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Effect of bio-stimulants and biofertilizers on quality and yield of Floribunda roses

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Abstract
The present study on "Effect of biostimulants and biofertilizers on quality and yield of Floribunda roses was undertaken during the year 2020-21 at College of Horticulture, Bengaluru. The experiment was laid out in Factorial Randomized Block Design with three replications. The biostimulants were sprayed at bimonthly interval on cvs. Mirabel and Charishma. Among the treatments, the highest flower diameter (5.45 cm), stalk length (3.94 cm) was registered when Seaweed extract @ 2000 ppm (T_7) sprayed on cv. Charishma. The highest number of flowers per cluster was recorded in Ecohume 3 ml/l (7.11) with cv. Mirabel. The highest 100 flower weight was recorded in Ecohume 3 ml/l (277.42 g) with cv. Charishma. The maximum number of flowers/plant (325.77), flower yield/plant (687.99 g) and per hectare (4.25 t) was also recorded in Ecohume 3 ml/l with cv. Mirabel and shelf life of flowers (42.22 hr.) was highest in T_7-Seaweed extract @ 2000 ppm in cv. Mirabel. This study indicated that foliar application of Ecohume at 3 ml/l at bimonthly interval to the plants exhibited superior yield and foliar application of Seaweed extract @ 2000 ppm performed best for quality in Floribunda roses

Keywords: Floribunda roses, biostimulants, biofertilizers, Mirabel, Charishma

Introduction
"Of all the flowers, me thinks a Rose is best" said by Willam Shakespeare. Rose is well known for its brilliancy and grace. Rose is an emblem of love, beauty, affection, elegance, inspiration, spirituality and source of aesthetic gratification. Rose belong to the family Rosacea and the *Rosa* genus, which includes 200 species and over >10000 cultivars (Gudin, 2000) [7]. Nowadays there is a huge extended demand for loose flowers in domestic markets, they are belongs to Floribunda group of garden roses. Floribunda means "many-flowering" in latin, they are developed by crossing hybrid teas with polyantha roses, Floribunda roses are also called as hybrid polyanthus (Gudin, 2000) [7]. Plants are vigorous, cold tolerant, growing medium tall in stature, highly floriferous in nature and bears a large number of flat, medium to large flowers. The cultivars Mirabel and Charishma are the most popular Floribunda rose varieties grown by the farmers.

Since the growth and production of roses are influenced by their nutrient requirement and is fulfilled especially by supplying inorganic fertilizers. Though the long-term and indiscriminate use of chemical fertilizers has not only led to imbalance of nutrients in soil resulting in degradation of soil structure but also increasing production cost brought an urge for balanced source of nutrients. In recent days, biostimulants and biofertilizers emerged as a supplemental for chemical fertilizers and will help to improve yield as well as quality of crops (Sankari *et al*., 2015) [14].

Biostimulants are defined as substance that encourages plant growth when applied in small quantities and are also referred to as metabolic enhancers (Zhang and Schmidt, 1997) [18]. They are natural or synthetic substances cause changes in vital and structural processes in order to influence the plant growth through improved resistance to abiotic stresses and increase the yield and quality. The different categories of plant biostimulants commonly used are humic acids, fulvic acids, protein hydrolysates, amino acids and seaweed extracts (Jardin, 2012) [9].

Biofertilizers or 'microbial inoculants' are the preparations containing live or latent cells of efficient strains of micro-organisms (Deshmukh, 1998) [4]. They may be biological N_2 fixers, P-solubilizing, mineralization of nitrogen, K-solubilizing and conversion of unavailable form of several elements like Sulphur (S) and Iron (Fe) into available forms. These biofertilizers add benefit in agriculture by supplying essential nutrients (Gawade *et al*., 2019) [6]. Common biofertilizers used in horticulture crops are *Azotobacter*, *Azospirillum*, Phosphate Solubilizing Bacteria (PSB), Potassium Solubilizing Bacteria (KSB) and Vesicular Arbuscular Mycorrhiza

(VAM). In the current experiment *Azospirilum*, PSB and KSB are used as a treatment. Keeping in view, the need and importance of biostimulants and biofertilizers the present investigation was undertaken with the objective to study the effect of different sources of biofertilizers and biostimulants on quality and yield of Floribunda roses.

