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Response of plotted Alstroemeria to different growth retardants under protected conditions

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ABSTRACT

Various concentrations of Alar (Daminozide), Chlormequat (Cycocel) and Paclobutrazol (Cultar) as spray, drench and combination of both drench and spray applications were tried on two cultivars of pot grown alstroemeria to study their effect on plant height, spread, and other flowering parameters in a factorial completely randomised block design under glasshouse conditions at Mashobra which were evaluated during two successive flushes in the year 2003-2005. Both the cultivars viz Selection No-14 and Riana responded favourably to retardant treatments. A height reduction of 31.5 per cent in the first flush was recorded with Alar (1500 ppm) spray whereas a combination drench and spray application of Alar (1500 ppm) resulted in 28 per cent height reduction in the second flush. Cultivar Riana in the second flush resulted in maximum height reduction and also produced maximum spread. Cultivar Selection No-14 took minimum days to bud formation, produced greater number of cymes per inflorescence in second flush and responded with a better pot presentability than cv Riana which remained in flowering for maximum duration in both the flushes. Significant reduction in days to bud formation was recorded with PP_{333} (50 ppm) drench and spray in the first flush. A marked positive effect of PP_{333} (50 ppm) drench and spray along with Alar (1500 ppm) drench and spray was observed on number of cymes per inflorescence in the first flush whereas in the second flush, Cycocel (1500 ppm) drench and spray resulted in maximum number of cymes per inflorescence. All the treatments significantly increased duration of flowering and pot presentability in both flushes, with spray application of Alar (1500 ppm) coupled with drench and spray application of Cycocel (1500 ppm) and PP_{333} (50 ppm) producing the best results.

Key words: Alstroemeria, pot plant, growth retardants, Alar, Chlormequat, Paclobutrazol.

INTRODUCTION

Alstroemeria is an important cut flower and potential emerging pot plant in international trade. At present, it is being grown as cut flower crop in Netherlands under protected conditions in 100 ha area and in rest of the world, the area under its cultivation is about 400 ha. Most of the research work on regulation of temperature and supplementary lighting in this crop has been undertaken by researchers based in Poland, Italy, USA, UK, Belgium and Netherlands, mainly on cut flower cultivars like Regina, Pelegrina, Monica and Atlas etc. In the late 1980s, several breeders started work on developing seed propagated Alstroemeria cultivars which

would be suitable for pot culture. Konst of Netherlands has been the pioneer breeding company in the world to introduce a series of successful dwarf alstroemeria cultivars belonging to Inca series, suitable for pot culture. Earlier dwarf cultivars include Rosalina and Dorotea. Although the alstroemeria cultivars available for pot culture are 50 per cent shorter than cut flower varieties, the plant height is still excessive for most markets. Moreover, the genetically dwarf plants are still beyond the reach of common grower as they are highly protected by plant breeder rights.

Chemical growth retardants have been known to be useful in manipulating shape, size and form of ornamental crops. They permit a direct approach to growth control by retarding internodal elongation without seriously disrupting growth processes. Most of the commercially available growth retardants are primarily used to retard plant height, regulate flowering and stimulate lateral or basal branches. Major work on standardization of growing media, lighting and use of growth retardants to control growth and flowering has mostly been done on cut flower varieties which are tall in growth habit (Healy and Wilkins 1982, Pobudkiewicz et al 2000). The cultivars used in the present studies, owing to their excessive vigour were subjected to various growth retardant treatment combinations including Alar (B-Nine) (Daminozide), Cycocel, and Paclobutrozol and their possible effects on growth and flowering parameters have been discussed to find out the best growth retardant(s) for making presentable pots.

MATERIALS AND METHODS

The present investigations were carried out at Regional Horticultural Research Station, Mashobra, Shimla during 2003-2005. Mashobra is situated at 2286 m amsl having a latitude of 31.1^0N and longitude of 77.1^0E. This area falls under wet temperate zone of Himachal Pradesh where typical temperate climate prevails.

