



Original Research Article

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## Performance of Hybrid Tea Rose cv. Bugatti in Response to Growth Regulators

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The present investigation was carried out at Horticultural Research Station, Mandouri, BCKV, Mohanpur, West Bengal, India to study the influence of plant growth regulators on growth, flowering, yield and quality of Hybrid Tea rose cv. Bugatti. The experimental results revealed that GA<sub>3</sub> (Gibberellic acid) at 200 ppm + BA (Benzyladenine) at 100 ppm (T<sub>6</sub>) showed maximum plant height (72.50 cm), leaf area (69.39 cm<sup>2</sup>), pedicel length (6.07 cm), least weight loss percentage in vase solution. The maximum primary (3.84) and secondary shoots (14.33), stalk diameter (0.62 cm), pedicel diameter (0.70 cm), total number of flowers per plot (16.67), vase life (9.03 days), total anthocyanin (42.76 mg/ 100 g) and chlorophyll content (11.13 mg/g) were obtained in BA at 200 ppm (T<sub>4</sub>). The treatment BA at 100 ppm (T<sub>3</sub>) showed maximum spread, bud diameter at tight bud stage, flower diameter at cup shape and stalk weight. The maximum shoot length and stalk length were under BA at 200 ppm + GA<sub>3</sub> at 100 ppm (T<sub>5</sub>). The earliness of flowering and flower diameter increase per cent in vase solution was maximum under GA<sub>3</sub> at 100 ppm (T<sub>1</sub>). The highest values on vegetative and flowering parameters as well as flower quality were achieved in BA at 200 ppm as compared to other treatments.

### Introduction

Rose is called “Queen of Flowers” by Sappho, a poetess more than 2500 years ago. Rose belongs to the family Rosaceae. Roses (*Rosa hybrida* L.) are one of the most important commercial crops grown for a variety of purposes such as pot plants, garden plants and cut flower production. Among all other cut flowers roses lead in popularity because of their beauty, fragrance and long lasting blooming quality (Ghaffor *et al.*, 2000; Tabassum *et al.*, 2002). It possesses multiple

uses like extraction of essential oils, Vit. C from hips for medicinal uses and as cut flowers (Khan, 1978). Roses are also used in the preparation of rose water, gulkand, pankhuri, gul-roghan, Potpourri, conserves, rose vinegar, rose petal wine, jam, jellies and syrups etc.

Yield and quality improvement are important aims of blomed growers. Growth regulators have been found effective in terms of vegetative growth of the plants, floriferousness flowering duration and

ultimate quality of the cut blooms. Earlier workers reported the positive influence of GA<sub>3</sub> on the growth parameters like shoot length, intermodal length, etc. and flowering parameters like early flowering(Gupta and Dutta,2001; Ramalingam, 2008), longer stalk, enhanced flowering period, increased yield(Chakradhar and Khiratkar, 2003), longer vase life (Nanjan and Muthuswami, 1975; Sadanand *et al.*, 2000). BA increased the number of basal shoots, flower number, flower longevity and vase life (Treder *et al.*, 1989). An experiment was conducted in open condition in the Gangetic alluvial plains of West Bengal with the objectives of assessing performance of Hybrid Tea rose cv. Bugatti under the influence of GA<sub>3</sub> and BA in terms of overall growth and floral attributes.

### Materials and Methods

The experiment was carried out at Horticultural Research Station, Mondouri, Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal, India from February 2016 - March 2017. The soil of the experimental site is sandy - loam in texture, slightly acidic in reaction with soil P<sup>H</sup> 6.6. The experiment was laid out in Randomised Block Design (RBD) with seven treatments and three replications. The treatments were as follows: T<sub>0</sub> = control, T<sub>1</sub>= GA<sub>3</sub>at 100 ppm, T<sub>2</sub>= GA<sub>3</sub>at 200 ppm, T<sub>3</sub>= BA at 100 ppm, T<sub>4</sub>= BA at 200 ppm, T<sub>5</sub>= BA at 200 ppm + GA<sub>3</sub>at 100 ppm, T<sub>6</sub> = GA<sub>3</sub>at 200 ppm + BA at 100 ppm. During the course of experiment the plants had attained an age of three years and the observations were recorded for the period of September 2016 - March 2017 i.e. for one flowering season. At the end of September, 2016 the plants were pruned moderately at a height of 35-40 cm above the budding point. One month after pruning, spraying of growth regulators (GA<sub>3</sub> and BA at different concentrations) were started with three sprays at an interval of seven days.

