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CONTRACT REPORT

Bedding plants: growth regulation by 'air-brushing'

HDC PC85

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Bedding plants: growth regulation by 'air-brushing'

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CONTENTS

RELEVANCE TO GROWERS AND PRACTICAL APPLICATION

Application

Two trials were planned, each with transplanted seedlings of petunia, salvia and impatiens, to test the efficacy of fan-generated air blowing, 'air-brushing', as a non-chemical means of producing compact bedding plants. It was judged during the first trial, however, that air brushing was unlikely to have any commercial value as a means of plant habit control for the species trialled, and the second trial was cancelled.

Summary

It is well established that mechanically induced stress (MIS), induced by the physical disturbance of plants or plant parts, commonly results in smaller, more compact plants. The trial reported here tested the potential of fan-generated air blowing, 'air-brushing' as a means of agitating plants and so achieving height regulation in bedding plants without recourse to the use of chemical plant growth regulators.

Pulsed and non-pulsed air flows were blown over 1.62m rows of recently transplanted seedlings of petunia, salvia and impatiens, growing in double-six trays. In this way an air-speed gradient was sampled, with velocities ranging from c. 4 metres per second to c. 11 metres per second. Treatments were applied for either five or ten minutes at each application, and once or twice per day for five days per week.

It quickly became apparent that air brushing was having a rather disappointing effect on plant flexing. Salvia was most affected, but there was little movement of the transplants at velocities below c. 5 metres per second at the start of the trial, and little below c. 6.5 metres per second two weeks later when the plants had grown to form a dense plant stand. Impatiens proved even more resistant to flexing and, from the outset, only those plants receiving air flows at velocities greater than c. 6.5 metres per second showed significant movement. Petunia, starting off a rosette plant, only became susceptible to air movement when stem elongation began and, by this time, the bushy nature of the plants had given a density of stand which was resistant to the effects of air movement below c. 6.5 metres per second. It was judged unreasonable, therefore, to expect much effect of air-brushing on plant height at air speeds below c. 6.5 metres per second (position 5 in Figures and Tables).

The effectiveness of air-brushing in reducing plant height closely mirrored the effectiveness of treatment in achieving plant flexing. Salvia showed clear treatment effects down to an air speed of c. 8.5 metres per second and, for some treatments, c. 6.5 metres per second; petunia was less affected and showed height reductions only to c. 8.5 metres per second, whilst impatiens showed no obvious height reduction even at c. 11 metres per second. It was judged not that air-brushing has little biological effect on internode elongation, but rather that extremely high air speeds are required to agitate bedding plants growing in dense stand.

The air speeds required to give marked height reductions in salvia (greater than c. 8.5 metres per second) also reduced quality by giving significant 'wind damage' symptoms on the leaves. Impatiens also showed 'wind damage' symptoms at these air speeds. Petunia, on the other hand, showed no such damage.

Air speeds of 6.5 metres per second and over are likely to prove extremely difficult to achieve with any semblance of uniformity on the scale that would be required in commercial practice. This, together with quality reductions due to 'wind damage' in sensitive species such as salvia and impatiens, leads one to conclude that air-brushing is unlikely to have commercial value for height regulation in bedding plants. If MIS is to be exploited, it is likely that it will be via some form of direct tactile stroking.

EXPERIMENTAL SECTION

Introduction

Bedding plants are typically grown at high densities and some form of height control is essential to prevent tall, straggly growth. This is currently achieved by a heavy reliance on the use of chemical plant growth regulators, but alternative approaches are now sought by growers. The use of temperature difference (DIF) shows a great deal of promise, but some growers have expressed the opinion that a level of environmental control is required which they are unable to achieve. Other alternatives include the manipulation of irrigation/nutrition stress and mechanically induced stress (MIS).

It is now well established that MIS, induced by the physical disturbance of plants or plant parts, commonly results in smaller, more compact plants, and extensive reviews of the topic have been written by Biddington (1985, 1986) and Latimer (1991). The nature of the disturbance can be either tactile (touching, rubbing, brushing) or non-tactile (shaking, vibrating, blowing) and there appear to be few species which are not affected by an appropriate level of treatment.

Baden and Latimer (1992) have recently described mechanical brushing systems for use with bench-grown vegetable transplants. These utilise brushing bars which are set at a height just below the tips of the plants and which are moved horizontally, backwards and forwards through the crop, bending the plants as they pass. Height restriction appears to be marked and damage is absent or minimal. Scaled up equipment of this type is currently being used in commercial trials in the USA for the production of tomato transplants (Latimer and

Thomas, 1991). UK growers, however, have expressed their doubts as to the feasibility of adopting this type of approach for bedding plants, since several to many species and stages of growth are usually present together in the same greenhouse. Consequently, plot sizes are rather small, and labour inputs in moving and adjusting the bars would be excessive.

An alternative approach which UK bedding plant growers believe might have potential is the use of fan-generated air blowing to agitate the plants ('air-brushing'). Liptay (1985), for example, demonstrated that the height of tomato transplants was reduced by 40% by exposing plants to upward currents of air (2 periods each of 1 hour per day) through holes drilled at the corners of cells in multi-cell trays standing on steel mesh benches. However, the plants also showed significant reductions in stem diameter and in fresh and dry weights. Air speeds were not reported.

More recently, Latimer (1990) has demonstrated a reduction in broccoli stem length of 12% in an experiment where seedlings were exposed to a fan-generated air speed of 7 metres per second (measured at the edge of the tray) for 5 minutes each day. However, there was no significant height reduction in two subsequent trials.

Adler and Wilcox (1987) used tomato in trials to compare oscillatory air-brushing at 20 metres per second delivered by 'sweeping' the plants backwards and forwards with a reverse action vacuum cleaner hose at a rate of 40 passes per minute, and unidirectional air-brushing at 40 metres per second. The former treatment, applied for 30 seconds on 3 occasions each day, reduced height by 52% and shoot dry weight by 39%, whilst the latter treatment had almost no effect. It was judged that unidirectional air-brushing failed because plants were caused merely to bend rather than to flex backwards and forwards as with oscillatory air movement. It might be imagined that unidirectional, pulsed air-brushing would have a similar effect to oscillatory blowing.

