HORTICULTURE RESEARCH INTERNATIONAL
EFFORD

REPORT TO:

Mr John Farthing
ADAS
Cambridge RO
Block C Government Buildings
Brooklands Avenue
Cambridge CB2 2DR

Tel: 0223 462727
Fax: 0223 455652

Dr John Braunholtz
HDC
18 Lavant Street
Petersfield
Hampshire
GU32 3EW

Tel: 0730 63736
Fax: 0730 65394

HRI CONTRACT MANAGER: Dr M R Shipway
HRI Efford
Lymington
Hampshire
SO41 OLZ

Tel: 0590 673341
Fax: 0590 671553

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CONTRACT REPORT
BEDDING PLANTS
USE OF DIF
CSG PC13 012
HDC PC 41a
HRI C224

PRINCIPAL WORKERS

HRI EFFORD

Mrs E J Hemming BSc Hons, (Hort), M.I.Hort	Technical Officer (Author of Report)
Mr R Goode, OND	Assistant Scientific Officer
Mr C A J Hemming	Nursery Staff
Mr S Langford	Nursery Staff
Miss A Peek	Nursery Staff
Mrs M Jenvey	Nursery Staff

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.

.....Margaret A. Scott.....
Signature

Margaret A Scott
Deputy Head of Station

Date .....6/12/91.....

Report authorised by .....
Signature

M R Shipway
Head of Station
HRI Efford
Lymington
Hants
SO41 OLZ

Date ...6/12/91.....

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SUMMARY

DIF - Difference in temperature regimes, have shown promise in preliminary trials work in helping to reduce plant growth regulant use and to control extension growth of both pot plant and bedding plant species. An investigation into its potential use as a growth control measure in bedding plant production during the module (plug) stage was commissioned at HRI Efford initially with Chief Scientists Group (CSG) funding and subsequently by the Horticultural Development Council (HDC).

This report represents the results of the initial growth (CSG) and subsequent 'shelf life' of plants (HDC) subjected to a range of DIF treatments. The main treatments were based on early morning temperature drops before and after sunrise compared to a standard temperature regime (control), with sub treatments of with and without plant growth regulant application.

Of the four species Impatiens walleriana, Pelargonium zonale, Petunia hybr. and Salvia splendens all showed a distinct response to regimes where the temperature was dropped in the early morning. The most effective temperature treatment involved a two hour drop starting at sunrise. The height suppressing effect of this treatment was even evident where no plant growth regulant was applied. Little difference was seen for leaf number between treatments.

Prior temperature treatments did not have an effect on the final 'shelf life' ie. garden performance, all plants performing equally well, with regard to flowering.

It is suggested that a cultural regime using DIF would enable the grower to reduce the input levels of plant growth regulants during bedding production and still achieve a high quality end product.

INTRODUCTION

Research in the United States and elsewhere in Europe has demonstrated the possibility of controlling plant growth with DIF (Difference in temperature) regimes. Initial trials work at HRI Efford (CSG PC13 009) using these regimes during the growth of bedding plants has given promising results.

The potential benefits to the grower include:
Reduction in chemical plant growth regulant use and soil/irrigation water contamination.
Reduced exposure of staff to sprays and residues and lower labour requirement.
Possible improvements in plant quality.

OBJECTIVE

The main objectives of the trial were:-

1) Investigate the use of DIF using early morning temperature manipulation as a means to control growth of four bedding plant species during the module stage.

2) To assess the subsequent 'shelf life' of plants grown on under DIF regimes (within glasshouse limitations) through to planting out and garden performance.

Although not directly involved, treatments and species were chosen to reflect those of a co-operative project with four research stations in Europe looking into DIF.

MATERIALS AND METHOD

Site

Seed for the trial was germinated on thermostatically controlled heated benches in a standard glasshouse equipped with automatic control of heating and ventilation. Plants were transferred to their respective treatment compartments in 'K Block', with computerised environmental control, once their first true leaves had expanded. Performance under glass and in the garden were assessed, with planting out on an area of newly rotovated and established ground which had previously been down to grass. The soil type was of the Waterstock Series - a slightly stony sandy silt loam.

Treatments

Temperature regime.

A. 2 hour drop, after sunrise
B. 2 hour drop, before sunrise
C. Control, no temperature drop

Heating temperatures	16°/16°C day/night
Ventilation temperatures	18°/20°C day/night
Temperature drop	6°C for heating
Ventilation set point	0.2°C above heating

Growth regulant regime.

1. Control - no growth regulant
2. Alar spray, 2500 ppm - Petunia and Impatiens
   Cycocel spray, 3 x 300 ppm - Pelargonium
   3000 ppm - Salvia

Species and cultivars

Impatiens	-	F1 Accent Salmon
Pelargonium	-	F1 Century Scarlet
Petunia	-	F1 Blue Ice
Salvia	-	Blaze of Fire

Design

3 temperature regimes
x
2 growth regulant regimes
x
3 replicates

18 plots per species
x
4 species

72 plots in total

Plot size = Half P180 module tray, 63 plants, of which the central 15 were recorded. The trial layout is given in Appendix I, page 13.

Cultural details

Seed was sown into Plantpak P180 module trays containing Fisons Levington F1 compost and placed into controlled environment facilities to germinate. Sowing, treatment application, transplanting dates etc are given in the crop diary below.

Impatiens were germinated at 21-24°C at seed level and covered with a light covering of medium grade vermiculite. Pelargonium at 18-22°C with an 8 mm covering of vermiculite. Petunia at 20-25°C with no vermiculite covering whilst Salvia at 21-24°C with a 2mm vermiculite covering.

Once emergence was complete a liquid feed was applied at every watering supplying 150 ppm N and K_20.

Seedlings were transferred to their respective treatment compartments once first true leaves were fully expanded, and grown on. Plant growth regulants appropriate for each species were applied during the module stage, (see crop diary).

Records were taken at the transplanting stage when seedling roots had fully explored the module, forming an easy to remove 'plug'. Plants were transplanted into 9 cm round pots (Optipot 9F) in Fisons Levington F2 compost and grown on to sale stage. Plants were fed at every watering with 200 ppm N and K_20.

Plants were grown-on in the glasshouse until the sale stage (maturity) ie. when 50% of plants in a plot had at least one flower showing colour. At this point final assessments were made.

Plant material was then planted out in the bedding out site on 10 June and maintained throughout the summer with observations being made on performance, (Garden performance).

