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Effect of plant spacing and GA_3 on growth and flowering of sweet william (*Dianthus barbatus* L)

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ABSTRACT

The present study was carried out to work out the optimum plant spacing and GA_3 dose for growth and flowering of sweet william. The experiment was laid out in RBD (factorial) with 12 treatment combinations of four levels of spacing viz S_1 (30 × 30 cm), S_2 (30 × 25 cm), S_3 (30 × 20 cm) and S_4 (20 × 20 cm) and three doses of GA_3 viz G_0 (0 ppm), G_1 (50 ppm) and G_2 (100 ppm) replicated thrice. The results obtained indicated maximum values for time taken to first flowering (131.67 days), plant spread (38.78 cm), number of flowers per plant (106.11), size of flowers (1.86 cm) and duration of flowering (39.11 days) at a spacing of 30 × 30 cm (S_1). Whereas maximum plant height (46.07 cm) and number of flowers per plot (2600.00) were noticed at a spacing of 20 × 20 cm (S_4). The application of GA_3 @ 100 ppm resulted in highest values for plant height (42.67 cm), plant spread (36.54 cm), number of flowers per plant (96.75), number of flowers per plot (2349.75), size of flowers (1.83 cm) and duration of flowering (36.75 days). However GA_3 @ 0 ppm recorded maximum values for days taken to first flowering (117.83). The interaction S_1 (30 × 30 cm) × G_2 (100 ppm) recorded maximum values in terms of most of the growth and flowering parameters except number of flowers per plot which were found to be maximum in the interaction S_4 (20 × 20 cm) × G_2 (100 ppm) but the effects were found to be non-significant. It was concluded that for better growth and flowering the plants of sweet William be spaced at 30 × 30 cm apart along with the application of GA_3 @ 100 ppm after 40 and 60 days of transplanting.

Keywords: Plant spacing; GA_3; sweet william; growth; flowering

INTRODUCTION

Sweet william (*Dianthus barbatus* L) belongs to the family Caryophyllaceae and is closely related to carnation and pinks. The sturdy sweet william is native to the mountainous regions of the southern Europe extended from Pyrenees East to the Capathians and Balkans and northeastern Asia. It is an excellent plant for cut flowers, borders and beds. In the hills seeds of sweet william are sown in August to October and plants come into flowering during early summer (Swarup 1967). Sweet william is commercially propagated by seeds and there are number of factors which affect its seed yield and quality. The quality of seed is very much influenced by the foliar application of gibberellic acid and plant density including other factors too. Plant spacing in the field is very important and plays a significant role in determining growth and development of the plant. Optimum plant spacing has been found to improve growth, flowering and flower quality. Besides this the application of GA_3 plays a very important role to enhance flowering and improve seed set and seed yield. So in order to enhance growth, flowering and flower yield as well as flower quality the need was felt to standardize optimum plant spacing and application of GA_3 in the crop. The present investigations were undertaken to study the influence of plant spacing and GA_3 applications on growth and flowering of sweet william.

MATERIAL and METHODS

The present study was carried out at the experimental farm of Department of Seed Science and Technology, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan. Himachal Pradesh. The experiment was laid out in RBD (factorial) with 12 treatment combinations of four levels of spacing viz S_1 (30 × 30 cm), S_2 (30 × 25 cm), S_3 (30 × 20 cm) and S_4 (20 × 20 cm) and three doses of GA_3 viz G_0 (0 ppm), G_1 (50 ppm) and G_2 (100 ppm) replicated thrice. The healthy, bold, disease-free and uniform size seeds of sweet william were sown in the nursery. Each seed was covered with sieved well rotten FYM and watered properly.

The healthy, disease-free and stocky seedlings of uniform size and vigour at 5-6 leaf stage were selected and transplanted in the beds of 2 × 1 m size at 4 different levels of spacing (30 × 30, 30 × 25, 30 × 20 and 20 × 20 cm). Light irrigation was given soon after transplanting of seedlings. The plants were gently watered daily during summer months and twice a week during winter months in the entire cropping period. Application of GA_3 was done at 40 and 60 days after planting. All the data were analyzed by OP stat (Sheoran et al 1998).

Observations were recorded on days taken to first flowering (days), plant height (cm), plant spread (cm), number of flowers per plant, number of flowers per plot, size of flowers (cm) and duration of flowering (days). The data recorded on various characters were subjected to statistical analysis as per randomized bock design (factorial) suggested by Panse and Sukhatme (2000).

RESULTS and DISCUSSION

The data on growth and flowering of sweet william as influenced by spacing and application of GA_3 are given in Table 1.

