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Effect of GA₃ on flowering and flower quality of different rose varieties under open conditions

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Abstract

An experiment was carried out during 2018-19, 2019-20 and 2021-22 at Department of Floriculture and Landscape Architecture, Dr. PDKV, Akola. The experiment was laid out in strip plot design with three replications and thirty treatment combinations consisting of ten rose varieties (Sofiya, Gladiator, Folklore, Royalden, Eiffel Tower, Paradise, Nashik Yellow, Gold Medal, Grand Moghal and White Masterpiece) and three levels of GA₃ (control, GA₃ 100 ppm and GA₃ 200 ppm). Significantly highest flower bud length, diameter of flower, length of petal and width of petal were recorded in the rose variety Eiffel Tower and treatment GA₃ 200 ppm, whereas the lowest flower bud length, diameter of flower, length of petal and width of petal were recorded in rose variety Gold Medal and in control treatment.

The highest flower bud diameter, duration of flowering and number of petals were recorded in the rose variety Gladiator and in GA₃ 200 ppm, whereas the lowest flower bud diameter, duration of flowering and number of petals were recorded in rose variety Royalden and in control treatment.

The parameters in respect of flower stalk length, and flower stalk diameter were superior in the rose variety Gladiator and also in treatment GA₃ 200 ppm, whereas the flower stalk length, and flower stalk diameter were recorded lowest in rose variety Gold Medal and in control treatment.

The characters in respect of flower breadth and days to full bloom was highest in the rose variety Gladiator and in GA₃ 200 ppm, while the less flower breadth and days to full bloom was recorded in rose variety Nashik yellow and White Masterpiece respectively and in treatment control.

Keywords: GA₃, rose, varieties, treatments, flowering, flower quality

Introduction

Indian floriculture industry has more or less established itself in the national and international markets after the initial struggle. The country has drawn strength from availability of different climatic zones, good soil, cheap labor, land and skilled manpower. Commonly flowers are of two types viz. cut and loose flowers. The aesthetic value of flowers and ornamental plants, their use in social events, overall satisfaction in working with them and high income generating power are attracting modern entrepreneurs to invest money in the floriculture industry. The demand for flowers and ornamental plants for different needs like religious, official ceremonies, parties, house decoration, weddings, funerals, etc. is on the rise. This demand for fresh flowers and plants is increasing world-wide over the coming years. The science and art of commercial floriculture has been recognized as an economic activity with the potential for generating employment and earning valuable foreign exchange. In several countries of the world, floricultural products are amongst the main export items of agricultural origin. Cut flowers that have a long stalk and used as single flower for vases, bouquets, flower arrangements etc. The Government of India has also identified floriculture as a niche area with vast potential for export. There are many incentives given by the Government for setting up of floricultural units as Export oriented units (EOUs).

There are so many varieties in roses, especially hybrid tea roses are more attracting flower in the market for their royal look, large and well shape bloom and perfect cut flower with attracting colour. The rose has been a symbol of love, beauty, even war and politics from way back in time. The variety, colour and even number of Roses carry symbolic meanings. The Rose is most popularly known as the flower of love, particularly Red Rose. The new era of roses occurred in 1867, by producing the first hybrid tea rose "La France" was developed by J.B. Guillot in France. India is bestowed with several agro-climatic zones conducive for production of sensitive and delicate floriculture products. During the decade after liberalization floriculture industries took giant steps in the export arena.

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This era has seen a dynamic shift from sustenance production to commercial production. Commercial production of cut rose is a major venture and highly profitable. For the commercial cultivation of rose varieties, popular varieties which can produce quality and quality blooms having more demand in the market were selected for experiment. There is bright prospect for the expansion of area under cut flowers in the near future. Good quality production is required to manipulate growth factors including light and temperature, which is very difficult and expensive. Since, plant growth and flowering depended in PGRs equilibrium, however, it is expected to control the response of plant to hormonal balance when used in small concentrations. Plant growth regulators (PGRs) have been used for more than 60 years to improve plant vigour and enhancing flower production in rose (Car Penter and Rodriguez, 1971; Mor and Zieslin, 1987) [3, 11].

Gibberellic acid (GA₃) is a natural synthetic growth hormone and is a part of a type of plant hormone called gibberellins. GA₃ promotes cell division and a number of plant development mechanism and encourages numerous desirable effects such as plant height, uniform flowering and increased flower number and size. GA₃ ppm enhanced vegetative growth and flowering.

