	1.60	1.00	94.70	10.40	10.98	12 May
0 + Feed	235.83	201.67	143.33	2.25	1.00	357.90	22.80	6.37	15 May
0.3	242.50	203.33	149.17	2.42	2.00	387.20	28.20	7.28	4 May
0.3 + Feed	154.17	143.33	122.50	1.50	3.00	215.90	15.80	7.32	4 May
0.6	181.67	160.00	145.42	2.25	2.00	294.00	22.50	7.65	26 Apr
0.6 + Feed	195.42	142.92	114.17	1.50	2.00	252.80	16.70	6.61	4 May
0.9	161.67	147.08	128.33	2.17	2.00	247.60	18.00	7.27	26 Apr
0.9 + Feed	110.83	115.83	95.00	1.33	1.00	101.50	8.40	8.28	26 Apr
1.2	148.75	165.83	137.08	2.08	2.00	256.20	19.00	7.42	26 Apr
1.2 + Feed	165.83	132.08	107.08	2.00	1.00	155.60	12.60	8.10	4 May

[1] At widest width
[2] At 90° to [1]

Table 78: *Petunia* 'F1 Express Blue'

Dry regime (mean of 12 plants per treatment)

	Height (mm)	Spread[1] (mm)	Spread[2] (mm)	Flower Score	Quality	Fresh Weight (g)	Dry Weight (g)	% Dry Matter	Recording Date
0	+	+	+	+	+	+	+	+	All dead
0 + Feed	98.33	111.67	91.25	1.00	1.00	77.10	8.10	10.51	12 May
0.3	172.08	142.50	120.83	1.83	3.00	245.20	21.00	8.56	4 May
0.3 + Feed	122.08	221.25	95.00	1.67	2.00	119.70	11.10	9.27	4 May
0.6	117.92	139.17	125.42	1.50	3.00	179.70	13.90	7.74	26 Apr
0.6 + Feed	129.58	112.92	95.00	1.83	1.00	112.60	12.40	11.01	4 May
0.9	111.67	122.92	105.00	1.50	1.00	140.50	12.20	8.68	26 Apr
0.9 + Feed	140.83	129.17	105.83	1.33	2.00	144.20	12.30	8.53	4 May
1.2	129.58	130.83	110.42	1.58	3.00	160.00	13.00	8.13	26 Apr
1.2 + Feed	134.17	117.92	91.25	1.33	1.00	96.50	13.00	13.47	4 May

[1] At widest width
[2] At 90° to [1]

APPENDIX VIII

Growing Media Analysis at Maturity

Table 79: *Petunia* 'F1 Express Blue' (no supplementary phosphate)

Standard Regime		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Bulk Density	g/ml	0.284	0.278	0.251	0.310	0.327
pH		5.6	6.1	6.1	6.0	6.1
Conductivity	µs/20C	289 (1)	107 (0)	87 (0)	126 (0)	114 (0)
Nitrate (as N)	mg/l	108 (4)	8 (0)	5 (0)	5 (0)	9 (0)
Ammonium (as N)	mg/l	4.1 (0)	0.7 (0)	1.1 (0)	1.5 (0)	1.8 (0)
Potassium	mg/l	101 (3)	13 (0)	17 (0)	16 (0)	24 (0)
Calcium	mg/l	101	42	32	49	39
Magnesium	mg/l	96 (7)	31 (4)	28 (4)	45 (5)	32 (4)
Phosphorus	mg/l	77 (8)	39 (5)	35 (5)	47 (6)	39 (5)
Iron	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/l	0.24	0.10	0.12	0.16	0.15
Manganese	mg/l	0.17	0.06	0.05	0.07	0.05
Copper	mg/l	0.03	0.04	0.03	0.04	0.04
Boron	mg/l	<0.01	0.09	<0.01	<0.01	0.10

Table 80: *Petunia* 'F1 Express Blue' (with supplementary phosphate liquid feed)

Standard Regime		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Bulk Density	g/ml	0.466	0.307	0.362	0.380	0.317
pH		5.8	5.7	5.9	5.9	5.8
Conductivity	µs/20C	158 (1)	160 (1)	191 (1)	198 (1)	205 (1)
Nitrate (as N)	mg/l	34 (2)	25 (1)	32 (2)	66 (3)	46 (2)
Ammonium (as N)	mg/l	3.6 (0)	4.4 (0)	4.6 (0)	27.5 (1)	12.8 (0)
Potassium	mg/l	30 (1)	38 (1)	40 (1)	84 (2)	55 (2)
Calcium	mg/l	58	53	62	69	67
Magnesium	mg/l	50 (6)	53 (6)	52 (6)	64 (6)	68 (6)
Phosphorus	mg/l	59 (7)	58 (7)	61 (7)	73 (7)	70 (7)
Iron	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/l	0.19	0.24	0.17	0.21	0.18
Manganese	mg/l	0.10	0.11	0.10	0.14	0.12
Copper	mg/l	0.05	0.04	0.04	0.04	0.03
Boron	mg/l	0.12	<0.01	<0.01	<0.01	<0.01

APPENDIX VIII

Growing Media Analysis at Maturity

Table 81: *Petunia* **'F1 Express Blue' (no supplementary phosphate)**

Dry Regime		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Bulk Density	g/ml	0.224	0.238	0.329	0.354	0.327
pH		5.5	5.8	6.0	5.9	5.8
Conductivity	µs/20C	634 (5)	203 (1)	194 (1)	202 (1)	224 (1)
Nitrate (as N)	mg/l	252 (6)	39 (2)	34 (2)	53 (3)	61 (3)
Ammonium (as N)	mg/l	85.3 (2)	3.5 (0)	19.4 (0)	14.1 (0)	13.6 (0)
Potassium	mg/l	296 (5)	40 (1)	66 (2)	82 (2)	83 (2)
Calcium	mg/l	149	73	54	57	67
Magnesium	mg/l	166 (8)	74 (6)	51 (6)	52 (6)	67 (6)
Phosphorus	mg/l	137 (9)	66 (7)	60 (7)	56 (7)	64 (7)
Iron	mg/l	0.30	<0.01	<0.01	<0.01	<0.01
Zinc	mg/l	0.30	0.11	0.15	0.20	0.15
Manganese	mg/l	0.33	0.11	0.10	0.10	0.12
Copper	mg/l	0.07	0.03	0.03	0.03	0.03
Boron	mg/l	0.28	<0.01	<0.01	0.14	<0.01

