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Effect of Cycocel and B-nine (Growth Retardants) on Growth and Flowering of *Erysimum marshallii* (Henfr.) Bois

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ABSTRACT

A study was undertaken to investigate the effect of foliar spray of different growth retardants (Cycocel and B-nine) on growth and flowering of *Erysimum marshallii*. The plants were sprayed with three concentrations of growth retardants viz. 500, 1000 and 1500 mg L^{-1} prepared in 0.1% Tween 80. Plant height was decreased by the Cycocel application but B-nine application was not effective in decreasing the plant height. The fresh and dry mass of roots, leaves and stem was decreased by the spray application of both Cycocel and B-nine. Cycocel application did not show any effect on the flowering and number of laterals in *Erysimum marshallii* but B-nine applications slightly decreased the flowering yield and number of laterals. The flower diameter was slightly decreased by the spray application of both cycocel and B-nine. Reduced leaf area was the characteristic feature of plants of *Erysimum marshallii* sprayed with cycocel and B-nine. The present investigation has suggested that the growth retardants decreased the plant height as also fresh and dry mass of the plants but did not improve the display value of plants in *Erysimum marshallii*.

Key words: Growth retardants, flower yield, plant height, leaf area, *Erysimum marshallii*

INTRODUCTION

The key uses of plant growth regulators in ornamental horticulture and floriculture include regulation of plant height, profusion of branching, propagation of cuttings and control of flowering (Halevy, 1995; Khan *et al*., 2000). They also enhance stress tolerance, increase postharvest longevity during shipping, marketing besides increasing the display of flowers and potted plants (Latimer, 2001; Chutichudet *et al*., 2010; Sharma *et al*., 2011; Satyavani *et al*., 2011). In most cases, reduction in plant height is desirable in bedding, potted and woody ornamentals but in some cases height enhancement is also desirable for cut flower use (Mackay and Sankhla, 2006; Mostafa and Alhamd, 2011).

Plant growth retardants are synthetic compounds used to retard the shoot length of plants in a desired way without changing developmental patterns or evoke phytotoxic effects. This has been achieved not only by reducing cell elongation but also by lowering the rate of cell division and regulating the plant height physiologically (Rademacher, 1995, 2000). Most plant growth retardants inhibit the formation of Growth-active gibberellins (GAs) and can thus be used to reduce unwanted shoot elongation (Singh, 2004; Mansuroglu *et al*., 2009). In addition to their agronomic

uses such as height reducer and anti lodging agent in cereals, sugarcane ripener, fruit set promoter as also turf growth inhibitor; plant growth retardants have been variously used in ornamental horticultural practices (Halevy, 1995; Dewir *et al*., 2007). The Plant growth retardants in ornamental horticulture are utilized commercially to produce compact, sturdy potted and bedding plants. This practice reduces the cost for pruning and allows obtaining a better ratio between vegetative growth and flower production, besides reducing the space in the greenhouse required for flower production thereby improving market quality (Marosz and Matysiak, 2005; Bekheta *et al*., 2008). Growth retardants are also used to enhance the green colour of the foliage, strengthen the flower stems, stimulate flowering and promote resistance against environmental stresses (Kahar, 2008). Growth retardants have also been noticed to increase the stress tolerance of plants during shipping, handling and retail marketing thereby improving the shelf life, an important aspect in marketing practices (Latimer, 2001). Growth retardants control excessive vegetative growth that helps to adjust a perennial plant species to an annual cycle of cultivation and costs for trimming hedges, trees and moving turf grasses may also be reduced by the application of growth retardants (Rademacher, 2000).

Growth retardants have been applied to ornamentals as foliar spray, soil drench, injecting into woody ornamentals or in sub irrigation water (Million *et al*., 1999). Recently pinching, preplant bulb soaks and liner dip techniques have been effectively used in ornamental horticulture (Gibson *et al*., 2003; Krug and Whipker, 2004; Blanchard and Runkle, 2007).

Erysimum marshallii (Henfr.) Bois (Brassicaceae) commonly known as Siberian wall flower blooms from March to May and produce inflorescences in raceme with bright yellow flowers. Owing to its long season of blooming and beautiful scented flowers, it is grown as bedding plant, in rock gardens, window boxes and pots (Naqshi and Javeid, 1987). The present experiment was conducted with an objective to improve the display value of plants by modulating the plant height and inducing the profusion of flowering.

MATERIALS AND METHODS

Uniform and healthy seedlings of *Erysimum marshallii* were used for the present study. The seedlings were raised from the seeds in the Kashmir University Botanic Garden (2009-2010) and transplanted to earthenware pots of uniform diameter (25 cm across), filled with sand, garden soil and farmyard manure in 1:2:1 ratio. The central drainage hole was plugged with a wad of glass wool to ensure adequate drainage and aeration. The seedlings were sprayed with different growth retardants (Cycocel and B-nine) in 500, 1000 and 1500 mg L^{-1} concentrations. The different concentrations were made from stock solutions that were freshly prepared at the time of experiment in 0.1% aqueous Tween 80 which serve as the wetting agent. For each concentration, there were five pots; besides a set of five pots each represented the distilled water control and 0.1% Tween 80 control. Irrigation was done on daily basis and hoeing twice a week. Each pot was supplied with 50 mL of full nutrient solution per week as described by Hewitt and Smith (1975). The plants were sprayed twice during the course of experiment and monitored till the plants senesce.

