Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; 8(5): 462-465
Received: 07-07-2019
Accepted: 09-08-2019

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Effect of GA_3 and salicylic acid on growth and flowering in rose grown under protected condition

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Abstract
The experiment was carried out at Horticulture Research Farm, Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. Treatment consisted of foliar application of GA_3 (200, 250 and 300 ppm) and SA (100, 150 and 200 ppm) along with control (distilled water) in the rose plant grown under protected condition. Experiment was laid out in a Randomized Block Design with four replications. Both GA_3 and SA treatments significantly affected the growth and flowering parameters of rose cv. Taj Mahal. Among all the treatments, application of GA_3 300 ppm is most effective treatment for increasing plant height at 60 DAS, number of leaves per plant at 60 DAS, number of leaves per branch at 45 DAS and number of branch per plant. Similarly, minimum days to first bud initiation, maximum bud length, bud diameter, number of petals per flower, petals length and petals breadth was also recorded with GA_3 300 ppm.

Keywords: Rose, GA_3, SA, growth and flowering

Introduction
Rose is one of the most cut flower in the international market. In the present time, the aim of florists is to improve quality as well as yield in rose. Low yield and low quality are a major problem in India compared to other countries. The problems can be controlled and corrected by optimizing the production conditions and also use of plant growth regulators (PGRs). Increasing good quality and yield can be achieved by manipulating growth factors such as environmental conditions (light, temperature, etc.). In roses, gibberellic acid plays an important role in regulating the growth and flowering through increasing the length of shoots by extending intermodal length and increasing the number of nodes (Singh, 2006) [20]. In plant life, PGRs play an important role in flowering and growth of plant and also quickly responds to hormonal balance (Khangoli, 2001) [14]. Plant growth retardant is also most important in ornamental plants like rose. These compounds affect cell division and growth in apical part but they do not affect meristem (Hedayat, 2001) [14]. PGRs supposedly decrease plant growth without affecting physically characters like leaves, branch number, etc. However, it may increase yield and quality of rose cut flowers *via* plant height, promoting flowering and improving flower characters (Khangoli, 2001 and Hedayat, 2001) [14]. Among PGRs, gibberellin acid (GA_3) plays an important role in the growth and development of a plant. The effect of GA_3 is to raise the growth and vigour of various horticultural plants is very old known and well documented (Gul *et al*., 2006) [10]. However, GA_3 increases yield and quality of ornamental plants *via* plant growth incitation and stem elongation. It increases cell size, stem height and number of leaves, etc. Whereas, SA plays an important role in the resistance of old leaves against pathogens. It acts as an induction signal for specific defense responses of plants. SA normally operates by producing low weight proteins with some interesting role in the resistance (Fathipour and Esmaellpour, 2000) [8]. This experiment was carried out to evaluate different levels of GA_3, SA, and control on the quality and yield performance of rose cv. Taj Mahal.

Materials and methods
The present experiment was carried out at Horticulture Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi (India). Three-year-old rose cv. Taj Mahal grown in the poly house was used in this experiment. The experiment was laid out in Randomized Block Design having 7 treatments i.e. three levels of GA_3 (200, 250 and 300 ppm), three levels of SA (100, 150 and 200 ppm) and distilled water as control with four replications. GA_3 and SA were applied on standing crop as foliar spray. The observations were recorded at a regular basis to evaluate the effect of GA_3 and SA on vegetative and flowering characters. Bud length and bud diameter were measured by using verniercalliper. The vegetative and flowering characters were measured accordingly and subjected to statistically analysis at 0.05% probability.

Table 1: Effect of different GA_3 and SA on vegetative growth characters of rose cv. Taj Mahal

Treatments	Plant height at 60 DAS	No. of leaves/plant at 60 DAS	No. of leaves/branch at 45 DAS	No. of branches/plant
GA_3 200 ppm	64.40	141.50	37.63	3.50
GA_3 250 ppm	65.47	153.00	40.73	3.50
GA_3 300 ppm	69.27	158.00	42.48	3.75
SA 100 ppm	47.53	119.25	32.20	3.00
SA 150 ppm	49.53	129.75	33.93	3.00
SA 200 ppm	51.43	132.50	35.80	3.25
Control	44.47	116.50	31.73	2.75
C.D. at 5 %	10.97	12.79	5.62	NS