The HDC trial which is reported here was designed to test the efficacy of unidirectional, pulsed and non-pulsed air-brushing on three species of bedding plants, using an air-speed gradient approach to sample a range of air speeds up to c. 11 metres per second. In this connection, and in relation to the tomato and broccoli trials reported above, Beaufort Scale equivalents are given in Table 1 below.

Table 1. Beaufort Wind Scale

Force	Description	Wind speed	
		miles per hour	metres per second
0	calm	0-1	0-0.4
1	light air	1-3	0.4-1.3
2	light breeze	4-7	1.8-3.1
3	gentle breeze	8-12	3.6-5.4
4	moderate breeze	13-18	5.8-8.1
5	fresh breeze	19-24	8.5-10.7
6	strong breeze	25-31	11.2-13.9
7	moderate gale	32-38	14.3-17.0
8	fresh gale	39-46	17.4-20.6
9	strong gale	47-54	21.3-24.1
10	whole gale	55-63	24.6-28.2
11	storm	64-75	28.6-33.5
12	hurricane	over 75	over 33.5

Materials and Methods

Air-brushing assembly

An air-brushing assembly was constructed, based on a 3 phase, 1.1 kW fan motor, which was capable of delivering either a unidirectional, non-pulsed or pulsed air stream through a

25cm diameter flexible hose to a multi-aperture orifice (see Plates 1 and 2 in Appendix 1). The duration of blowing could be set using a mechanical timer, and pulsing (one second on, one second off) was given by installing a cam-operated, hinged flap in the air inlet duct. For non-pulsed blowing, the flap was set in the permanently open position. The mouth of the air delivery orifice was 1m x 10 cm in size and was so baffled as to deliver a uniform air flow along its width.

The air-brushing assembly with its flexible hose was stood on an otherwise empty bench and treatments were given by blowing air through the orifice over bedding plants on the two immediately adjacent benches. This was achieved (see Plate 1, Appendix 1) by moving the orifice along these adjacent benches from plot to plot, positioning it prior to treatment by the aid of mountings which fitted over the raised edges of the benches. The height of the orifice above the bench could be adjusted to match plant growth. The performance of the assembly is given in the Results section.

The plants

Three bedding plant species were trialled: petunia (Prime Time), salvia (Vanguard) and impatiens (Accent). These were supplied on 23 February as newly transplanted, module-grown seedlings in polystyrene double-six trays by Roundstone Nurseries of Angmering, West Sussex. The compost was a Roundstone own mix of 80% peat and 20% loam with added lime, slow release fertiliser 'Plantazan', and 'Aaterra'.

Following the agreed protocol, the double-six trays were benched (perforated black polythene over capillary matting) in a glasshouse compartment at a minimum set air temperature of

10°C (venting at 15°C). Plant watering was by hand and was generously applied to avoid the complicating effects of moisture stress which has a well documented effect in reducing plant height. Air-brushing treatments began one week later on 1 March. With the agreement of the co-ordinator, the minimum set air temperature was raised to 15°C (venting at 18°C) and a liquid feed given on 12 March since foliage yellowing was becoming pronounced in impatiens and salvia. Losses in these two species due to *Pythium* were combatted by the use of 'Fungarid' drenches. Brushing was ended and plant harvesting was begun on 8 April.

Trial design and treatments

The concept of the trial was to blow air over plots comprising rows of double-six trays placed edge to edge, so as to impose an air speed gradient from the front of the plot to the back. In this way it was hoped to determine optimal air speeds for the three species to guide subsequent larger-scale trials. Each row comprised six trays, giving eighteen plants from front to back (positions 1 to 18) and four plants at each position across the row. Each plot comprised one such row of each of the three species, randomised as to the order of these. Each plot, therefore, comprised 18 trays in total, had a front edge of 93cm facing the 1m wide air-delivery orifice, and had a row length of 1.62m.

Treatments applied (with codes) were:

1. Pulsed air flow applied for five minutes each morning (P5A).
2. Pulsed air flow applied for five minutes each morning and afternoon (P5AP).
3. Pulsed air flow applied for ten minutes each morning (P10A).
4. Pulsed air flow applied for ten minutes each morning and afternoon (P10AP).

5. Non-pulsed air flow applied for five minutes each morning (NP5A).
6. Non-pulsed air flow applied for five minutes each morning and afternoon (NP5AP).
7. Non-pulsed air flow applied for ten minutes each morning (NP10A).
8. Non-pulsed air flow applied for ten minutes each morning and afternoon (NP10AP).

There were two replicates of each of the eight treatments, one on each of the adjacent benches; treatment plots were randomised as to position on each bench, but treatment was applied in systematic order (1 to 8) each day. Treatment was given for five days each week. Moveable polystyrene screens were positioned between the plots during treatment to avoid air spillage to adjacent plots. A further eight plots were grown as controls without treatment on another bench within the same glasshouse compartment. A general view of plots within the trial (one treated bench and the control bench) is given in Plate 3, Appendix 1. The initial project plan was to conduct two such trials, with the second trial starting in April/May.

At the completion of the trial in April, the two central plants at each of the positions 1,2,5,8,11,14,17 and 18 in each row (see earlier) were harvested. Plants were assessed for height, number of nodes on the main stem (except petunia) and 'wind' damage. This latter was scored on a subjective scale of 0 = no damage, 1 = slight damage, 2 = severe damage. Statistical analysis was based on the plots on the two air-blown benches only; control plots were scored but not included in these analyses since they all occupied a separate bench and were essentially for visual comparison only. Data relating to the control treatment in the Figures and Tables which follow are averaged over all eight plots; data relating to all other treatments are averaged over the two replicate plots in question.