Days taken to first flowering: The minimum time taken to first flowering (100.44 days) was recorded in the closest plant spacing ie S_4 (20 × 20 cm) and maximum (131.67 days) was observed under wider spacing ie S_1 (30 × 30 cm). This might be due to reduction in growth of plants at the closer spacing as a result of which the plants switched over to reproductive phase comparatively in lesser period. In case of GA_3 minimum time taken to first flowering (106.75 days) was reported with GA_3 @ 100 ppm and maximum (117.83 days) in the control (GA_3 @ 0 ppm). The earliness of flowering in those plants treated with GA_3 may be due to the fact that GA_3 had played a positive role in advancing the flowering at this particular concentration. The interactive effects exhibited minimum time taken to first flowering (97.33 days) in the interaction S_4 (20 × 20 cm) × G_2 (100 ppm) and maximum time taken to first flowering (135.00 days) was observed in the interaction S_1 (30 × 30 cm) × G_0 (0 ppm). Similar results have also been reported by Sharma et al (2012) and Chauhan et al (2014) in African marigold.

Plant height: The maximum height of plants (46.07 cm) was observed at a spacing of 20 × 20 cm (S_4) and minimum (27.24 cm) in S_1 (30 × 30 cm). The tallness of plants at a closer spacing might be due to intra-plant competition for light, moisture, space, nutrients, aeration etc thus resulting in the elongation of stems. The tallest plants (42.67 cm) were also observed with the application of GA_3 @ 100 ppm and shortest (32.26 cm) in control. This could be because of the fact that application of higher concentrations of GA_3 might have increased plant height as a consequence of hyper-elongation in stems and internodes as well. Thus the plants grew comparatively longer. Maximum plant height (51.00 cm) was noticed in the interaction S_4 (20 × 20 cm) × G_2 (100 ppm) and minimum (19.23 cm) in S_1 (30 × 30 cm) × G_0 (0 ppm). The results get support from the findings of Khobragade et al (2012) and Kumar et al (2015) in China aster.

Plant spread: Widest plant spread (38.78 cm) was observed at a spacing of 30 × 30 cm (S_1) and minimum (25.97 cm) at 20 × 20 cm (S_4). This might be due to the availability of large space for growth of plants and comparatively less competition for various productive factors viz nutrients, water, light etc as a consequence of which the plants spaced widely could put up more vegetative growth especially the production of secondary and tertiary branches. In case of GA_3 maximum plant spread (36.54 cm) was observed with GA_3 @ 100 ppm and it was minimum (27.15 cm) in control. This could be because of the fact that application of GA_3 @ 100 ppm exhibited positive effects on stem elongation besides inducing more protein synthesis which ultimately enhanced the vegetative growth. The widest plant spread (45.67 cm) was noticed in the interaction S_1 (30 × 30 cm) × G_2

Table 1. Effect of plant spacing and GA_3 on growth and flowering of sweet william (*Dianthus barbatus* L)

Treatment	Days taken to first flowering (days)	Plant height (cm)	Plant spread (cm)	Number of flowers /plant	Number of flowers /plot	Size of flower (cm)	Duration of flowering (days)
Spacing							
S_1	131.67	27.24	38.78	106.11	1910.00	1.86	39.11
S_2	111.33	35.67	33.61	94.56	1985.67	1.83	33.33
S_3	105.11	41.82	28.94	82.44	2226.00	1.81	29.00
S_4	100.44	46.07	25.97	72.22	2600.00	1.65	25.78
$CD_{0.05}$	2.16	2.13	2.35	3.21	90.25	0.01	1.74
GA_3							
G_0	117.83	32.26	27.15	82.08	2031.75	1.76	26.83
G_1	111.83	38.18	31.79	87.67	2159.75	1.78	31.83
G_2	106.75	42.67	36.54	96.75	2349.75	1.83	36.75
$CD_{0.05}$	1.87	1.84	2.03	2.78	78.16	0.01	1.51
Interaction							
$S_1 \times G_0$	135.00	19.23	30.33	95.00	1710.00	1.83	31.33
$S_1 \times G_1$	133.00	27.50	40.33	102.67	1848.00	1.86	40.33
$S_1 \times G_2$	127.00	35.00	45.67	120.67	2172.00	1.89	45.67
$S_2 \times G_0$	121.00	31.00	29.00	86.00	1806.00	1.81	28.00
$S_2 \times G_1$	110.33	36.00	32.83	92.67	1946.00	1.82	32.33
$S_2 \times G_2$	102.67	40.00	39.00	105.00	2205.00	1.87	39.67
$S_3 \times G_0$	110.67	38.80	25.33	77.00	2079.00	1.78	25.00
$S_3 \times G_1$	104.67	42.00	29.00	83.00	2241.00	1.79	29.67
$S_3 \times G_2$	100.00	44.67	32.50	87.33	2358.00	1.85	32.33
$S_4 \times G_0$	104.67	40.00	23.92	70.33	2532.00	1.62	23.00
$S_4 \times G_1$	99.33	47.20	25.00	72.33	2604.00	1.65	25.00
$S_4 \times G_2$	97.33	51.00	29.00	74.00	2664.00	1.69	29.33
$CD_{0.05}$	3.75	3.69	4.06	5.56	NS	NS	3.01

