

BRITISH SOCIETY FOR HORTICULTURAL RESEARCH

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CONTRACT REPORT

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BEDDING PLANTS
HDC - MODULE GROWTH
REGULANT TRIAL 1989

Undertaken for HDC

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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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SUMMARY

Third and final trial in a series started at Lee Valley EHS assessing the effectiveness of the growth regulant daminozide in holding growth during the modular stage without affecting saleable quality. Bedding species Impatiens, Marigold, Petunia, Salvia, Verbena and Primrose were single seeded into 15 mm modules filled with a peat based compost. Plants were subjected to foliar sprays of the growth regulant daminozide at 0, 1250, 2500 and 5000 ppm, once, twice or three times at weekly intervals starting when the first pair of true leaves had developed.

Assessments made at transplanting demonstrated effects on all species. In particular, plant height was reduced by all daminozide treatments, the effect increasing with rate and to a lesser extent with number of applications. Leaf size was also reduced in a similar pattern. Impatiens, Marigold and Petunia had fewer leaves at transplanting than untreated controls.

However, by the time plants reached the marketable stage, the effects of earlier growth regulant treatments had disappeared for Impatiens, Petunia and Salvia, and while treated plants of Marigold and Verbena still stayed slightly smaller than untreated plants, the effect was not considered commercially important.

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INTRODUCTION

The advent of direct seeded modular raised bedding plants which are subsequently transplanted into containers for retail sale has given rise to the need for the development of appropriate growth regulant treatments.

The use of growth regulators, such as daminozide while seedlings are still in the module stage may have the following beneficial effects.

- * Space economy - allowing plants to be grown for longer in the module.
- * Production of robust seedlings for transport and handling.
- * To improve quality of "plug" plant and subsequent finished plant at sale stage.

OBJECTIVE

To compare the effects of different rates and number of applications of daminozide on module raised bedding plant seedlings of six species.

The trial constitutes the third and final year of experimentation previously sited at the Lee Valley EHS.

MATERIALS AND METHODS

The trial was carried out at Efford EHS, Lymington, Hampshire in a glasshouse compartment equipped with computerised control of heating and ventilation.

Treatments

Rates of daminozide spray:

1. Control (water only)
2. 1250 ppm
3. 2500 ppm
4. 5000 ppm

Number of daminozide sprays:

- a. One application at first pair of true leaves stage.
- b. Two applications - as a., plus one week later.
- c. Three applications as a., plus one and two weeks later.

Species and cultivars:

Impatiens	cv	Futura Pink
Marigold	cv	Yellow Boy
Petunia	cv	Ultra Rose
Primrose	cv	Easter Bouquet Mixed
Salvia	cv	Fury
Verbena	cv	Romance Scarlet

Sowing

Seed of Impatiens, Marigold, Petunia, Salvia and Verbena was direct sown into 15 mm modules (PG 432) filled with Fisons Levington F1 compost. Primrose seed was sown into standard seed trays containing Fisons Levington F1 compost and pricked out into 25 mm modules (Hassy 308) containing Fisons Levington F2 compost. A light covering of medium grade vermiculite was applied. Trays were wrapped in polythene and placed into a controlled environment facility. A temperature of 20-22°C (18-19°C for Primroses) was maintained throughout germination.

Once emergence was complete a liquid feed was applied at every watering supplying 100 ppm N and K₂O.

All seedlings were given a protectant fungicidal drench, post emergence of Filex plus Basilex at 2.0 ml per litre and 2.0 g per litre respectively.

Growing on of seedlings was carried out in the glasshouse with a heating set point of 12°C, venting at 16°C.

Transplanting

When seedling roots had fully explored the module, forming an easy to remove "plug" plants, were transplanted into 70 mm square pots (Plantpak FP7) filled with Fisons Levington F2 compost and grown on to the sale stage. Plants were fed at every watering with 200 ppm N and K₂O from transplanting.

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

Unfortunately Primroses became heavily infected with Red Spider Mite which did not respond to chemical treatment. These plants were discarded before final sale stage.