Table 82: *Petunia* **'F1 Express Blue' (with supplementary phosphate liquid feed)**

Dry Regime		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Bulk Density	g/ml	0.446	0.271	0.270	0.290	0.253
pH		5.6	5.5	5.7	5.6	5.6
Conductivity	µs/20C	283 (1)	198 (1)	259 (1)	177 (1)	284 (1)
Nitrate (as N)	mg/l	39 (2)	44 (2)	80 (4)	38 (2)	81 (4)
Ammonium (as N)	mg/l	34.9 (1)	19.8 (0)	12.1 (0)	9.8 (0)	14.4 (0)
Potassium	mg/l	121 (3)	58 (2)	80 (2)	55 (2)	74 (2)
Calcium	mg/l	56	53	79	51	92
Magnesium	mg/l	57 (6)	58 (6)	86 (6)	50 (5)	102 (7)
Phosphorus	mg/l	68 (7)	56 (7)	73 (7)	55 (7)	83 (8)
Iron	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/l	0.52	0.15	0.20	0.09	0.15
Manganese	mg/l	0.12	0.11	0.15	0.10	0.21
Copper	mg/l	0.05	0.03	0.03	0.03	0.08
Boron	mg/l	0.10	<0.01	<0.01	<0.01	<0.01

APPENDIX VIII

Foliage Analysis at Maturity

Table 83: *Petunia* 'F1 Express Blue' (no supplementary phosphate)

Standard Regime		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Nitrogen	%	3.39	3.05	3.85	3.88	4.07
Phosphorus	%	0.760	1.042	0.881	0.972	0.999
Potassium	%	4.14	5.43	4.53	3.94	4.68
Calcium	%	1.271	1.142	1.067	1.365	1.085
Magnesium	%	0.714	0.791	0.800	0.851	0.858
Manganese	mg/kg	89.32	109.03	114.76	147.03	130.36

Table 84: *Petunia* 'F1 Express Blue' (with supplementary phosphate liquid feed)

Standard Regime		Treatment Level of Single Superphosphate (g/l)				
		0	**0.3**	**0.6**	**0.9**	**1.2**
Nitrogen	%	N/A	3.60	5.33	4.75	4.16
Phosphorus	%		0.984	1.085	0.934	0.982
Potassium	%		5.56	5.84	4.88	5.84
Calcium	%		1.125	1.501	1.488	1.324
Magnesium	%		0.675	0.791	0.795	0.791
Manganese	mg/kg		84.29	129.82	97.97	116.45

APPENDIX VIII

Foliage Analysis at Transplanting

Table 85: *Petunia* 'F1 Express Blue' (no supplementary phosphate)

Dry Regime		Treatment Level of Single Superphosphate (g/l)				
		0	0.3	0.6	0.9	1.2
Nitrogen	%	N/A	5.27	5.67	5.53	3.72
Phosphorus	%		0.837	0.979	0.937	0.886
Potassium	%		4.80	4.98	4.53	4.58
Calcium	%		1.104	1.097	1.198	1.155
Magnesium	%		0.678	0.822	0.815	0.774
Manganese	mg/kg		100.31	100.83	112.88	108.86

Table 86: *Petunia* 'F1 Express Blue' (with supplementary phosphate liquid feed)

Dry Regime		Treatment Level of Single Superphosphate (g/l)				
		0	0.3	0.6	0.9	1.2
Nitrogen	%	6.08	5.26	4.82	4.08	3.24
Phosphorus	%	0.787	0.871	0.797	0.906	0.819
Potassium	%	4.84	4.37	3.97	4.91	3.92
Calcium	%	1.099	1.156	1.337	1.304	1.560
Magnesium	%	0.687	0.801	0.711	0.735	0.836
Manganese	mg/kg	83.13	93.26	82.69	106.81	93.10