Rhizomes having 3-4 cm length, containing 1-2 sprouted shoots, 3-4 fleshy storage roots and sufficient number of fibrous roots were planted in 25 cm diameter plastic pots (1 per pot) in a sieved potting mixture consisting of equal parts by volume of soil, cocopeat, vermicompost, FYM and sand in September 2004 to see the effect of growth retardants like Alar (daminozide), Cycocel (CCC) and Paclobutrazol (PP_{333}) on growth and flowering of Asltroemeria cvs Selection No-14 and Riana through spray and drench applications. All the growing shoots were trimmed to 4 cm height to bring uniformity in the growth pattern and later on only 10 healthy generative shoots were retained in each pot to avoid overcrowding and competition. Two drenchings of each chemical were done once when shoots were 10-15 cm tall and second when about 50

per cent shoots were 30 cm tall. Two sprays of each chemical were made, first when the shoots were 10-15 cm tall and second 20 days after the first spray. Also, a single drenching of each chemical at a stage when shoots were 10-15 cm tall, was followed by a single spray of all three chemicals when about 50 per cent of the shoots in each pot were 30 cm tall. Same set of treatments was repeated in both the cultivars as soon as growth resumed after dormancy in August. Both soil and air temperatures, light intensity and relative humidity in the glass houses were periodically recorded during the period of investigations. A fortnightly application of 200 ppm of Polyfeed (19N:19P:19K) was given during period ranging from October 2004 to July 2005 and thin, weak shoots were periodically removed.

Alar (daminozide) 1500 ppm solution was prepared by dissolving 1500 milligrams of Alar in 1000 ml distilled water. The plants were sprayed until droplet formation on the leaves and drenched till run off. For 1st and 2nd drench application, 150 and 250 ml per pot of this solution was used, respectively. Chlormequat (CCC)\Cycocel commercial formulation manufactured by Cynamid company of UK was used which contained 40 per cent weight/volume of Chlormequat. For making 1500 ppm solution of CCC, both for spraying and drenching treatments, 3.75 ml of 40 per cent cycocel was dissolved in sufficient distilled water to make final volume of 1000 ml. Both spray and drench applications were made as done for Alar. Paclobutrazol (PP_{333})\Cultar (25%W/V) was used as a source of paclobutrazol. Firstly, a stock solution of 2500 ppm PP_{333} was prepared by dissolving 10 ml of cultar in 990 ml of water to make final volume to 1000 ml from which further dilutions were made. Pot presentability scores were assessed on the basis of point system modified after Conover (1986).

RESULTS

Retardant effects on vegetative parameters

The results in Table 1 clearly show that plants of cv Riana were shorter than those of Selection No-14 in both the flushes. Maximum height reduction was achieved by Alar (1500 ppm) spray (47.70 cm) when compared to the control plants (69.73 cm) in the first flush whereas in the second flush, Alar (1500 ppm) drench followed by spray application produced the most dwarf plants which were 28 per cent more dwarf than the control plants. The interaction effects reveal that maximum reduction in height was observed in case of cv Riana with Alar (1500 ppm) spray (35.67 cm). Plants of cv Selection No-14 had greater plant spread (43.22 cm) than those of Riana (37.35 cm) in the first flush whereas in the second flush, this trend was reverse. Growth retardant means reveal that in the second flush, Cycocel (1500 ppm) drench and

spray produced the maximum plant spread (40.45 cm). The interaction effect of growth retardants and cultivars in the second flush revealed that maximum spread was obtained with Cycocel (1500 ppm) drench and spray in cultivar Riana (45.55 cm) and minimum in control plants of Riana (35.02 cm) (Table 1).

Retardant effects on floral parameters

Selection No-14 took minimum days to bud formation, produced greater number of cymes per inflorescence in second flush and responded with a better pot presentability than cv Riana which remained in flowering for maximum duration in both the flushes. In both flushes, Selection No-14 took less days to flower bud formation than Riana. Growth retardant means indicate that minimum days to bud formation were recorded with PP_{333} (50 ppm) drench and spray (158.9) when compared to the control plants (178.2) in the first flush. In the first flush, the interaction effects indicate that cv Riana and Selection No-14 took minimum days to bud to bud formation (158.9 and 160.1, respectively) when treated with PP_{333} (50 ppm) drench and spray (Table 2).