Hence the present study was undertaken with the objective to find out suitable rose for the region and to find out suitable concentration of GA₃ for quality flower production.

Materials and Methods

An experiment entitled, "Response of hybrid tea rose varieties to GA₃ under open condition" was carried out during the years 2018-19, 2019-20 and 2021-22 at the Experimental field, Department of Floriculture and Landscape Architecture, Dr. PDKV, Akola. The experiment was laid out in strip plot design with three replications and thirty treatment combinations consisting of ten rose varieties (Sofiya, Gladiator, Folklore, Royalden, Eiffel Tower, Paradise, Nashik Yellow, Gold Medal, Grand Moghal and White Masterpiece) and three levels of GA₃ (Control, GA₃-100 ppm and GA₃-200 ppm) were selected for investigation. Ninety individual plots of 3.00 x 1.50 m size were demarcated in research trial field. Light earthing up operation was done prior to pruning so as to loosen the soil for better aeration. Five plants were selected randomly from each treatment plot and labelled for recording the various observations of flowering and flowering characters. The observations were recorded from 45 days after the 1st spray of GA₃ at 30 days interval till 135 days of plant growth.

The treatment comprised with ten hybrid tea rose varieties V₁- Sofiya, V₂- Gladiator, V₃- Folklore, V₄- Royalden, V₅-Eiffel Tower, V₆- Paradise, V₇- Nashik Yellow, V₈- Gold Medal, V₉- Grand Moghal and V₁₀- White Masterpiece and the treatments are G₀- control, G₁- GA₃ 100 ppm and G₂- GA₃ 200 ppm with thirty treatment combinations with three replications. As per the treatments the first foliar application of GA₃ was done 15 days after pruning and there after 20 days of first spray, a second spray was given. The various observations of flowering and flower quality parameters like days to full bloom (days), duration of flowering (days), flower bud length (cm), flower bud diameter (cm), flower stalk length (cm), flower stalk diameter (cm), number of petal per flower, length of petal (cm), width of petal (cm) and diameter of flower (cm). The data obtained on various parameters was

statistically analyzed as per methods suggested by Panse and Sukhatme (1976) [14].

Results and Discussion

The data presented in Table 1, 2 and 3 revealed that, effect of different varieties and GA₃ concentrations on flowering and flower quality parameters.

Flowering parameter

The data pertaining to different flowering parameters viz. days to full bloom and duration of flowering are presented in table 1.

Days to full bloom (Days)

Effect of rose varieties

The highest number of days to full bloom from bud initiation to full flower opening stage was recorded in the hybrid tea rose variety Gladiator (20.33, 20.67 and 20.71 days) which was significantly superior to rest of all the treatments during the three years 2018-19, 2019-20 and 2021-22. And it was followed by the rose variety Paradise (18.89, 19.56 and 19.56 days) and Royalden recorded (18.36, 18.80 and 18.87 days). However, the lowest number of days to full bloom was found in rose variety White Masterpiece (14.64, 14.73 and 14.76 days). Similarly pooled mean of three year data for highest number of days to full bloom was recorded in rose variety Gladiator (20.57 days) and it was followed by variety Paradise (18.67 days) and Royalden (18.67 days). The lowest number of days to full bloom was recorded in rose variety White Masterpiece (14.71) days.

From the above results it is indicated that, the highest number of days to full bloom from bud initiation to full flower opening stage was recorded in the hybrid tea rose variety Gladiator. The difference in days to full bloom may be due to varietal characteristics.

Effect of gibberellic acid

Significantly highest number of days to full bloom was recorded in treatment gibberellic acid (GA₃) 200 ppm (18.05, 16.93 and 16.99 days) which was significantly superior than rest of all the treatments during the year 2018-19, 2019-20 and 2021-22. This was followed by GA₃ 100 ppm (17.27, 17.66 and 17.69 days). Whereas, the significantly lowest number of days to full bloom was found in the control treatment (16.67, 16.93 and 16.99). Similarly pooled mean of three year data shown highest number of days to full bloom was recorded in GA₃ 200 ppm (18.30) days which was followed by the GA₃ 100 ppm (17.54 days). However, significantly lowest number of days to full bloom was found in the control treatment (16.86 days).