APPENDIX IX

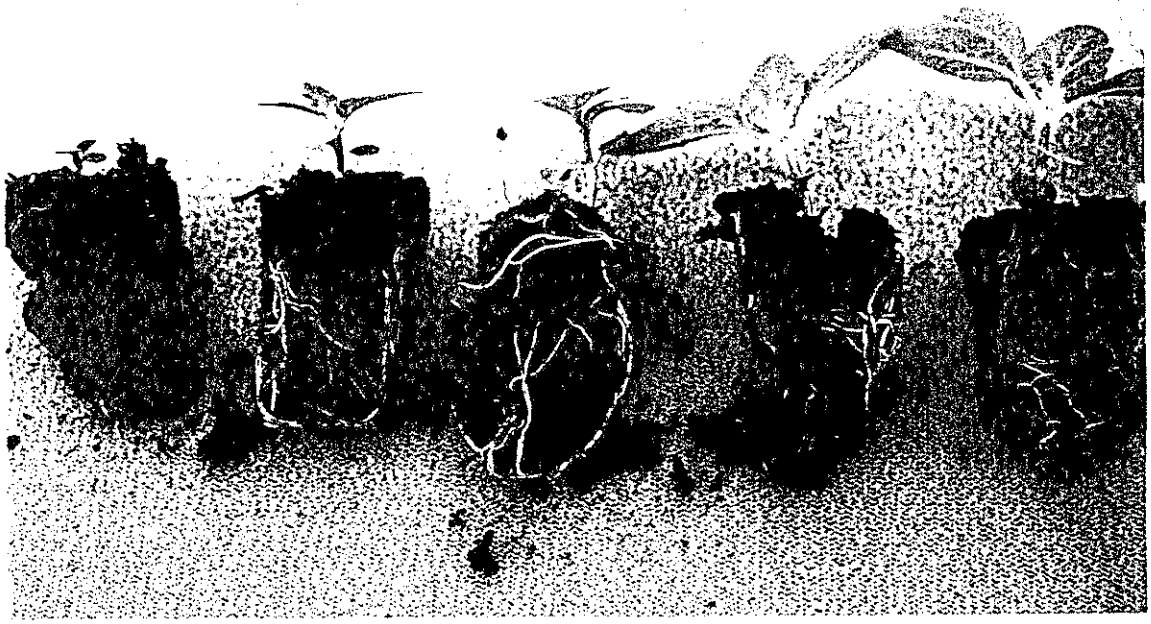
Photographic Plates

Plate 1: *Ageratum* at transplanting

Treatment level single superphosphate (g/l)

0	0.3	0.6	0.9	1.2

No supplementary phosphate



With supplementary phosphate

APPENDIX IX

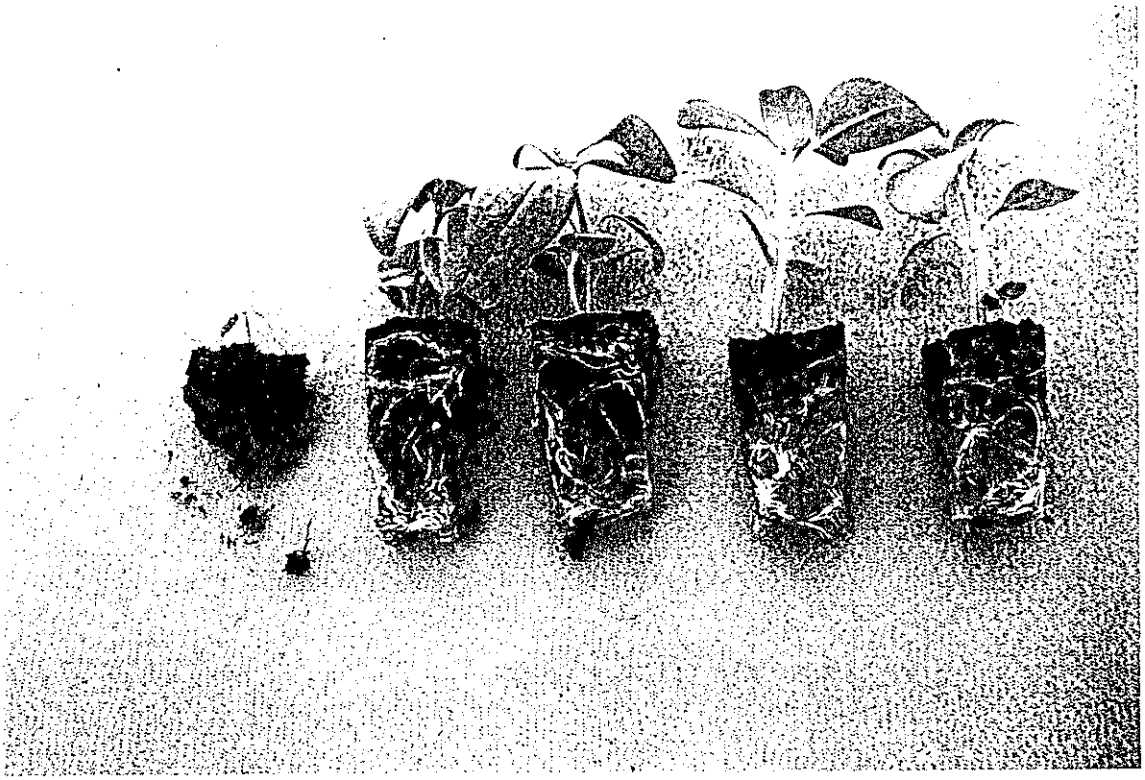
Photographic Plates

Plate 2: *Antirrhinum* at transplanting

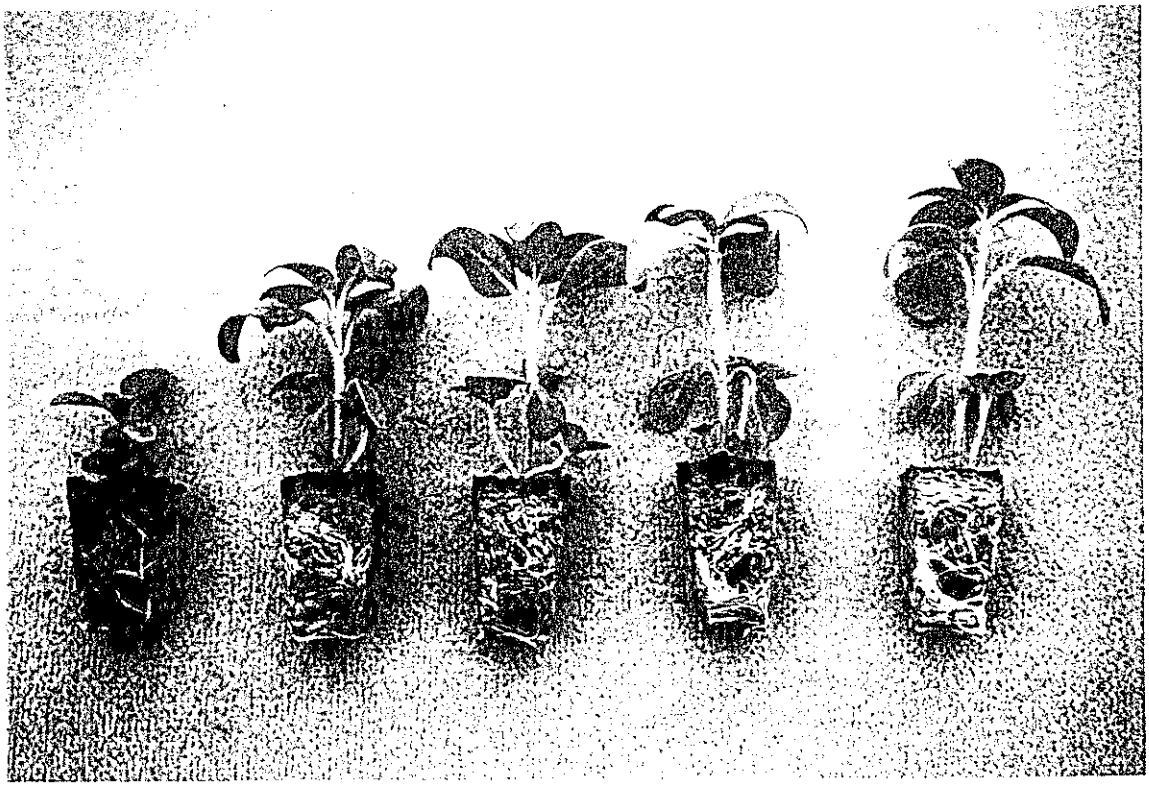
Treatment level single superphosphate (g/l)