Crop diary

Species	**Sowing date**	**Germination date**	**DIF trt commenced**	**PGR application**	**Transplant date***	**Sale Stage date+**
Impatiens	28 Feb	3 Mar	28 Mar	14 Apr	19 Apr	10 May
Pelargonium	29 Feb	2 Mar	18 Mar	21 Mar 28 Mar 5 Apr	17 Apr	4 Jan
Petunia	28 Feb	4 Mar	18 Mar	5 Apr	18 Apr	2 Jan
Salvia	28 Feb	5 Mar	18 Mar	2 Apr	16 Apr	3 Jan

* **Transplant date = first recording date**

\+ **Sale stage date = second recording date**

Assessments

During the course of the trial the following assessments were made:-

At transplanting:

1. Plant height
2. Leaf number
3. Leaf size (length and width for Pelargonium and Salvia)
4. Internode length (Impatiens and Salvia)

At maturity:

5. Plant height
6. Shoot number (Impatiens and Petunia)
7. Flowers in colour (Petunia)
8. Leaf size (Pelargonium)
9. Internode length (Impatiens)
10. % Dry Matter

Garden Performance:

11. Visual observations

Statistical analysis:

Data was subjected to statistical analysis at HRI Littlehampton. The design of the trial was such that while there was no replication of the main compartment temperature treatments - there was a three fold replication of the within compartment growth regulant treatments. For this reason, no tests of significance could be made on the main effects of temperature treatments, but an estimate of the interaction of temperature and plant growth regulants was possible. Treatment means are presented.

The four species were analysed separately, as were the two stages when data was recorded (transplanting and maturity).

RESULTS

Impatiens

Transplanting stage

Values for mean plant height are given in Table 1, Appendix II page 14 and are shown graphically in Figure 1, page 23. The shortest plants were from treatment A where the temperature drop commenced at sunrise, even when no plant growth regulant was used. The use of plant growth regulant gave the shortest plants as might be expected. Plant growth regulant use also gave shorter internode lengths (Table 2, Appendix II, page 14) and a marginally less leaf count (Table 3, Appendix II, page 14).

For Impatiens, unlike the other three species the control plants (Treatment C) were the next tallest, while plants subjected to a two hour drop prior to sunrise gave the tallest plants as well as having the longest first internode length and greatest leaf number.

Comparison photographs of the effect of temperature and growth regulant treatments are shown in Appendix III for all four species, (Plates 1-4, page 25).

Maturity stage

By maturity, measurements for plant height (Table 4, Appendix II, page 15 and Figure 2, page 26) demonstrated that plants from treatment A were still the shortest (approximately 15 mm) with those from the other two treatments of similar size. Plant growth regulant use superimposed on top of the temperature treatments gave the tallest plants in the control plus plant growth regulants, whereas, where no plant growth regulant was used, heights measured for both control and two hour drop, before sunrise treatments were similar.

Shoot number (Table 5 Appendix II, page 15) and internode lengths (Table 6, Appendix II, page 15) were similar for all treatments.

Percentage dry matter results (Table 7, Appendix II, page 16) were similar between 6.4 and 6.8%.

Garden performance

After planting out, fortnightly visual observations showed little difference in plant growth between the various treatments. There was no difference in flowering performance.

Pelargonium

Transplanting stage

For Pelargonium results for mean plant height at maturity are given in Table 8, Appendix II, page 17, Figure 1, page 23). Dropping the compartment temperature at sunrise for two hours gave slightly shorter plants than the other two treatments whose values were similar. As might be expected, the variates for the mean responses - height, number of true leaves, (Table 9, Appendix II, page 23) leaf length and leaf width (Table 10, Appendix II, page 23) all indicated growth regulant effects. Plant growth regulants reduced average height, leaf length and width compared with untreated, but increase average leaf number.

Temperature treatments had little effect on leaf number or width but did have an effect on leaf length with treatment A having the shortest length.

Maturity stage

DIF treatment for two hours after sunrise gave the shortest plants. With plant growth regulant, control plants were the tallest, with the two hour drop before sunrise giving an intermediate result. Where no plant growth regulant was used treatment B, (Two hour drop, before sunrise) gave marginally taller plants than the control, (Table 11, Appendix II, page 18 and Figure 2, page 24).

Measurements for leaf width (widest part) and leaf length (point where stem joins leaf to tip) showed that slightly smaller leaves were produced under treatment A both with and without plant growth regulant. (Table 12, Appendix II, page 18).

Percentage dry matter (Table 13, Appendix II, page 18) gave higher figures for those plants subjected to treatment A, a two hour drop, at sunrise. Whilst the lowest were from the control treatment.

Garden performance

There were no visible differences between treatments with regard to flowering period.

Petunia

Transplanting stage

As with the previous two species the most compact plants were in the treatment where temperatures had been dropped at sunrise for two hours, (Table 14, Appendix II, page 19). Intermediate were those from the regime where temperatures were dropped prior to sunrise, with the tallest plants from the control treatment. Plant growth regulant use gave shorter plants which followed the above main treatment trend. Even without plant growth regulant, treatment A plants were approximately 20 mm smaller, (Figure 1, Appendix II, page 23). The best DIF treatment gave as good height control as where plant growth regulants had been used.

Leaf numbers were similar for all treatments. (Table 15, Appendix II, page 19).

Maturity stage

By maturity (sale stage) a similar pattern to that at transplanting had been maintained for plant height (Table 16, Appendix II, page 19 and Figure 2, page 24) although not as pronounced. Plant growth regulant use gave less variation in results.

Both DIF and plant growth regulant use had a influence on development (Table 17, Appendix II, page 20). Side shooting was greater where plant growth regulants had been used as well as being higher for the two hour drop after sunrise without regulant. Flower number in colour was greatest for the two hour drop after sunrise (Treatment A) both with and without plant growth regulant. This suggested that flowering was advanced by this treatment. Overall, the use of plant growth regulant increased flower number.

The values for percentage dry matter are given in Table 18, Appendix II, page 20. Control plants had marginally greater dry matter gain than the other two treatments.

Garden performance

Plants from all treatments performed equally well during the bedding out stage - flowering into late September. Treatment A plants remained more compact throughout, which meant less damage was suffered in windy conditions.

Salvia

Transplanting stage

The forth species, Salvia demonstrated a similar response to the other subjects to both temperature and plant growth regulant treatments. Even without growth regulants Salvia height was 15-30 mm less in treatment A, (dropping temperature after sunrise), compared to the control, (Table 19, Appendix II, page 21 and Figure 1, page 23). Measurements of the first three internode lengths reflected the pattern for overall height, as might be expected (Table 20, Appendix II, page 21). Salvia was extremely responsive to early morning temperature drop giving nicely compact plugs.

The mean leaf number were similar for all treatments and are given in Table 21, Appendix II, page 21, whilst measurements of leaf length and width (Table 22, Appendix II, page 22) gave marginally smaller leaves where plants had been subjected to a two hour temperature drop after sunrise and where plant growth regulant had been used.

Maturity stage

Values for plant height (Table 23, Appendix II, page 22 and Figure 2, page 24) were less marked but followed a similar pattern to transplanting results. Shortest plants from the two hour drop after sunrise plus plant growth regulant to tallest in the control, no plant growth regulant plots.

Garden performance

All treatments gave good garden performance although the shorter plant (from treatment A), were once again more wind resistant (ie more stable).