Assessments

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

At transplanting:

1. Plant height
2. Leaf number
3. Leaf size - the length of the largest leaf measured from the base of the petiole to the leaf tip.

It was not practical to measure heights of Petunia or Primrose due to their rosette type growth at this stage.

At transplanting:

4. Mean flowering date
5. Height
6. Spread of plant (2 diameters one at the widest part, second at 90° to (this.
(The two figures are multiplied together to give a (notional area occupied).

Statistical analysis

Data was subjected to statistical analysis at BSHR Littlehampton. Each species was treated as a separate experiment. The variates have been analysed using standard analysis of variance (ANOVA). The Standard Error of the Differences (SED's) are presented where appropriate in the results tables.

RESULTS

Appendix II Tables

Impatiens

Height at transplant stage - some evidence of growth regulant giving shorter plants than the controls. Similar results were obtained for all three rates. Increased number of applications gave shorter plants (one application - 37.8 mm; three applications - 35.3 mm).

Leaf number at transplant stage - a reduced number of leaves. (1% significance level) was recorded for the all rates of growth regulant treatments. There was some weak evidence (5% significance level) of an interaction with the number of sprays applied, with those plants treated three times having the least number of leaves at transplanting.

Leaf size at transplant stage - some reduction in leaf size was recorded (5% significance level) due to the average effect of the growth regulant treatments compared to the controls. Rate and number of applications did not give significant differences.

At the sale stage no evidence of treatment effects were evident on any of the measured variates.

Marigold

Height at transplant stage - Highly significant linear trend in heights over the three rates of application with the heights decreasing with increasing rate and number of applications. Control plants - 51.9 mm, 1250 ppm - 49.4 mm, 2500 ppm - 46.9 mm, 5000 ppm - 44.6 mm.

Leaf number at transplant stage - Significant differences between controls and daminozide treated plants with weak evidence (5% significance level) of a linear trend over the three rates and numbers of applications causing a reduction in leaf number.

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Leaf size at transplant stage - A distinct reduction in leaf size was recorded with increasing rate and number of applications of daminozide.

Plant height at sale - Very significant differences were recorded (0.1% level). Once again a distinct linear trend was evident with higher rates and number of applications giving shorter plants. No differences were recorded in plant spread at this stage.

Petunia

Leaf number at transplant stage - Significance at the 1% level of a reduction in leaf number due to the average effect of growth regulant compared to the controls. No other significant treatment effects.

Leaf size at transplant stage - Highly significant evidence (0.1% level) of a reduction in leaf size with the use of daminozide, with some evidence of a linear trend over the three rates of application with leaf size decreasing with increasing rate of application.

No significant treatment effects were recorded at sale stage.

Primrose

Leaf number at transplant stage - No significant treatment effect.

Leaf size at transplant stage - Strong evidence of reduced leaf size with increasing rate and number of applications of daminozide.

Plants were discarded prior to sale stage.

Salvia

Plant height at transplant stage - Very significant differences (0.1% level). Strong linear trend over the three rates of application with plant height decreasing with increasing rate of daminozide.

Leaf number at transplant stage - No significant differences.

Leaf size at transplant stage - The growth regulant treatments reduced leaf size (0.1% level) significantly compared to the controls. Leaf size decreasing with increasing rate of application. Number of applications had no significant effect.

Plant height and spread at sale stage - No significant differences.

Verbena

Plant height at transplant stage - Strong evidence (0.1% level) of a decrease in plant height with increasing rate and number of applications of daminozide.

Leaf number at transplant stage - No significant differences.

Leaf size at transplant stage - Leaf size decreased significantly (0.1% level) with increasing rate and number of applications of daminozide. There was evidence of interactions between rate and number of applications.

These results are summarised in Tables 2 and 3.

Table 2. Summary of significant effects of daminozide rates and application number on growth of a range of subjects at transplanting.