0 0.3 0.6 0.9 1.2

No supplementary phosphate



With supplementary phosphate



APPENDIX IX

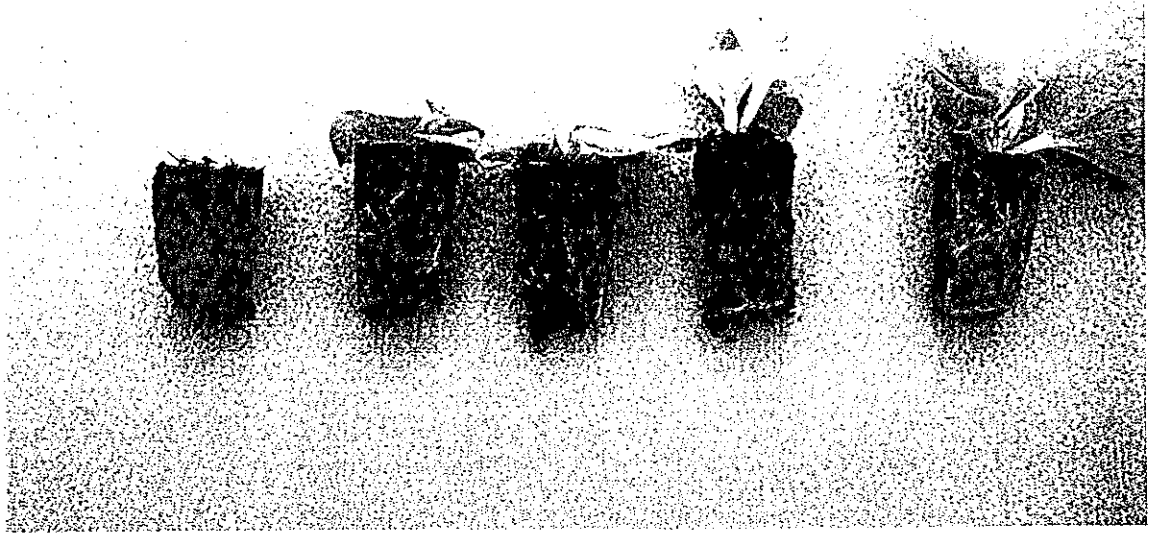
Photographic Plates

Plate 3: *Begonia* at transplanting

Treatment level single superphosphate (g/l)

0 0.3 0.6 0.9 1.2

No supplementary phosphate



With supplementary phosphate

APPENDIX IX

Photographic Plates

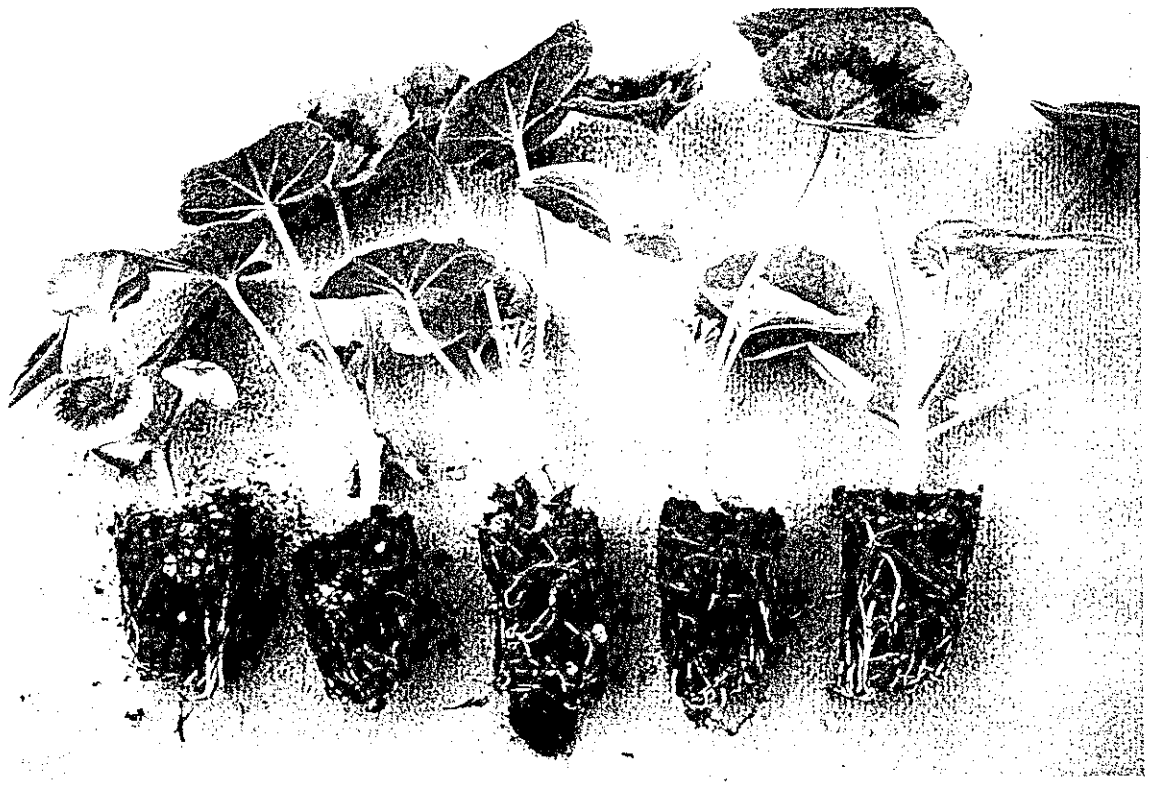
Plate 1: Geranium at transplanting

Treatment level single superphosphate (g/l)

