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CONTENTS

Effect of biostimulants and biofertilizer on performance of rose cv. Rose Sherbet

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ABSTRACT: The present investigation was carried out at Model Floriculture Centre, G. B. Pant University of Agriculture and Technology, Pantnagar. The trial was laid in Randomized Block Design (RBD) with three replications and nine treatments. Among all the treatments plant height (63.53 cm), plant spread (55.57 cm), number of branches (5.93), number of leaves (189.33) and stem diameter (1.31 cm) were found maximum in plants treated with humic acid @ 3 mL L^{-1} and 75% Recommended dose of fertilizers (RDF-60:120:120 NPK kg ha^{-1}) i.e., T_4 after 150 days of application. T_4 also exhibited maximum leaf area per plant (1023.75 cm^2), early flower bud appearance (31.47 days), days taken for bud to bloom (12.47 days), 50 per cent flowering (49.33 days), maximum number of flowering shoots per plant per month (3.8), earliest days to harvest (44.40 days), maximum bud length (3.19 cm), bud diameter (1.85 cm), flower diameter (5.44 cm), number of petals per flower (46.73) andlongest flower longevity (5.73 days).Weight of single flower (3.97 g) and 100 flowers (398.87 g), number of flowers per plant per month (18.13), flower yield per plant per month (61.72 g), flower yield per plant per hectare (5693.17 Kg) and shelf life (29.20 hr) were also enhanced by T_4which also recorded highest benefit – cost ratio (2.62) whereas lowest value (0.73) was noticed in T_9 (Arka microbial consortium + 50 % RDF)

Key words: Biostimulants, biofertilizer, flowering, rose, shelf life, yield

Rose (*Rosa hybrida* L.) belongs to the family Rosaceae, it has chromosome number 2n=14 and is native to the temperate regions of Northern Hemisphere. Due to multiple uses of rose, it has great demand for production throughout the year. In many regions the traditional methods of farming are still used (Sivaramane *et al.*, 2015). Under conventional cultivation practices, rose plants are grown with chemical farming system which in excess may cause frequent changes in soil pH, contaminates air and water and kills beneficial insects and other natural ecosystem members. To avoid this, agricultural practices have been advancing towards sustainable, organic and environment- friendly systems. Plant extracts called biostimulants contain a variety of bioactive chemicals. These compounds can often improve the plant's nutrient utilisation efficiency as well as its tolerance to biotic and abiotic challenges. Various technical revolutions have been proposed in recent years in order to improve the sustainability of production systems by drastically reducing the use of agrochemicals. Usage of chemicals and/or microorganisms that strengthen plant development, increase tolerance to unfavourable soil and environmental factors and increase resource use efficiency would be an optimistic approach. Such compounds are biostimulants and biofertilizers. The studies related to the application of biostimulants and biofertilizers on rose flower cultivation are meagre in number. Therefore, the present experiment was carried out to study the effect of biostimulants and biofertilizer on the performance of rose cv. Rose Sherbet.

MATERIALS AND METHODS

The investigation was conducted at Model Floriculture Centre, G. B. Pant University of Agriculture and Technology, Pantnagar during December 2021 to May 2022 and it is 243.84 metres above mean sea level, is situated at 29° North latitude and 79.3° East longitude and has humid, sub-tropical climate with the maximum temperature ranging from 32°C to 44°C in summer and minimum temperature ranging from 0°C to 4.4°C in winter. The summer is dry and hot, winter is too cold and frost can be expected from the last week of December to middle of February. The onset of Monsoon usually occurs from the last week of June and continues in appreciable

amounts up to the last week of September. The soil is classified as a mollisol. It has a sandy loam texture and has an ideal water holding capacity as well as appropriate drainage.The trial was laid out under open condition in Randomized Block Design (RBD) with three replications and nine treatments *viz.,* T_1-100 % Recommended dose of fertilizers (RDF- 60:120:120 NPK kg ha^{-1}) , T_2-75 %RDF + Fulvic acid , T_3-50 %RDF + Fulvic acid , T_4-75 % RDF + Humic acid , T_5 -50 % RDF + Humic acid , T_6 -75 % RDF + Sea weed extract (IFFCO Sagarika), T_7-50 % RDF + Sea weed extract (IFFCO Sagarika) , T_8-75 %RDF + IIHR- Arka microbial consortium , T_9-50 %RDF + IIHR- Arka microbial consortium. Fulvic acid, humic acid (himedia) were applied at 15, 30 and 45 days through foliar application after planting@ 3g L^{-1}. Sea weed extract (IFFCO Sagarika) was applied at 15, 30 and 45 days through foliar application after planting @ 3mL L^{-1} and IIHR-Arka microbial consortium was applied 10 days after planting through soil drenching, @ 50 g L^{-1} $plant^{-1}$. Three months old rose cv. Rose Sherbet plants which were propagated through stem cuttings were selected for investigation. 30 cm^3 pits were dug and filled with a mixture of soil and FYM. Recommended dose of NPK fertilizers were applied as per treatments. The fertilizers were applied in the form of NPK (12:32:16), urea and muriate of potash. The healthy plants were selected and planted in the December 2021 with a spacing of 60 cm x 60 cm. Certain gaps were noticed due to plant mortality and these gaps were replaced with new plants grown in the nursery for this purpose. Uniform cultural practices were followed for all the treatments during the investigation.

