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Effect of organic manures and biofertilizers on growth, flowering and flower yield of rose (*Rosa hybrida* L.) cv. Gladiator

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Abstract
The present investigation on **"**Effect of organic manures and biofertilizers on growth, flowering and flower yield of rose (*Rosa hybrida* L.) cv. Gladiator**"** was conducted at Department of Horticulture, College of Agriculture, Junagadh Agricultural University, Junagadh (Gujarat) during *Rabi* season in the year of 2016 -17. Different treatments were significantly affected on the growth, flowering and flower yield parameters. It is evident that significantly maximum plant height (98.50 cm), plant spread (64.86 cm), number of branches per plant (7.20) and stem diameter (1.18 cm) at peak flowering stage were recorded with Castor cake @ 0.8 kg + *Azotobacter* @ 1 ml + PSM @ 1 ml + KSB @ 1 ml / plant. Similarly, significantly the minimum average days to first flower (37.95), maximum average days to flowering span (118.18), diameter of flower (7.58 cm), number of petals per flower (72.55), stalk length (30.03 cm), stalk diameter (0.30 cm), number of flowers per plant (64.83), number of flowers per plot (324.15), number of flower per hectare (4.32 lac), flower yield per plot (5.82 kg) and flower yield per hectare (7753.66 kg) were recorded with Castor cake @ 0.8 kg + *Azotobacter* @ 1 ml + PSM @ 1 ml + KSB @ 1 ml / plant. As per economics point of view, treatment consisting Castor cake @ 0.8 kg + *Azotobacter* @ 1 ml + PSM @ 1 ml + KSB @ 1 ml / plant was found maximum gross realization (Rs. 8.64 lac ha^{-1}) and net return (Rs. 5.39 lac ha^{-1}) but the highest cost benefit ratio was obtained under the treatment consisting Farm yard manure @ 4 kg + *Azotobacter* @ 1 ml + PSM @ 1 ml + KSB @ 1 ml / plant (1:2.70). Overall it can be concluded that Castor cake @ 0.8 kg + *Azotobacter* @ 1 ml + PSM @ 1 ml + KSB @ 1 ml / plant was found superior for growth, flowering and yield of rose.

Keywords: Rose, Gladiator, Azotobacter, Yield

Introduction
The God's best gift to humankind is flower. Flowers are delicate, colourful and bright, attracting insects, animals and human beings. Flowers are the soul of the garden and convey the message of nature to man. They are integral part of human livings.

"Some words instantaneously suggest beauty because they are associated with things that Afford pleasure and delight. The Rose is one of them" [7].

It is one of the nature beautiful creation and is universally known as the Queen of flower due to its majestic fragrance, brilliant colour, attractive shape, varying sizes and excellent keeping quality. It belongs to the family Rosaceae. Globally, about 150 species of roses are found, out of which 34 species are cultivated in India. It is the most powerful symbol in metaphysical word.

Roses are symbol of love and peace and are used to convey the message of nature to human and vice-versa. Since rose flower are so beautiful in shape, size, fragrance and colour, slow opening of flowers and good keeping quality made them so popular that crop is grown commercially to meet the demand for domestic and international market. It is top ranking cut flower in the flower. The *Rosa hybrida* L. is a vigorous shrub of family Rosaceae with mild fragrance and gray -green foliage. Branches are very prickly and flowers are most attractive with good vase life and have tremendous demand from growers, exporters and flower lovers. Roses are also suitable for garden decoration and landscaping. Roses are also grown for cut flowers and loose flower. Essential oil from rose petals for perfume and allied products like rose oil, gulkand, pankhuri, gul roghan are important preparations [11].

India is endowed with an ideal climatic condition which provides remarkable quality of flower. Karnataka, Tamil Nadu and Andhra Pradesh are the leading flower producing states in the country. In India total area of flower crops is 2,55,000 hectares with 17,54,000 metric tons

production of loose flowers and 543 lakh flowers. The total area under flower crops in Gujarat is 17,300 ha. With production of 1, 63, 600 metric tons loose flowers [2]. The commercial cultivation of rose in Gujarat is confined to Ahmedabad, Vadodara, Anand, Surat, Navsari and Valsad. In Gujarat, interest in rose cultivation is an increasing order because it is a cash crop which gives higher income per unit area than any other flower crop and also has increasing demand in local and international markets.

The use of organic manures holds prestigious position with the farmers since longback. The organic manures play an important role in crop production. Physically, organic manures promotes formation of soil crumbs that help the easy absorption of rainwater. Chemically, organic manures add an organic compound to the soil while going under decomposition. Biologically, organic manures provide food for the beneficial soil microorganisms. Continuous use of inorganic fertilizers is hazardous to the soil health in respect of physical, chemical and biological properties of soil. Therefore, it is necessary to minimize the application of inorganic fertilizer by substituting with the organics. It is well established fact that the improvement in quality and productivity of crops can be achieved with application of organic manure. Application of organic manure increase the maximum water-holding capacity, hydraulic conductivity and porosity of the soil and it is most critical in the sustainable agriculture.