Recommended cultural operations were followed during the experiment. After one month of the last spray observations of various parameters on growth and flowering were recorded by using standard methods. Five plants selected randomly from each plot were tagged to record the observations. The data regarding various characters were statistically analysed according to the Fischer's analysis of variance techniques as given by Panse and Sukhatme (1989).

### Results and Discussion

The application of BA and GA<sub>3</sub> resulted in significant influence on vegetative growth of Hybrid tea rose cv. Bugatti. Discounting the concentration levels GA<sub>3</sub> and BA sprays proved superior in terms of vegetative parameters over control. Among the treatments BA at 100 ppm + GA<sub>3</sub> at 200 ppm (T<sub>6</sub>) influenced plant height (72.50 cm) and leaf area (69.39 cm<sup>2</sup>) to maximum limit as compared to the control (Table 1). The observations recorded are in conformity with the results reported by Sandoei (2014) on *Dizigotheca elegantissima*, *Ficus benjamina* and *Schefflera arboricola*. The increase in height may be attributed to the effect of GA<sub>3</sub> on cellular processes by stimulating cell elongation, lengthening cells caused increased growth and influence of BA on cell division and formation of meristematic growth (Stuart and Jones, 1977).

The plants treated with BA at 200 ppm (T<sub>4</sub>) produced maximum number of primary (3.84) and secondary branches (14.33) (Table 1). Least number of primary (2.61) and secondary branches (5.33) was recorded in plants treated as control. Foliar application of BA (100 and 200 ppm) on cv. Superstar resulted in more number of primary and secondary shoots (Gowda, 1985). The branching reinforcement may be considered as a result of the ability of cytokinin (BA) to promote lateral bud

development by disrupting the apical dominance acting in opposition to auxin. The data furnished in Table 1 showed that plant spread both in East-West and North-South direction was greatest (50.13 and 50.74 cm, respectively) in plants treated with BA at 100 ppm (T<sub>3</sub>). The readings were statistically at par with BA at 200 ppm (T<sub>4</sub>), this may be attributed to higher branch count (Primary and secondary) as a result of BA application regardless of the concentration levels. Exogenous application of cytokinin increases auxin-cytokinin ratio resulting in enhanced axillary bud growth. Exogenous cytokinin has been found to improve branching of numerous species of ornamental plants viz. Verbena (Svenson, 1990) and Petunia (Carey *et al.*, 2007) leading to abundant flowering.

The tabular representation (Table 2) showed significant variation among the treatments in terms of flowering parameters. Plants receiving GA<sub>3</sub> at 100 ppm sprays showed advanced bud formation (35.11 days) closely followed by the treatment GA<sub>3</sub> at 200 ppm. The result was supported by earlier findings of Muthu Kumar *et al.*, (2012) in rose cv. First Red; Janowska and Andrzejak (2010) in calla lily. Days required to tight bud stage from flower bud emergence was earliest in control plants (9.44 days), compared to the plants in receipt of either GA<sub>3</sub> or BA. BA at 200 ppm took maximum days (12.57 days) to attain the stage. The plants sprayed with GA<sub>3</sub> at 200 ppm took minimum number of days (7.11 days) to reach cup shape from the tight bud stage followed by GA<sub>3</sub> at 100 ppm (7.23 days). While the maximum day counts (10.61 days) were registered in the treatment BA at 200 ppm followed by the treatment BA at 100 ppm. Plants treated with GA<sub>3</sub> at 200 ppm were earliest to reach full bloom (FB) stage with 2.53 days, followed by GA<sub>3</sub> at 100 ppm. The plants treated with BA @ 200 ppm registered maximum number of days (3.71 days) to attain full bloom. Compared to the GA<sub>3</sub> treated