DISCUSSION

Generally, all four species responded to the use of DIF temperature regimes where an early morning temperature drop for two hours restricted extension growth, giving rise to more compact plant at both the transplanting and maturity stages. For most species, the greatest response was where the drop in temperature took place starting at sunrise for a period of two hours. The use of plant growth regulants gave the shortest plants but even where no growth regulants were applied, a beneficial effect of shorter plants/internodes was noted.

Some species were more responsive than others. The results of this particular trial showed Salvia exhibiting the most reaction to treatment. Pelargonium and Petunia were intermediate whilst the results for Impatiens, while more variable, still demonstrated shorter plants where temperatures had been dropped for two hours commencing at sunrise.

DIF treatment had no adverse effect on results for leaf number, % dry matter and subsequent garden performance was unaffected by the prior temperature treatments. There was some suggestion that flower number and shoot number were greater under treatment A (Two hour drop, after sunrise) and that flowering was advanced by up to four days, though this may not be commercially significant.

From the results obtained it is suggested that the use of DIF to restrict extension growth, may offer the potential for reducing or even eliminating the use of plant growth regulant during bedding plant production. The regime involving a two hour drop in temperature starting at sunrise in some cases was as effective in restricting height as where plant growth regulants were used.

The effectiveness of DIF was more pronounced during early growth ie. module stage even though for the purposes of this work DIF was maintained throughout the trial. The ability to maintain the early morning cool treatment becomes more difficult as the season progresses and this may well account for the less marked differences between treatments at maturity.

CONCLUSIONS

This trial was commissioned with the objectives of investigating the effect of DIF temperature regimes for use on bedding plants particularly during the module stage, to reduce plant growth regulant use.

The main conclusions to be drawn are:

* Dropping temperature for two hours starting at sunrise was the most effective treatment and gave reduced heights and internode lengths even where no plant growth regulant was used, ie. the best DIF treatment was equivalent to control temperature regime plus plant growth regulant.

* There was little difference in leaf number between temperature treatments.

* The responsiveness of each species was variable. The greatest response to the DIF regimes was from Salvia followed by Pelargonium and Petunia with more variable results for Impatiens.

* All treatments produced saleable plants, although Control plants tended to be more 'leggy'.

* DIF temperature regimes would appear to advance flowering.

* The combined use of DIF and reduced plant growth regulant inputs offers an attractive and manageable alternative regime without resorting to the current heavy reliance on plant growth regulants for growth control.

* DIF was more effective in restricting height during the module stage.

* Manipulation of the temperature regime was more difficult to achieve as the season progressed.

APPENDIX I - Trial Layout

rep III	C1 5	C2 6	C2 23	C1 24	C2 41	C1 42	C1 59	C2 60
rep II	C2 3	C1 4	C1 21	C2 22	C1 39	C2 40	C2 57	C1 58
rep I	C1 1	C2 2	C2 19	C1 20	C1 37	C2 38	C2 55	C1 56

rep III	B1 11	B2 12	B2 29	B1 30	B2 47	B1 48	B1 65	B2 66
rep II	B2 9	B1 10	B1 27	B2 28	B1 45	B2 46	B2 63	B1 64
rep I	B1 7	B2 8	B2 25	B1 26	B1 43	B2 44	B2 61	B1 62

rep III	A1 17	A2 18	A2 35	A1 36	A2 53	A1 54	A1 71	A2 72
rep II	A2 15	A1 16	A1 33	A2 34	A1 51	A2 52	A2 69	A1 70
rep I	A1 13	A2 14	A2 31	A1 32	A1 49	A2 50	A2 67	A1 68

Impatiens	Pelagonium	Petunia	Salvia
F1 Accent	F1 Century	F1 Blue Ice	Blaze of Fire

Plot size = ½ P180 module tray, 63 plants, central 15 recorded
Growth regulant treatment

1. No growth regulant - white label
2. Growth regulant - red label

COMPARTMENT 13 2 hour drop
after sunrise
TREATMENT A (black)

COMPARTMENT 12 2 hour drop
before sunrise
TREATMENT B (green/yellow stripe)

COMPARTMENT 7 CONTROL
TREATMENT C

APPENDIX II

Table 1. Impatiens - Mean plant height (mm) at transplanting

Temperature regime	- Plant growth regulant	+ Plant growth regulant
A. 2 hour drop, after sunrise	46.2	38.4
B. 2 hour drop, before sunrise	62.5	52.0
C. Control, no temperature drop	56.2	48.9

Table 2. Impatiens - Mean 1st internode length (mm) at transplanting

Temperature regime	- Plant growth regulant	+ Plant growth regulant
A. 2 hour drop, after sunrise	12.3	9.4
B. 2 hour drop, before sunrise	15.8	12.2
C. Control, no temperature drop	13.9	12.0

Table 3. Impatiens - Mean leaf number at transplanting

Temperature regime	- Plant growth regulant	+ Plant growth regulant
A. 2 hour drop, after sunrise	8.8	8.2
B. 2 hour drop, before sunrise	11.6	10.0
C. Control, no temperature drop	10.0	9.6

APPENDIX II

Table 4. Impatiens - Mean Plant height (mm) at maturity

Temperature regime	- Plant growth regulant	+ Plant growth regulant
A. 2 hour drop, after sunrise	80.8	74.7
B. 2 hour drop, before sunrise	98.4	85.5
C. Control, no temperature drop	96.9	90.7

Table 5. Impatiens - Mean shoot number at maturity

Temperature regime	- Plant growth regulant	+ Plant growth regulant
A. 2 hour drop, after sunrise	9.6	9.4
B. 2 hour drop, before sunrise	10.1	9.3
C. Control, no temperature drop	9.2	9.1

Table 6. Impatiens - Mean length (mm), Internodes 1 and 2 at maturity

Temperature regime	- Plant growth regulant		+ Plant growth regulant	
	Int. 1	Int. 2	Int. 1	Int. 2
A. 2 hour drop, after sunrise	13.9	18.7	11.2	15.2
B. 2 hour drop, before sunrise	16.7	25.6	13.2	23.7
C. Control, no temperature drop	15.7	24.4	14.2	21.5

APPENDIX II

Table 7. Impatiens - Fresh weight, dry weight (g) and % DM at maturity

Temperature regime	- plant growth regulant			+ plant growth regulant		
	Fresh wt.	Dry wt.	% DM	Fresh wt.	Dry wt.	% DM
A. 2 hour drop, after sunrise	156.3	10.1	6.4	131.8	8.8	6.6
B. 2 hour drop, before sunrise	177.5	12.1	6.8	156.3	10.7	6.8
C. Control, no temperature drop.	152.4	9.8	6.4	139.4	9.2	6.5

APPENDIX II

Table 8. Pelargonium - Mean plant height (mm) at transplanting

Temperature regime	- plant growth regulant	+ plant growth regulant
A. 2 hour drop, after sunrise	68.6	47.7
B. 2 hour drop, before sunrise	72.6	53.3
C. Control, no temperature drop	73.8	53.6