Species	Height		Leaf No.		Leaf size	
	Rate	No.	Rate	No.	Rate	No.
Impatiens	*	NS	**	*	*	NS
Marigold	***	NS	*	NS	***	NS
Petunia	-	-	**	NS	***	NS
Primrose	-	-	NS	NS	***	***
Salvia	***	*	NS	NS	***	NS
Verbena	***	*	NS	NS	***	*

NS = No significant effects
 * = Significant effect 5% level
 ** = " " 1% "
 *** = " " 0.1% "
 - = Not recorded

Table 3. Summary of significant effects of daminozide rates and application number on growth of a range of subjects at sale stage.

Species	Height		Date marketable		Spread	
	Rate	No.	Rate	No.	Rate	No.
Impatiens	NS	NS	NS	NS	NS	NS
Marigold	***	**	NS	NS	NS	NS
Petunia	NS	NS	NS	NS	NS	NS
Primrose	-	-	-	-	-	-
Salvia	NS	NS	NS	NS	NS	NS
Verbena	*	**	NS	NS	*	NS

NS = No significant effects
 * = Significant effects 5% level
 ** = " " 1% "
 *** = " " 0.1% "
 - = Not recorded

DISCUSSION

Growth regulators are widely used throughout horticulture to control plant size and form.

The Bedding Plant Industry at present greatly exploits their use to produce and hold plants in good condition. The use of modules for plant raising necessitates the need for suitable techniques whereby plants can be compact and healthy with no carry over detrimental affects once transplanted which may affect final sales.

The results from this trial back-up previous results from work carried out at Lee Valley. Daminozide had significant effects on the size of all species at transplanting. Plant height and leaf size being the most significantly affected variants. Generally, the higher the rate of daminozide the greater the reduction in height.

Leaf size was significantly affected for all species except Impatiens where leaf size was lesser affected. The effect on leaf number was less distinct, with only Impatiens, Marigold and Petunia giving some reduction with the use of daminozide.

The number of applications had a lesser effect than did application rate. Increasing number of applications did reduce height in Salvia and Verbena (5% level) and leaf size in Primrose and Verbena. However these effects were small.

The results from variates measured at sale stage were less marked than those at transplanting. Daminozide reduced the height of Marigold and Verbena at all rates when compared to the controls. Variable results were obtained for the other four species but the trend was for a slight residual effect on plant height at the sale stage.

Differences in date of sale were minimal with daminozide plants giving a small delay usually of a single day. Results obtained for the notional area occupied by the plants varied widely and conclusions could not be drawn.

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CONCLUSIONS

This trial was commissioned with the objective of investigating the effect of daminozide application on a range of module raised bedding plant species. The results obtained reiterated those found at Lee Valley in similar trials.

The main conclusions to be drawn are:

- * Daminozide proved an effective dwarfing agent on all six test species particularly during the module stage.
- * In general all variates measured such as height, leaf number and leaf size decreased with increasing rate of daminozide.
- * Increasing the number of applications of any one rate generally increased the dwarfing effect, although to a lesser extent than increased rate.
- * The response of each species to daminozide varied. The greatest response to the growth regulant was from Marigold, Salvia and Verbena.
- * All treatments produced saleable plants, with little or no carry over of growth regulant treatments to the sale stage.
- * No treatment detrimentally affected any species during the course of the trial.

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SUGGESTED FURTHER ACTION

1. Follow-up trials on a range of species to provide precise regimes for the use of growth regulants during the module stage to prevent excessive use.
2. Widen the scope of the trial to look at the possible interaction of DIF temperature control used in conjunction with plant growth regulators to reduce the use of plant growth regulators.

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APPENDIX I.