Visual observations were recorded throughout the experiment. Plant height, number of laterals, number of floral heads and flowers, floral diameter, fresh and dry mass of roots, leaves and stem and leaf area were recorded at regular intervals. Fresh mass was determined after removing the plants carefully with the help of a small trovel. Roots were washed thoroughly. The plants were separated into roots, leaves and upper portion of the plant and weighed to determine their fresh mass. Dry mass was determined after drying the plant material in an oven for 48 h at 70°C and

then placed in dessicator for 12 h and weighed again to determine their dry mass. Leaf area was determined by a gravimetric method as described by Sestak *et al.* (1971). For this the outlines of the leaves from individual plants were traced on a uniformly smooth paper, excising the traced outlines and determining their weight. The total leaf area was then calculated with reference to the weight of 100 cm^2 of the same sheet of paper.

Statistical analysis: The values given in the tables represent the mean of six independent replicates and difference between various treatments have been evaluated by simple analysis of variance and Least Significant Difference (LSD) computed at $p = 0.05$ using MINITAB (v15.1.2-EQUINOX_Softddl.net) software.

RESULTS

Plant height: The average height of plants sprayed with 500 mg L^{-1} Cycocel was comparable to that of plants sprayed with distilled water and 0.1% Tween 80. The plants which received foliar application of Cycocel at 1000 and 1500 mg L^{-1} concentrations showed decrease in plant height and the plant height decreased with increase in Cycocel concentration (Table 2). Spraying plants with B-nine spray at different concentrations did not show any significant reduction in plant height. The height of plants sprayed with 500, 1000 and 1500 mg L^{-1} B-nine concentrations was comparable to controls (Table 4).

Fresh and dry mass: The fresh and dry mass of roots, leaves and stem was relatively lower in plants sprayed with cycocel as compared to DW and Tween control. The higher fresh and dry mass of roots, leaves and stem was recorded in plants sprayed with 0.1% Tween 80 (Table 1). In case of

Table 1: Effect of graded concentrations of Cycocel on fresh and dry mass of roots, stem and leaves in *Erysimum marshallii*

Treatment	Fresh mass roots (g)	Fresh mass leaves (g)	Fresh mass stem (g)	Dry mass roots (g)	Dry mass leaves (g)	Dry mass stem (g)
DW control	1.47	2.77	6.50	0.48	0.64	1.40
0.1% Tween 80	1.79	4.23	7.27	0.60	0.83	1.97
Cycocel 500 mg L^{-1}	1.45	3.23	6.34	0.52	0.77	1.72
Cycocel 1000 mg L^{-1}	1.60	4.13	6.73	0.55	0.63	1.44
Cycocel 1500 mg L^{-1}	1.35	2.23	6.07	0.50	0.62	1.34
LSD at p = 0.05	0.07	0.29	0.65	0.02	0.04	0.11

Each value represents mean of six independent replicates

Table 2: Effect of graded concentrations of Cycocel on plant height, number of laterals, leaf area, number of floral heads, number of flowers and floral diameter in *Erysimum marshallii*

Treatment	Plant height (cm)	No. of laterals	Leaf area (cm^2)	No. of floral heads/plant	No. of flowers/plant	Floral diameter
DW control	40.21	4.00	74.37	3.83	60.00	1.71
0.1% Tween 80	39.67	5.83	85.33	5.17	85.00	1.72
Cycocel 500 mg L^{-1}	39.83	3.17	70.67	4.00	59.00	1.68
Cycocel 1000 mg L^{-1}	36.17	3.17	71.17	3.67	56.00	1.68
Cycocel 1500 mg L^{-1}	32.17	4.17	69.33	3.00	62.00	1.66
LSD at p = 0.05	4.37	0.73	9.91	0.54	6.17	0.17

Each value represents mean of six independent replicates

Table 3: Effect of graded concentrations of B-nine on fresh and dry mass of roots, stem and leaves in *Erysimum marshallii*

Treatment	Fresh mass roots (g)	Fresh mass leaves (g)	Fresh mass stem (g)	Dry mass leaves (g)	Dry mass roots (g)	Dry mass stem (g)
DW control	1.61	2.97	6.50	0.48	0.69	1.40
0.1% Tween 80	1.79	4.23	7.27	0.60	0.83	1.96
B-nine 500 mg L^{-1}	1.57	2.83	6.57	0.47	0.68	1.35
B-nine 1000 mg L^{-1}	1.49	2.67	6.09	0.42	0.64	1.30
B-nine 1500 mg L^{-1}	1.53	2.71	6.37	0.45	0.66	1.34
LSD at p = 0.05	0.08	0.15	0.40	0.02	0.08	0.16

Each value represents mean of six independent replicates

Table 4: Effect of graded concentrations of B-nine on plant height, number of laterals, leaf area, number of floral heads, number of flowers and floral diameter in *Erysimum marshallii*