RESULTS AND DISCUSSION

Based on analysis of variance (ANOVA), significant differences were recorded between treatments for all characteristics at 5% level of significance. The data presented in Table 1 depict vegetative parameters *viz.* plant height (63.53 cm), plant spread (55.57 cm), number of branches per plant (5.93), number of leaves per plant (189.33), stem diameter (1.31 cm) and leaf area per plant (1023.75 cm^2) were found highest in T_4 (75 % RDF + Humic acid).

This could be owing to the easier nutrient absorption, which would encourage protein synthesis from stored carbohydrates. These results are in conformity with El-Nashar (2021) in calendula, Praveen *et al.* (2021) in rose, Ali *et al.* (2014) in tulip and Nasiri *et al.* (2015) in geranium.

There was a significant difference was among all treatments for other parameters (Table 2). Earliest days to flower bud appearance (31.47 days), days

Table 1: Effect of biostimulants and biofertilizer on vegetative growth attributes of rose cv. Rose Sherbet

Treatments	Plant height (cm)	Plant spread (cm)	Number of branches per plant	Number of leaves per plant	Stem diameter (cm)	Leaf area per plant (cm^2)
T_1	57.80	52.83	5.27	176.00	1.26	959.15
T_2	61.27	54.23	5.67	186.00	1.29	996.50
T_3	53.80	51.00	5.07	165.47	1.25	906.46
T_4	63.53	55.57	5.93	189.33	1.31	1023.75
T_5	57.13	52.23	5.47	171.00	1.26	921.52
T_6	60.53	54.03	5.60	185.87	1.28	991.93
T_7	54.93	51.43	5.13	167.47	1.26	914.13
T_8	59.40	53.20	5.40	180.80	1.27	943.06
T_9	52.60	50.57	4.93	162.27	1.24	895.90
SEm ±	0.71	0.42	0.07	1.03	0.01	8.60
$CD_{0.05}$	2.15	2.55	0.21	3.11	0.02	25.80
CV(%)	2.14	1.38	2.34	1.02	0.87	1.56

T_1-100 % Recommended dose of fertilizers (RDF- 60:120:120NPK $kgha^{-1}$) T_2-75 %RDF + Fulvic acid, T_3-50 %RDF + Fulvic acid, T_4- 75 %RDF + Humic acid , T_5-50 % RDF + Humic acid , T_6-75 % RDF + Sea weed extract (IFFCO Sagarika), T_7-50 % RDF + Sea weed extract (IFFCO Sagarika), T_8-75 %RDF + IIHR- Arka microbial consortium, T_9-50 %RDF + IIHR-Arka microbial consortium

taken for bud to bloom (12.47days), days taken to 50 per cent flowering (49.33 days), maximum number of flowering shoots (3.80) and earliest days to harvest (44.40 days) was registered in T_4. The formation of early flower bud might have been impacted by triggering of such metabolic activity and lowering of the C: N ratio by the accumulation of carbohydrates. Early blooming would have also been influenced by the increased production of auxin and growth factors brought on by the application of humic acid. This may also be related to gibberellin-like activity of humic acid, according toVaughan *et al.* (1985). Similar results were reported by Bashir *et al.* (2016), Jabbar and AL-Bakkar (2022) in rose, Najarian *et al.* (2022) in *Pelargonium×hortorum* and Mirzaei *et al.* (2019) in gerbera.

