Influence of Growth Regulators on the Height and Number of Inflorescence Shoots in the Chrysanthemum Cultivar 'Revert'

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SUMMARY

Influence of a single foliar application of growth regulators on the height and number of inflorescence shoots of the chrysanthemum cultivar ‚Revert' was investigated during two growing seasons (2000, 2001). Two growth regulators were used, daminozide (Alar 85) and chlormequat (Cycocel). Daminozide was applied in concentrations of 1000, 2000 and 3000 mg l^{-1} and a control (without treatment) while chlormequat was used in concentrations of 2000, 3000, 4000 mg l^{-1} and a control (without treatment). The concentrations used differed significantly in their effects on plant height in both years whereas their effects on the number of inflorescence shoots were not significantly different. Daminozide concentration of 3000 mg l^{-1} was the most efficient concentration in the first year and that of 2000 mg l^{-1} in the second year. However, as no statistically significant differences between these two concentrations were recorded in either year, the use of the lower daminozide concentration in height regulation of 'Revert' chrysanthemum is recommended for environmental reasons. In the second trial year daminozide concentrations were more efficient in regulating the upward growth than chlormequat concentrations while this was not the case in the first year.

KEY WORDS

cut chrysanthemum, 'Revert', daminozide, chlormequat

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INTRODUCTION

Growth retardants have been proven to prevent excessive stem elongation (Sachs et al., 1975) and reduce internode length in plants (Kuehny et al., 2001). Retardants are commonly used in floriculture for height control (Pasian, 1999) but they may also increase the number of lateral shoots or suppress the growth of vegetative shoots developing beneath the flower, resulting in a larger number of inflorescences (Whealy et al., 1988; Keever and Foster, 1989). Height control has an important role in avoiding unacceptably tall plants, which require more space, labor and incur higher transport costs (Hayashi et al., 2001). Besides being more suitable for transport, there is a higher demand for lower plants on the market (Kuehny et al., 2001) and they also look better, which is important because the aesthetic impression of the final product determines the market value of the plant (McMahon and Kelly, 1999). In chrysanthemum grown for cutflower, growth regulators are used in order to reduce the so called «long neck» (Bailey and Whipker, 1998, Evers, 1987), resulting in lower and stronger plants and less lodging. Chlormequat and daminozide are successfully used to control the height, branching and flowering of many plants (Hayashi et al., 2001), among others, also chrysanthemum.

The effect of chlormequat on chrysanthemum growth and development was investigated by de Larra (1974) and Zalewska (1989) while Gregov et al. (1995) studied the effect of daminozide on the height of two chrysanthemum cultivars and recorded a significant reduction in their height at harvest.

The objective of this research was to determine the influence of growth retardants, daminozide and chlormequat, upon the height and number of inflorescence shoots of the chrysanthemum cultivar 'Revert'.

MATERIAL AND METHODS

The chrysanthemum trial was conducted at the family farm of Zdravko Petrić in Prugovac near Đurđevac, Croatia, during two growing seasons (2000, 2001). There were 150 plants included in the trial, which was laid out according to the completely randomized block scheme with five replications. The trial was done on the chrysanthemum cultivar 'Revert', a 9-week, large-flower cultivar used as cutflower. Rooted cuttings of 'Revert' chrysanthemum, average height 13 cm, were planted in an unheated polythene greenhouse on 20 July 2000 and on 20 July 2001. Lateral branches were pinched off when plants were 15-20 cm tall. Plants were grown under the natural-day conditions. Plant darkening was applied in the period from 23 August to 15 September. The plants were darkened using black PVC film from 19:00 to 8:00 h. The single growth retardant treatment was done on 5 September 2000 and on 14 September 2001. Both retardants were applied foliarly: daminozide (Alar 85) in concentrations 0 (control), 1000, 2000 and 3000 mg l^{-1}, and chlormequat (Cycocel) in concentrations 0 (control), 2000, 3000 and 4000 mg l^{-1}. Two height measurements were taken in the first year, just before the growth retardant application and 14 days after it. In the second trial year, plant height was measured four times: before the growth retardant application and 14, 30 and 42 days after the treatment. The number of inflorescence shoots was counted 24 and 44 days after the treatment in 2000 and 42 days after the treatment in 2001.

The results were processed by the analysis of variance (ANOVA) per trial years.

RESULTS AND DISCUSSION

Results of the analysis of variance (Table 1) indicate that the applied different concentrations (of both agents) had a significantly different effect on plant height in both years and that there were no significant differences between the effects of different concentrations for the number of inflorescence shoots.

In the first trial year, daminozide and chlormequat influenced a height reduction of chrysanthemum compared to the control (Table 2). There were no significant differences between daminozide and chlormequat in the reduction of plant height.

The lowest plants were obtained by treating plants with daminozide concentrations of 2000 and 3000 mg l^{-1} and with chlormequat concentrations of 3000 and 4000 mg l^{-1}. Compared to the control, 12.56% lower plants were obtained using the daminozide concentration of 3000 mg l^{-1}, and 5.92% lower plants using the chlormequat concentration of 4000 mg l^{-1}.

Although the highest concentrations of daminozide and chlormequat resulted in the lowest plants (82.86 cm for daminozide and 84.57 for chlormequat), there were no statistically significant differences between the concentrations of 2000 and 3000 mg l^{-1} or between 3000 and 4000 mg l^{-1}.