Treatment	Plant height (cm)	No. of laterals	Leaf area (cm^2)	No. of Floral flowers/plant	No. of heads/plant	Floral diameter
DW Control	40.21	4.00	74.37	3.83	60.00	1.71
0.1% Tween 80	39.67	5.83	85.33	5.17	85.00	1.72
B-nine 500 mg L^{-1}	42.17	3.00	71.17	3.67	54.00	1.67
B-nine 1000 mg L^{-1}	43.00	3.00	73.00	3.33	52.00	1.66
B-nine 1500 mg L^{-1}	42.17	3.00	71.00	4.67	60.00	1.65
LSD at p = 0.05	5.86	0.57	8.24	0.61	7.14	0.15

Each value represents mean of six independent replicates

plants sprayed with B-nine fresh and dry mass of roots, leaves and stem was almost comparable in plants sprayed with 500, 1000 and 1500 mg L^{-1} but it was slightly less as compared to DW and Tween control (Table 3).

Number of laterals: The maximum number of laterals per plant was recorded in plants sprayed with 0.1% Tween 80 followed by plants sprayed with 1500 mg L^{-1} cycocel concentration (Table 2). Spraying plants with B-nine at different concentrations did not have any significant effect on the number of laterals per plant (Table 4).

Leaf area: Leaf area registered a decreasing trend with the increase in the concentration of Cycocel. The plants which received a foliar spray of 1500 mg L^{-1} cycocel concentration showed the minimum value for leaf area per plant, whereas the maximum value for leaf area was recorded in plants sprayed with 0.1% Tween 80 (Table 2). The plants sprayed with B-nine at different concentrations did not have any significant effect on the leaf area. It was comparable in plants sprayed with B-nine at 500, 1000 and 1500 mg L^{-1} concentrations but less as compared to DW and Tween 80 (Table 4).

Number of floral heads: The maximum number of floral heads per plant was recorded in plants sprayed with 0.1% Tween 80 followed by plants sprayed with 500 mg L^{-1} cycocel concentration (Table 2). In case of plants sprayed with B-nine, the maximum number of floral heads per plant was recorded 0.1% Tween control, followed by plants sprayed with 1500 mg L^{-1} B-nine concentration (Table 4).

Number of flowers: The maximum number of flowers was recorded in plants sprayed with 0.1% Tween 80. The number of flowers per plant was comparable in plants sprayed with DW, 500, 1000

and 1500 mg L^{-1} cycocel concentrations (Table 2). The number of flowers per plant registered a decrease in plants sprayed with B-nine as compared to DW and Tween control. The maximum number of flowers per plant was recorded in plants sprayed with 0.1% Tween followed by plants sprayed with DW (Table 4).

Floral diameter: There was a slight decrease in floral diameter with increase in cycocel and B-nine concentration compared to distilled water and Tween controls (Table 2, 4).

DISCUSSION

Cycocel application as foliar spray decreased the plant height in *Erysimum marshallii* but the height in all the plants of *Erysimum marshallii* sprayed with B-nine was almost comparable with the controls. The application of cycocel has been shown to reduce the plant height in a number of plant species such as *Epidendrum radicans, Encelia farinosa, Zinnia elegans, Chrysanthemum, Poinsettia* (Pateli *et al*., 2004; El-Mokadem and Hadia, 2008; Pinto *et al*., 2005; Lodeta *et al*., 2010). Our results showing B-nine not effective in controlling plant height in *Erysimum marshallii* corroborate with that of (Gibson *et al*., 2003) who also reported the ineffectivity of B-nine in controlling plant height in *Argyranthemum frutescence*. During the present investigation the cycocel application did not show much effect on the flowering and number of laterals in *Erysimum marshallii* but B-nine application slightly decreased the flowering yield and number of laterals in plants of *Erysimum marshallii*. During the course of experimentation we found that the flower diameter was slightly decreased in the plants of *Erysimum marshallii* by the spray application of both cycocel and B-nine. Earlier also in *Rosa damascena* both Cycocel and B-nine have been shown to produce smaller flowers (Abbas *et al*., 2007). Our investigation also showed that the reduced leaf area was the characteristic feature of plants of *Erysimum marshallii* sprayed with cycocel and B-nine. In the plants of *Encelia farinosa* and *Altemanthera versicolor* both Cycocel and B-nine application have been shown to reduce the leaf area (El-Mokadem and Hadia, 2008). The total fresh and dry mass of *Erysimum marshallii* plants was decreased with cycocel and B-nine application. Our results corroborate with those of El-Mokadem and Hadia (2008), who found in *Encelia farinosa* that both cycocel and B-nine reduced the total fresh and dry mass.

CONCLUSION

The present investigation suggest that the growth retardants decreased the plant height as also fresh and dry mass of the plants but did not improve the display value of plants in *Erysimum marshallii*. Therefore, it may be concluded that the desired effects of PGRs on the display value of ornamental plants are dependent on the type and dose of a particular PGR, time and method of application and more importantly the species and cultivar of the ornamental plant.

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