The increased duration of number of days to full bloom as enhanced by GA₃ might be due to increase in carbohydrate content in the plant. Similar results were observed by Reddy and Sulladmath (1983) in China aster, Dutta *et al.* (1993) [5] and Verma *et al.* (1995) [17] in chrysanthemum.

Interaction effect

The results of pooled data presented in Table 1 revealed that, an interaction effect of number of days to full bloom from bud initiation to full flower opening stage influenced by hybrid tea rose varieties and GA₃ was found to be non-significant during three years of experimentation and whereas pooled was also found to be non-significant.

Duration of flowering (Days)

Effect of rose varieties

The highest duration of flowering from first harvest to last harvest of flowers was recorded in the hybrid tea rose variety Gladiator (117.33, 121.33 and 122.56 days) which was significantly superior to rest of all the varieties during the three years 2018-19, 2019-20 and 2021-22. This was followed by the rose variety Paradise (114.89, 118.67 and 121.33 days) and Eiffel Tower (110.78, 115.11 and 116.00 days). However, the lowest duration of flowering was found in rose variety Royalden (93.78, 97.22 and 98.33 days). Similarly pooled mean of three year data for highest duration of flowering was recorded in rose variety Gladiator (120.41 days) followed by with rose variety Paradise (119.81 days) and Eiffel Tower (113.96 days). The lowest duration of flowering was recorded in rose variety Royalden (96.44 days).

Effect of gibberellic acid

The highest duration of flowering was recorded GA₃ 200 ppm (109.03, 113.33 and 113.47) which was significantly superior than rest of all the treatments during the year 2018-19, 2019-2020 and 2021-2022. This was followed by GA₃ 100 ppm (105.03, 108.20 and 109.33). Whereas, the significantly lowest duration of flowering was found in the control treatment (101.00, 104.77 and 105.60). Similarly pooled mean of three year data shown highest duration of flowering was recorded in the treatment GA₃ 200 ppm (119.94) which was followed by the treatment GA₃ 100 ppm (107.52 days). However, significantly lowest duration of flowering was found in the control treatment (103.79).

The results noticed from the above investigation it is shown that, the highest duration of flowering period was observed in treatment GA₃ 200 ppm. However the similar results was reported by Wasnik *et al.* (2020) [18]. This might be due to greater dry matter accumulation which certainly suggestive to better photosynthesis. The results of this investigation are in close accordance with Reddy and Sulladmath (1983) with the treatment GA₃ at 300 ppm.

Interaction effect

Data presented in Table 1 revealed that, an interaction effect of duration of flowering from first harvest to last harvest of flowers was influenced by hybrid tea rose varieties and GA₃ was found to be non-significant during three years of experimentation and whereas pooled was also found to be non-significant.

Flower quality parameters

The data pertaining to different flowering parameters *viz.* flower bud length (cm), flower bud diameter (cm), flower stalk length (cm), flower stalk diameter (cm), number of petal per flower, length of petal (cm), width of petal (cm) and diameter of flower (cm) in table 1, 2 and 3.

Flower bud length (cm)

Effect of rose varieties: Significantly highest length of flower bud at full bud grown stage was recorded in the hybrid tea rose variety Eiffel Tower (4.55 cm, 4.84 cm and 4.88 cm) which was significantly superior to rest of all the varieties during the year 2018-19, 2019-20 and 2020-21. Which was followed by the rose variety Folklore (4.37 cm, 4.58 cm and 4.68 cm) and Grand Moghul (4.31 cm, 4.44 cm and 4.48 cm). However, the lowest flower bud length was found in rose

variety Gold Medal (3.52 cm, 3.62 cm and 3.68 cm). Similarly pooled mean of three year data, the highest flower bud length was recorded in rose variety Eiffel Tower (4.76 cm) and which was followed by with rose variety Folklore (4.52) and Grand Moghul (4.41 cm).

From the above data the highest length of flower bud at full bud grown stage was recorded in the hybrid tea rose variety Eiffel Tower. This difference might be due to the varietal characteristics of the different varieties. The results found in above investigation are in close conformity with Paramagoudar (2010) [15] and Mohanty *et al.* (2011) [9] in rose.