Results

Air-speed gradient

A Testovent 4200 portable air speed meter was used to monitor actual air speeds over the 1.62m rows of bedding plants during the first week of treatment when the transplanted seedlings were offering little impedence to air flow. In practice, there was little difference in maximum air speed whether air flows were pulsed or non-pulsed, so measurements for these were combined. Measurements were also combined over the three plant rows in each plot, although slight differences were shown; this was because the positions of species within plots had been randomized to take out any such position effects.

Average spot measurements are shown in Figure 1 with the positions sampled corresponding to the 18 plant positions along each row (1 being that nearest the orifice and 18 being that furthest away - see 'Trial design and treatments' in Materials and Methods). It can be seen that the air-speed gradient fell rapidly from 11.3 metres per second at position 1 (front of the first tray) to 6.4 metres per second at position 5 (centre of the second tray), and then more gradually to 4.2 metres per second at position 18 (back of the sixth tray).

In spite of achieving rather high air speeds, brushing had rather disappointing effects on plant flexing. In the case of salvia at the start of treatment (1 March), there was appreciable flexing of plants in the tray nearest the air-blowing orifice, fluttering of plants in the second tray and some slight vibration of plants in the third. There was, however, little or no plant movement in trays four to six. By the middle of March, only those plants in the tray nearest to the blower were showing any significant effect of the air flow over them. This appeared

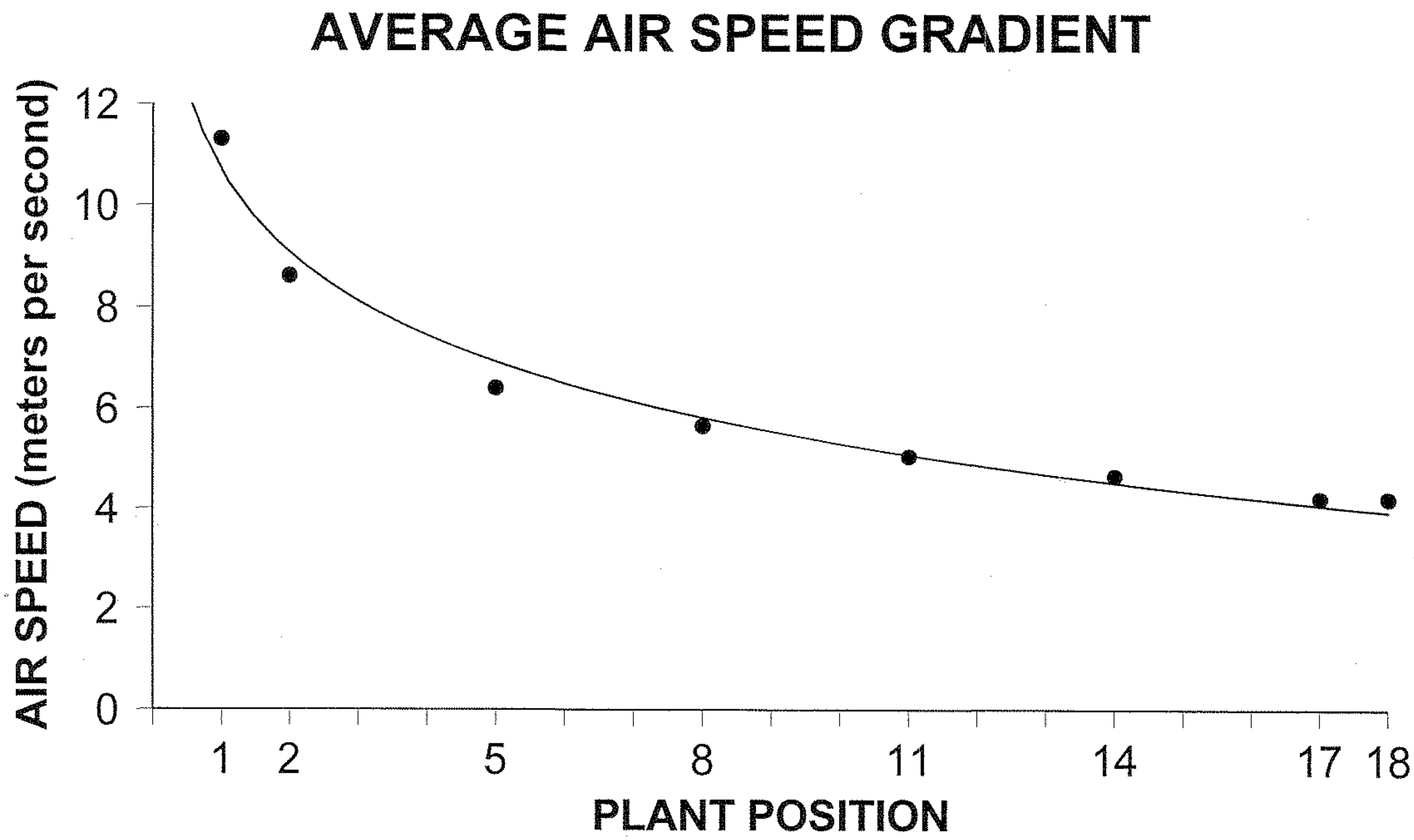

Fig. 1. Average air-speed gradient for air flows along 1.62m rows of bedding plants planted in double six trays (see text for details of 'plant position'.

to be due to the self-supporting nature of the dense plant stand which had developed and increased rigidity of the stems as the plants grew.

Stems of impatiens were somewhat more resistant than those of salvia to flexing from the start, and only those plants in the tray nearest the blower showed significant movement. Petunia starts off as a rosette plant with little or no stem to flex. Only later did air movement have an opportunity to flex the stems and by this time the bushy nature of the plants had given a density of stand which was resistant to the effects of air movement other than in tray one. It was judged unreasonable, therefore, to expect much effect on plant height beyond plant position 5 (middle of the second tray), corresponding to an air speed of c. 6.5 metres per second, 'moderate breeze' on the Beaufort wind scale (Table 1).