Results and Discussion

It is apparent from Table 1 that the foliar spray of GA_3 and SA significantly affected plant height, number of leaves at 60 DAS, number of leaves per branch at 45 DAS. Maximum plant height was observed with GA_3 300 ppm (69.27 cm) which was statistically at par with GA_3 250 ppm (65.47 cm) and GA_3 200 ppm (64.40 cm). Whereas, minimum plant height was observed with control (44.47 cm) followed by SA 100 ppm (47.73 cm) and SA 150 ppm (49.53 cm). Gibberellins are known to promote the elongation of the stem by cell elongation and cell multiplication. The results of the present investigation are in accordance with Sable *et al*. (1992) [19], Bhattacharjee (1993) [3] and Porwal *et al*. (2002) [18] in rose. Maximum number of leaves per plant was recorded in plants treated with GA_3 300 ppm (158.00) which was statistically at par with GA_3 250 ppm (153.00). While, minimum number of leaves per plant was recorded with control (116.50) followed by SA 100 ppm (119.25) and SA 150 ppm (129.75). Similarly, maximum number of leaves per branch was recorded with GA_3 300 ppm (42.48) which was found to be statistically at par with GA_3 250 ppm (40.73) and GA_3 200 ppm (37.63). Whereas minimum number of leaves per plant at 45DAS was recorded with control (31.73).The physiological role played by GA_3 in increasing the area of photosynthesis to produce more carbohydrate. This increased in number of leaves may be due to the increased number of internodes and increased photosynthetic efficiency of the plant due to an increase in chlorophyll. These results are in conformity with the results of Singh *et al*. (2018) [21] in Lolium, Padhi *et al*. (2018) [20] in gladiolus, Nanjan and Muthuswamy (1975) [15] in Edward Rose and Chakradhar (2002) [4] with GA_3 in rose cv. Gladiator. Foliar application of GA_3 and SA has non-significant effect on number of branches per plant. Maximum number of branches per plant was recorded with GA_3 300 ppm as compared to other treatments. While, minimum number of branches per plant was recorded with control.

It is clear from the Table 2 that early initiation of first bud was recorded with GA_3 300 ppm (30.63 days) which was statistically at par with GA_3 250 ppm (30.83 days), GA_3 200 ppm (31.75 days), SA 200 ppm (32.25 days) and SA 250 ppm (32.50 days), whereas, maximum day taken to first flower initiation was obtained with control (36.75 days) followed by SA 100 ppm (33.90 days). Early bud initiation also could be due to the quick availability of the optimum level of nutrients. Further, GA_3 also increases the activity of IAA oxidase enzyme which is responsible for the degradation of auxins, thus inducing early flowering and harvesting (Padmapriya and Chezhiyan, 2003) [17]. The maximum bud length and bud diameter was recorded with GA_3 300 ppm (3.58 cm and 2.26 cm) which was statistically at par with GA_3 250 ppm (3.47 and 2.23 cm); while, minimum bud length and bud diameter was recorded with control (3.14 cm and 1.69 cm) followed by SA 100 ppm (3.17 cm and 1.78 cm) and SA 150 ppm (3.20 cm and 1.97 cm), respectively. This was due to the genetic response of the cultivars to the treatments. Simialr results were obtained by Dhekney *et al.* (2000) [7], Chakradhar *et al.* (2003) [5], Arun *et al*. (2000) in rose CV. First Red, Baskaran and Misra (2007) [2] in gladiolus and Delvadia *et al.* (2009) [6] in gaillardia.

Table 2: Effect of different GA_3 and SA on flowering characters of rose cv. Taj Mahal

Treatment	Days to first bud initiation (Days)	Bud length (cm)	Bud diameter (cm)	Number of petals/flower	Petals length (cm)	Petals breadth (cm)
GA_3 200 ppm	31.75	3.31	2.03	45.27	4.60	3.97
GA_3 250 ppm	30.83	3.47	2.23	45.50	4.68	4.01
GA_3 300 ppm	30.63	3.58	2.26	47.44	4.73	4.03
SA 100 ppm	33.90	3.17	1.78	41.44	4.41	3.72
SA 150 ppm	32.50	3.20	1.97	43.33	4.46	3.85
SA 200 ppm	32.25	3.27	1.97	43.97	4.49	3.89
Control	36.75	3.14	1.69	38.69	4.39	3.62
C.D. at 5 %	2.60	0.25	0.22	3.24	NS	NS