A marked positive effect of PP_{333} (50 ppm) drench and spray (6.14) along with Alar (1500 ppm) drench and spray (6.04) was noticed on number of cymes per inflorescence in the first flush whereas in the second flush, Cycocel (1500 ppm) drench and spray resulted in maximum number of cymes per inflorescence (4.76). Duration of flowering (68.18 days) was more in cultivar Riana as compared to Selection No-14 (64.12 days) in the first flush. Growth retardant means reveal that plants treated with Alar (1500 ppm) spray remained in flowering for maximum duration (73.39 days) in the first flush. The interaction of first flush reveals that in both the cultivars, maximum duration of flowering in Selection No-14 was obtained with PP_{333} (50 ppm) drench (78.15 days) whereas in case of cv Riana, the same effect could be achieved with Alar (1500 ppm) spray (75.55 days). Pot presentability scores reflected the overall appearance of plants in pots and plants of Selection No-14 were more presentable in both flushes. Drench and spray application of PP_{333} (50 ppm) in both the flushes resulted in plants acquiring maximum presentability scores (76.22 and 80.73, respectively).

DISCUSSION

Both the cultivars, Selection No-14 and Riana responded in the same manner with respect to various retardant treatments. However, cultivar Selection No-14 was genetically taller, had thicker stems with more chlorophyll content, took less days to bud formation and flowering, produced more number of cymes per inflorescence and had better pot presentability in both the flushes than cultivar Riana which was having better

Table 1. Effect of growth retardants on vegetative parameters of potted Alstroemeria during two successive flushes

Growth retardant treatments	Plant height (cm)				Mean		Plant spread (cm)				Mean	
	Sel No 14		Riana		1st	2nd	Sel No 14		Riana		1st	2nd
	1st	2nd	1st	2nd			1st	2nd	1st	2nd		
Alar (1500 ppm) spray	50.29	49.07	45.12	35.67	47.70	42.37	38.42	38.75	38.70	40.72	38.56	39.73
CCC (1500 ppm) spray	54.48	49.78	49.50	40.67	51.99	45.23	42.33	38.85	35.98	38.33	39.16	38.59
PP_{333} (50 ppm) spray	64.73	53.67	52.48	45.15	58.61	49.41	46.85	41.77	37.60	36.22	42.22	38.99
Alar (1500 ppm) drench	71.52	49.75	53.17	45.72	62.34	47.73	42.73	38.77	39.63	36.58	41.18	37.67
CCC (1500 ppm) drench	55.8	51.47	56.02	50.28	55.91	50.87	43.08	39.92	35.13	37.02	39.11	37.47
PP_{333} (50 ppm) drench	56.8	46.63	55.27	50.37	56.03	48.50	43.33	36.45	39.70	38.05	41.52	37.25
Alar (1500 ppm) (drency & spray)	48.55	46.42	47.88	35.85	48.22	41.13	37.65	36.50	36.10	42.98	36.87	39.74
CCC (1500 ppm) (drenchg & spray)	51.25	45.22	50.17	37.98	50.71	41.60	39.60	35.35	37.60	45.55	38.60	40.45
PP_{333} (50 ppm) (drench & spray)	50.47	47.55	52.52	35.75	51.29	41.65	52.17	37.53	37.65	42.48	44.91	40.01
Control (tap water)	78.42	67.67	61.05	50.15	69.73	58.91	46.07	35.02	35.42	38.18	40.74	36.60
Mean	58.19	50.72	52.32	42.76	-	-	43.22	39.09	37.35	39.61	-	-
$CD_{0.05}$	0.42	0.52					2.84	0.49				
GR	0.92	1.16					NS	1.09				
GR x Var	NS	1.64					NS	1.54				

Table 2. Effect of growth retardants on floral parameters of potted Alstroemeria during two successive flushes

