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Effect of Gibberellic Acid, Spacing and Nutrient Sprays on Growth and Flowering in Snapdragon (*Antirrhinum majus* L.) cv. Rocket Pink

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Authors' contributions

This work was carried out in collaboration among all authors. Authors SAM, Neelofar and ITN designed the study and wrote the protocol of the manuscript. Authors SAM and MSP performed the statistical analysis. Authors FAK and ZAQ managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

An experiment was conducted to study the effect of different concentrations of gibberellic acid, spacing and nutrient sprays on vegetative and floral parameters of snapdragon (*Antirrhinum majus* cv. Rocket Pink) at Urban Technological Park, Habak, Srinagar, J&K, India during two successive years in 2017and 2018. Eighteen different treatments with 3 concentrations of gibberellic acid (0 ppm, 100 ppm and 200 ppm), 2 spacings (15 cm x 15 cm and 15 cm x 20 cm) and nutrient sprays (3 sprays, 4 sprays and 5 sprays) were replicated thrice in Completely Randomized Block Design.

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The investigation revealed that gibberellic acid at 200 ppm proved best among all in vegetative including height (91.07 cm), number of primary branches (4.11) and number of leaves (174.60) as well as in floral parameters including days to first inflorescence initiation (47.77), days to first inflorescence opening (50.81), days to 50% flowering (54.30), length of flower stalk (45.91 cm), length of inflorescence (38.80 cm), number of spikes per plant (7.72), number of florets per spike (22.35), number of fully developed florets (5.17), duration of flowering (52.62 days) and vase life (13.00 days). Spacing of 15 cm x 15 cm proved better in terms of height (85.23 cm) in vegetative parameters and length of flower stalk (43.81 cm) and length of inflorescence (37.65 cm) in floral parameters while spacing of 15 cm x 20 cm proved better in number of primary branches (3.64) and number of leaves (170.68) as well as days to first inflorescence initiation (49.49), days to first inflorescence opening (52.33), days to 50% flowering (55.42), number of florets per spike (17.64), number of fully developed florets (4.47), duration of flowering (50.75 days) and vase life (10.71 days). Among different nutrient sprays application of 5 sprays proved best in all vegetative including height (87.06 cm), number of primary branches (4.26) and number of leaves (182.92) and floral parameters including length of flower stalk (42.88 cm), length of inflorescence (36.18 cm), number of spikes per plant (7.80), number of florets per spike (19.21), number of fully developed florets (4.67), duration of flowering (52.26 days) and vase life (10.92 days). While minimum days to first inflorescence initiation (49.05), first inflorescence opening (51.89) and 50% flowering were obtained by 3 nutrient sprays.

Keywords: Snapdragon; gibberellic acid; spacing; nutrient sprays.

1. INTRODUCTION

Antirrhinum majus L. commonly known as snapdragon or dog flower is native to Mediterranean region. It is abundant in the temperate regions of the world. In India it is represented by 273 species and is commercially cultivated in the states of Assam, Gujrat, Uttar Pradesh, Maharashtra, Karnataka and Tamil Nadu. It is one of the principal cut flower crops wherein the flowers are borne on terminal long spikes of many colours and shades. The variation in plant height (12-36 inches) in different types and groups provide wide scope of using *Antirrhinum* for different purposes [1].

Spacing of plants is an important aspect that needs to be carefully considered. Proper spacing between the plants can efficiently utilize the available area for healthy growth and thus result in the better yield. Inaba and Ohshiro [2] reported the yield of cut flowers per plant decreases with an increase in the planting density. However, yield per unit area increases. Inaba et al. [3] also reported decrease in the weight of cut flowers and the number of axillary buds with the increase in planting density.

Fertilizers give nutrition to the plant and can develop tolerance against pests and diseases. Fertilizers don't only assist in increasing yields and promoting healthy growth of plants but also in their development. Snapdragon shows a great response to different types of fertilizers. With the increase in the concentration of nitrogen fertilizers there is increase in the number of leaves, number of branches, longevity of inflorescence and number of lateral inflorescence [4]. Mjeed and Ali [5] also reported that with an increase in the concentration of nitrogen there is an increase in plant height, fresh weight of the plant, stem diameter, number of leaves per plant, number of branches per plant, number of spikes per plant, number of florets per spike and flower spike length.