0	0.3	0.6	0.9	1.2

No supplementary phosphate

With supplementary phosphate



APPENDIX IX

Photographic Plates

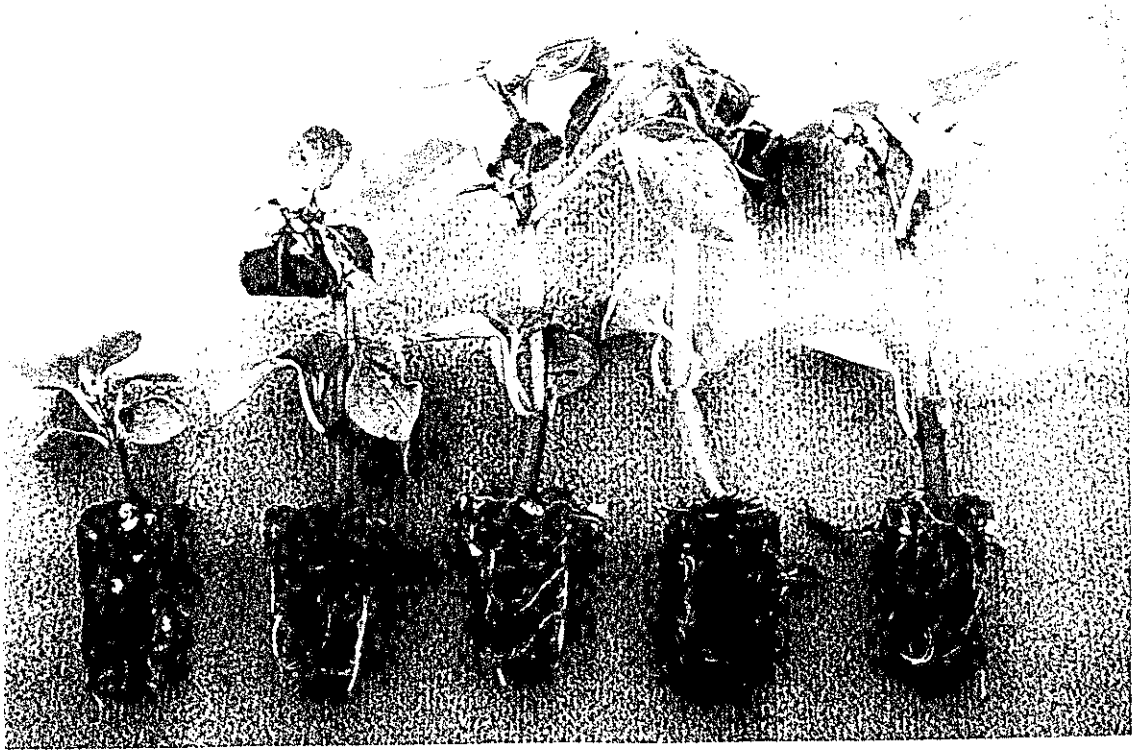
Plate 5: *Impatiens* at transplanting

Treatment level single superphosphate (g/l)

0 0.3 0.6 0.9 1.2

No supplementary phosphate

With supplementary phosphate



APPENDIX IX

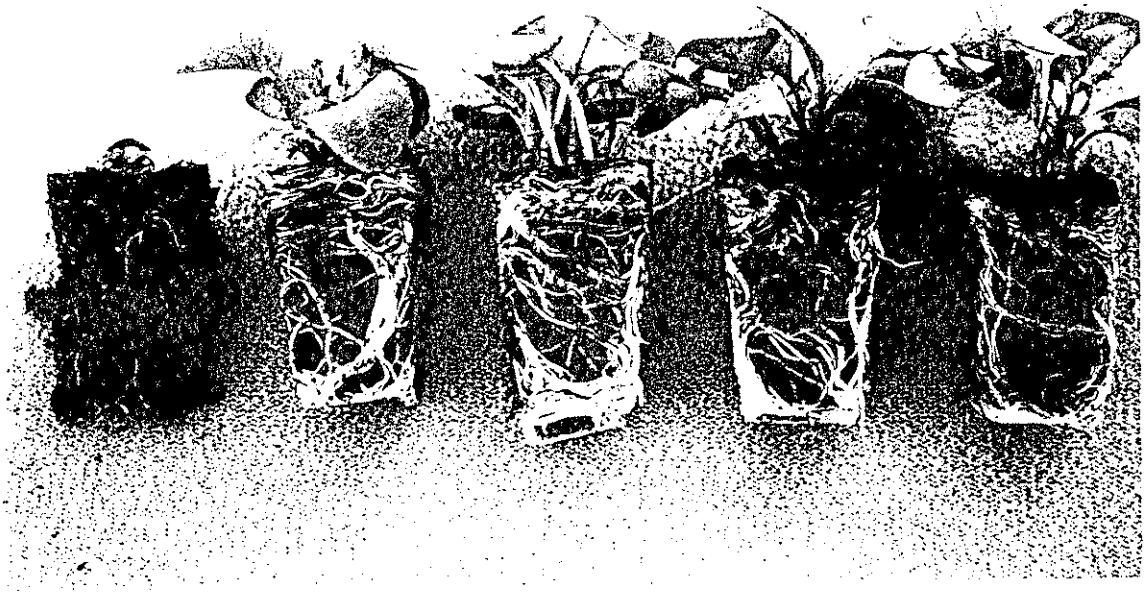
Photographic Plates

Plate 6: *Lobelia* at transplanting

Treatment level single superphosphate (g/l)