Growth retardant treatments	Plant height (cm)				Mean		Plant spread (cm)				Mean	
	Sel No 14		Riana		1st	2nd	Sel No 14		Riana		1st	2nd
	1st	2nd	1st	2nd			1st	2nd	1st	2nd		
Alar (1500 ppm) spray	167.1	55.32	171.4	55.28	169.3	55.30	5.76	5.13	5.14	3.99	5.45	4.57
CCC (1500 ppm) spray	166.6	60.95	168.1	57.75	167.4	59.35	5.95	5.24	5.80	4.00	5.88	4.62
PP_{333} (50 ppm) spray	171.4	56.33	169.0	59.42	170.2	57.88	5.85	5.06	5.55	3.55	5.69	4.31
Alar (1500 ppm) drench	169.7	55.68	171.9	71.12	170.8	63.40	5.22	3.51	4.47	3.51	4.84	3.51
CCC (1500 ppm) drench	168.6	57.95	168.7	69.87	168.6	63.91	4.99	3.51	4.58	3.55	4.79	3.53
PP_{333} (50 ppm) drench	165.7	53.13	168.0	66.87	166.8	60.00	5.03	3.55	4.51	3.47	4.77	3.51
Alar (1500 ppm) (drency & spray)	162.3	56.62	161.1	58.48	161.7	57.55	5.94	3.34	6.15	4.13	6.04	4.74
CCC (1500 ppm) (drenchg & spray)	164.5	49.57	163.0	55.55	163.7	52.56	5.76	5.38	5.31	4.14	5.53	4.76
PP^{333} (50 ppm) (drench & spray)	160.1	64.35	157.8	65.72	158.9	64.49	6.49	5.16	5.80	4.01	6.14	4.59
Control (tap water)	178.7	63.27	177.6	55.35	178.2	59.85	4.50	3.46	4.46	3.55	4.48	3.51
Mean	167.5	57.32	172.9	61.54	-	-	5.55	4.52	5.18	3.79	-	-
CD (0.05) Var.	0.70	3.44					0.10	0.10				
GR	1.56	NS					0.22	0.22				
GR x Var	2.20	NS					0.32	0.22				

plant spread in the second flush, more number of florets per cyme and greater number of rhizomes per pot. Alar (1500 ppm) spray and Alar (1500 ppm) spray and drench along with other retardants resulted in better height control and lesser shoot length in both the flushes with similar response in both the cultivars. Our results are in consent with those of Healy and Klick (1993) who advocated that spray treatments of B-Nine (Alar) were effective in controlling plant height in Alstroemeria. In close conformity to the present investigations, Blomme and Dambre (1982) reported that B-Nine @ 0-3 gl^{-1} when applied to ten month-old plants of Alstroemeria resulted in reduction of stalk length by 19-23 cm. Heins et al (1979) suggested application of daminozide at concentration of 2500-5000 ppm, 3-4 weeks after transplanting, with repeat applications if needed. The difference in plant height and corresponding shoot length in the two flushes was primarily a function of temperature and photoperiod. The interaction effect reveals that PP_{333} (50 ppm) drench and spray application was found to be the best treatment for enhancing pot presentability of both the cultivars in both flushes except for cv Riana in first flush when maximum presentability score (73.17) was obtained with Alar 1500 ppm drench and spray. Healy and Wilkins (1982) also reported that vegetative shoot production in Alstroemeria is stimulated by high air temperature (25°C) and long photo periods (12 hour to 16 hours) but under decreasing photo periods (8 hour) and low temperatures, plant height and shoot length drastically reduced.

All the retardant treatments were equally effective in increasing plant spread in the first flush with Selection No-14 producing more spread whereas in second flush, cultivar Riana had better plant spread with PP_{333} drench and spray and CCC (1500 ppm) drench and spray resulting in greater plant spread than other treatments. Healy and Klick (1993) while working on Alstroemeria also concluded that PP_{333} (Bonzi) at 10-20 ppm was the most effective in achieving the desired results followed by CCC (1500 ppm) and B-Nine (1500 ppm) spray.

Cultivar Selection No-14 took minimum days to bud formation, produced greater number of cymes per inflorescence and number of florets per cyme in second flush, had greater diameter of primary floret and responded with a better presentability than cultivar Riana which produced greater number of florets per cyme in the first flush and remained in flowering for maximum duration in both the flushes. The differences in days to bud formation and total flower duration in the two flushes reflect that it is more or less a function of temperatures and photoperiods prevalent during the two flushes. Flowering was initiated in the month of April when the air temperature was 20-25°C and photoperiod was 14 hours. Significant reduction in days to bud formation was recorded with PP_{333} (50 ppm) drench and spray in the first flush . A

Table 3. Effect of growth retardants on floral parameters of potted Alstroemeria during two successive flushes