Ornamental crops find extensive use of growth regulators for modifying their developmental processes. The major areas where growth regulators have successfully played their roles in ornamental plants are in vegetative propagation, inhibition of abscission, prevention of bud dormancy, growth control, promotion of flowering, prolonging the vase life of flowers and retarding their senescence [6]. Growth regulators have a great impact on the growth and flowering of snapdragon. Gibberellic acid has been found to increase the stem length and vase life of snapdragon [7] and advance flowering by 6-7 days [8]. Te-sen and Toop [9] reported significant increase in the length of inflorescence, overall height of the plant at maturity and the fresh weight of top of snapdragon by gibberellic acid. The objectives of the study were to improve the growth and flowering of snapdragon by manipulating gibberellic acid, spacing and nutrient sprays.

2. MATERIALS AND METHODS

The experiment was carried out at Urban Technology Park, Habak, Srinagar, J&K, India during 2017 and 2018. It is situated between 35.5° - 34.7° North latitude and 74.8°- 74.9° East longitude at an altitude of 1588 m above mean sea level. In general, the climate of the area is temperate-cum-mediterranean and of continental type characterized by hot summers and severe winters. Hottest months are July and August during which temperature shoots up 36°C. Winter is severe, extending over 70 days from the middle of December to March, when the temperature often goes below the freezing point and the whole of Kashmir valley remains covered under snow. A Randomized Complete Block Design was used comprising of three replications. The land was divided into three blocks and each block was divided into 18 plots of 0.6 x 0.6 m size separated by a path of 0.3 m. Uniform dose of fertilizers N, P and K= 10 g each) and FYM was added to each plot at the final preparation prior to planting of seedlings. Uniform sized seedlings of snapdragon (*Antirrhinum majus*) cv. Rocket Pink were planted in the field on 22nd of March at a spacing of 15 cm x 15 cm and 15 cm x 20 cm in the alternative plots and were slightly watered by rose can. Factors used were gibberellic acid (0 ppm, 100 ppm and 200 ppm), Spacing (15 cm x 15 cm and 15 cm x 20cm) and Nutrient sprays (19:19:19+Calmax Gold) (3 sprays, 4 sprays and 5 sprays). The stock solution of gibberellic acid and nutrient sprays were prepared by dissolving them in appropriate solvents and followed by dilution with distilled water. Spraying of micronutrient solutions [CalMax Gold (mixture of Nitrogen and micronutrients) and 19:19:19 (mixture of NPK)] was done uniformly with the help of garden sprayer. First spray of gibberellic acid (100 and 200 ppm) was done 40 days after planting (Ist May). First dose of 19:19:19 and Calmax Gold was sprayed on 3rd of May. Plants were taken randomly from each treatment in every replication at the appropriate time to record the observations. The observations were recorded for growth parameters such as plant height, number of leaves and number of primary branches; for flowering parameters days to first inflorescence initiation, days to first inflorescence opening, days to 50% flowering, length of flower stalk (cm), length of inflorescence (cm), number of spikes per plant, number of florets per spike, number of fully developed florets, duration of flowering (days) and vase life (days) were recorded. Data analysis was done using Microsoft Excel and OPSTAT.

3. RESULTS AND DISCUSSION

3.1 Gibberellic Acid

Gibberellic acid had a significant effect on all the three growth parameters including plant height, number of primary and number of leaves. Highest plant height (91.07 cm), maximum number of primary branches (4.11) and maximum number of leaves (174.60) were obtained at 200 ppm, while the lowest (79.07cm, 3.24 and 160.58, respectively) were obtained at control. Highest plant height is due to cell elongation caused by gibberellic acid. Our findings for number of branches and leaves are in consent with those of Saleh et al. [10] who advocated that by increasing gibberellic acid concentration there is increase in branch number in petunia cv. Carnival. Due to increase in the branch number there is increase in the number of leaves. Gibberellic acid significantly decreased the number of days to first inflorescence initiation, first inflorescence opening and 50% flowering. Minimum number of days to first inflorescence initiation (47.77), first inflorescence opening (50.81) and 50% flowering (54.30) were observed at 200 ppm while the maximum number of days (51.15, 54.06 and 57.62 respectively) were observed in control. Our findings are in consent with those of Dhiman [11] in lilium hybrids and Pal and Das [12] in *Lilium longiforum* who advocated the induction of early flowering by gibberellic acid. There was a significant increase in the length of flower stalk and length of inflorescence. Longest flower stalk (45.91 cm) and inflorescence (38.80 cm) were obtained at 200 ppm while the shortest (38.85 cm and 30.63 cm respectively) were obtained at control. This is due to cell elongation caused by gibberellic acid. Number of spikes per plant, number of florets per spike and number of fully developed florets obtained maximum value (7.72, 22.35 and 5.17 respectively) at 200 ppm while the lowest (6.38, 14.66 and 3.76 respectively) at control. This is due increase in the number of branches which increases the number of spike, gibberellic acid treated plants produced more number of leaves as compared to control, which might have resulted in production and accumulation of more photosynthates that were diverted to flowers. The findings are in agreement with those of Pal and Chowdhury [13] who found that gibberellic acid significantly increased leaf area and number of florets per