Table 9. Pelargonium - Mean number of leaves at transplanting

Temperature regime	- plant growth regulant	+ plant growth regulant
A. 2 hour drop, after sunrise	3.8	4.0
B. 2 hour drop, before sunrise	3.9	4.1
C. Control, no temperature drop	3.8	4.0

Table 10. Pelargonium - Mean leaf length and width (mm) at transplanting

Temperature regime	- plant growth regulant		+ plant growth regulant	
	length	width	length	width
A. 2 hour drop, after sunrise	72.7	37.0	49.7	29.2
B. 2 hour drop, before sunrise	75.5	37.5	53.7	29.3
C. Control, no temperature drop	76.6	37.9	55.2	29.1

APPENDIX II

Table 11. Pelargonium - Mean plant height (mm) at maturity

Temperature regime	- plant growth regulant	+ plant growth regulant
A. 2 hour drop, after sunrise	226.5	163.7
B. 2 hour drop, before sunrise	238.5	173.4
C. Control, no temperature drop	233.9	179.4

Table 12. Pelargonium - Mean leaf length and width (mm) at maturity

Temperature regime	- plant growth regulant		+ plant growth regulant	
	length	width	length	width
A. 2 hour drop, after sunrise	78.0	133.4	58.3	94.8
B. 2 hour drop, before sunrise	78.2	136.6	61.9	105.2
C. Control, no temperature drop	81.4	139.3	63.2	104.9

Table 13. Pelargonium - Fresh weight, dry weight (g) at % DM at maturity

Temperature regime	- plant growth regulant			+ plant growth regulant		
	Fresh wt.	Dry wt.	% DM	Fresh wt.	Dry wt.	% DM
A. 2 hour drop, after sunrise	423.0	42.8	10.1	310.0	31.7	10.2
B. 2 hour drop, before sunrise	478.0	47.9	10.0	403.0	39.6	9.8
C. Control, no temperature drop.	477.0	46.6	9.7	388.0	35.6	9.1

APPENDIX II

Table 14. Petunia - Mean plant height (mm) at transplanting

Temperature regime	- plant growth regulant	+ plant growth regulant
A. 2 hour drop, after sunrise	95.1	87.0
B. 2 hour drop, before sunrise	108.9	90.8
C. Control, no temperature drop	115.7	95.0

Table 15. Petunia - Mean leaf number at transplanting

Temperature regime	- plant growth regulant	+ plant growth regulant
A. 2 hour drop, after sunrise	7.7	7.8
B. 2 hour drop, before sunrise	8.1	7.8
C. Control, no temperature drop	8.0	7.9

Table 16. Petunia - Mean plant height (mm) at maturity

Temperature regime	- plant growth regulant	+ plant growth regulant
A. 2 hour drop, after sunrise	220.4	200.0
B. 2 hour drop, before sunrise	217.8	205.4
C. Control, no temperature drop	227.6	215.1

APPENDIX II

Table 17. Petunia - Mean numbers of side shoots and flowers in colour at maturity

Temperature regime	- plant growth regulant		+ plant growth regulant	
	shoots	flowers	shoots	flowers
A. 2 hour drop, after sunrise	4.0	6.2	4.5	7.1
B. 2 hour drop, before sunrise	3.5	5.2	5.2	6.3
C. Control, no temperature drop	3.2	5.4	4.1	6.9

Table 18. Petunia - Fresh weight, dry weight (g) and % DM at maturity

Temperature regime	- plant growth regulant			+ plant growth regulant		
	Fresh wt.	Dry wt.	% DM	Fresh wt.	Dry wt.	% DM
A. 2 hour drop, after sunrise	368.5	31.0	8.4	381.5	30.9	8.0
B. 2 hour drop, before sunrise	299.0	27.7	9.2	358.5	31.5	8.7
C. Control, no temperature drop.	317.5	29.4	9.2	336.5	31.2	9.2

APPENDIX II

Table 19. Salvia - Mean plant height (mm) at transplanting

Temperature regime	- plant growth regulant	+ plant growth regulant
A. 2 hour drop, after sunrise	74.2	55.1
B. 2 hour drop, before sunrise	92.6	64.4
C. Control, no temperature drop	107.9	70.8

Table 20. Salvia - Mean length of internodes 1, 2 and 3 (mm) at transplanting

Temperature regime	- plant growth regulant			+ plant growth regulant		
	Int. 1	Int.2	Int.3	Int.1	Int.2	Int.3
A. 2 hour drop, after sunrise	24.9	23.5	8.1	16.4	15.1	5.7
B. 2 hour drop, before sunrise	28.3	32.0	12.6	18.6	18.4	8.6
C. Control, no temperature drop	35.0	39.4	14.0	21.8	20.6	8.1

Table 21. Salvia - Mean leaf number at transplanting

Temperature regime	- plant growth regulant	+ plant growth regulant
A. 2 hour drop, after sunrise	6.0	5.9
B. 2 hour drop, before sunrise	6.0	6.0
C. Control, no temperature drop	6.0	5.9

APPENDIX II

Table 22. Salvia - Mean length and width (mm) at transplanting

Temperature regime	- plant growth regulant		+ plant growth regulant	
	length	width	length	width
A. 2 hour drop, after sunrise	63.3	32.3	53.0	28.9
B. 2 hour drop, before sunrise	68.3	33.4	58.4	30.2
C. Control, no temperature drop	69.6	35.1	57.7	31.5

Table 23. Salvia - Mean plant height (mm) at maturity

Temperature regime	- plant growth regulant	+ plant growth regulant
A. 2 hour drop, after sunrise	202.8	196.2
B. 2 hour drop, before sunrise	203.1	198.6
C. Control, no temperature drop	222.6	201.1