0 0.3 0.6 0.9 1.2

No supplementary phosphate



With supplementary phosphate

APPENDIX IX

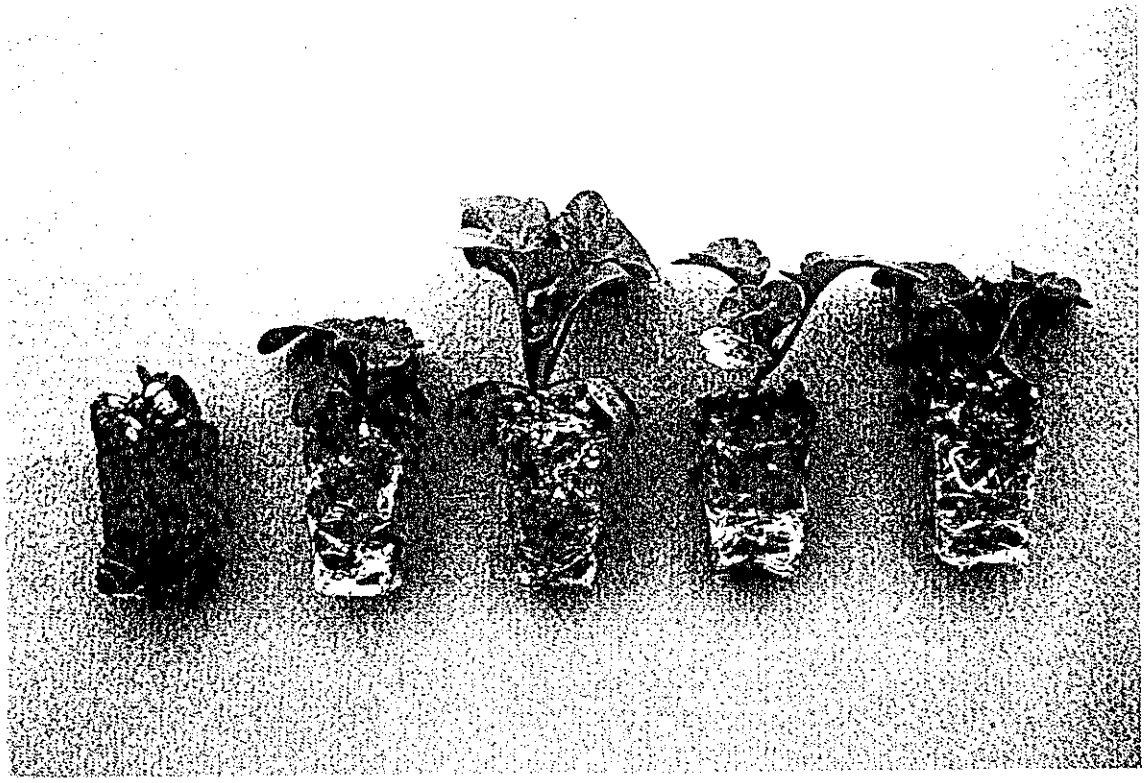
Photographic Plates

Plate 7: Pansy at transplanting

Treatment level single superphosphate (g/l)

0 0.3 0.6 0.9 1.2

No supplementary phosphate



With supplementary phosphate

APPENDIX IX

Photographic Plates

Plate 8: *Petunia* at transplanting

Treatment level single superphosphate (g/l)