Vermicompost increase soil organic matter and nutrient content, improves the soil structure and increase cation exchange capacity. Earth worms utilize organic wastes as food and the undigested material excreted by them has gained the name 'vermicompost'. The vermicompost serves as organic manure, since it is a source of nutrients, such as nitrogen, phosphate, potassium and micronutrients. Farmyard manure refers to the decomposed mixture of dung and urine of farm animals along with litter and left over material from roughages or fodder fed to the cattle. On an average well decomposed farmyard manure contains 0.5 per cent N, 0.2 per cent P_2O_5 and 0.5 per cent K_2O. Farm yard manures are very important components of nutrient management and they have been maintaining soil fertility and quality of flowers.

Neem cake organic manure is the by-product obtained in the process of cold pressing of neem tree fruits and kernels, and the solvent extraction process for neem oil cake. It is a potential source of organic manure. Neem has demonstrated considerable potential as a fertilizer. For this purpose, neem cake and neem leaves are especially promising. After processing, neem cake can be used for partial replacement of poultry and cattle feed. Neem cake organic manure protects plant roots from nematodes, soil grubs and white ants probably due to its residual limonoid content. It also acts as a natural fertilizer with pesticidal properties. Castor cake is one of the most versatile natural manures. It is truly an organic manure which enhances the fertility of the soil without causing any damage or decay. It is enriched with the three big elements vital and conducive to the proper growth of crops - Nitrogen, Phosphorus and Potassium. It also has traces of nutrients like Manganese, Zinc and Copper, thus making it a balanced fertilizer. Moreover, it helps to neutralize the detrimental effects of chemical fertilizers.

Biofertilizers are microbial inoculants of selective microorganisms like bacteria, algae and fungi, already existing in nature. They may help in improving soil fertility by the way of accelerating biological nitrogen fixation from Atmosphere, solubalization of the insoluble nutrients already present in soil, decomposing plant residues, stimulating plant growth and production. The process consumes less energy and provides cheap nutrients to crops without polluting the nature.

Materials and Methods

The experiment was conducted at the Department of Horticulture, College of Agriculture, Junagadh Agricultural University, Junagadh (Gujarat) during *Rabi* season of the year 2016-17. Junagadh is situated at 21.5°N latitude and 70.5°E longitude with an altitude of 60 meters above MSL on the western side at the foot hill of mountain Girnar sierra (Gujarat). Climate is typically subtropical, characterized by fairly cool and dry winter, hot and dry summer and warm and moderately humid monsoon. The rainy season commences by third week of June and ends in September. July and August are the months of heavy precipitation. Winter sets in the month of November and continues till the month of February. December and January are the coldest months of winter. Summer commence in the second fortnight of February and ends in the middle of June. April and May are the hottest months.

The present study was conducted on one year old rose plants of variety 'Gladiator'. Planted at Department of Horticulture, College of Agriculture, Junagadh Agricultural University, Junagadh. All the plants selected were uniform in growth, size and planted at the distance of 1.0 x 1.5 meters. All the plants were subjected to uniform application of cultural practices like pruning, irrigation, application of manures and fertilizer (as per treatment), plant protection measures, etc.

There were nine treatments embedded in a Randomized Block Design with three replications. The details of the treatments applied in the present investigation are as under:

Table 1

Treatments	Treatment Details
T_1	Control
T_2	Vermicompost @ 2 kg / plant
T_3	Farm yard manure @ 4 kg / plant
T_4	Neem cake @ 0.8 kg / plant
T_5	Castor cake @ 0.8 kg / plant
T_6	Vermicompost @ 2 kg + *Azotobacter* @ 1 ml + PSM @ 1 ml + KSB @ 1 ml / plant
T_7	Farm yard manure @ 4 kg + *Azotobacter* @ 1 ml + PSM @ 1 ml + KSB @ 1 ml / plant
T_8	Neem cake @ 0.8 kg + *Azotobacter* @ 1 ml + PSM @ 1 ml + KSB @ 1 ml / plant
T_9	Castor cake @ 0.8 kg + *Azotobacter* @ 1 ml + PSM @ 1 ml + KSB @ 1 ml / plant

Immediately after pruning the nitrogen (N), phosphorus (P), and potassium (K) as per treatment (in the form of different organic manures and biofertilizers) were applied as per treatment in basins prepared nearby the plants in each plot by ring method. Irrigation was given immediately after treatment. Weeding and hoeing were done at the monthly intervals to keep plot clean and free from weeds. Necessary plant protection measures were adopted, no serious pests and diseases were observed on plant during the course of study. All the plant protection measures were taken as per the requirement of the crop. Just after pruning, the cut ends were coated with Bordeaux paste to prevent the fungal infection in plants.