plants BA at 200 ppm (T<sub>4</sub>) registered longer (27.06 days) duration of flowering phenophase BA at 100 ppm (T<sub>3</sub>). Unappreciable influence of GA<sub>3</sub> on flowering duration was also reported by Schroeter-Zakrzewska and Janowska (2007) in *Impatiens walleriana*.

An inquisition of data presented in Table 3 revealed that the treatment BA at 100 ppm produced flowers with maximum diameter at tight bud stage (1.87 cm) and cup shape (3.85 cm). Positive effect of BA on flower size was also reported by Nambiar *et al.*, (2012) in *Dendrobium* orchid. Flower shoot length and stalk length was maximum (43.00 cm and 42.54 cm respectively) in the plants receiving BA at 200 ppm + GA<sub>3</sub> at 100 ppm (T<sub>5</sub>) closely followed by BA at 100 ppm + GA<sub>3</sub> at 200 ppm (T<sub>6</sub>). The plants in the control plots produced shortest flowering shoots (27.93 cm). Increase in stalk length as a result of GA<sub>3</sub> and BA application may be due to cell elongation induced by gibberellic acid and cell division promoted by cytokinin (Gardner *et al.*, 1985).

Maximum thickness of stalks (0.62 cm), pedicel diameter (0.70 cm), and number of flowers per plant (16.67) were recorded in plants treated with BA at 200 ppm. The results were in agreement with the findings of Nambiar *et al.*, (2012) in *Dendrobium* orchid and Janowska (2014) in calla lily. The higher yield in BA treated plants may be attributed to higher chlorophyll levels leading to increased photosynthesis.

The effect of Pre-harvest spraying of GA<sub>3</sub> and BA on vase life as presented in Table 4 indicated a gradual increase in the weight up to 4<sup>th</sup> days in vase in all the treatments except for plants receiving GA<sub>3</sub> at 200 ppm (T<sub>2</sub>) which exhibited a decline in the weight of cut stems after 48 hours (33.02 g initial weight and 31.57 g 2<sup>nd</sup> day) with a consistent decline in weight thereafter with maximum (- 3.32 g) loss of flower weight at the end of 10 days.

**Table.1** Effect of GA<sub>3</sub> and BA on vegetative parameters of Hybrid Tea rose cv. Bugatti

Treatment	Plant height (cm) 75 DAS	Leaf area (cm <sup>2</sup> )	Number of branches per plant		Plant Spread (cm) (90DAS)	
			Primary	secondary	East-West	North-South
T <sub>0</sub>	52.33	50.23	2.61	5.33	38.37	34.71
T <sub>1</sub>	68.45	61.28	3.07	9.50	42.51	45.55
T <sub>2</sub>	62.54	60.40	3.25	10.17	39.15	43.44
T <sub>3</sub>	62.85	53.57	3.76	12.59	50.13	50.74
T <sub>4</sub>	60.97	58.59	3.84	14.33	49.16	50.35
T <sub>5</sub>	58.77	63.47	3.23	12.33	41.42	44.69
T <sub>6</sub>	72.50	69.39	3.17	10.20	44.17	46.27
S.Em (±)	0.93	0.67	0.12	0.67	0.74	1.12
CD at 5%	2.89	2.07	0.37	2.09	2.31	3.49