0 0.3 0.6 0.9 1.2

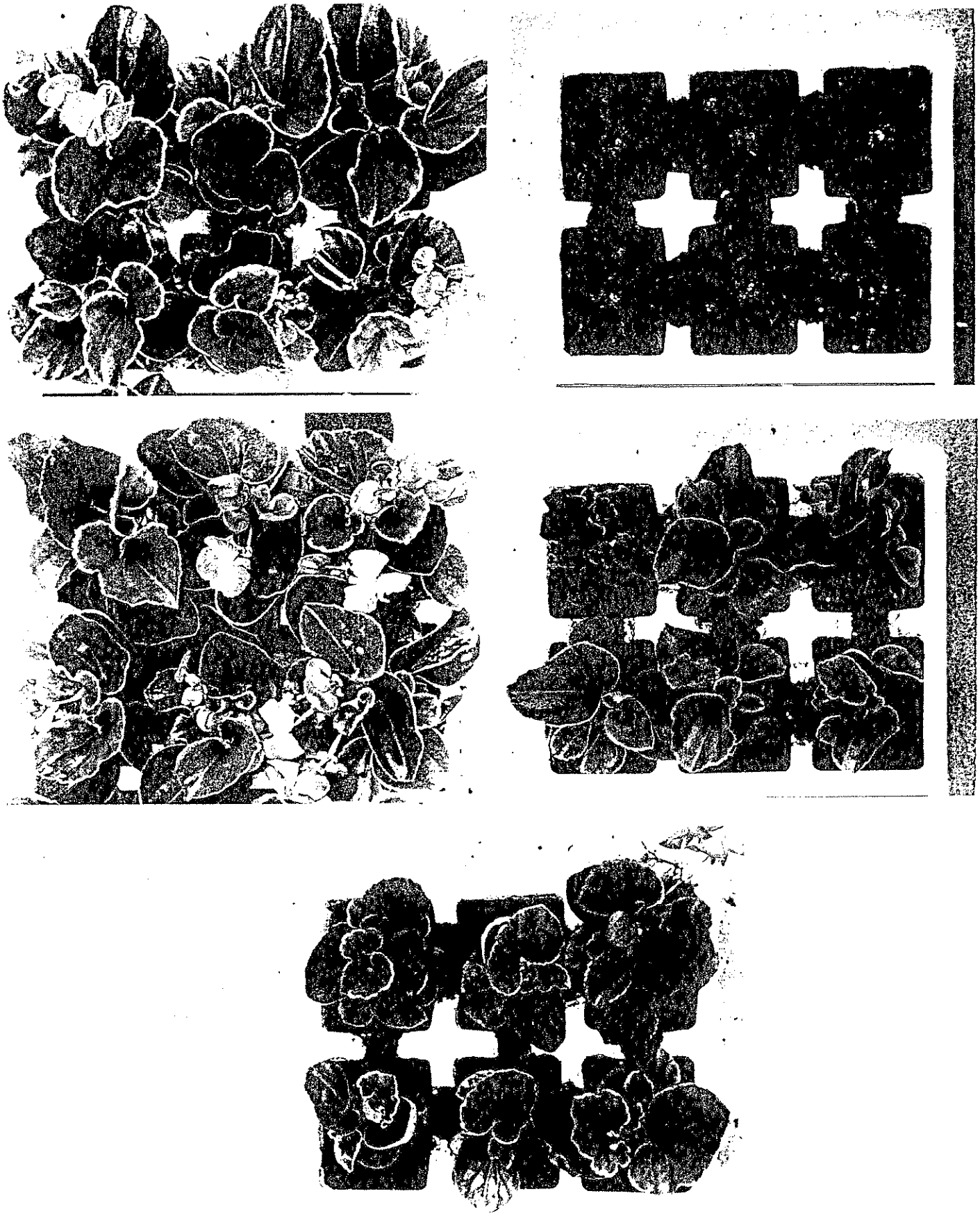
No supplementary phosphate

With supplementary phosphate

APPENDIX IX

Photographic Plates

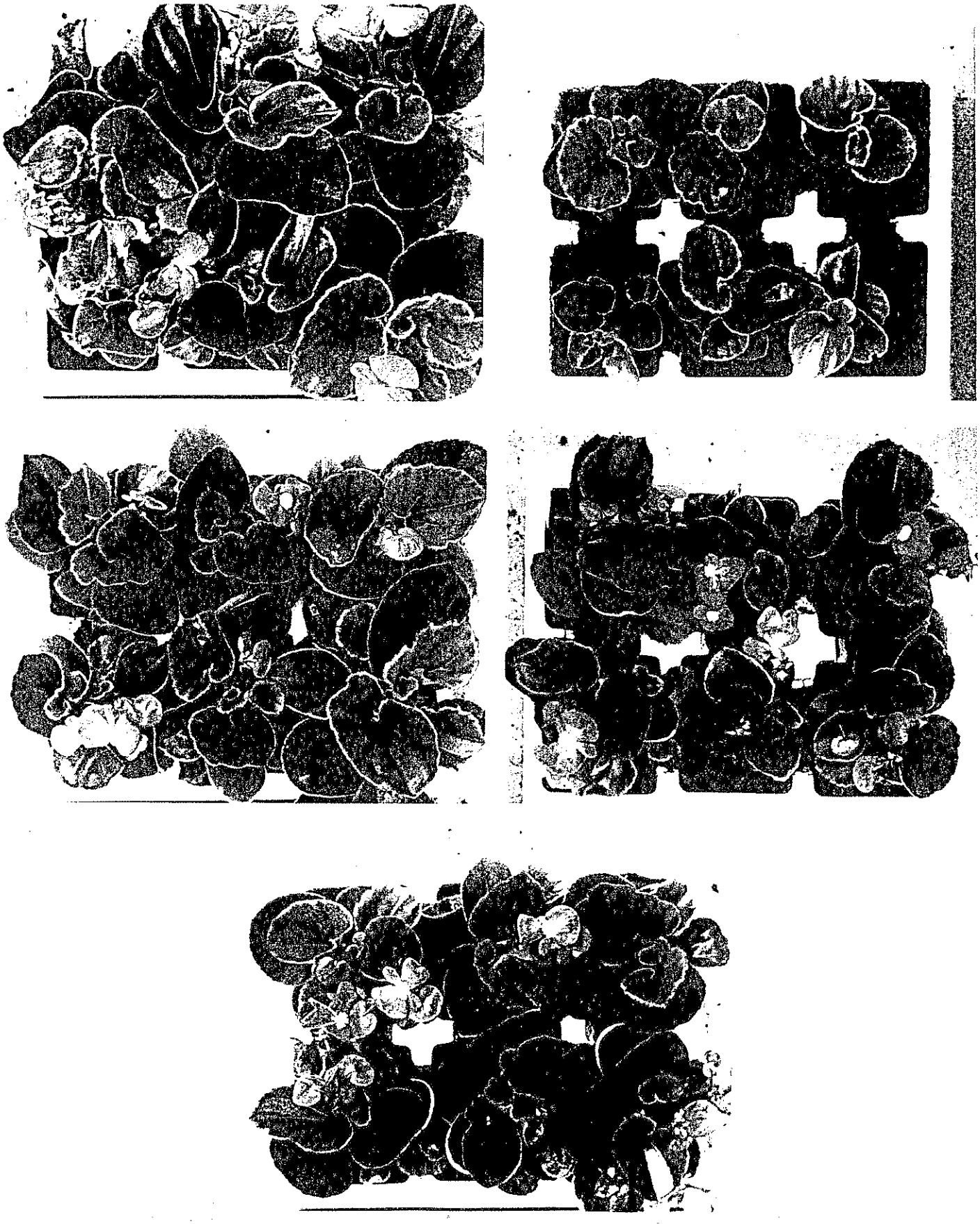
Plate 9: *Begonia* at marketing (no supplementary phosphate)(from top right in clockwise direction: zero, 0.3 g/l, 0.6 g/l, 0.9 g/l and 1.2 g/l)



APPENDIX IX

Photographic Plates

Plate 10: *Begonia* at marketing (with supplementary feed)(from top right in clockwise direction: zero, 0.3 g/l, 0.6 g/l, 0.9 g/l and 1.2 g/l)



References

Armitage, M. Allan (1994). Ornamental Bedding Plants. Crop Production Science in Horticulture 4, CAB International, 175pp

Koranski, D.S. (1988). Feed plugs early. Grower Talks 51 (9), p36

Metcoff, L. (1992). Nutrition testing : a plant's four basic food groups. Proceedings of the 1992 International Plug Conference, Orlando, FL.