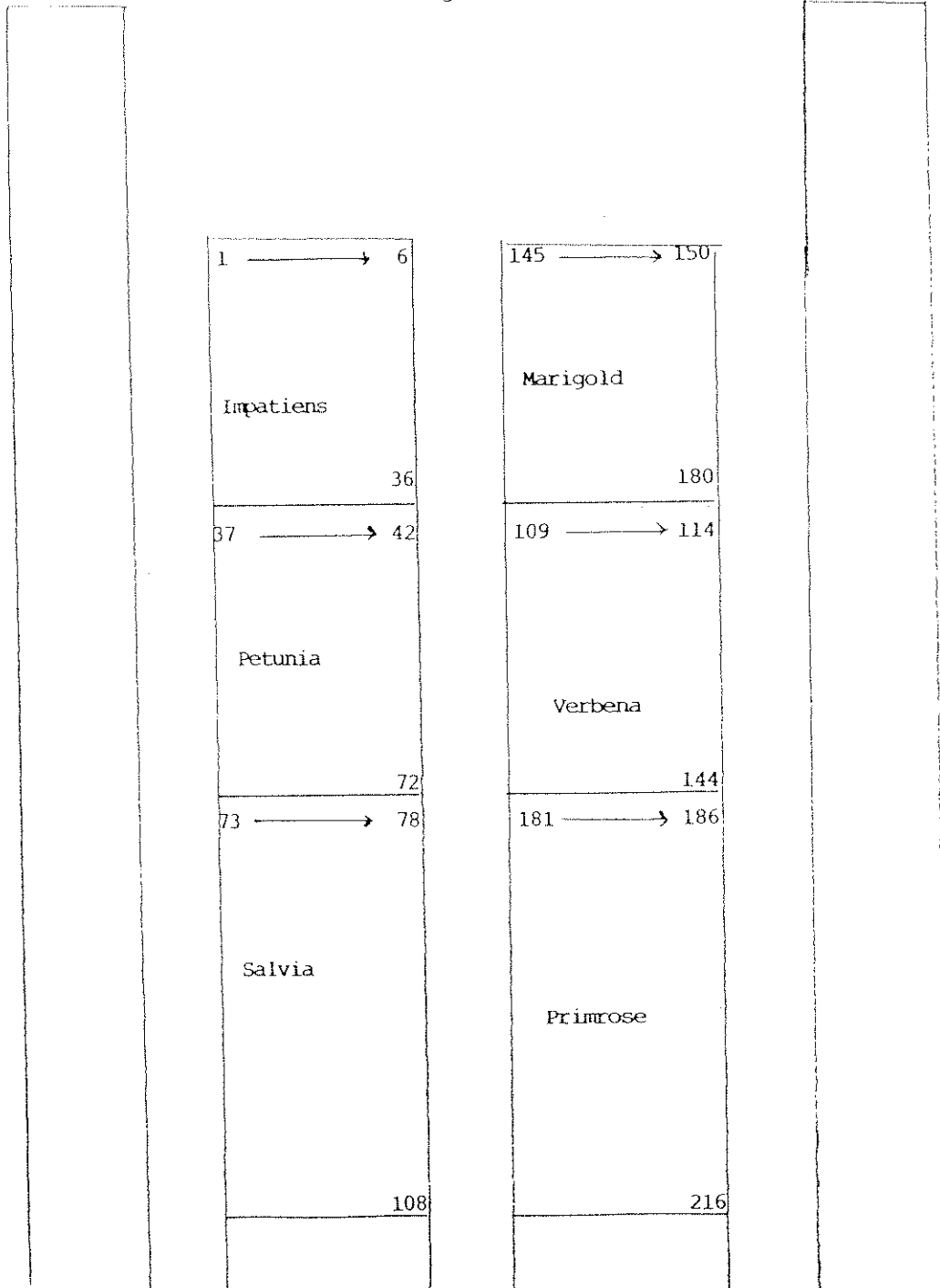
Plot layout.