In the following trial year, in contrast to chlormequat, daminozide influenced a significant plant height reduction compared to the control (Table 3). All together, concentrations with daminozide were significantly more efficient (P=5%) in decreasing the upward growth of 'Revert' chrysanthemum than the applied concentrations with chlormequat. The stronger action of daminozide compared to chlormequat was confirmed also by Zalewska (1989) and Seager (1969), who achieved a small height reduction in potted chrysanthemums after the application of Cycocel into substrates and a moderate height reduction by foliar application of daminozide.

At all three measurements in 2001, taken after the treatment with growth regulator, the 2000 mg l^{-1}

Table 1. Results of the analysis of variance for the traits studied

Source of variability	Year	Traits	
		Plant height	Number of inflorescence shoots
Growth retardants with concentrations	2000	**	ns
	2001	**	ns

ns – not significant; ** – significant at P=0.01

Table 2. Average plant heights (cm) monitored 14 days after treatment in 2000

Retardant	Retardant concentration				
	Control	1000 mg l^{-1}	2000 mg l^{-1}	3000 mg l^{-1}	4000 mg l^{-1}
Daminozid	94.76	87.80	84.23	82.86	cnu
Chlormequat	89.89	cnu	88.29	84.58	84.57

$LSD_{0.05}$=4.3; $LSD_{0.01}$=6.0; cnu – concentration not used

Table 3. Average plant heights (cm) monitored 14 days after treatment in 2001

Retardant	Retardant concentration				
	Control	1000 mg l^{-1}	2000 mg l^{-1}	3000 mg l^{-1}	4000 mg l^{-1}
Daminozid	64.64	57.60	53.58	57.33	cnu
Chlormequat	67.46	cnu	63.39	65.40	65.45

$LSD_{0.05}$=6.8; $LSD_{0.01}$=9.6; cnu – concentration not used

Table 4. Average heights of 'Revert' chrysanthemums (in cm) per measurement dates, 2001

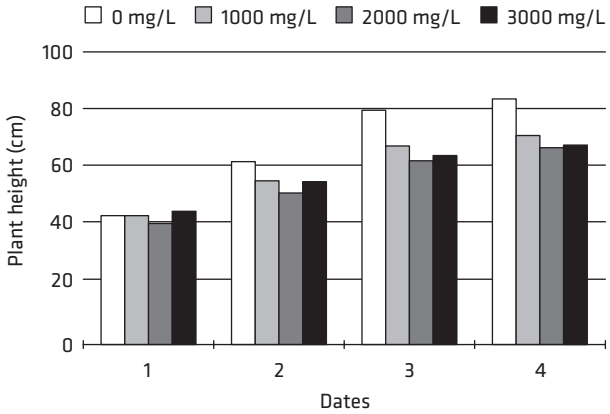
Retardant	Measurement dates			
	1	2	3	4
Daminozid	45.12	58.29	70.97	74.99
Chlormequat	46.93	65.43	82.90	88.94

Daminozid: $LSD_{0.05}$=5.97; $LSD_{0.01}$=8.59. Chlormequat: $LSD_{0.05}$=2.34; $LSD_{0.01}$=3.37
Legend: 1 – just before treatment; 2 – 14 days after treatment; 3 – 30 days after treatment; 4 – 42 days after treatment

daminozide concentration was found to be the best (Graph 1).

The effect of daminozide lasted as long as 42 days after the treatment. At the last measurement, plants treated with 2000 mg l^{-1} daminozide were by 19.72% lower than the control plants. This result is not in agreement with Larsen and Lieth (1993), who reported that daminozide exerted the strongest inhibitory effect immediately after application, and that its effect wore off later on. Hence, daminozide is usually applied to chrysanthemum in several treatments (Mitlehner, 1966). On the other hand, Sachs et al. (1975) maintain that daminozide is a stable agent for chrysanthemum. To investigate the duration of the inhibitory effect of the agents tested, the upward growth of plants was compared per dates. Since only one measurement was taken in the first trial year after the treatment with growth retardants whereas there were three measurements in the second year, comparison of the average height values in the second year was made for daminozide and chlormequat per dates.

On the last two measurement dates, significant differences (P=1%) in the plant height of chlormequat treated plants were recorded per dates whereas in daminozide treated plants there were no significant differences between plant heights in the last two measurements (Table 4).



Graph 1. Average plant height (cm) after daminozide application, per measurement dates in 2001 (Legend: 1=just before treatment; 2=14 days after treatment; 3=30 days after treatment; 4=42 days after treatment)

These results indicate that the action of daminozide lasts longer than that of chlormequat in the chrysanthemum cultivar 'Revert'. As the last measurement was taken 42 days after the growth retardant application (that is, just before the flowers were sent to market), it can be concluded that a single application of daminozide to 'Revert' chrysanthemum was sufficient because the inhibitory effect was long enough. HAMID AND WILLIAMS (1997) confirmed the effect of daminozide on growth retardation by 8 weeks.

No significant differences were recorded in the number of inflorescence shoots between the combinations in any trial year. In both trial years, however, plants treated with the highest chlormequat concentration had the largest number of inflorescence shoots (4.8 in the first year and 2.0 in the second year) whereas the opposite was recorded for daminozide treated plants, that is, the number of inflorescence shoots was the smallest in plants treated with the highest concentration.

CONCLUSIONS

The concentrations used differed significantly in their effects on plant height in both trial years whereas their effects were not significantly different for the other trait studied - the number of inflorescence shoots.

Compared to chlormequat, daminozide was more efficient in reducing the upward growth of 'Revert' chrysanthemum.

Daminozide also showed a longer inhibitory action than chlormequat. Hence, based on the data collected, a single application of daminozide concentration of 2000 $mg \cdot l^{-1}$ may be recommended for reducing the height of the 'Revert' cultivar.

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