Effect of gibberellic acid

The data furnished in Table 1 revealed that, The highest length of flower bud was recorded in GA₃ 200 ppm (4.42 cm, 4.59 cm and 4.61 cm) which was significantly superior than rest of all the GA₃ treatments during the year 2018-19, 2019-2020 and 2021-2022. This was followed by GA₃ 100 ppm (4.06 cm, 4.24 cm and 4.27 cm). Whereas, the significantly lowest flower bud length was found in the treatment control (3.73 cm, 3.87 cm and 3.93 cm). Similarly pooled mean of three year data for highest flower bud length was recorded in the GA₃ 200 ppm (4.54 cm) which was followed by the treatment GA₃ 100 ppm (4.19 cm). However, significantly lowest length of flower bud was found in the control treatment (3.85 cm).

From the above result it is investigated that, the highest length of flower bud was recorded in GA₃ 200 ppm. This might be due to increase in cell size. The results related to gibberellic acid influences were in close conformity with the findings of Bankar and Mukhopadhyay (1982) [2] in rose.

Interaction effect

The interaction data indicated that, an interaction effect of flower bud length at full bud grown stage as influenced by hybrid tea rose varieties and GA₃ was found to be non-significant during three years of experimentation and whereas pooled was also found to be non-significant.

Flower bud diameter (cm)

Effect of rose varieties

The highest flower bud diameter at full bud grown stage was recorded in the hybrid tea rose variety Gladiator (3.83 cm, 4.13 cm and 4.18 cm) which was significantly superior to rest of all the treatments during the three years 2018-19, 2019-20 and 2021-22. This was followed by the rose variety Sofiya (3.38 cm, 3.58 cm and 3.61 cm) and Gold Medal (3.01 cm, 3.17 cm and 3.31 cm). However, the lowest flower bud diameter was found in rose variety Royalden (2.31 cm, 2.37 cm and 2.42 cm). Similarly pooled mean of three year data for highest flower bud diameter was recorded in rose variety Gladiator (4.06 cm) and which was followed by with rose variety Sofiya (3.53) and Gold Medal (3.16 cm). The lowest flower bud diameter was recorded in rose variety Royalden (2.37 cm).

From the above results it is indicated that, Gladiator has maximum diameter of flower bud. This might be due to the fact that genetic makeup in different varieties.

Similar results are closely related with Mohanty *et al.* (2011) [9] noticed that cv. Gladiator produced highest bud diameter among Minuparle and Montezuma. These results are in close conformity with those of Man Bihari *et al.* (2009) [8] in cv. Rakta local and Atram. *et al.* (2015) in rose cv. Forever.

Effect of gibberellic acid

The highest flower bud diameter was recorded in GA₃ 200 ppm (3.03 cm, 3.21 cm and 3.27 cm) which was significantly superior than rest of all the treatments during the year 2018-19, 2019-20 and 2021-22. This was followed by GA₃ 100 ppm (2.85 cm, 3.00 cm and 3.05 cm). Whereas, the significantly lowest flower bud diameter was found in the control treatment (2.58 cm, 2.73 cm and 2.81 cm). Similarly pooled mean of three year data, the highest flower bud diameter was recorded in the treatment GA₃ 200 ppm (3.17 cm) which was followed by the treatment GA₃ 100 ppm (2.97 cm). However, significantly lowest diameter of flower bud was found in the treatment control (2.71 cm).

The results noticed from the above investigated is that, the highest diameter of flower bud was recorded in GA₃ 200 ppm. This might be due to increase in cell size and availability of more carbohydrates and elaborate food during the development of flower bud under these treatment. The results obtained during this investigation is in close agreement with the findings of Bankar and Mukhopadhyay (1982)^[2] in rose, Goyal and Gupta (1994)^[6] in rose, Arun *et al.* (2000)^[1], Sadanand *et al.* (2000)^[16] in rose and Wasnik *et al.* (2020)^[18].

Interaction effect

Data presented in Table 2 furnished that, an interaction effect of flower bud diameter at full bud grown stage was influenced by hybrid tea rose varieties and GA₃ and found to be non-significant during three years of experimentation and whereas pooled was also found to be non-significant.