Material and Methods

The present experiment was undertaken at Department of Floriculture and Landscape Architecture, College of Horticulture, University of Horticultural Sciences Campus, GKVK, Bengaluru during 2020-21. The experimental site is located in the Eastern Dry zone of Karnataka and situated at latitude of North 130 5'25.472" and at a longitude of East 770 33'40.605"and at an altitude of 1300 m above Mean Sea Level (MSL). Soil of the experimental site was red sandy loam soil with a pH of 5.38, moderate to rich in organic matter. Uniformly grown well developed budded plants were planted at 1.8 m × 0.9 m spacing. The trial was laid out in Factorial Randomized Complete Block design with two factors, seven treatments and three replications in that first factor was the two cultivars *viz*., Mirabel, Charishma and second factor was varied levels of biostimulants and biofertilizers. The treatments are T_1- Control- RDF 100% NPK (50:50:75 g/plant/year), T_2- 100% RDF + Humesol @ 2.5 ml/ l, T_3- 100% RDF + Stenohume @ 5 ml/ l, T_4- 100% RDF + Ecohume @ 3 ml/ l as foliar spray, T_5- 75% RDF + *Azospirilum* + PSB + KSB each @ 4 ml/plant as soil application, T_6- 100% RDF + Seaweed extract @ 1000 ppm and T_7- 100% RDF + Seaweed extract @ 2000 ppm as a foliar spray in bimonthly interval. Each treatment consist of 15 plants, the observations on quality and yield parameters were recorded in five labelled plants which were selected in every treatment and the mean data was statistically analysed.

Results and Discussion

Flower quality parameters

The flower quality like diameter of flower (cm), stalk length (cm) and shelf life of flowers (hr.) were found significant (Table 1).

Flower diameter

Flower diameter was maximum (5.13 cm) in cv. Charishma while, minimum in cv. Mirabel. Among the treatments, T_7- 100% NPK + Seaweed extract @ 2000 ppm has recorded significantly highest flower diameter of 5.41 cm and it was lowest in control (T_1). In case of interaction between varieties and different treatments, larger flower diameter (5.45 cm) was recorded with V_2T_7, while it was lowest in V_1T_1 treatment combination. The larger flower diameter was observed in foliar spray of seaweed extract because they are the precursors of auxin, cytokinin and micronutrients. Present study is in agreement with the results obtained by Karthiraj *et al.* (2008) [10] in China aster; Shinde *et al*. (2010) [15] in marigold; in chrysanthemum and Bashir *et al*. (2016) [2] in gladiolus.

Stalk length

Stalk length was enhanced in cv. Charishma (3.48 cm) while, it was minimum in cv. Mirabel. Among the treatments, T_7- 100% NPK + Seaweed extract 2000 ppm has recorded significantly highest stalk length of 3.66 cm and it was lowest in control (T_1). In case of interaction between varieties and different treatments, longer stalk length of 3.94 cm was recorded in V_2T_7 (100% NPK + Seaweed extract 2000 ppm with cv. Charishma), while it was lowest (2.89 cm) in V_1T_1 treatment combination. The stalk length stimulation by seaweed extract was might be due to presence of cytokinin and auxin precursors, macro and micronutrients which increased the cell division and cell enlargement. Same finding was observed by Hedge *et al*. (2016) in chrysanthemum. These results are corroborated with the findings of Karthiraj *et al*. (2008) [10] in China aster and Shinde *et al*. (2010) [15] in marigold.

Shelf life of flowers

Maximum shelf life of flowers (36.14 hr.) was reported in cv. Mirabel while minimum (33.71 hr.) was observed in cv. Charishma. Among the different levels of biostimulants and biofertilizers, T_7-100% RDF + Seaweed extract @ 2000 ppm significantly recorded the highest shelf life of flower (40.53) and lowest duration of shelf life (27.89 hr.) was documented in control (T_1). In case of interaction effect maximum shelf life duration (42.22 hr.) was recorded in V_1T_7 (100% NPK + Seaweed extract 2000 ppm with cv. Mirabel whereas, it was minimum (27.50 hr.) in V_2T_1 (RDF 100% with cv. Charishma). Variations in shelf life of flowers might be due to the sensitivity of genotypes to ethylene. Similar studies depicting significant differences among cultivars for shelf life was reported by Kumari *et al*. (2017) [12] and Hegde *et al*. (2016) [8] in chrysanthemum, in addition to this seaweed extract contain cytokinin and auxin that might have increased the antioxidant levels and improved resistance to senescence leading to enhanced longevity of flowers. The increased shelf life also might be due to triggering of metabolic activity and narrowing of the C: N ratio by the significant accumulation of carbohydrates. Same was observed by in chrysanthemum. Present study is also in agreement with the results obtained by Bashir *et al*. (2016) [2] and Sankari *et al*. (2015) [14] in gladiolus.