Petunia

Plants of petunia were harvested on 26-27 April when at least half had fully open flowers. Average heights at each of the sampled positions are shown in Figure 2 with the data on which this is based being given in Table 4, Appendix 2. A factor which complicated analysis was that plants growing in positions 1 and 18 were reduced in height due to row edge effects, this effect being as noticeable in the control plots as in treated plots. However, air-brushed plants in position 1, nearest the air-blowing orifice, were far shorter than control plants in this position and shorter than air-brushed plants in the symmetrical position 18, furthest from the orifice. This indicates a clear effect of air flow at c. 11 metres per second reducing plant height. A similar, but less marked effect, was also shown at position 2 (air speed c. 8.5 metres per second). Visual inspection suggested that pulsed air given for ten minutes, twice per day was more effective than other air-brushing treatments over positions 1 to 8 (c. 6.5

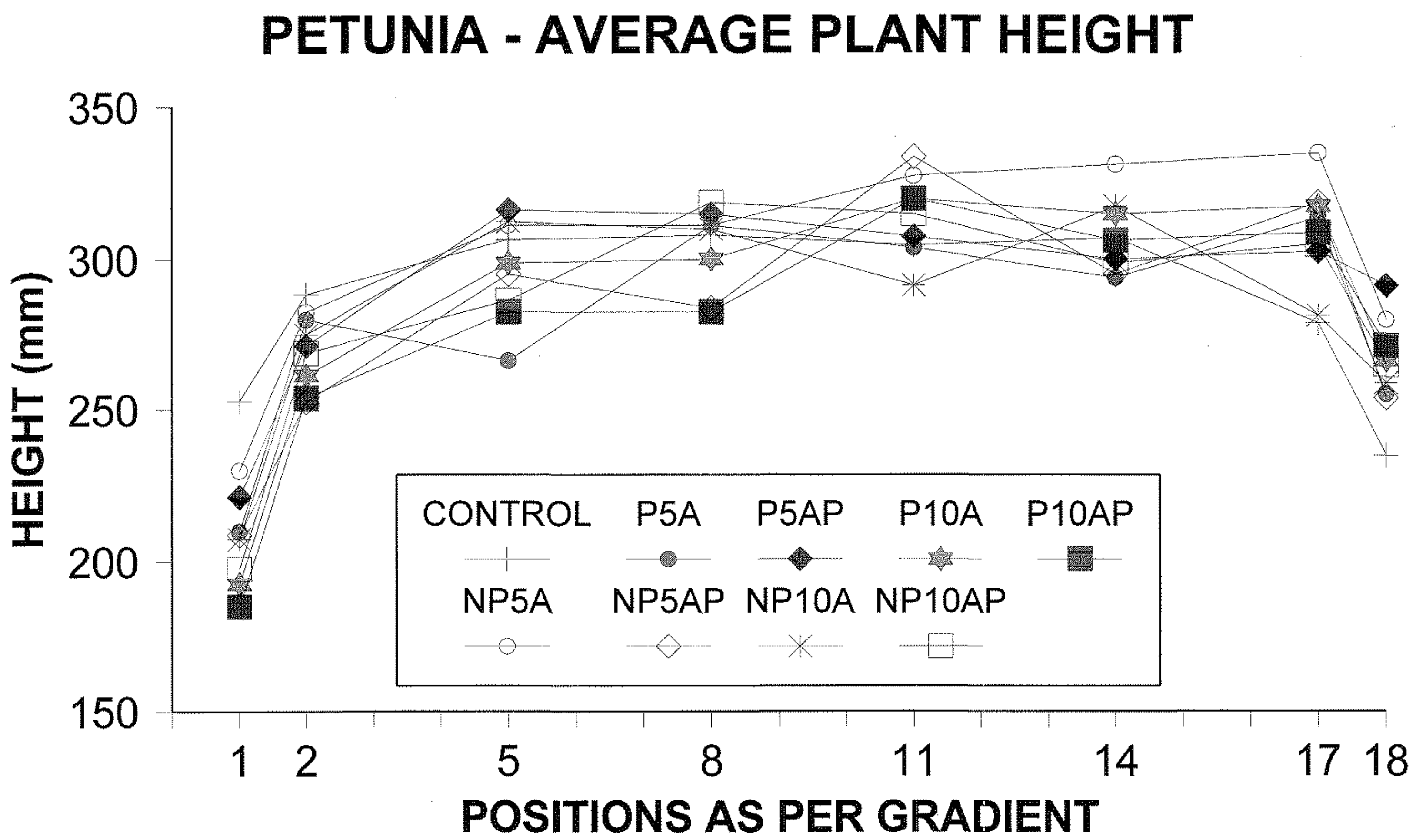

Fig. 2. Petunia: average plant height by treatment and position. P, pulsed air flow; NP, non-pulsed air flow; 5, five minutes of treatment; 10, ten minutes of treatment; A, am only; AP, am and pm.

metres per second) but rigorous statistical analysis did not support this conclusion. It has to be borne in mind, however, that the level of replication was low and that plant variability was rather great. Plate 4, Appendix 1, shows plants from one of the two rows constituting the pulsed air treatment applied for ten minutes, twice each day. Brushing gave no symptoms of damage on the petunia plants, even at the highest air speed.

Salvia

Plants of salvia were harvested on 20-24 April when most were showing pronounced 'reddening' at their growing tips. Edge effects were again apparent, and air-brushed plants were markedly shorter at positions 1 and 2 than the controls or air-brushed plants at positions 17 and 18 as shown in Figure 3 and Table 5, Appendix 2. Height reduction was proportionally greater than for petunia and was clearly shown down to an air speed of c. 8.5 metres per second, and for some treatments, to 6.5 metres per second. Pulsed air for ten minutes, twice each day, gave as good or better height reduction than other treatments for positions 1 to 11, and one of the two rows representing this treatment is shown in Plate 5, Appendix 1. As with petunia, however, rigorous statistical analysis, position by position, showed no one treatment to be superior to any other. There was no effect of treatment on the average of nodes per stem (see Table 7, Appendix 2).