NS= Non-significant
Levels of plant spacing: S_1= 30 × 30 cm, S_2= 30 × 25 cm, S_3= 30 × 20 cm, S_4= 20 × 20 cm
Doses of GA_3: G_0= 0 ppm, G_1= 50 ppm, G_2= 100 ppm

(100 ppm) and minimum (23.92 cm) in S_4 (20 × 20 cm) × G_0 (0 ppm). Similar results have been reported by Deshmukh et al (2014) in marigold.

Number of flowers per plant: Maximum flowers per plant (106.11) were recorded in the plants spaced at 30 × 30 cm apart (S_1) and least (72.22) at 20 × 20 cm (S_4). Under wider spacing plants grew more luxuriantly by uptaking requisite nutrients so they put up more plant spread by producing higher number of branches which later on produced more flowers. The application of GA_3 @ 100 ppm (G_2) recorded maximum number of flowers per plant (96.75) and minimum (82.08) was in control. This may be because of increase in plant height and number of branches. The interaction S_1 (30 × 30 cm) × G_2 (100 ppm) resulted in the production of maximum number of flowers per plant (120.67) and minimum (70.33)) was recorded in S_4 (20 × 20 cm) × G_0 (0 ppm). Similar results were reported by Deshmukh et al (2014) in marigold.

Number of flowers per plot: Maximum number of flowers per plot (2600.00) was recorded at closer spacing of 20 × 20 cm (S_4) and least number (1910.00) was obtained at 30 × 30 cm (S_1). This could be due to increased plant population at closer spacing which ultimately lead to increase in flower yield or number of flowers per plot. The application of GA_3 @ 100 ppm (G_2) recorded maximum number of flowers per plot (2349.75) and minimum was obtained in control. Number of flowers per plot was more at highest level of GA_3 (100 ppm) as compared to control. The interaction S_4 (20 × 20 cm) × G_2 (100 ppm) resulted in the production of highest number of flowers per plot (2664.00) and minimum (1710.00) was recorded in S_1 (30 × 30 cm) × G_0 (0 ppm). These results are in close agreement with the findings of Pal and Pandey (2007) and Singh et al (1991) in African marigold.

Size of flowers: Maximum size of flowers (1.86 cm) was recorded when plants were spaced at 30 × 30 cm

apart (S_1) and smallest (1.65 cm) at 20 × 20 cm (S_4). This may be due to widely spaced plants faced less competition for space, soil moisture and light etc thereby received more nutrition which resulted in better quality of flowers. Largest flowers (1.83 cm) were produced with the application of GA_3 @ 100 ppm (G_2) and smallest (1.76 cm) in control. Maximum flower size (1.89 cm) was recorded in the interaction S_1 (30 × 30 cm) × G_2 (100 ppm) whereas minimum (1.62 cm) in S_4 (20 × 20 cm) × G_0 (0 ppm). Similar results were reported by Tiwari et al (2010) in marigold and Sharifuzzaman et al (2011) in chrysanthemum.

Duration of flowering (days): Maximum duration of flowering (39.11 days) was achieved under the spacing of 30 × 30 cm (S_1) whereas minimum (25.78 days) under 20 × 20 cm (S_4). This could be because more the number of laterals more will be the number of flowers per plant which may proportionately enhance the flowering duration. The highest duration of flowering (36.75 days) was observed with the application of GA_3 @ 100 ppm (G_2) and minimum (26.83 days) in control. This may be due to increase in production as well as higher indigenous levels of bioregulators. Maximum duration of flowering (45.67 days) was obtained in the interaction S_1 (30 × 30 cm) × G_2 (100 ppm) and minimum (23.00 days) in S_4 (20 × 20 cm) × G_0 (0 ppm). These results are in agreement with the findings of Chaudhary et al (2007) in zinnia and Dutta et al (1998) in chrysanthemum.

CONCLUSION

The response of different levels of spacing and GA_3 on growth and flowering of sweet william revealed that a plant spacing of 30 × 30 cm along with GA_3 @ 100 ppm improved the various growth and flowering parameters.

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