APPENDIX XI Contract Terms and Conditions

Contract between HRI (hereinafter called the "Contractor") and the Horticultural Development Council (hereinafter called the "Council") for a research/development project.

1. TITLE OF PROJECT

Contract No: PC86
Extension for a third year
Contract date: 9.1.95

BEDDING PLANTS: INVESTIGATION OF CULTURAL METHODS FOR CONTROLLING PLANT HEIGHT

2. BACKGROUND AND COMMERCIAL OBJECTIVE

As for PC86.

Plant growth regulators are one of the most commonly used methods of controlling pot and bedding plants to produce high quality, compact plants for marketing. The high chemical input concerns growers and customers alike. Cost of chemicals, and their application in the future with regard to legislation means several alternative methods are being investigated to reduce plant height. Use of temperature and lighting manipulation are currently included in research.

Manipulation of nutrition (phosphate) and the use of water stress on plants has formed the basis for research at Efford in 1993 and 1994, PC86. The use of controlled phosphate as a means of height control has been proved effective, with additional effects on flowering being recorded. In addition, height control using water stress during the growing on phase has been demonstrated, with early attempts to quantify a regime which growers can adopt. The encouraging results in 1994 lead towards more detailed assessment at the level of phosphate which achieves greatest height control in the plug stage, and subsequently applying phosphate rich feeds in the plug and growing on stage, with the aim to switch growth 'on and off'. Effect on flowering also needs to be assessed. Use of these techniques needs further development and evaluation in order to provide growers with the required information on a wide range of bedding plants species.

Performance in the growing on stage in the module can affect subsequent establishment upon planting out. The use of 'water stress' can aid toning of plants to increase shelf-life at the point of sale and garden performance. Increasingly the consumer is demanding a high quality product, with an ability to withstand adverse conditions in the garden. Work is necessary to provide a 'dry regime' which is acceptable and can be managed by growers.

3. POTENTIAL FINANCIAL BENEFIT TO THE INDUSTRY

To reduce the input of plant growth regulators and associated costs in spraying time. Reduced use of phosphates and agrochemicals. Produce a more effective and efficient method of height control in contrast to DIF which can be species specific; and the capital and running costs involved in supplementary lighting. Reduce losses in production and at the retail end by appropriate crop scheduling.

4. SCIENTIFIC/TECHNICAL TARGET OF THE WORK

Provide information towards physiological effect of nutritional control on plant height (and flowering). Establish level of phosphate which will give growth without detrimental effects on subsequent plant performance for a range of bedding plant species, in combination with standard and dry watering regime during the growing on phase.

The work during the 3rd year will focus on the development of a "grower blue-print" for bedding plant height manipulation. It is anticipated that there will be enough data at the end of 1995 to compile a robust "blue-print" for all the species which have been examined over the 3 year period.

5. CLOSELY RELATED WORK - COMPLETED OR IN PROGRESS

As for PC86.

6. DESCRIPTION OF THE WORK IN YEAR 3

Level of phosphate:

0 kg/m^3 (single superphosphate)
0.3 kg/m^3
0.6 kg/m^3
0.9 kg/m^3
1.2 kg/m^3

Nutritional regime:

i. High phosphate liquid feed at plug stage prior to pricking off.

ii. Prick off into standard compost without prior liquid feed.

Watering regime (during growing on)

i. Standard

ii. Plants allowed to dry back until flaccid before watering.

Species: Subject to further discussion with regard to varieties used.

Grown on at 10/12°C:	Pansy	Turbo
	Antirrhinum	Coronette
	Ageratum	Champion
	Lobelia	Crystal Palace
Grown on at 14/16°C:	Impatiens	Accent
	Petunia	Express
	Begonias	Olympia
	Geranium	Century

All species sown in 286 plug trays in February and grown on in double sixes.

Design: Block design replicated trial.

5	phosphate levels
x	
2	nutritional regimes
x	
2	watering regimes
x	
2	replicates
40	plot species
x	
8	species
320	plots in total

Plot size: Plug tray: central 20 plants
Growing on: 12 plants

Garden Performance: 12 plants from each treatment to be planted out to evaluate effects of cultural treatments on shelf-life.

Assessments:

a. At plug stage:
- Height
- Quality Score
- Fresh Weight
- % Dry matter

b. At maturity:
- Height
- Flower score
- Quality score

c. Garden performance:
- Height score
- Quality score
- Flower score

at 6, 12 and 18 weeks post planting out.

d. Photographs: plug stage
maturity
garden performance

e. Record of watering regime; dry/standard.

f. Compost/leaf analysis - at plug stage/maturity.

7. COMMENCEMENT DATE AND DURATION

Start date 01.02.93; duration 3 years (10 months p.a.).

A report for years 1 and 2 will be produced by December 1994 and the final report will be produced by December 1995. The final report will include all data presented in the earlier report as well as the data from the 1995 work.

8. STAFF RESPONSIBILITIES

Trials officer: Andrew Fuller
HDC Co-ordinator: Neil Bragg

9. LOCATION

HRI Efford

10. COSTS

Contract No: PC86-EXT

TERMS AND CONDITIONS

The Council's standard terms and conditions of contract shall apply.

Signed for the Contractor(s)

Signature.....

Position.....

Date.....13/1/95.....

Signed for the Contractor(s)

Signature.....

Position.....

Date.....

Signed for the Council

Signature.....

Position.....CHIEF EXECUTIVE.....

Date.....9.1.95.....