spike in Gladiolus, cv. Friendship and Sanjeeta and Maiti [4] for number of florets per spike and number of fully developed florets. Duration of flowering and vase life were significantly increased by gibberellic acid. Maximum duration (52.62 days) and vase life (13.00 days) were obtained at 200 ppm while the minimum (47.59 days and 7.72 days respectively) were obtained by control. The findings are in agreement with those of Inaba et al. [3] in case of duration of flowering and Prakash and Jha [6] in case of vaselife.

3.2 Spacing

Spacing significantly affected the plant height, number of primary branches and the number of leaves. Higher plant height (85.23 cm) was observed in higher density while low density recorded lower plant height (84.90 cm). The higher plant height might be due to intra plant competition for light and aeration which promoted the elongation of the main stem. The effect of closer spacing was supported by Singh and Sangama [14]. Number of primary branches and

Table 1. Effect of GA_3, spacing and nutrient sprays on growth parameters in snapdragon (*Antirrhinum majus* L.) cv. "Rocket Pink"

Treatment	Plant height (cm)	Number of leaves	Number of primary branches
Gibberellic acid (G)			
Without GA_3 application (G_0)	79.07	160.58	3.24
GA_3 100 ppm (G_1)	85.06	166.99	3.37
GA_3 200 ppm (G_2)	91.07	174.60	4.11
C.D ($P \leq 0.05$)	0.05	2.45	0.07
Spacing (S)			
15 cm × 15 cm (S_1)	85.23	164.11	3.49
15 cm× 20 cm (S_2)	84.90	170.68	3.66
C.D ($P \leq 0.05$)	0.04	2.00	0.05
Nutrient sprays (N)			
3 Sprays (N_1)	83.06	154.61	2.90
4 Sprays (N_2)	85.07	164.65	3.56
5 Sprays (N_3)	87.06	182.92	4.26
C.D ($P \leq 0.05$)	0.05	2.45	0.07

Table 2. Effect of Gibberellic acid, spacing and nutrient sprays on flowering parameters in snapdragon (*Antirrhinum majus* L.) cv. "Rocket Pink"

Treatment	Days to first inflorescence initiation	Days to first inflorescence opening	Days to 50% flowering	Length of flower stalk (cm)	Length of inflorescence (cm)
Gibberellic acid (G)					
Without GA_3 application (G_0)	51.15	54.06	57.62	38.85	30.63
GA_3 100 ppm (G_1)	50.17	53.00	55.48	42.02	37.03
GA_3 200 ppm (G_2)	47.77	50.81	54.30	45.91	38.80
C.D ($P \leq 0.05$)	0.05	0.02	0.03	0.04	0.02
Spacing (S)					
15cm × 15cm (S_1)	49.49	52.34	55.42	43.81	37.65
15cm× 20cm (S_2)	49.91	52.91	56.18	40.71	33.32
C.D ($P \leq 0.05$)	0.04	0.02	0.03	0.03	0.02
Nutrient Sprays (N)					
3 Sprays (N_1)	49.05	51.89	55.14	41.45	34.78
4 Sprays (N_2)	50.00	52.84	55.78	42.44	35.49
5 Sprays (N_3)	50.04	53.14	56.49	42.88	36.18
C.D ($P \leq 0.05$)	0.053	0.02	0.03	0.04	0.02

Table 3. Effect of Gibberellic acid, spacing and nutrient sprays on flowering parameters in snapdragon (*Antirrhinum majus* L.) cv. "Rocket Pink"