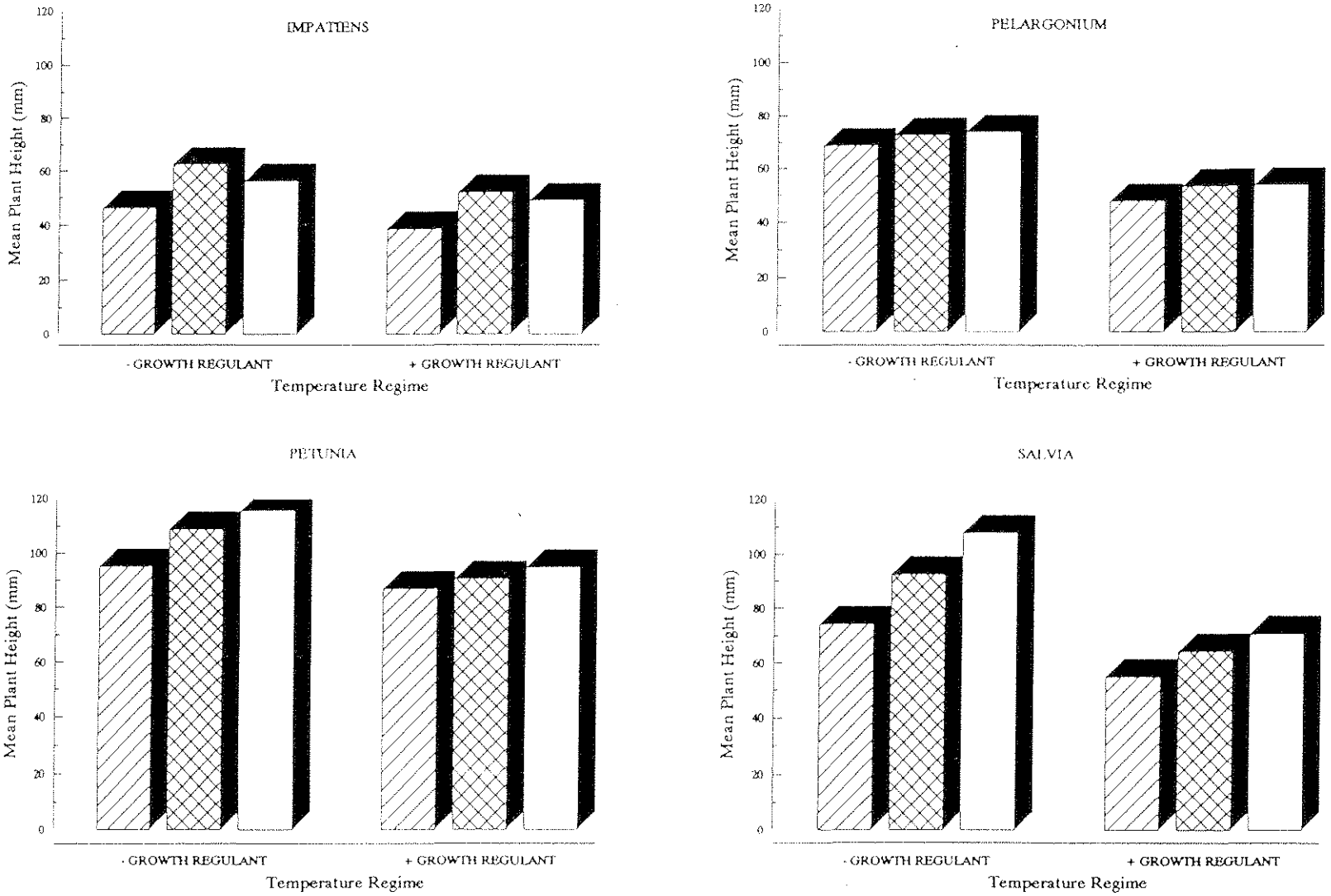
Table 24. Salvia - Fresh weight, dry weight (g) and % DM at maturity

Temperature regime	- plant growth regulant			+ plant growth regulant		
	Fresh wt.	Dry wt.	% DM	Fresh wt.	Dry wt.	% DM
A. 2 hour drop, after sunrise	451.7	45.5	10.0	421.7	40.4	9.5
B. 2 hour drop, before sunrise	383.3	42.2	11.0	401.7	40.7	10.1
C. Control, no temperature drop.	401.7	42.6	10.6	398.3	42.6	10.6

APPENDIX II

Figure 1.

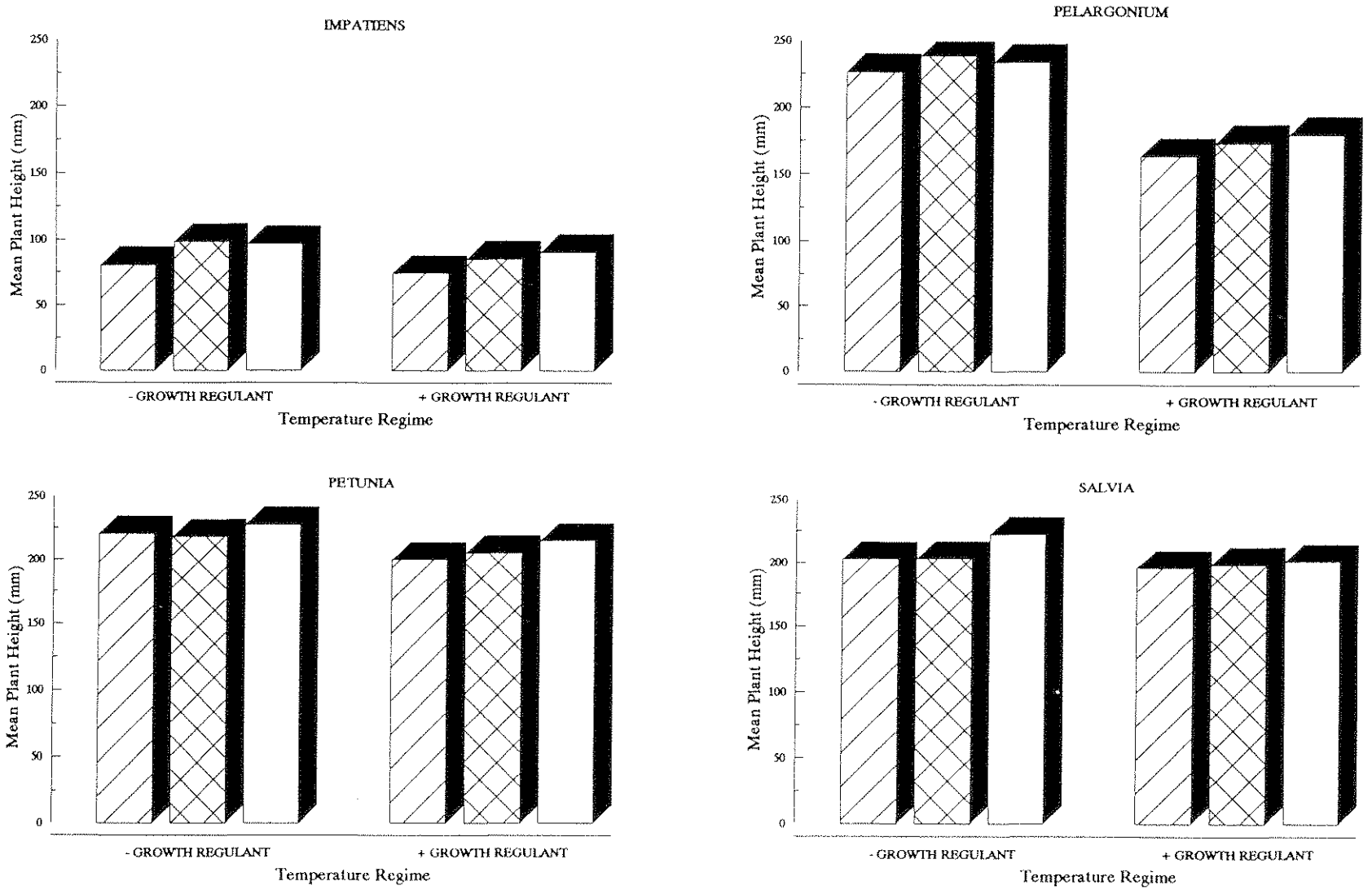
MEAN PLANT HEIGHT (mm) AT TRANSPLANTING



APPENDIX II

Figure 2.