With regards to flower quality parameters (Table 3), significantly improved the bud length (3.19 cm), bud diameter (1.85 cm), flower diameter (5.44 cm), number of petals per flower (46.73) and flower longevity (5.73 days) by foliar application of humic

Table 2: Effect of biostimulants and biofertilizer on flowering of rose cv. Rose Sherbet

Treatments	Days to flower bud appearance	Days for bud to bloom	Days to50 % flowering	No. of flowering shoots plant^{-1}	Days to harvest
T_1	39.80	12.80	54.87	2.40	56.13
T_2	35.07	12.53	51.33	3.27	48.60
T_3	43.73	12.87	59.47	1.80	63.60
T_4	31.47	12.47	49.33	3.80	44.40
T_5	41.80	12.80	58.47	2.07	52.80
T_6	35.00	12.67	51.60	3.00	49.20
T_7	44.00	12.93	58.40	1.80	63.27
T_8	38.40	12.93	55.33	2.80	54.20
T_9	43.80	13.00	60.33	1.73	64.20
SEm ±	1.09	0.30	0.59	0.10	1.30
$CD_{0.05}$	3.29	NS	1.78	0.31	3.91
CV(%)	4.85	4.1	1.86	7.16	4.10

T_1-100 % Recommended dose of fertilizers (RDF- 60:120:120NPK kgha^{-1}) T_2-75 %RDF + Fulvic acid, T_3-50 %RDF + Fulvic acid, T_4- 75 %RDF + Humic acid , T_5-50 % RDF + Humic acid , T_6-75 % RDF + Sea weed extract (IFFCO Sagarika), T_7-50 % RDF + Sea weed extract (IFFCO Sagarika), T_8-75 %RDF + IIHR- Arka microbial consortium, T_9-50 %RDF + IIHR-Arka microbial consortium

Table 3: Effect of biostimulants and biofertilizer on flower quality of rose cv. Rose Sherbet

Treatments	Bud length (cm)	Bud diameter (cm)	Flower diameter (cm)	Number of petals flower^{-1}	Flower longevity (days)
T_1	2.75	1.52	5.09	43.47	4.67
T_2	3.03	1.67	5.29	45.27	5.27
T_3	2.39	1.50	5.06	40.60	3.80
T_4	3.19	1.85	5.44	46.73	5.73
T_5	2.51	1.51	5.15	42.87	4.47
T_6	3.00	1.60	5.27	44.20	5.20
T_7	2.48	1.46	5.05	40.07	4.27
T_8	2.83	1.61	5.26	43.00	4.93
T_9	2.35	1.45	4.93	39.53	3.47
SEm ±	0.05	0.04	0.14	0.47	0.14
$CD_{0.05}$	0.16	0.13	NS	1.42	0.43
CV(%)	3.56	5.06	4.92	1.92	5.34

T_1-100 % Recommended dose of fertilizers (RDF- 60:120:120NPK kgha^{-1}) T_2-75 % RDF + Fulvic acid, T_3-50 %RDF + Fulvic acid, T_4- 75 %RDF + Humic acid , T_5-50 % RDF + Humic acid , T_6-75 % RDF + Sea weed extract (IFFCO Sagarika), T_7-50 % RDF + Sea weed extract (IFFCO Sagarika), T_8-75 %RDF + IIHR- Arka microbial consortium, T_9-50 %RDF + IIHR-Arka microbial consortium

acid + 75% RDF i.e., T_4 (Table 3).

This could be associated with better absorption of nutrients, particularly the gibberellin-like compounds in humic acid (Al-Hayani, 2016). The humic acid induced significantly higher number of petals per flower as has the ability to improve plant membrane permeability, intensify plant enzyme systems, speed up cell division and boost root development which ultimately resulted plants became healthier and have more food available to them and ultimately more number of petals per flower (Khaled and Fawy, 2011). These results of present study are in accordance with the findings of Al-Hayani (2016) who observed similar results in lemon (*Citrus lemon* L.) when treated with humic acid.

The data presented in Table 4 shows that significantly increased fresh weight of single flower (3.97 g) and 100 flowers (398.87 g), number of flowers per plant per month (15.55), flower yield per plant per month (51.24 g), flower yield per hectare per month (5693.17 Kg) and improved shelf life (29.20 hr) was noted in T_4. The increased photosynthetic activity brought by the application of humic acid along with NPK may have contributed to an increase in dry matter accumulation and effective partitioning of photosynthates toward the sink, which could explain the increase in flower weight. The increased number of flowers per plant

Table 4: Effect of biostimulants and biofertilizer on flower yield and shelf life of rose cv. Rose Sherbet