Flower stalk length (cm)

Effect of rose varieties

The data from Table 2 indicated that, the highest flower stalk length at the time of harvest was recorded in the hybrid tea rose variety Gladiator (41.04 cm, 42.64 cm and 42.93 cm) which was significantly superior to rest of all the treatments during the three years 2018-19, 2019-20 and 2021-22. This was followed by rose variety Eiffel Tower (38.98 cm, 40.02 cm and 40.29 cm) and rose variety Sofiya (35.98 cm, 37.53 cm and 37.80 cm). However, the lowest flower stalk length was found in rose variety Nashik Yellow (27.67 cm, 28.42 cm and 29.00 cm). Similarly pooled mean of three year data, the highest flower stalk length was recorded in rose variety Gladiator (42.21 cm). Which was followed by with rose variety Eiffel Tower (39.76) and Sofiya (37.10 cm). The lowest flower stalk length was recorded in rose variety Nashik Yellow (28.36 cm).

From the above results it is noticed that, the highest flower stalk length was recorded in the hybrid tea rose variety Gladiator. This difference might be due to the varietal characteristics of the different varieties.

The similar results were reported by Mohanty *et al.* (2011)^[9] in rose variety Gladiator. These results obtained during this investigation are in close conformity with findings of Paramagoudar (2010)^[15] in cv. Grandgala and Atram *et al.* (2015) in rose.

Effect of gibberellic acid

Significantly, highest flower stalk length was recorded in GA₃ 200 ppm (37.52 cm, 38.67 cm and 39.09 cm) which was significantly superior to rest of all the treatments during the year 2018-19, 2019-2020 and 2021-2022. This was followed by GA₃ 100 ppm (33.25 cm, 34.39 cm and 34.65 cm).

Whereas, the significantly lowest flower stalk length was found in the control treatment (29.81 cm, 30.81 cm and 30.95 cm). Similarly pooled mean of three year data for highest flower stalk length was recorded in the treatment GA₃ 200 ppm (38.43 cm) which was followed by the treatment GA₃ 100 ppm (34.10 cm). However, significantly lowest flower stalk length was found in the control treatment (30.52 cm).

In respect of above results, the highest flower stalk length was recorded in GA₃ 200 ppm. This might be due to the higher concentration of GA₃ enhanced apical dominance indirectly inhibit Auxin content. The results obtained during this investigation are in close agreement with the findings of Chaudhari *et al.* (2018)^[4] in rose, Lakhani. (2007)^[7] and Wasnik *et al.* (2020)^[18] in rose.

Interaction effect

The pooled data regarding flower stalk length exhibited in Table 25 revealed that, an interaction effect of flower stalk length at the time of harvest was influenced by hybrid tea rose varieties and GA₃, which was found to be non-significant during three years of experimentation and whereas pooled was also found to be non-significant.

Flower stalk diameter (cm)

Effect of rose varieties

From the data presented in Table 26 it is found that, the highest flower stalk diameter at the time of harvest was recorded in the hybrid tea rose variety Gladiator (0.67 cm, 0.72 cm and 0.72 cm) which was significantly superior to rest of all the treatments during the three years 2018-19, 2019-20 and 2021-22. This was at par with rose variety Sofiya (0.66 cm, 0.71 cm and 0.71 cm). However, the lowest flower stalk diameter was found in rose variety Gold Medal (0.56 cm, 0.62 cm and 0.60 cm). Similarly pooled mean of three year data, the highest flower stalk diameter was recorded in rose variety Gladiator (0.70 cm) and which was at par with rose variety Sofiya (0.69 cm) and Folklore (0.68 cm). The lowest flower stalk diameter was recorded in rose variety Gold Medal (0.59 cm).

From the above results it is noticed that, the highest flower stalk diameter was recorded in the hybrid tea rose variety Gladiator. This difference might be due to the varietal characteristics of the different varieties. The similar results were reported by Pal (1991)^[13] and Mohanty *et al.* (2011)^[9] in rose variety Gladiator. The results obtained during this investigation are in close conformity with findings of Man Bihari *et al.* (2009)^[8] and Paramagoudar (2010)^[15] in rose.

Effect of gibberellic acid

The data depicted in Table 2 indicated that, the highest flower stalk diameter was recorded in GA₃ 200 ppm (0.69 cm, 0.75 cm and 0.74 cm) which was significantly superior than rest of all the treatments during the year 2018-19, 2019-20 and 2021-22. This was followed by GA₃ 100 ppm (0.62 cm, 0.67 cm and 0.66 cm). Whereas, the significantly lowest flower stalk diameter was found in the control treatment (0.53 cm, 0.57 cm and 0.57 cm). Similarly pooled mean of three year data for highest flower stalk diameter was recorded in GA₃ 200 ppm (0.73 cm) which was followed by GA₃ 100 ppm (0.65 cm). However, significantly lowest flower stalk diameter was found in the control treatment (0.55 cm).