**Table.2** Effect of GA<sub>3</sub> and BA on flowering parameters of Hybrid Tea rose Cv. Bugatti

Treatment	Number of days required from last spray to flower bud emergence	Flower bud emergence to tight bud stage(days)	Tight bud stage to cup stage(days)	Cup stage to full bloom stage (days)	Flowering duration (Days)
T <sub>0</sub>	41.13	9.44	7.51	2.61	19.60
T <sub>1</sub>	35.11	10.57	7.23	2.58	20.38
T <sub>2</sub>	36.58	10.19	7.11	2.53	19.83
T <sub>3</sub>	38.03	12.18	9.73	3.50	26.80
T <sub>4</sub>	39.75	12.57	10.61	3.71	27.06
T <sub>5</sub>	37.02	12.00	8.76	3.66	24.55
T <sub>6</sub>	37.76	11.20	7.54	3.22	22.00
S.Em (±)	0.53	0.31	0.31	0.13	0.65
CD at 5%	1.67	0.95	0.96	0.42	2.03

**Table.3** Effect of GA<sub>3</sub> and BA on floral characteristics and number of flowers per plant of Hybrid Tea rose cv. Bugatti

Treatment	Flower bud diameter at TBS (cm)	Flower diameter at cup shape (cm)	Flower shoot length (cm)	Stalk length (cm)	Stalk diameter (cm)	Stalk weight with flower (g)	Pedicel length (cm)	Pedicel diameter (cm)	Number of flowers per plant
T <sub>0</sub>	1.59	2.67	27.93	28.09	0.47	27.07	5.35	0.52	10.14
T <sub>1</sub>	1.68	3.00	40.27	39.70	0.51	35.33	5.62	0.60	12.40
T <sub>2</sub>	1.85	3.16	37.87	38.83	0.52	33.02	5.91	0.67	12.77
T <sub>3</sub>	1.87	3.85	41.20	41.00	0.59	36.79	5.41	0.69	14.94
T <sub>4</sub>	1.73	3.38	41.66	40.17	0.62	35.78	5.43	0.70	16.67
T <sub>5</sub>	1.82	3.11	43.00	42.54	0.56	33.40	5.68	0.66	14.63
T <sub>6</sub>	1.74	3.20	42.04	41.51	0.53	35.92	6.07	0.64	14.80
S.Em (±)	0.01	0.08	0.90	0.41	0.01	0.51	0.05	0.02	0.42
CD at 5%	0.03	0.24	2.82	1.26	0.04	1.59	0.15	0.05	1.30

**Table.4** Effect of GA<sub>3</sub> and BA on Post- Harvest Parameters of Hybrid Tea rose cv. Bugatti

Treatment	Variation of weight of flower stalk in vase(g)						Change in flower Diameter (cm)					Vase life (days)	
	Weight in different Days						Diameter in different days						
	Initial	2nd day	4 <sup>th</sup> day	6 <sup>th</sup> day	8 <sup>th</sup> day	10 <sup>th</sup> day	Initial	2 <sup>nd</sup> day	4 <sup>th</sup> day	6 <sup>th</sup> day	8 <sup>th</sup> day		
T <sub>0</sub>	27.07	27.53	27.57	28.07	27.10	26.95	2.63	2.98	3.65	3.85	4.00	6.20	
T <sub>1</sub>	35.33	36.45	37.03	35.13	34.33	32.53	3.54	8.17	9.30	10.50	10.33	7.55	
T <sub>2</sub>	33.02	31.57	31.60	31.08	30.70	30.12	2.45	3.40	3.75	3.80	3.88	7.34	
T <sub>3</sub>	36.79	38.73	38.70	38.12	37.15	35.38	2.71	3.75	4.35	4.70	4.90	8.59	
T <sub>4</sub>	35.78	37.68	39.07	38.82	37.70	35.15	3.23	4.24	5.07	5.80	6.15	9.03	
T <sub>5</sub>	33.40	34.47	34.58	34.57	33.48	32.17	3.03	4.70	5.40	7.00	7.60	8.05	
T <sub>6</sub>	35.92	36.47	36.70	37.03	36.55	35.57	3.10	3.90	4.00	4.60	4.61	7.76	
S.Em (±)	0.51	0.38	0.15	0.40	0.38	0.26	0.10	0.09	0.06	0.07	0.06	0.12	
CD at 5%	1.59	1.19	0.48	1.25	1.18	0.80	0.32	0.29	0.17	0.22	0.18	0.39	