In contrast to petunia, air-brushing did cause considerable leaf damage at the highest air speed (positions 1, 2 and, to a lesser extent, 5); leaves were frequently puckered and malformed, and affected leaves showed areas of dry necrosis. An indication of the severity of this 'wind damage' is given in Table 2 below, with the full data set presented in Table 9, Appendix 2.

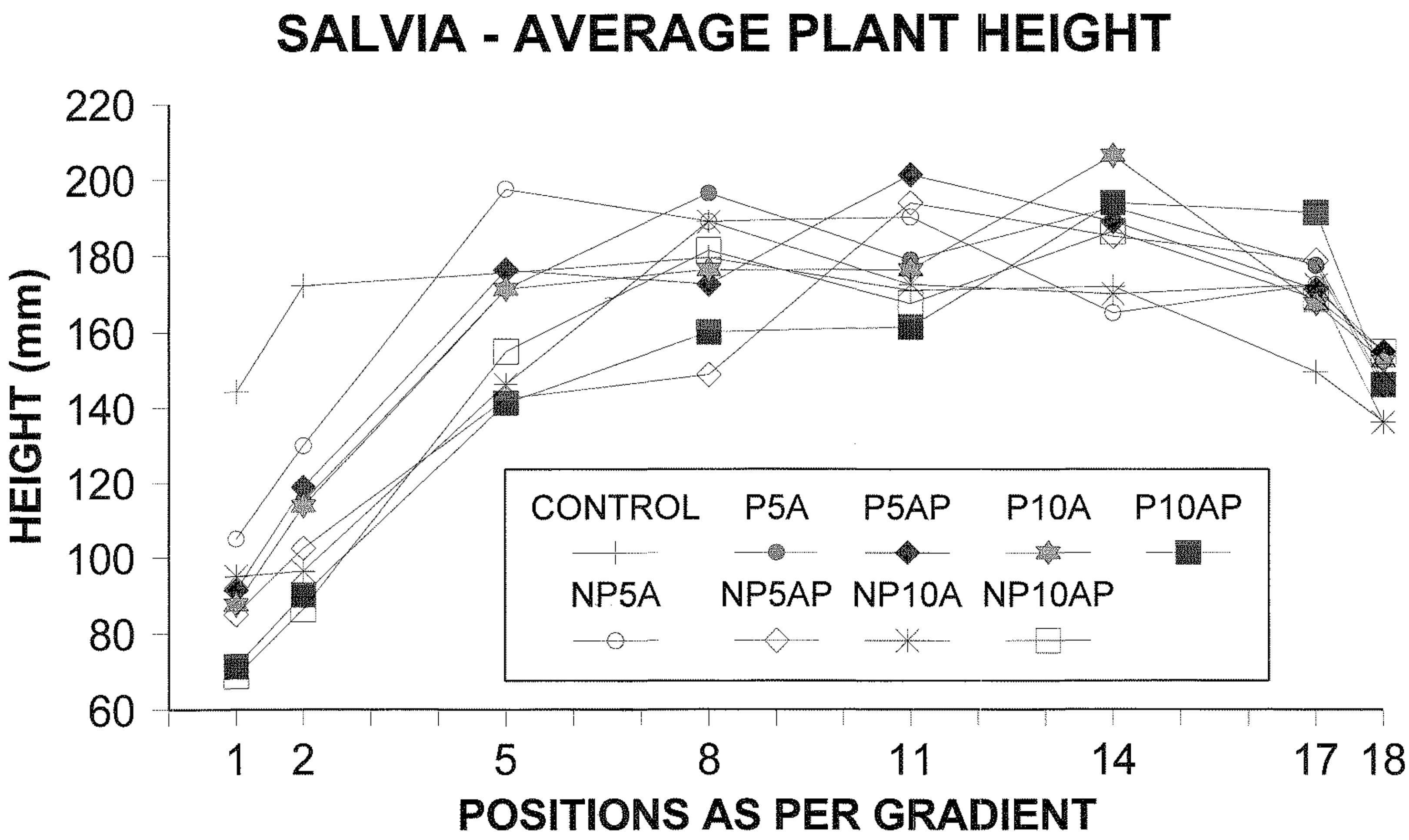

Fig. 3. Salvia: average plant height by treatment and position. For key, see Fig. 2.

Table 2. Symptoms of leaf damage[1] on air-brushed plants of salvia

	Position							
Treatment	1	2	5	8	11	14	17	18
Control	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pulsed, ten minutes, twice per day	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
Average of other treatments	1.3	1.0	0.2	0.0	0.0	0.0	0.0	0.0

[1]0, no damage; 1, slight damage; 2, severe damage

Impatiens

Plants of impatiens were harvested on 13-15 April when c. 50% of the plants had open flowers. Edge effects were apparent but, in contrast to petunia and salvia, plant height in treated plots at position 1 was not dissimilar to that of plants in equivalent positions in control plots or at position 18 in treated plots (see Figure 3 and Table 6, Appendix 2). There thus appeared to be little evidence of any effect of air flow in reducing plant height in this species. Statistical analysis, however, gave some indication of a beneficial effect on height of treatment twice per day in plots subjected to non-pulsed air at position 1 only ($P = 0.045$). For comparison with petunia and salvia, Plate 6, Appendix 1, shows one of the two rows of impatiens subjected to pulsed air for ten minutes, twice each day.