Maximum number of petals was recorded with GA_3 300 ppm (47.44) which was statistically at par with GA_3 250 ppm (45.50) and GA_3 200 ppm (45.27) whereas, the minimum number of petals was recorded with control (38.69) followed by SA 100 ppm (41.44) and SA 150 ppm (43.33), respectively (Table 2).Increase in number of petals per flower might be due to high levels endogenous gibberellins and auxins which contributed to the development of flower, more production of carbohydrate associated with existence of more leaf number and area per flowering shoot. Similar results regarding the number of petals were noted by Gowda (1988) [9] in rose cv. American Heritage, Chakradhar (2002) [4] in rose cv. Gladiator and Horibe *et al*. (2009) [12] in rose, Kapri *et al*. (2018) [13] in lilium, Singh *et al*. (2017) [22] in marigold. Again the effect of plant growth regulators showed a non-significant effect on the petals length and petals breadth. However, treatment $GA_3$300 ppm showed maximum petals length and breadth followed by GA_3 250 ppm whereas minimum petals length and petal breadth was observed with control.

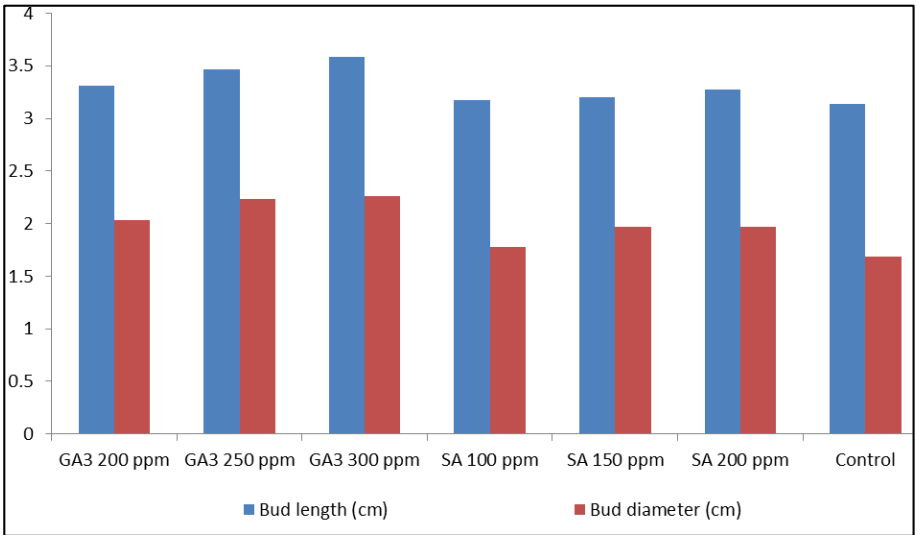

Fig 1: Effect of different concentrations of GA_3 and SA on bud length (cm) and bud diameter (cm) in rose cv. Taj Mahal

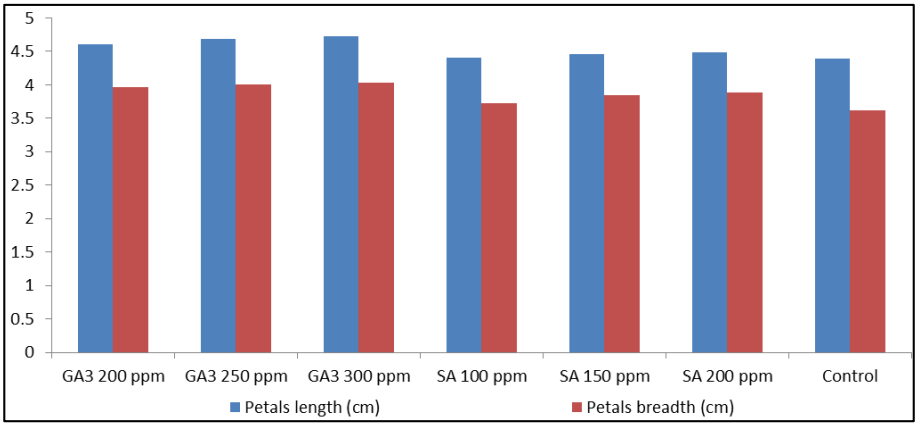

Fig 2: Effect of different concentrations of GA_3 and SA on petals length (cm) and petals diameter (cm) in rose cv. Taj Mahal

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