In respect of above results, the highest flower stalk diameter was recorded in GA₃ 200 ppm. This might be due to the

higher concentration of GA₃ enhanced apical dominance indirectly inhibit Auxin content. The results obtained during this investigation are in close agreement with the findings of Mondal and Sarkar (2018)^[10] in rose, Chaudhari *et al.* (2018)^[4] in rose, and Wasnik *et al.* (2020)^[18] in rose.

Interaction effect

Data presented in Table 2 furnished that, an interaction effect of flower stalk diameter at 50% flowering was influenced by hybrid tea rose varieties and GA₃ and found to be non-significant during three years of experimentation and whereas pooled was also found to be non-significant.

Diameter of flower (cm)

Effect of rose varieties

The highest diameter of flower at full flower open stage was recorded in the hybrid tea rose variety Eiffel Tower (12.25 cm, 12.57 cm and 12.63 cm) which was significantly superior to rest of all the treatments during the three years 2018-19, 2019-20 and 2021-22. This was followed by the rose variety Gladiator (11.52 cm, 11.88 cm and 11.98 cm) and Grand Moghul (11.17cm, 11.48 cm and 11.56 cm). However, the lowest diameter of flower was found in rose variety Gold Medal (9.26 cm, 9.48 cm and 9.54 cm). Similarly pooled mean of three year data, the highest diameter of flower was recorded in rose variety Eiffel Tower (12.48cm) and which was followed by with rose variety Gladiator (11.76) and Grand Moghul (11.40 cm). The lowest diameter of flower was recorded in rose variety Gold Medal (9.42 cm)

From the above results it is indicated that, Gladiator has maximum diameter of flower. This might be due to the fact that genetic variability producing differences under similar agro-climatic conditions in different varieties. The similar

results was reported by the Mohanty *et al.* (2011)^[9].

Effect of gibberellic acid

In respect of diameter of flower, the highest diameter of flower was recorded in GA₃ 200 ppm (11.17 cm, 11.48 cm and 11.56 cm) which was significantly superior than rest of all the treatments during the year 2018-19, 2019-2020 and 2021-2022. This was followed by GA₃ 100 ppm (10.25 cm, 10.52 cm and 10.60 cm). Whereas, the significantly lowest diameter of flower was found in the control treatment (9.05 cm, 9.32 cm and 9.43 cm). Similarly pooled mean of three year data, the highest diameter of flower was recorded in the treatment GA₃ 200 ppm (12.00 cm) which was followed by the treatment GA₃ 100 ppm (10.46 cm). However, significantly lowest diameter of the flower was found in the control treatment (9.27 cm).

From the above investigation the results noticed that, the highest diameter of flower was recorded in GA₃ 200 ppm. The similar results were reported by Chaudhari and Patil (2018)^[4]. This might be due to increase in cell size and availability of more carbohydrates and elaborate food during the development of flower bud under these treatment. The results obtained during this investigation are in close agreement with the findings of Goyal and Gupta (1994)^[6] in rose cv. Super Star, Muthu Kumar *et al.* (2012)^[12] in rose cv. First Red.

Interaction effect

The pooled data presented in Table 3, noticed that, an interaction effect of diameter of flower at full flower open stage was influenced by hybrid tea rose varieties and GA₃ and found to be non-significant during three years of experimentation and pooled was also found to be non-significant.

Table 1: Effect of hybrid tea rose varieties and GA₃ on flowering and flower quality