Air-brushing also appeared to have no obvious effect on the rate of leaf production as evidenced by average numbers of nodes on main stems (Table 8, Appendix 2). It did, however, have a detrimental effect on quality, at least at positions 1 and 2 (and to a smaller extent to position 5), by inducing 'wind' damage. This is indicated in Table 3 below, with the full data set presented in Table 10, Appendix 2.

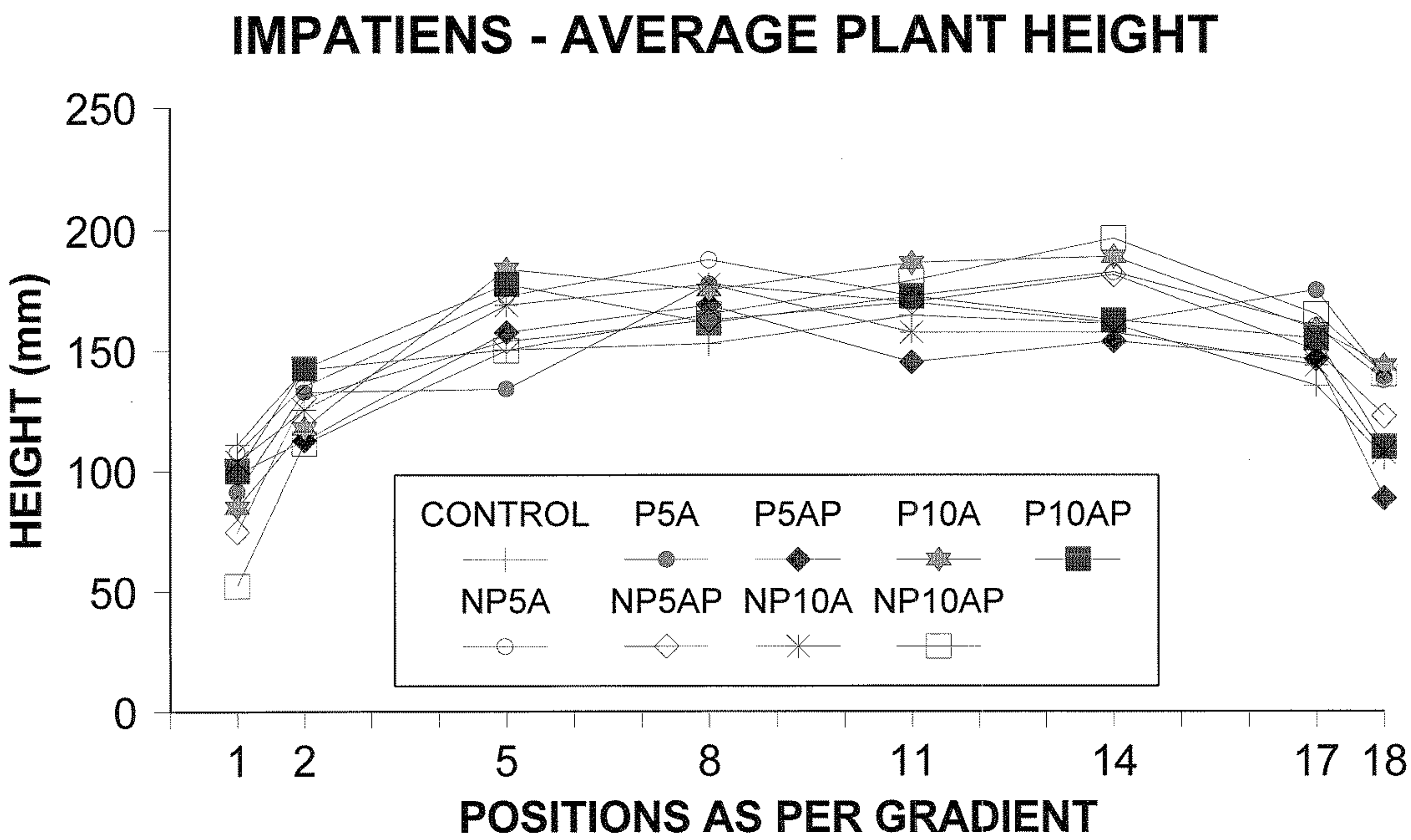

Fig. 4. Impatiens: average plant height by treatment and position. For key, see Fig. 2.

Table 3. Symptoms of leaf damage[1] on air-brushed plants of impatiens

	Position							
Treatment	1	2	5	8	11	14	17	18
Control	0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.0
Pulsed, ten minutes, twice per day	1.5	0.8	0.3	0.0	0.0	0.0	0.0	0.0
Average of other treatments	1.2	0.8	0.2	0.1	0.0	0.0	0.2	0.1

[1] For key see table 2

Discussion

Clear effects of air-brushing in reducing height were shown for salvia, but only at air speeds greater than c. 6.5 metres per second. Effects were less marked for petunia and only at air speeds greater than c. 8.5 metres per second. Impatiens was not reduced in height even at an air speed of 11 metres per second. It seemed clear that effectiveness was related to the degree of plant flexing exhibited, indicating not that air-brushing has little biological effect, but rather the difficulty, in practice, of generating sufficient plant movement.

Air speeds of 6.5 metres per second and over are likely to prove extremely difficult to achieve with any semblance of uniformity on the scale that would be required in commercial practice. Furthermore, air flows at such velocities can be expected to give severe 'wind' damage in sensitive species as was shown by salvia and impatiens. For these reasons it was concluded that the air-brushing concept was without commercial value for bedding plants, and the second of the two planned trials was cancelled. If mechanically induced stress is to be exploited for height regulation in ornamental plants, it is likely that it will be via some form of direct tactile stroking.