Flower yield parameters

The yield parameters *viz*., Number of flowers per cluster, 100 flower weight, number of flowers per plant, cumulative flower yield per plant and per hectare were found significant (Table 2).

Flowers per cluster

The maximum flowers per cluster (6.48) is recorded in cv. Mirabel, while it was minimum in cv. Charishma. Among the treatments, 100% RDF + Ecohume at 3 ml/l (T_4) has significantly enhanced the number of flowers per cluster (6.86) and it was found lowest in control (T_1). In case of interaction between varieties and different treatments, maximum number of flowers per cluster (7.11 cm) was recorded with V_1T_4- 100% RDF + Ecohume at 3 ml/l with cv. Mirabel, while it was lowest in V_2T_1 (RDF 100% with cv. Charishma) treatment combination. This might have aided by the application of balanced nutrition and humic acid at optimum concentration helped in production of auxin like growth substances at early phase of development (Vaughan *et al*., 1985) [16]. The results are in concurrence with the findings of Hegde *et al*. (2016) [8] and Bhargavi *et al*. (2018) [3] in chrysanthemum.

100 flower weight

100 flower weight was significantly maximum (252.86 g) in cv. Charishma, while it was minimum in cv. Mirabel. Among the treatments, application of 100% RDF + Ecohume at 3 ml/l (T_4) has recorded the maximum 100 flower weight (271.44 g) compared to control. In case of interaction effect, the maximum 100 flower weight (277.42 g) was recorded with V_2T_4 combinations, while it was lowest in V_2T_1 treatment combination. The higher 100 flower weight due to humic acid application could also be due to stimulation of photosynthetic activity which led to accumulation of more carbohydrates. The above results were in accordance with studies conducted by Raghava *et al.* (1992) [13] in chrysanthemum and Farjami in marigold.

Number of flowers per plant, flower yield per plant and per hectare

The maximum number of flowers per plant (283.02), cumulative flower yield per plant (597.37 g) and per hectare (3.69 t) was registered in cv. Mirabel, while it was minimum in cv. Charishma. Among the treatments, T_4-100% RDF + Ecohume at 3 ml/l has significantly recorded significantly highest number of flowers per plant (322.88), cumulative flower yield per plant (681.94 g) and per hectare (4.21 t) and it was lowest in control (T_1). Interaction between varieties and different treatments, maximum number of flowers per plant (325.77), cumulative flower yield per plant (687.99 g) and per hectare (4.25 t) was recorded with V_1T_4-100% RDF + Ecohume at 3 ml/l with cv. Mirabel, while it was minimum in V_2T_1 (RDF 100% with cv. Charishma) combination. The improved yield parameters might be due to significant increase in number of branches, producing more photosynthates, which were probably diverted towards sink and their utilization to buildup of new cells, thereby increasing the production of more number of flowers. The results obtained in the present study is in agreement with the studies conducted by Sankari *et al*. (2015) [14] in gladiolus; Khenizy *et al*. (2013) [11] in gerbera; Yasser *et al*. (2011) [17] in hibiscus; Ali *et al*. (2015) [1] in tulip.

Conclusion

From the present investigation it can be concluded that, among the varieties cv. Mirabel performed well for the attributes like number of flowers per cluster, number of flowers per plant, flower yield. The plants applied with 100% RDF + Seaweed extract 2000 ppm performed best for quality parameters like diameter of flower, stalk length, shelf life of flowers. Foliar application of Ecohume at 3 ml/l in bimonthly interval along with 100% RDF resulted in optimum yield of Floribunda roses. Among the interaction between different levels of biostimulants and biofertilizers, the cv. Mirabel performed best with application of 100% RDF + Ecohume at 3 ml/l in bimonthly interval.

Table 1: Quality of the flowers as influenced by foliar spray of bio stimulants and soil application of biofertilizers in Floribunda roses.