Main plot	Days to full bloom (Days)				Duration of flowering (Days)				Flower bud length (cm)			
	First Year	Second Year	Third Year	Pooled	First Year	Second Year	Third Year	Pooled	First Year	Second Year	Third Year	Pooled
Hybrid tea rose varieties												
V ₁ - Sofiya	16.73	17.00	17.02	16.92	110.33	114.67	114.00	113.00	4.09	4.23	4.32	4.21
V ₂ - Gladiator	20.33	20.67	20.71	20.57	117.33	121.33	122.56	120.41	4.24	4.38	4.40	4.34
V ₃ - Folklore	18.13	18.44	18.44	18.34	94.33	98.56	99.67	97.52	4.37	4.58	4.68	4.54
V ₄ - Royalden	18.36	18.80	18.87	18.67	93.78	97.22	98.33	96.44	4.00	4.16	4.22	4.13
V ₅ - Eiffel Tower	18.22	18.76	18.82	18.60	110.78	115.11	116.00	113.96	4.55	4.84	4.88	4.76
V ₆ - Paradise	18.89	19.56	19.56	19.33	114.89	118.67	121.33	119.81	3.99	4.17	4.23	4.13
V ₇ - Nashik Yellow	17.13	17.31	17.40	17.28	104.56	108.11	109.11	107.26	3.82	3.92	3.91	3.88
V ₈ - Gold Medal	15.04	15.24	15.29	15.19	106.67	109.11	109.67	108.48	3.52	3.62	3.68	3.60
V ₉ - Grand Moghul	15.78	16.16	16.22	16.05	100.67	104.89	106.22	103.93	4.31	4.44	4.48	4.41
V ₁₀ - White Masterpiece	14.64	14.73	14.76	14.71	96.89	100.56	100.67	99.37	3.83	3.98	3.93	3.91
'F' Test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE (m) ±	0.17	0.16	0.16	0.11	0.55	0.95	1.14	0.46	0.05	0.04	0.05	0.03
CD at 5%	0.50	0.49	0.47	0.33	1.63	2.82	3.38	1.37	0.16	0.11	0.14	0.10
Sub plot												
GA₃ Treatments												
G ₀ - Control	16.67	16.93	16.99	16.86	101.00	104.77	105.60	103.79	3.73	3.87	3.93	3.85
G ₁ - GA ₃ 100 ppm	17.27	17.66	17.69	17.54	105.03	108.20	109.33	107.52	4.06	4.24	4.27	4.19
G ₂ - GA ₃ 200 ppm	18.05	18.41	18.45	18.30	109.03	113.33	113.47	111.94	4.42	4.59	4.61	4.54
'F' Test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE (m) ±	0.08	0.04	0.07	0.11	0.33	0.24	0.31	0.77	0.02	0.01	0.03	0.04
CD at 5%	0.30	0.15	0.26	0.42	1.29	0.94	1.21	3.01	0.08	0.05	0.11	0.17
Interaction (V X T)												
'F' Test	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
SE (m) ±	0.25	0.21	0.21	0.41	1.05	1.04	1.25	2.97	0.09	0.08	0.09	0.17
CD at 5%	-	-	-	-	-	-	-	-	-	-	-	-

Table 2: Effect of hybrid tea rose varieties and GA₃ on flowering and flower quality (cm)

Main plot	Flower bud diameter				Flower stalk length (cm)				Flower stalk diameter (cm)			
	First Year	Second Year	Third Year	Pooled	First Year	Second Year	Third Year	Pooled	First Year	Second Year	Third Year	Pooled
Hybrid tea rose varieties												
V ₁ - Sofiya	3.38	3.58	3.61	3.53	35.98	37.53	37.80	37.10	0.66	0.71	0.71	0.69
V ₂ - Gladiator	3.83	4.13	4.18	4.06	41.04	42.64	42.93	42.21	0.67	0.72	0.72	0.70
V ₃ - Folklore	2.61	2.79	2.84	2.75	34.80	35.91	36.44	35.72	0.65	0.69	0.69	0.68
V ₄ - Royalden	2.31	2.37	2.42	2.37	33.53	34.27	34.53	34.11	0.61	0.64	0.64	0.63
V ₅ - Eiffel Tower	2.33	2.42	2.49	2.41	38.98	40.02	40.29	39.76	0.60	0.65	0.65	0.64
V ₆ - Paradise	2.51	2.64	2.72	2.62	35.89	37.47	37.29	36.88	0.62	0.67	0.67	0.66
V ₇ - Nashik Yellow	2.58	2.70	2.77	2.68	27.67	28.42	29.00	28.36	0.58	0.63	0.62	0.61
V ₈ - Gold Medal	3.01	3.17	3.31	3.16	28.07	28.91	29.18	28.72	0.56	0.62	0.60	0.59
V ₉ - Grand Moghul	2.82	2.98	3.05	2.95	31.07	31.93	32.20	31.73	0.58	0.63	0.63	0.62
V ₁₀ - White Masterpiece	2.83	2.98	3.02	2.95	28.24	29.11	29.33	28.90	0.59	0.63	0.62	0.61
'F' Test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE (m) ±	0.04	0.03	0.04	0.02	0.56	0.53	0.47	0.38	0.02	0.02	0.02	0.02
CD at 5%	0.11	0.09	0.13	0.07	1.66	1.57	1.41	1.13	0.05	0.05	0.05	0.06
Sub plot												
GA₃ Treatments												
G ₀ - Control	2.58	2.73	2.81	2.71	29.81	30.81	30.95	30.52	0.53	0.57	0.57	0.55
G ₁ - GA ₃ 100 ppm	2.85	3.00	3.05	2.97	33.25	34.39	34.65	34.10	0.62	0.67	0.66	0.65
G ₂ - GA ₃ 200 ppm	3.03	3.21	3.27	3.17	37.52	38.67	39.09	38.43	0.69	0.75	0.74	0.73
'F' Test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE (m) ±	0.01	0.01	0.03	0.04	0.27	0.31	0.27	0.35	0.01	0.01	0.01	0.01
CD at 5%	0.05	0.04	0.13	0.16	1.05	1.21	1.07	1.39	0.05	0.02	0.03	0.04
Interaction (VxT)												
'F' Test	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
SE (m) ±	0.06	0.05	0.11	0.15	0.74	0.76	0.76	1.37	0.02	0.02	0.02	0.04
CD at 5%	-	-	-	-	-	-	-	-	-	-	-	-