Treatment	Number of spikes per plant	Number of florets per spike	Number of fully developed florets	Duration of flowering (days)	Vase life (days)
Gibberellic acid (G)					
Without GA_3 application (G_0)	6.38	14.66	3.76	47.59	7.72
GA_3 100 ppm (G_1)	7.70	15.40	4.12	50.42	10.28
GA_3 200 ppm (G_2)	7.72	22.35	5.17	52.62	13.00
C.D ($P \leq 0.05$)	0.61	0.37	0.05	0.20	0.10
Spacing (S)					
15 cm × 15 cm (S_1)	7.13	17.29	4.23	49.67	9.96
15 cm× 20 cm (S_2)	7.41	17.64	4.47	50.75	10.71
C.D ($P \leq 0.05$)	N.S	0.31	0.04	0.16	0.08
Nutrient Sprays (N)					
3 Sprays (N_1)	6.97	16.05	4.08	48.57	9.84
4 Sprays (N_2)	7.03	17.15	4.31	49.81	10.25
5 Sprays (N_3)	7.80	19.21	4.67	52.26	10.92
C.D ($P \leq 0.05$)	0.61	0.37	0.05	0.20	0.10

number of leaves were higher (3.64 and 170.68 respectively) at low density while lower (3.49 and 164.11 respectively) at high density. This might be due to wider spacing for branch development which then increased the number of leaves as well. Our findings are in consent with Chanda and Roychoudhary [15] who reported number of primary branches were higher at wider spacing. Days to first inflorescence initiation, first inflorescence opening and 50% flowering were earlier (49.49, 52.33, and 55.42 respectively) in case of high density than at low density (49.91, 52.91 and 56.18 respectively). Length of flower stalk and inflorescence were longer (43.81 cm and 37.65 cm respectively) in case of high density than in low density (40.71 cm and 33.32 cm respectively). This might be due to high competition for light and aeration in closer spacing. Spacing had insignificant effect on the number of spikes per plant. Number of florets per spike, number of fully developed florets, duration of flowering and vase life were significantly affected by spacing, obtaining higher values (17.64, 4.47, 50.75 days and 10.71 days respectively) at low planting density than those (17.29, 4.23, 49.67 days and 9.96 days respectively) at higher density. This might be due to more photosynthates produced by more number of leaves in case of wider spacing.

3.3 Nutrient Sprays

Plant height, number of primary branches and number of leaves were significantly increased by the application of nutrient spray obtaining highest values (87.06 cm, 4.26, 182.92 respectively) by 5 sprays while lowest (83.06 cm, 2.90, 154.61 respectively) by control. This might be due to availability of more nutrients in case of 5 sprays. Days to first inflorescence initiation, days to first inflorescence opening and 50% flowering were minimum (49.05, 51.89, and 55.14 respectively) at 3 sprays while maximum (50.04, 53.14 and 56.49 respectively) at 5 sprays Length of flower stalk and inflorescence were longest (42.88 cm and 36.18 cm respectively) by 5 sprays while shortest (41.45 cm and 34.78 cm respectively) by 3 sprays. Number of spikes per plant were maximum (7.80) by 5 sprays while minimum (6.97) by 3 sprays. Number of florets per spike and number of fully developed florets were maximum (19.21 and 4.67 respectively) by 5 sprays while minimum (16.05 and 4.03 respectively) by 3 sprays. Our results are in consent with [3] and [4]. Duration of flowering and vase life were significantly increased by nutrient sprays. Maximum duration (52.26) and vase life (10.92) were obtained by 5 sprays while their minimum values (48.57 and 9.84 respectively were obtained by 3 sprays. Our results are in consent with Inaba et al. [3] and Prakash and Jha [6].

4. CONCLUSION

This study showed that gibberellic acid at 200 ppm proved best among all the concentrations in both vegetative as well as in floral parameters. While studying effect of spacing, closer spacing resulted in higher plants with lesser number of

branches and leaves, floral characters were better in case of wider spacing except days to first inflorescence initiation, first inflorescence opening, 50% flowering, stem and inflorescence length. Among Nutrient sprays, 5 sprays proved best in all vegetative and floral parameters except days to first inflorescence initiation, first inflorescence opening and 50% flowering which recorded best values at 3 sprays.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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