"J" Block Compartment. 1989

Bedding plants HDC Growth regulant trial

Growing on stage

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Randomisation

Impatiens Futura pink

Plot No.	Treatment	Plot No.	Treatment	Plot No.	Treatment
1	3a	13	4a	25	3c
2	2b	14	4c	26	2a
3	3c	15	3c	27	1a
4	1a	16	3b	28	4c
5	1b	17	1b	29	2c
6	2c	18	4b	30	2b
7	4b	19	2b	31	3b
8	3b	20	1c	32	1b
9	4c	21	2c	33	3a
10	1c	22	3a	34	1c
11	4a	23	2a	35	4a
12	2a	24	1a	36	4b

Petunia Ultra rose

Plot No.	Treatment	Plot No.	Treatment	Plot No.	Treatment
37	2a	49	3c	61	4a
38	4b	50	2b	62	2b
39	4a	51	4c	63	3c
40	1b	52	2a	64	4c
41	1c	53	3a	65	3a
42	2c	54	1a	66	1a
43	3a	55	2c	67	1c
44	4c	56	4a	68	3b
45	3c	57	4b	69	1b
46	3b	58	1c	70	4b
47	1a	59	3b	71	2c
48	2b	60	1b	72	2a

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Salvia Fury

Plot No.	Treatment	Plot No.	Treatment	Plot No.	Treatment
73	4b	85	2b	97	2b
74	1b	86	1a	98	2c
75	1c	87	4c	99	4c
76	2a	88	3b	100	1a
77	3b	89	3c	101	4a
78	2c	90	2c	102	3c
79	1a	91	1c	103	4b
80	3c	92	3a	104	3a
81	2b	93	1b	105	2a
82	4c	94	4b	106	1c
83	3a	95	2a	107	1b
84	4a	96	4a	108	3b

Verbena Romance Scarlet

Plot No.	Treatment	Plot No.	Treatment	Plot No.	Treatment
109	1a	121	1b	133	4a
110	2c	122	4b	134	3b
111	1b	123	3b	135	3c
112	4a	124	2a	136	2b
113	4c	125	2c	137	1a
114	3b	126	3a	138	1b
115	2a	127	1c	139	1c
116	3a	128	2b	140	3a
117	4b	129	1a	141	4b
118	3c	130	3c	142	2c
119	2b	131	4a	143	4c
120	1c	132	4c	144	2a

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Marigold - Yellow Boy

Plot No.	Treatment	Plot No.	Treatment	Plot No.	Treatment
145	1a	157	3c	169	2c
146	4c	158	1c	170	2b
147	2b	159	1a	171	4b
148	4a	160	4b	172	3b
149	2c	161	2c	173	4c
150	4b	162	2a	174	1b
151	1c	163	1b	175	1c
152	3a	164	3b	176	3c
153	3c	165	4c	177	4a
154	2a	166	2b	178	2a
155	3b	167	4a	179	3a
156	1b	168	3a	180	1a

Primrose Easter Bouquet Mixed

Plot No.	Treatment	Plot No.	Treatment	Plot No.	Treatment
181	4a	193	1a	205	3a
182	2b	194	4c	206	2c
183	2a	195	3b	207	3c
184	1c	196	4b	208	4a
185	1b	197	3a	209	1b
186	3c	198	3c	210	2a
187	3a	199	2c	211	4c
188	3b	200	1c	212	1c
189	2c	201	1b	213	3b
190	1a	202	4a	214	4b
191	4b	203	2a	215	2b
192	4c	204	2b	216	1a

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APPENDIX II.

Table 4. Effect of rate of daminozide on plant height (mm) at transplanting

Species	Rate ppm				SED
	5000	2500	1250	Control	
Impatiens	35.82	35.55	34.81	38.25	1.692
Marigold	44.60	46.95	49.37	51.95	1.607
Petunia	-	-	-	-	
Primrose	-	-	-	-	
Salvia	47.70	55.09	61.50	64.99	2.025
Verbena	35.45	36.73	43.61	44.07	1.499

Table 5. Effect of rate of daminozide on leaf number at transplanting

Species	Rate ppm				SED
	5000	2500	1250	Control	
Impatiens	9.87	9.54	9.32	10.39	0.3460
Marigold	4.66	4.71	4.98	5.16	0.1186
Petunia	5.80	5.94	5.95	6.17	0.1219
Primrose	7.43	7.32	7.51	7.73	0.2715
Salvia	5.63	5.73	5.76	5.77	0.1149
Verbena	5.83	5.81	5.88	5.87	0.1025