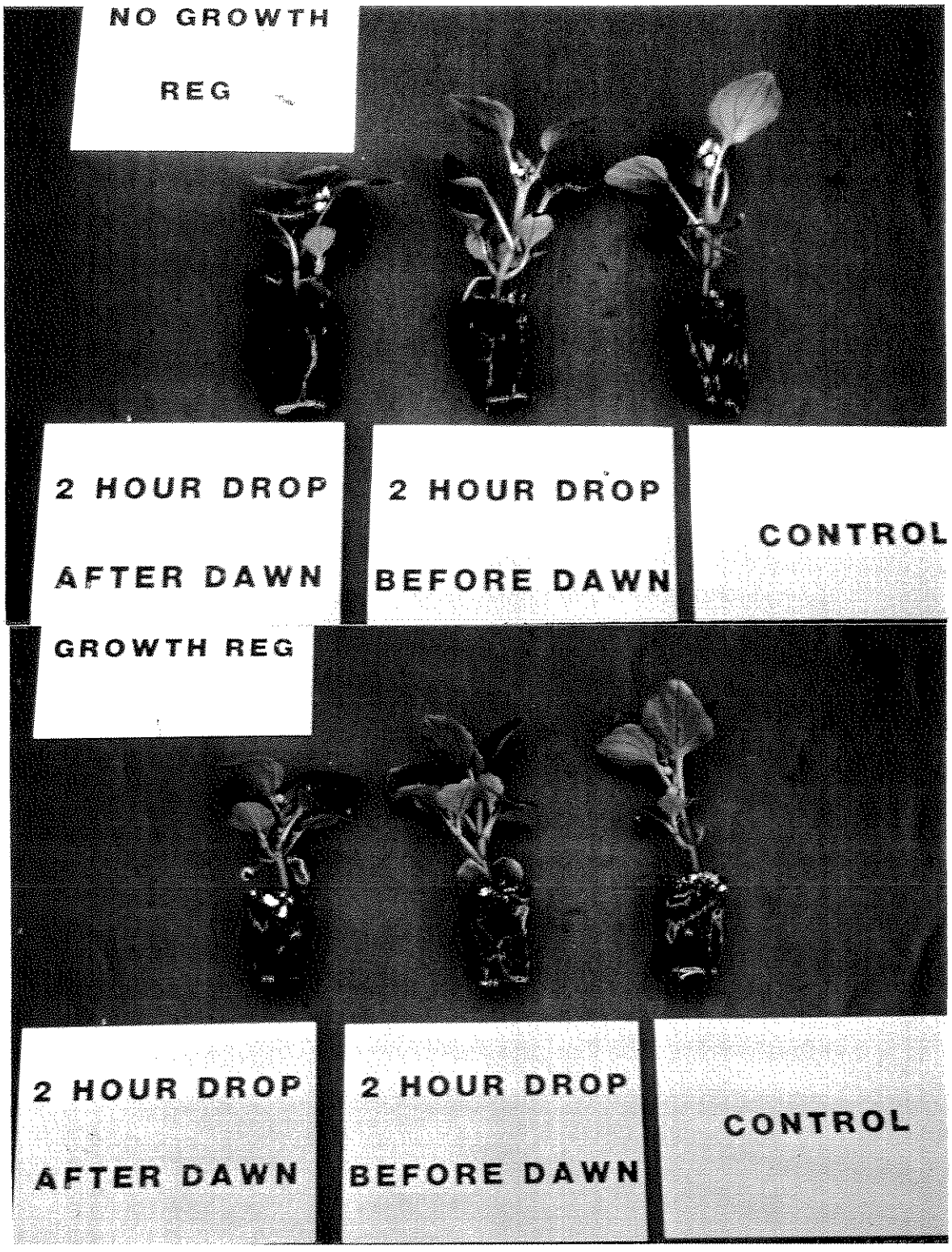
MEAN PLANT HEIGHT (mm) AT MATURITY



APPENDIX III

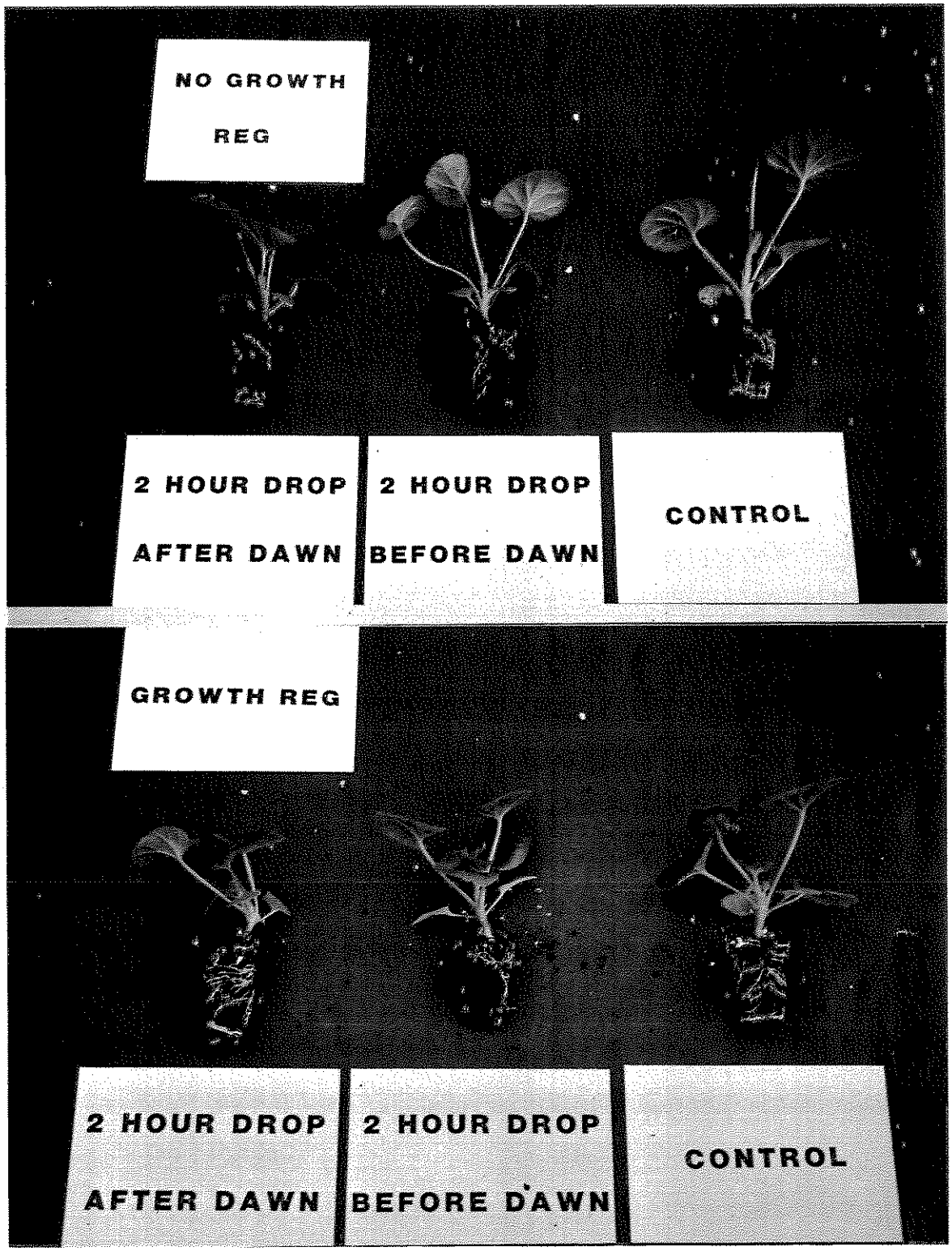
Photographic records

Plate 1. Impatiens - plants at transplanting stage



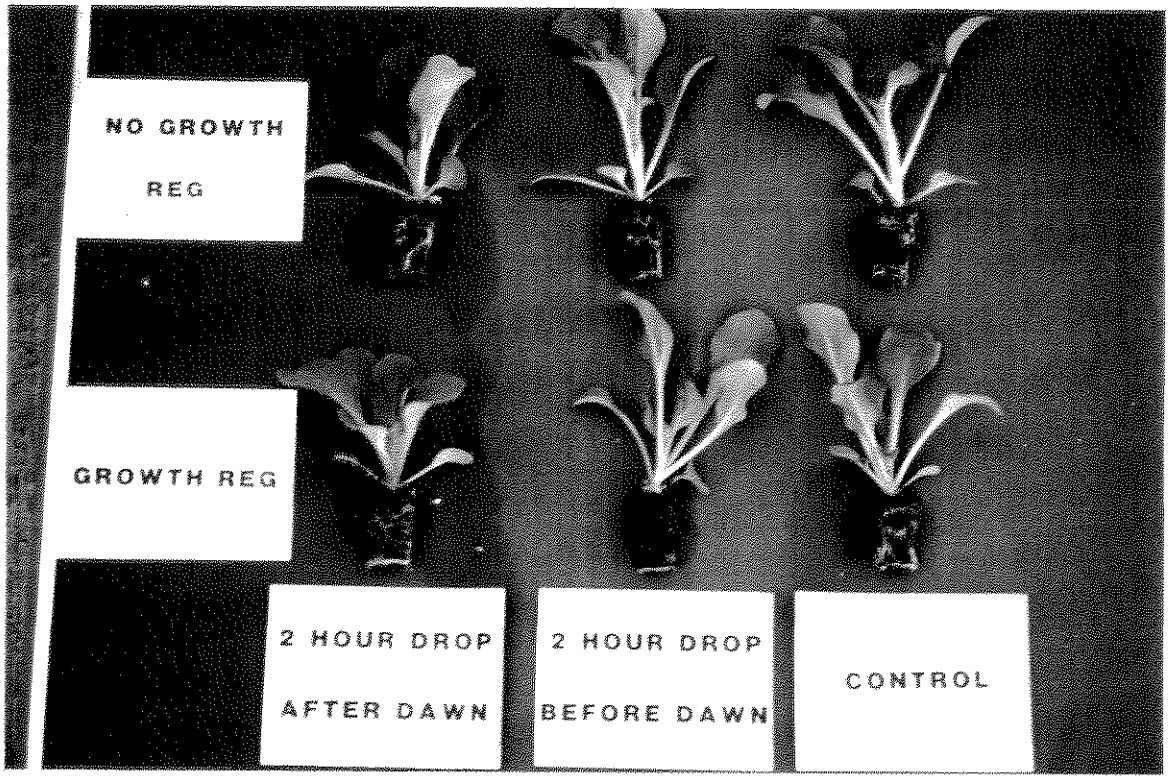
APPENDIX III

Plate 2. Pelargonium - plants at transplanting stage



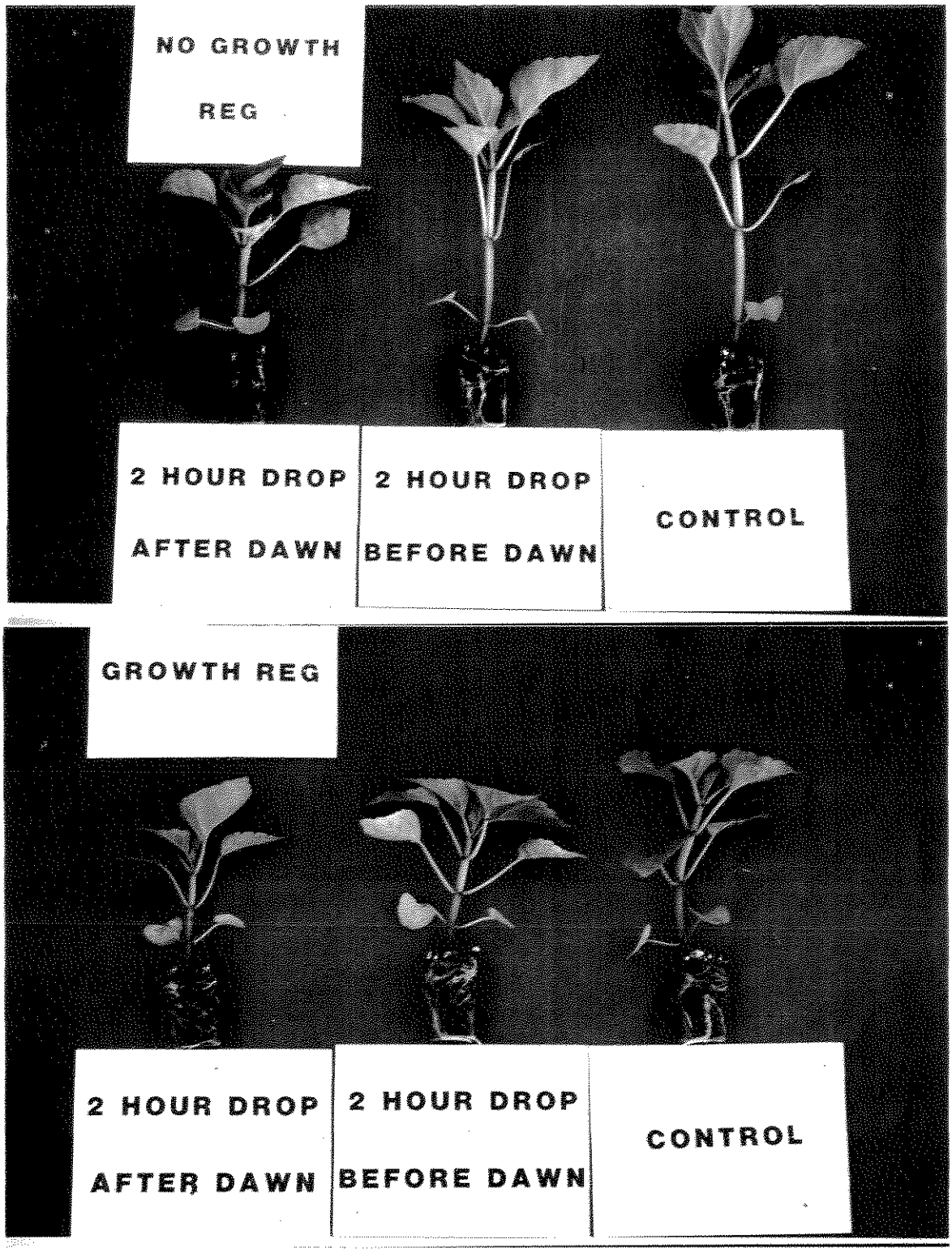
APPENDIX III

Plate 3. Petunia - plants at transplanting stage



APPENDIX III

Plate 4. Salvia - plants at transplanting stage



APPENDIX IV

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

PROPOSAL

1. TITLE OF PROJECT **Contract No: PC 41a**

BEDDING PLANTS - TO ASSESS THE USE OF DIF DURING GROWING ON AND ITS INFLUENCE ON SHELF LIFE

2. BACKGROUND AND COMMERCIAL OBJECTIVE

See Contract PC41 (in preparation).

3. POTENTIAL FINANCIAL BENEFIT TO THE INDUSTRY

See Contract PC41 (in preparation).

4. SCIENTIFIC/TECHNICAL TARGET OF THE WORK

This project aims to investigate the use of DIF during the growing on phase and to provide information on any potential detrimental effects on subsequent shelf life of plants.

5. RELATED WORK

This trial would be a continuation of an investigation commenced under CSG funding which expired on 31 March 1991. It would provide useful additional information prior to the commencement of the main programme of work at Efford in the Autumn in 1991. It links indirectly with other research projects on the subject of DIF currently being carried out at other research centres in Europe.

6. DESCRIPTION OF THE WORK

Plant growth and subsequent shelf life performance of four bedding species would be assessed. The temperature treatments from the CSG funded trial would be continued (within glasshouse limitations) until plant maturity.

These treatments are:

A. 2 hour drop after sunrise
B. 2 hour drop before sunrise
C. Control no temperature drop

Heating temperatures	16/16°C day/night