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Appendix 1. Photographic Plates

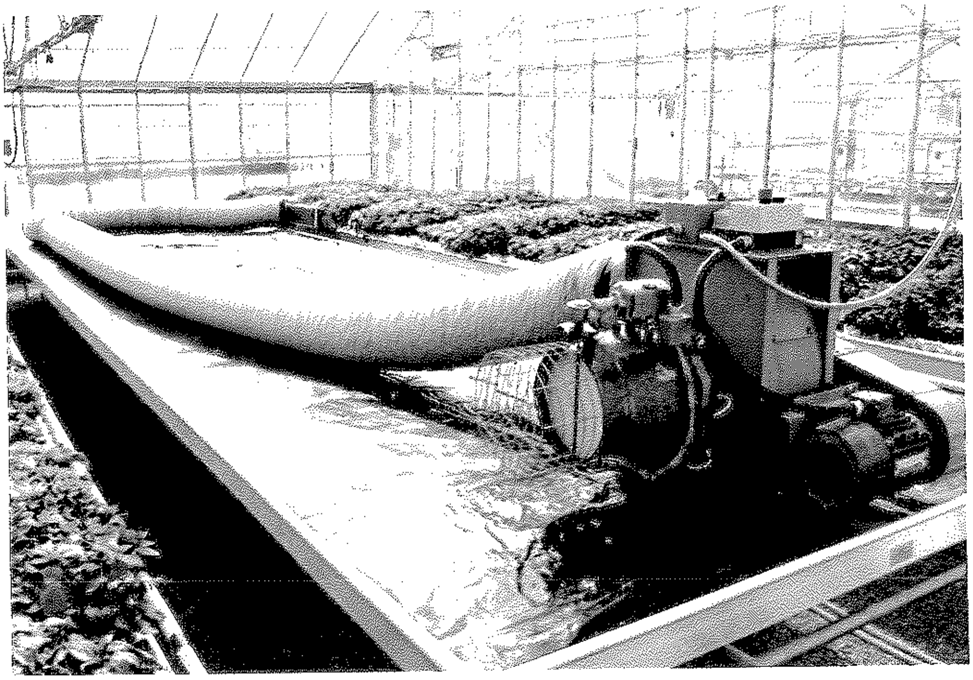

Plate 1. The air-brushing assembly in use

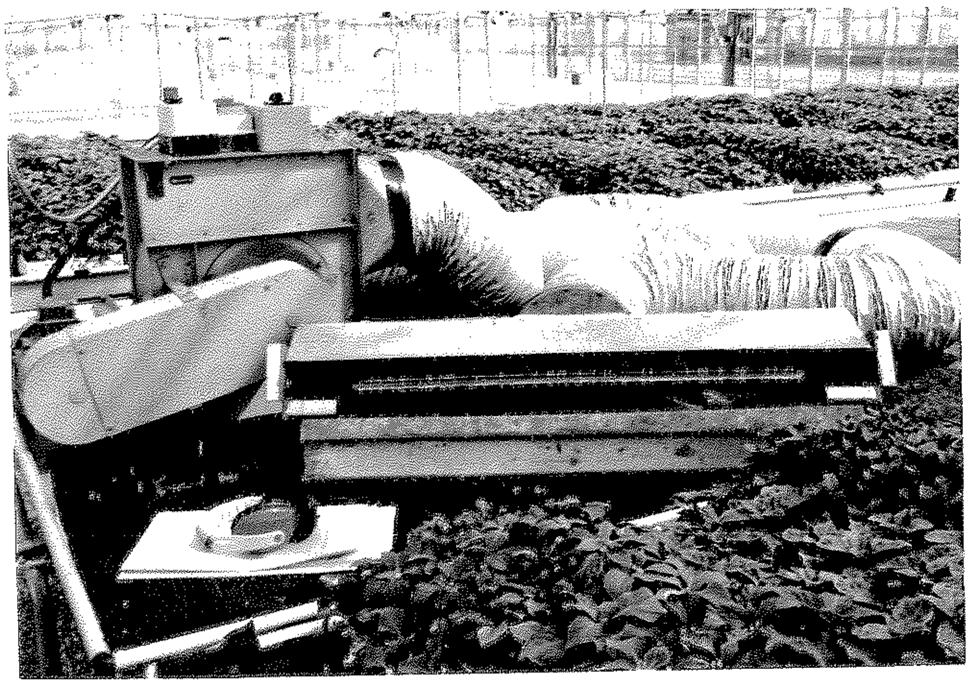

Plate 2. Detail of the air delivery orifice

Plate 3. General view of plant pots (treated bench in foreground, control bench behind).

Plate 4. Effect of air-speed gradient (applied right to left) on petunia. Treatment shown is pulsed air given for ten minutes, twice each day.

Plate 5. Effect of air-speed gradient (applied right to left) on salvia. Treatment shown is pulsed air given for ten minutes, twice each day.

Plate 6. Effect of air-speed gradient (applied left to right) on impatiens. Treatment shown is pulsed air given for ten minutes, twice each day.

Appendix 2. Data

Table 4. Petunia - average plant height by treatment and position

	Position							
Treatment[1]	1	2	5	8	11	14	17	18
Control	252.8	288.4	306.6	308.1	304.7	307.2	278.8	235.0
P5A	210.0	280.0	266.3	311.3	303.8	293.8	313.8	255.0
P5AP	221.3	271.3	316.3	315.0	307.5	300.0	302.5	291.3
P10A	192.5	261.3	298.8	300.0	320.0	315.0	317.5	266.3
P10AP	185.0	253.8	282.5	282.5	320.0	306.3	308.8	271.3
NP5A	230.0	282.5	311.3	311.3	327.5	331.3	335.0	280.0
NP5AP	208.8	252.5	295.0	283.8	333.8	295.0	318.8	253.8
NP10A	207.5	275.0	312.5	310.0	291.3	317.5	281.3	258.8
NP10AP	197.5	268.8	286.3	318.8	315.0	298.8	305.0	265.0
S.E.x[2]	29.44	14.88	15.13	17.05	12.89	11.37	19.06	14.79

[1]Key: P, pulsed air flow; NP, non-pulsed air flow; 5, five minutes of treatment; 10, ten minutes of treatment; A, am only; AP, am and pm.
[2]Excluding control plots; n = 2, df = 7.