**Table.5** Effect of GA<sub>3</sub> and BA on Biochemical Parameters of Hybrid Tea rose cv. Bugatti

**Table.6**

Treatment	Chlorophyll content(mg/g)	Anthocyanin content(mg/100g)
T <sub>0</sub>	7.56	36.65
T <sub>1</sub>	7.93	38.90
T <sub>2</sub>	8.13	38.29
T <sub>3</sub>	10.40	39.71
T <sub>4</sub>	11.13	42.76
T <sub>5</sub>	8.09	40.14
T <sub>6</sub>	9.26	40.40
S.Em ( $\pm$ )	0.06	0.010
CD	0.19	0.032

Correlation coefficient values of growth charactets on yield (Number of flowers per plant) of Hybrid Tea rose cv. Bugatti

	Plant height	Leaf area	Primary branch per plant	Secondary branch per plant	Plant Spread (E-W)	Plant Spread (N-S)	No of flowers per plant
Plant height	1	0.744**	0.412	0.500*	0.288	0.630**	0.401
Leaf area		1	0.269	0.446*	0.027	0.447*	0.339
Primary branch per plant			1	0.972**	0.885**	0.925**	0.896**
Secondary branch per plant				1	0.845	0.951**	0.936**
Plant Spread (E-W)					1	0.879**	0.814**
Plant Spread (N-S)						1	0.869**
No of flowers per plant							1

(\*\* & \* significance at 1 and 5 % level of probability, respectively)

**Table.7** Correlation coefficient values of flowering and quality characters on yield (Number of flowers per plant) of Hybrid Tea rose cv. Bugatti

	Stalk length	Stalk diameter	Pedicel length	Pedicel Diameter	Flower dia. at TBS	Flower dia. at CS	Weight of the stalk	No of flowers per plant
<b>Stalk length</b>	1	0.730**	0.345	0.827**	0.727**	0.718**	0.960**	0.746**
<b>Stalk diameter</b>		1	-0.09	0.757**	0.714**	0.848**	0.776**	0.802**
<b>Pedicel length</b>			1	0.245	0.447*	-0.144	0.115	-0.077
<b>Pedicel Diameter</b>				1	0.812**	0.766**	0.788**	0.790**
<b>Flower dia. at TBS</b>					1	0.756**	0.635**	0.517*
<b>Flower dia. at CS</b>						1	0.775**	0.723**
<b>Weight of the stalk</b>							1	0.765**
<b>No of flowers per plant</b>								1

(\*\* & \* significance at 1 and 5 % level of probability, respectively)

Initial flower weight was maximum in cut stems harvested from plots treated with BA at 100 ppm + GA<sub>3</sub> at 200 ppm (T<sub>6</sub>) and also resulted in minimum weight loss on the 10 day. Per cent weight loss of cut stems over initial weight at the end of experiment i.e. 10<sup>th</sup> day from the beginning of the experiment was minimum (3.42 %) in GA<sub>3</sub> at 200 ppm + BA at 100 ppm (T<sub>6</sub>) while weight loss is highest (8.78 %) in GA<sub>3</sub> at 200 ppm. The trait flower diameter of cut flowers in the Table 4 indicated a gradual increase in the flower diameter from the initial 6 days of the experiment with a decline in size thereafter (i.e. on 8<sup>th</sup> day). GA<sub>3</sub> at 100 ppm recorded maximum (10.33 cm) flower diameter of cut rose (cv. Bugatti) in the vase while minimum (4.00 cm) opening of flowers were in flowers harvested from control plots. GA<sub>3</sub> at 100 ppm proved superior with maximum diameter increase over other treatments. A study made by Pobudkiewicz and Nowak (1992) in *Gerbera jamesonii* showed positive influence of GA<sub>3</sub> on flower diameter. The plants receiving required gibberellic acid in an optimum proportion could have results in flowering quality by increasing number of cells.