Ventilation temperatures	18/20°C day/night
Temperature drop	6°C for heating during the drop
Ventilation set point	0.2°C above heating set point during drop

Plants were module grown with and without growth retardant treatment. For the purposes of this trial plot plants will be grown on in 9 cm pots until maturity and then submitted to "shelf life" testing.

Species - Petunia, Impatiens, Pelargonium and Salvia.

Assessments to include:

* Effect on plant internode length, growth and habit
* 50% and 100% harvest date
* Waste
* Disease incidence
* Shelf life

7. **COMMENCEMENT DATE AND DURATION**

1.4.1991 to run for approximately 3 months.

8. **STAFF RESPONSIBILITIES**

Trials Officer: Miss E J Sapsed - HRI Efford
Project Leader: Mr J Farthing - ADAS Cambridge

9. **LOCATION**

HRI Efford

10. **COSTS**

HRI Efford	£1400
ADAS Cambridge	£600
Total	£2000

11. **PAYMENT**

On each quarter day the Council will pay the Contactor in accordance with the following schedule:

HRI

Quarter/Year	1991
1	-
2	1400
3	-
4	-

ADAS

Quarter/Year	1991
1	-
2	600
3	-
4	-

HRI EFFORD

CSG COMMISSIONED R & D - EXPERIMENT PROPOSAL

BEDDING PLANTS: USE OF DIF (DIFFERENCE IN TEMPERATURE REGIMES TO CONTROL PLANT GROWTH)

BACKGROUND:

Research in the United States and elsewhere in Europe has demonstrated the possibility of controlling plant growth with DIF temperature regimes. The use of cool day/warm night regimes may have several potential benefits, these include:

* Highly desirable reduction in chemical plant growth regulant use.
* Reduced exposure of staff to sprays and residues.
* The potential for sowing energy inputs where higher night temperature regimes are used in conjunction with thermal screens.
* Possible improvements in plant quality ie. compactness, branching, flowering.
* Lower labour inputs due to the reduction in the number of spray applications required.
* Reduction in soil/irrigation water contamination with plant growth regulants.