Table 3: Effect of hybrid tea rose varieties and GA₃ on diameter of flower (cm)

Main plot	Diameter of flower			
	First Year	Second Year	Third Year	Pooled
Hybrid tea rose varieties				
V ₁ - Sofiya	9.87	9.63	9.70	9.73
V ₂ - Gladiator	11.52	11.88	11.98	11.79
V ₃ - Folklore	10.62	10.87	10.97	10.82
V ₄ - Royalden	10.08	10.38	10.46	10.31
V ₅ - Eiffel Tower	12.25	12.57	12.63	12.48
V ₆ - Paradise	10.40	10.66	10.73	10.60
V ₇ - Nashik Yellow	9.28	9.66	9.78	9.57
V ₈ - Gold Medal	9.26	9.48	9.54	9.42
V ₉ - Grand Moghul	11.17	11.48	11.56	11.40
V ₁₀ - White Masterpiece	9.41	9.66	9.79	9.62
'F' Test	Sig	Sig	Sig	Sig
SE (m) ±	0.11	0.11	0.12	0.05
CD at 5%	0.33	0.34	0.34	0.16
Sub plot				
GA₃ Treatments				
G ₀ - Control	9.05	9.32	9.43	9.27
G ₁ - Gibberellic acid 100 ppm	10.25	10.52	10.60	10.46
G ₂ - Gibberellic acid 200 ppm	11.86	12.04	12.10	12.00
'F' Test	Sig	Sig	Sig	Sig
SE (m) ±	0.02	0.04	0.03	0.09
CD at 5%	0.08	0.15	0.14	0.37
Interaction (V X T)				
'F' Test	NS	NS	NS	NS
SE (m) ±	0.21	0.21	0.23	0.37
CD at 5%	-	-	-	-

Conclusion

The flowering parameters in respect of highest flower bud length, diameter of flower, length of petal and width of petal were recorded in the rose variety Eiffel Tower and GA₃ 200 ppm, whereas the lowest flower bud length, diameter of flower, length of petal and width of petal were recorded in

rose variety Gold Medal and in treatment control.

The highest flower bud diameter, duration of flowering and number of petals were recorded in the rose variety Gladiator and GA₃ 200 ppm, whereas the lowest flower bud diameter, duration of flowering and number of petals were recorded in rose variety Royalden and in control treatment.

The parameters in respect of flower stalk length, and flower stalk diameter in the rose variety Gladiator was found superior among all the varieties and also in treatment GA₃ 200 ppm, whereas the flower stalk length, and flower stalk diameter were recorded lowest in rose variety Gold Medal and also in control treatment.

Among the GA₃ application GA₃ 200 ppm was found superior in respect flower stalk length and flower stalk diameter.

The characters in respect of flower breadth and days to full bloom was recorded in the rose variety Gladiator was found superior and also in GA₃ 200 ppm, while the less flower breadth and days to full bloom was recorded in rose variety Nashik yellow and White Masterpiece respectively and also in treatment control.

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