Table 5. Salvia - average plant height by treatment and position

	Position							
Treatment[1]	1	2	5	8	11	14	17	18
Control	144.4	172.2	175.6	179.4	170.9	171.9	149.7	136.4
P5A	-	115.0	171.3	196.3	178.8	192.5	177.5	145.0
P5AP	91.3	118.8	176.3	172.5	201.3	188.8	171.3	155.0
P10A	87.5	113.8	171.3	176.3	176.3	206.3	167.5	152.5
P10AP	71.3	90.0	141.3	160.0	161.3	193.8	191.3	146.3
NP5A	105.0	130.0	197.5	188.8	190.0	165.0	172.5	152.5
NP5AP	85.0	102.5	142.5	148.8	193.8	185.0	178.8	146.3
NP10A	95.0	96.3	146.3	188.8	172.5	170.0	172.5	136.3
NP10AP	68.8	86.3	155.0	181.3	167.5	186.3	168.8	155.0
S.E.x[2]	12.90	10.43	12.27	12.44	8.03	15.97	17.37	15.71

[1]For key, see Table 4.
[2]Excluding control plots; n = 2, df = 7.

Table 6. Impatiens - average plant height by treatment and position

	Position							
Treatment[1]	1	2	5	8	11	14	17	18
Control	110.9	141.9	150.3	152.8	164.4	160.9	135.3	105.6
P5A	91.3	132.5	133.8	177.5	170.0	161.3	175.0	138.8
P5AP	98.8	112.5	157.5	168.8	145.0	153.8	146.3	88.8
P10A	85.0	117.5	183.8	175.0	186.3	188.8	158.8	143.8
P10AP	100.0	142.5	177.5	161.3	172.5	162.5	155.0	110.0
NP5A	107.5	135.0	172.5	187.5	172.5	182.5	160.0	137.5
NP5AP	75.0	130.0	153.8	162.5	170.0	181.3	150.0	122.5
NP10A	103.8	125.0	168.8	177.5	157.5	157.5	143.8	107.5
NP10AP	52.5	111.3	150.0	165.0	178.8	196.3	165.0	140.0
S.E.x[2]	15.45	8.22	15.44	19.76	16.94	18.75	20.09	15.50

[1]For key, see Table 4.
[2]Excluding control plots; n = 2, df = 7.

Table 7. Salvia - average number of nodes on the main stem

	Position							
Treatment[1]	1	2	5	8	11	14	17	18
Control	7.8	7.8	7.9	8.3	8.3	7.9	7.8	8.1
P5A	-	7.3	8.0	8.0	7.8	7.0	7.8	7.5
P5AP	7.8	7.8	8.5	7.5	7.8	7.5	7.8	8.5
P10A	8.0	8.0	7.8	8.3	7.8	8.3	7.8	7.8
P10AP	8.3	7.8	7.8	7.3	8.0	8.5	7.3	7.8
NP5A	8.0	8.0	8.3	8.0	8.0	8.5	8.0	7.8
NP5AP	8.3	7.5	8.0	7.5	7.8	7.5	7.8	7.5
NP10A	7.5	7.8	8.0	7.8	7.8	7.8	7.8	7.0
NP10AP	8.3	8.0	7.0	7.3	7.5	7.0	7.5	7.5

[1]For key, see Table 4.

Table 8. Impatiens - average number of nodes on the main stem

Treatment[1]	Position							
	1	2	5	8	11	14	17	18
Control	13.8	14.4	13.8	14.9	13.5	14.8	14.6	13.7
P5A	15.0	14.3	14.3	15.3	18.0	14.0	16.5	14.5
P5AP	13.8	14.8	14.0	15.5	15.3	13.3	14.5	12.5
P10A	13.8	13.3	14.3	12.8	15.0	15.8	15.5	16.5
P10AP	14.0	14.8	15.8	14.8	15.0	14.3	14.5	16.5
NP5A	15.8	14.3	14.8	14.8	15.5	15.5	16.2	17.2
NP5AP	11.8	14.5	15.5	18.2	15.0	14.5	14.3	15.3
NP10A	14.5	14.0	14.5	15.0	16.0	13.8	15.5	14.8
NP10AP	11.0	15.3	15.3	14.0	16.7	15.0	15.3	15.5

[1]For key, see Table 4.

Table 9. Salvia - average damage assessment scores[1]

Treatment[2]	Position							
	1	2	5	8	11	14	17	18
Control	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P5A	-	0.8	0.5	0.0	0.0	0.0	0.0	0.0
P5AP	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
P10A	1.0	1.0	0.3	0.0	0.0	0.0	0.0	0.0
P10AP	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
NP5A	1.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0
NP5AP	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
NP10A	1.5	1.5	0.5	0.0	0.0	0.0	0.0	0.0
NP10AP	2.0	1.5	0.3	0.0	0.0	0.0	0.0	0.0

[1]0, no damage; 1, slight damage; 2, severe damage
[2]For key, see Table 4.

Table 10. Impatiens - average damage assessment scores[1]

Treatment[2]	Position							
	1	2	5	8	11	14	17	18
Control	0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.0
P5A	1.0	0.3	0.3	0.3	0.3	0.0	0.0	0.0
P5AP	1.0	0.5	0.0	0.3	0.0	0.0	0.0	0.3
P10A	1.2	1.0	0.3	0.0	0.0	0.0	0.3	0.3
P10AP	1.5	0.8	0.3	0.0	0.0	0.0	0.0	0.0
NP5A	1.2	0.5	0.3	0.0	0.0	0.0	0.0	0.0
NP5AP	1.0	1.0	0.3	0.3	0.0	0.3	0.5	0.3
NP10A	1.7	1.2	0.3	0.0	0.0	0.0	0.3	0.0
NP10AP	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0

[1]0, no damage; 1, slight damage; 2, severe damage
[2]For key, see Table 4.