OBJECTIVE

This aim of the trial would be to further investigate the use of DIF using early morning temperature drops as a means to control growth of a range of bedding plant species grown in modules. Treatments and species to be chosen to link the proposed work to a co-operative project between four research stations in Europe.

TREATMENTS

SPECIES

Impatiens walleriana	cv. FI Accent Salmon
Pelargonium zonale	cv. FI Century Cardinal
Petunia hybr.	cv. FI Blue Ice
Salvia splendens	cv. Blaze of Fire

TEMPERATURE REGIMES

1. Control, no temperature drop
2. 2 hour drop before sunrise
3. 2 hour drop after sunrise

Heating temperatures	16°/16°C day/night
Ventilation temperature	18°/20°C day/night
Temperature drop	6°C for heating, during this drop

Ventilation setpoint 0.2°C above heating set point

GROWTH RETARDENTS

1. Control, no growth retardants
2. Alar spray, 2500 ppm
   Petunia, Impatiens
   Cycocel spray, 3 x 300 ppm, 3000 ppm
   Pelargonium, Salvia

As per seed suppliers

DESIGN

3 temperature regimes
x
2 growth regulant treatments
x
4 speices
x
3 replicates

72 plots in total

CULTURE

Site	Germination	- Shelf life room 1
Containers	Module stage	- Plantpak P180 plug tray
	growing on	- 9cm round terracotta pots
Compost	Module stage	- Fisons Levington F1 compost
	growing on	- Fisons Levington M2 compost

Fertilization

1) 150 ppm N, 150 ppm $k_2 0$ at every watering once colyledons fully expanded.

2) 150 ppm N, 110 ppm $P_2 0_5$ 150 ppm $K_2 0$ at every watering once transplanted.

RECORDS REQUIRED

1. Global outside radiation
2. Temperature day (sunrise - sunset)
   night
   24 hr mean temp.
3. Relative humidity
4. Plant fresh and dry weight
5. Plant height
6. Length of internodes
7. Number of shoots
8. Leaf number, only with some crops
9. Cultivation time until flower buds visible
10. Cultivation time until flowering
11. Photographic records
12. General observations