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Table 6. Effect of rate of daminozide on leaf size (mm) at transplanting

Species	Rate ppm				SED
	5000	2500	1250	Control	
Impatiens	28.99	28.43	28.21	30.00	0.741
Marigold	39.65	42.00	43.16	45.38	1.144
Petunia	39.88	41.14	42.46	45.91	1.296
Primrose	67.30	68.15	82.55	93.35	2.641
Salvia	36.74	38.71	42.35	45.33	1.218
Verbena	31.41	31.33	34.30	34.12	0.671

Table 7. Effect of number of applications on plant height (mm) at transplanting

Species	Number of applications			SED
	1	2	3	
Impatiens	37.59	34.50	34.09	1.692
Marigold	47.27	46.78	46.86	1.607
Petunia	-	-	-	-
Primrose	-	-	-	-
Salvia	59.62	53.20	51.48	2.025
Verbena	40.05	37.01	38.73	1.499

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Table 8. Effect of number of applications on leaf number at transplanting

Species	Number of applications			SED
	1	2	3	
Impatiens	10.19	9.33	9.21	0.3460
Marigold	4.93	4.77	4.65	0.1186
Petunia	6.03	5.81	5.85	0.1219
Primrose	7.33	7.51	7.42	0.2715
Salvia	5.76	5.63	5.73	0.1149
Verbena	5.86	5.87	5.78	0.1025

Table 9. Effect of number of applications on leaf size (mm) at transplanting

Species	Number of applications			SED
	1	2	3	
Impatiens	28.86	28.26	28.51	0.741
Marigold	43.00	40.90	40.91	1.144
Petunia	42.33	40.01	41.13	1.296
Primrose	85.22	73.97	58.82	2.641
Salvia	39.50	39.67	38.63	1.218
Verbena	32.68	32.19	32.16	0.671

Table 10. Effect of daminozide on height (mm)
at marketing

Species	Rate ppm				SED
	5000	2500	1250	Control	
Impatiens	237.08	246.40	244.90	242.04	10.38
Marigold	143.42	146.12	152.94	155.49	2.757
Petunia	310.50	334.40	307.90	314.20	11.05
Primrose	-	-	-	-	
Salvia	257.70	261.50	264.80	272.30	10.65
Verbena	185.82	187.48	190.89	202.38	2.809

Table 11. Effect of daminozide on date marketable

Species	Rate ppm				
	5000	2500	1250	Control	
Impatiens	145	147	146	145	NS
Marigold	135	136	135	133	NS
Petunia	134	134	131	132	NS
Primrose	-	-	-	-	
Salvia	133	132	131	131	NS
Verbena	143	142	142	143	NS

Date 131 - 11 May.

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Table 12. Effect of rate of daminozide on area (cm²)
at marketing

Species	Rate ppm				
	5000	2500	1250	Control	
Impatiens	332	407	376	346	NS
Marigold	249	243	257	239	NS
Petunia	-	-	-	-	
Primrose	-	-	-	-	
Salvia	472	495	487	488	NS
Verbena	291	292	285	317	NS

Table 13. Effect of number of applications on height (mm)
at marketing

Species	Number of application			SED
	1	2	3	
Impatiens	250.10	234.50	244.60	10.38
Marigold	150.81	148.28	143.40	2.757
Petunia	314.00	313.30	325.50	11.05
Primrose	-	-	-	
Salvia	268.20	254.70	261.20	10.65
Verbena	194.30	186.02	183.87	2.809

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Table 14. Effect of number of applications on marketable date

Species	Number of applications			
	1	2	3	
Impatiens	146	146	146	NS
Marigold	134	135	136	NS
Petunia	132	134	133	NS
Primrose	-	-	-	
Salvia	131	131	133	NS
Verbena	143	142	143	NS

Day 131 = 11 May.