Quality parameters			
Treatments	**Flower diameter (cm)**	**Stalk length (cm)**	**Shelf life (hours)**
Varieties			
V_1-Mirabel	4.93	3.22	36.14
V_2-Charishma	5.13	3.48	33.71
S.Em±	0.005	0.008	0.121
CD @ 5%	0.014	0.022	0.355
Biostimulants and biofertilizers			
T_1- Control	4.34	3.04	27.89
T_2- Humesol- 2.5 ml/l	4.60	3.21	30.83
T_3- Stenohume- 5 ml/l	4.97	3.28	33.44
T_4- Ecohume- 3 ml/l	5.25	3.35	35.58
T_5- Azospirilum + PSB + KSB- each 4ml/plant	5.32	3.42	37.69
T_6- Seaweed extract- 1000 ppm	5.27	3.45	38.50
T_7- Seaweed extract- 2000 ppm	5.41	3.66	40.53
S.Em±	0.009	0.014	0.227
CD @ 5%	0.026	0.041	0.664
Interaction (V×T)			
V_1T_1	4.22	2.89	28.28
V_1T_2	4.46	3.14	32.83
V_1T_3	4.70	3.21	34.50
V_1T_4	5.20	3.27	36.78
V_1T_5	5.34	3.33	38.78
V_1T_6	5.24	3.28	39.61
V_1T_7	5.39	3.39	42.22
V_2T_1	4.46	3.19	27.50
V_2T_2	4.73	3.28	28.83
V_2T_3	5.25	3.35	32.39
V_2T_4	5.31	3.42	34.39
V_2T_5	5.42	3.51	36.61
V_2T_6	5.30	3.63	37.39
V_2T_7	5.45	3.94	38.83
S.Em±	0.012	0.020	0.321
CD @ 5%	0.036	0.058	0.939

*T_1 - T_7 RDF 100% - 50:50:75 NPK g/plant/year except T_5 75% RDF

Table 2: Yield of flowers as influenced by foliar application of bio stimulants and soil application of biofertilizers in Floribunda roses

Yield parameters					
Treatments	**Number of flowers/ cluster**	**100 flowers weight (g)**	**Average number of flowers/plant**	**Cumulative yield/plant (g)**	**Cumulative yield/ha (t)**
Varieties					
V_1-Mirabel	6.48	241.92	283.02	597.37	3.69
V_2-Charishma	5.63	252.86	278.42	594.57	3.66
S.Em±	0.018	0.862	0.424	0.644	0.004
CD @ 5%	0.052	2.520	1.241	1.882	0.012
Biostimulants and biofertilizers					
T_1- Control	4.82	216.03	236.17	501.56	3.10
T_2- Humesol- 2.5 ml/l	5.43	231.96	259.57	556.26	3.43
T_3- Stenohume- 5 ml/l	6.00	246.78	275.93	588.93	3.64
T_4- Ecohume- 3 ml/l	6.86	271.44	322.88	681.94	4.21
T_5- Azospirilum + PSB + KSB-each 4ml/plant	6.24	249.29	278.35	598.04	3.69
T_6- Seaweed extract- 1000 ppm	6.42	252.80	286.77	603.75	3.70
T_7- Seaweed extract- 2000 ppm	6.62	263.40	305.37	641.31	3.96
S.Em±	0.034	1.613	0.794	1.205	0.008
CD @ 5%	0.098	4.715	2.321	3.521	0.023
Interaction					
V_1T_1	5.49	210.64	241.27	510.68	3.15
V_1T_2	6.09	226.82	261.20	554.23	3.42
V_1T_3	6.38	242.86	277.87	584.85	3.61
V_1T_4	7.11	265.47	325.77	687.99	4.25
V_1T_5	6.67	234.60	279.80	600.32	3.71
V_1T_6	6.71	251.61	286.65	602.07	3.72
V_1T_7	6.93	261.41	308.60	641.43	3.96
V_2T_1	4.16	221.42	231.07	492.43	3.04
V_2T_2	4.78	237.10	257.93	558.30	3.45
V_2T_3	5.62	250.70	274.00	593.01	3.66
V_2T_4	6.60	277.42	320.00	675.89	4.17
V_2T_5	5.82	263.97	276.90	595.75	3.68
V_2T_6	6.13	254.00	286.88	605.43	3.68
V_2T_7	6.31	267.05	302.13	641.18	3.96
S.Em±	0.047	2.281	1.123	1.703	0.011
CD @ 5%	0.139	6.668	3.283	4.979	0.033

*T_1 - T_7 RDF 100% - 50:50:75 NPK g/plant/year except T_5 75% RDF

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