Treatments	Weight of single flower (g)	Weight of 100 flowers (g)	Number of flowers plant^{-1} month^{-1}	Flower yield plant^{-1} month^{-1}(g)	Flower yield ha^{-1} month^{-1}(Kg)	Shelf life (hrs)
T_1	3.47	348.07	10.10	33.13	3680.64	27.87
T_2	3.73	381.37	14.07	45.99	5110.23	28.60
T_3	3.30	333.87	7.82	26.28	2920.29	27.00
T_4	3.97	398.87	15.55	51.24	5693.17	29.20
T_5	3.42	333.33	8.75	28.69	3187.32	27.73
T_6	3.69	370.17	13.80	45.34	5037.45	28.20
T_7	3.33	330.13	7.75	25.30	2811.22	26.93
T_8	3.55	355.90	12.13	39.18	4352.84	28.00
T_9	3.24	318.70	6.15	20.28	2253.09	26.73
SEm ±	0.07	5.03	0.12	0.61	67.64	0.15
$CD_{0.05}$	0.22	15.08	0.36	1.83	202.80	0.47
CV(%)	3.73	2.47	1.95	3.00	3.00	0.98

T_1-100 % Recommended dose of fertilizers (RDF- 60:120:120NPK kgha^{-1}) T_2-75 %RDF + Fulvic acid, T_3-50 %RDF + Fulvic acid, T_4- 75 %RDF + Humic acid , T_5-50 % RDF + Humic acid , T_6-75 % RDF + Sea weed extract (IFFCO Sagarika), T_7-50 % RDF + Sea weed extract (IFFCO Sagarika), T_8-75 %RDF + IIHR- Arka microbial consortium, T_9-50 %RDF + IIHR-Arka microbial consortium

Table 5: Effect of biostimulants and biofertilizer on economics of cultivation of rose cv. Rose Sherbet

Treatments	Total expenditure (Rs ha^{-1})	Yield (kg ha^{-1})	Gross return (Rs ha^{-1})	B:C Ratio
T_1	403736.66	3680.64	596263.30	1.96
T_2	432713.46	5110.23	827856.82	2.62
T_3	405049.65	2920.29	473086.75	1.51
T_4	475724.08	5693.17	922294.18	2.62
T_5	444477.76	3187.32	516345.54	1.48
T_6	426688.19	5037.45	816067.15	2.62
T_7	398612.78	2811.22	455417.25	1.48
T_8	620852.14	4352.84	705160.25	1.39
T_9	594211.00	2253.09	364999.78	0.73

T_1-100 % Recommended dose of fertilizers (RDF- 60:120:120NPK kgha^{-1}) T_2-75 %RDF + Fulvic acid, T_3-50 %RDF + Fulvic acid, T_4- 75 %RDF + Humic acid , T_5-50 % RDF + Humic acid , T_6-75 % RDF + Sea weed extract (IFFCO Sagarika), T_7-50 % RDF + Sea weed extract (IFFCO Sagarika), T_8-75 %RDF + IIHR- Arka microbial consortium, T_9-50 %RDF + IIHR-Arka microbial consortium

might be due to the presence of growth-promoting substances viz. essential plant nutrients, vitamins, enzymes and antibiotics.

Improved translocation of more metabolites from source to sink may have resulted in higher yield. These results are in line with the findings of Bashir *et al.* (2016) in gladiolus, Praveen *et al.* (2021) in rose, El-Nashar (2021) in calendula and Jabbar and AL-Bakkar (2022) in rose. The thickened cells of the flowers would indicate a longer shelf life as they would have acquired more nutrition. The thicker cells are meant to increase the longevity of flowers. It is possible that cytokinin and auxin present in humic acid boosted antioxidant levels and senescence resistance (Zhang and Schmidt, 1997). These results were similar to Jabbar and AL-Bakkar (2022) in rose, Bashir *et al.* (2016) in gladiolus and Mirzaei *et al.* (2019) in gerbera.

The variation in benefit – cost ratio (Table 5) and the maximum cost benefit ratio was found in T_4 (2.62), T_2 (2.62) and T_6 (2.62) followed by T_1 (1.96) while the minimum ratio was noted in T_9 (0.73). This difference in the ratio could be due to variation in variable cost and yield. These results are in conformity with the findings of Archana (2018) in tuberose.

CONCLUSION

The results of the present study showed that for getting better growth and flowering of rose cv. Rose Sherbet in open conditions under *Tarai* conditions of Uttarakhand, the plants must be sprayed with humic acid @ $3gL^{-1}$ at 15-day intervals, three times after planting and 75 per cent RDF (60:120:120 NPK kg ha^{-1}) which enhances the vegetative growth, flowering, flower quality, yield and shelf life.

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