The flowers harvested from plants under the treatment BA at 200 ppm and BA at 100 ppm exhibited delayed senescence with a longer vase life(9.00 and 8.50 days respectively) compared to control and GA<sub>3</sub> treated plants. The observations recorded also revealed that combined application of GA<sub>3</sub> + BA (T<sub>5</sub> and T<sub>6</sub>) also registered longer vase life compared to GA<sub>3</sub> at 100 and 200 ppm (T<sub>1</sub> and T<sub>2</sub>) and control. The observation is in conformity with the result of Prashanth *et al.*, (2006) in rose cv. Iceburg. The positive effect of BA on vase life may be attributed to the ability of cytokinin to retard senescence and slow the ageing process. Delayed senescence by the application of BA was also reported by Leopold (1964). The finding was also

supported by Mayak and Halevy (1970). Delayed senescence may be also manifested to high chlorophyll content in the leaves as a result of BA application.

In view of the results in Table 5 significant variation was recorded as a result of foliar spray applications of GA<sub>3</sub> and BA. Maximum chlorophyll content (11.13 mg/g) was obtained in application of BA at 200 ppm (T<sub>4</sub>) followed by BA at 100 ppm (T<sub>3</sub>) (10.40 mg/g) with minimum in the control plants. The results are in conformity with the findings reported by Sardoei (2014) in indoor plants (*Ficus benjamina*, *Schefflera arboricola*, *Dizigotheca elegantissima*); Abd El- Aziz (2007) in *Codiaeum variegatum*.

The parameter anthocyanin content of fresh flowersexhibited significant variation under the treatment influences, while maximum anthocyanin (42.76 mg/100 g) was recorded in plants treated with BA 200 ppm followed by GA<sub>3</sub> 200 ppm + BA 100 ppm. Minimum anthocyanin content (36.65 mg/100g) was observed in untreated control. The result was supported by earlier findings of Klein and Hagen (1961) in *Impatiens balsamina*.

Data represented in Tables 6 and 7 revealed the correlation among the growth, flowering and quality parameters with yield (Number of flowers per plant). The estimates for correlation co-efficient for plant height, plant spread, leaf area, branches per plant and yield (number of flowers per plant) in Table 6. Almost all the growth and yield attributing characters were shown to be significant to highly significant positive correlation with yield. Highly significant positive association with yield was shown by primary ( $r= 0.896^{**}$ ) and secondary ( $r= 0.936^{**}$ ) branch per plant, East-West ( $r= 0.814^{**}$ ) and North-South ( $r= 0.869^{**}$ ) spread. Similarly, the yield was positively correlated with flowering, quality and yield attributing

characters, viz. stalk length, stalk diameter, pedicel length, pedicel diameter, flower diameter at cup shape stage and tight bud stage, weight of the stalk and yield (number of flowers per plant) (Table 7). The parameters like Stalk length ( $r= 0.746^{**}$ ), stalk diameter ( $r= 0.802^{**}$ ), pedicel diameter ( $r= 0.790$ ), weight of the stalk ( $0.765^{**}$ ) and flower diameter at cup shape ( $r= 0.723$ ) were positively correlated with yield and effect was found to be highly significant for all the parameters. While flower diameter at tight bud stage ( $r= 0.517^*$ ) was significantly correlated with number of flowers per plant (yield).

Roses for the market are usually preferred with higher stalk length, flowering period, flower diameter, bright and even coloration of petals and with a long vase life. The investigation results exhibited an advantageous effect of the growth regulators regardless of its concentration levels over control. Among the treatments the performance efficiency of the plants in the vegetative growth responses and flower characteristics was conspicuous with maximum readings recorded under BA at 200 ppm. Therefore, application of BA at 200 ppm can be suggested for overall crop performance and cut flower quality.

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