Table 15. Effect of number of applications on area (cm²) at marketing

Species	Number of applications			
	1	2	3	
Impatiens	383	336	375	NS
Marigold	241	246	254	NS
Petunia	-	-	-	
Primrose	-	-	-	
Salvia	480	463	515	NS
Verbena	309	281	298	NS

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Introduction

The plant growth regulator Daminozide is widely used to dwarf plants making them more compact. The use of this chemical on bedding plant seedlings grown in modules could have the following beneficial effects:

- * to allow plants to be grown for longer in modules prior to "potting-up" hence space economy.
- * to produce more robust seedlings for transport/transplanting.
- * to promote branching and consequently increase flower numbers.
- * to improve the quality of the plants at sale stage.

Objectives

This is the third and final year of a trial that has previously been sited at Lee Valley EHS.

The objective of the trial is to compare the effects of different rates and frequencies of application of Daminozide to bedding plant seedlings grown in modules.

Species

Species	Variety	Approx. Sowing date	Approx. 'sale' date
Impatiens	Futura Pink	16.2.89	Mid-May 1989
Petunia		16.2.89	"
Salvia	Fury	23.2.89	"
Marigold	Yellow Boy	16.3.89	"
Verbena	Romance Scarlet	23.2.89	"
Primrose	Easter Bouquet Mixed	11.5.89	Oct./Nov. 1989

1. Sowing

Sow into 1/8 module trays - see stock from Lee Valley EHS

All species except Primrose - direct, single sown into 1/8 PG432 modules filled with Fisons F1 compost.

Primrose - Sown into 6 standard seed trays of Fisons F1 compost and then pricked out into Hassey 308 modules filled with Fisons F2 compost.

Covering - Cover all seed **except Petunia** with a thin layer of medium grade vermiculite. Wrap trays in polythene and germinate at 20-22°C (18°-19°C for Primroses).

SOW 1 SEED TRAY (FISONS F1) OF ALL VARIETIES - TO BE USED FOR GAPPING UP

Site for germination - J6 side bench if room, otherwise in situ in J5.
Primroses; Fisons cabinet.

2. Growing on - Modules

Site: J5.

Layout: see enclosed plan.

Temperature: 12°C venting at 16°C.

Feeding: 100 ppm N and K₂O at every watering once emergence is complete/well underway.

Treatments

Rates of Daminozide spray

1. Control (water only)
2. 1250 ppm (Alar 1.25 g/l)
3. 2500 ppm (Alar 2.5 g/l)
4. 5000 ppm (Alar 5 g/l)

Number of Applications

- a. Once - at first pair of true leaves
- b. Twice - as a. + 1 week later
- c. Three times - as b. + 1 week later

Design

12 treatment
x
3 replicates

36 plots/variety
x

6 varieties
216 plots in all

Plot = 1 PG432 tray (108 cells) or Hassey 308 tray, only centre area used.

15 recorded plants/plot surrounded by 1 row guards

3. Transplanting

Transplanted when roots fully explore the module forming an easy-to-remove 'plug'.

Transplant into Fisons F2 compost in Plantpak FP7 pots (70 mm square pots).

Set up in Empot trays (30 units) which hold 2 plots/tray. Will need a guard row of plants around bench. See plan for layout.

Grown on in J5 until the sale stage ie when half of the plants in the plot have at least 1 flower. This will be approx. Oct./Nov. for Primrose and mid-May for all other subjects. Primrose should be moved to a cold frame or similar over the summer period. (L5 Polynet if available).

4. Planting out

A proportion of the material will be planted out to assess "Garden performance". Site and method to be finalised.

RECORDS

Records are taken at 'transplanting stage' and at 'sale stage'.

Records taken at transplanting

This stage is defined as when the roots fully explore the compost forming an easy to remove 'plug'.

1. Plant height
2. Leaf number
3. Leaf size - the length of the largest leaf measured from the base of the petiole to the tip of the leaf.

Records taken at 'sale stage'

This stage is defined as when at least half of the plants in the plot have at least 1 flower. Plots are recorded individually as they reach the sale stage.

1. Mean flowering date.
2. Height and spread of plant.