Growth retardant treatments	Plant height (cm)				Mean		Plant spread (cm)				Mean	
	Sel No 14		Riana		1st	2nd	Sel No 14		Riana		1st	2nd
	1st	2nd	1st	2nd			1st	2nd	1st	2nd		
Alar (1500 ppm) spray	71.23	56.27	75.55	52.85	73.39	54.56	74.95	79.47	70.72	75.38	72.83	77.42
CCC (1500 ppm) spray	65.02	55.22	72.57	49.35	68.79	52.28	76.72	79.25	69.39	73.38	73.01	76.32
PP_{333} (50 ppm) spray	70.30	53.47	68.08	48.58	69.19	51.02	75.28	78.70	69.65	74.93	72.47	76.82
Alar (1500 ppm) drench	58.48	49.67	63.03	42.85	60.76	46.26	65.70	69.58	68.32	74.52	67.04	72.05
CCC (1500 ppm) drench	55.43	49.08	65.06	58.08	60.58	53.58	65.30	69.67	68.95	68.95	67.12	69.31
PP_{333} (50 ppm) drench	78.15	50.13	63.25	48.53	60.52	49.33	65.78	68.65	68.88	72.47	67.33	70.56
Alar (1500 ppm) (drench & spray)	66.15	53.40	72.87	55.43	69.71	54.42	78.40	79.30	73.17	78.23	75.78	78.77
CCC (1500 ppm) (drench & spray)	73.32	58.88	70.25	58.00	71.78	58.44	78.62	80.53	70.97	75.17	74.79	77.85
PP_{333} (50 ppm) (drench & spray)	70.88	57.93	74.92	57.45	72.90	57.69	80.32	84.55	72.12	77.90	76.22	80.73
Control (tap water)	52.17	85.27	55.53	46.28	53.85	48.27	64.70	65.35	59.58	66.20	62.14	65.77
Mean	64.12	53.43	68.18	51.76	-	-	72.58	75.41	69.17	75.75	-	-
CD (0.05) Var	0.89	NS					0.51	0.68				
GR	2.0	7.17					1.15	1.51				
GR x Var	2.83	NS					0.57	0.75				

marked positive effect of PP_{333} (50 ppm) drench and spray along with Alar (1500 ppm) drench and spray was observed on number of cymes per inflorescence in the first flush, whereas, in second flush, CCC (1500 ppm) drench and spray resulted in maximum number of cymes per inflorescence in addition to PP_{333} (50 ppm) drench and spray and Alar (1500 ppm) drench and spray. All the treatments significantly increased duration of flowering and pot presentability in both the flushes. Spray application of Alar (1500 ppm) coupled with drench and spray applications of CCC (1500 ppm) and PP_{333} (50 ppm) were highly effective in producing the desired results with respect to these parameters. Similar results have also been reported by Wazir (1994) in pelargoniums, fuchsias and begonias. Podwyszynska et al (1998) also reported that Paclobutrazol when applied @ 0-1 mg ai /l to the rooting medium for plant establishment of dwarf cv Rosalina propagated in vitro and for pot production, markedly decreased flower stem length. Similar results on advanced flowering have also been reported by Biermann (1989) who studied the effect of CCC (1500 to 3000 ppm) spray on fuchsia plants and observed that CCC promoted flowering, dwarfed the plants and advanced the flowering by 15 days. Blomme and Dambre (1982) applied Alar @ 0-3 g/l to 10 month old plants of Alstroemeria in early September and found that flower stalk lengths were reduced by 19-23 cm by all treatments. Similar results on control of flowering parameters have been reported by Pobudkiewicz et al (2000) while working in two dwarf alstroemeria cultivars, after treating plants with daminozide @ 2500 ppm spray. The difference in days to bud formation, duration of flowering and pot presentability is merely a function of the time of the year and the corresponding temperature regimes and photoperiods prevalent during both flushes than the growth regulator treatments . Advancement of flowering by the use of paclobutrazol and CCC has also been reported by Papageorgiou (1997) in Lavendula. Xia et al (1999) also found an increase in tillering rate (number of flowers per stem) with the application of paclobutrazol in Dendrobium nobile. Increased pot presentability and duration of flowering in geranium, fluchsia and begonia was also reported by Wazir (1994) after spray treatments with CCC and ethephon. From the present studies, it is therefore concluded that growth retardants greatly affect the form and size of Alstroemeria when growth in pots and pot study influenced the growth and flowering parameters. Reduction in vegetative growth due to Alar, PP_{333} and Cycocel is attributed to specific inhibition of intermodal elongation in the sub-apical meristematic region without disruption of apical meristematic function and loss of apical dominance.

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