Five plants were selected at random from each treatment and tagged for recording the observations. Observations should be recorded as per as appropriate method. Required observations

were recorded from each replication of different treatments and average value was calculated. The analysis of variance for experimental design was carried out for all the characters under study.

Result and Discussion

The experimental findings obtained from the present study have been discussed here in following heads:

Effect on growth parameters

The data pertaining to various growth characters *viz.*, plant height (cm), plant spread (N-S and E-W) (cm), number of branches per plant and stem diameter (cm) clearly indicated that the rose plant showed significant response and presented in Table 1.

It is evident that significantly maximum plant height (98.50 cm), plant spread (64.86 cm), number of branches per plant (7.20) and stem diameter (1.18 cm) at peak flowering stage were recorded with T_9 i.e. Castor cake @ 0.8 kg + *Azotobacter* @ 1 ml + PSM @ 1 ml + KSB @ 1 ml / plant.

The better performance in growth parameters may be due to the fact that castor cake improves the soil physical condition due to spot application and inadvertent addition of essential plant nutrient and favourable C: N ratio. This could be due to use of oiled castor cake which kept availability of nutrient particularly N for longer time due to presence of ricinin as nitrification inhibitor. Bio-fertilizers which are preparation of efficient nitrogen, potash solubilising and phosphate solubilising or cellulose decomposing of microorganisms, when applied to soil enhances availability of nutrients to plant providing an economically viable and ecological sound means of reducing or helping external input of chemical fertilizers. These results are in close agreement with [9] and [3] in rose, [6] in chrysanthemum.

Table 2: Effect of organic manures and biofertilizers on growth parameters of rose

Treatment	Plant height (cm)	Plant spread (cm)	Number of branches per plant	Stem diameter (cm)
T_1	83.82	53.38	5.50	0.95
T_2	89.58	55.98	6.12	0.99
T_3	87.36	55.08	5.70	0.96
T_4	93.81	57.03	6.74	1.06
T_5	95.78	57.86	6.93	1.08
T_6	96.88	61.28	7.03	1.08
T_7	90.79	59.96	6.58	1.02
T_8	97.77	63.09	7.12	1.15
T_9	98.50	64.86	7.20	1.18
S. Em±	3.16	2.29	0.30	0.04
C.D. at 5%	9.48	6.87	0.91	0.12
C.V. %	5.91	6.76	8.05	6.83

Effect on flowering and yield parameters

The data presented in Table 2 revealed that, significantly the minimum average days to first flower (37.95), maximum average days to flowering span (118.18), diameter of flower (7.58 cm), number of petals per flower (72.55), stalk length (30.03 cm), stalk diameter (0.30 cm), number of flowers per plant (64.83), number of flowers per plot (324.15), number of flower per hectare (4.32 lac), flower yield per plot (5.82 kg) and flower yield per hectare (7753.66 kg) were recorded with T_9 i.e. Castor cake @ 0.8 kg + *Azotobacter* @ 1 ml + PSM @ 1 ml + KSB @ 1 ml / plant.

All flowering and yield attributes were positively affected by organic manure because chemically, organic manures add an organic compound to the soil while going under decomposing. Biologically, organic manures provide food for the beneficial soil microorganisms which increased availability of nutrients. The experimental soil was low in available N_2 and medium in available P_2O_5 and therefore the addition of organic manures might have helped in the supply of these nutrients and in creating congenial atmosphere in the root rhizosphere in overall improvement of rose flowering and yield. Whereas, bio-fertilizer may be due to *Azotobacter*, PSM and KSB an associative living diazotroph have been certified as potential microbial inoculants for increasing the productivity of various non-legume crops. These organisms besides fixation synthesize and secrete many amino acids, which influence flowering and yield. More or less the above findings are in agreement with the results of [4], [9], [3], [1], [10], [5] in rose, [6] in chrysanthemum, [12] in anthurium and [8] in gladiolus.

Table 3: Effect of organic manures and biofertilizers on flowering of rose

Treatment	Days to first flower	Flowering span (days)	Diameter of flower (cm)	Number of petals per flower	Stalk length (cm)	Stalk diameter (cm)
T_1	45.01	84.67	5.23	58.33	14.22	0.18
T_2	42.91	92.51	5.74	58.02	18.43	0.20
T_3	43.80	88.30	5.41	56.31	17.02	0.20
T_4	40.77	100.38	6.49	61.58	20.12	0.24
T_5	40.31	103.29	6.70	63.78	21.64	0.25
T_6	38.97	108.52	6.88	66.94	25.47	0.26
T_7	40.10	98.35	6.02	58.90	21.82	0.22
T_8	38.33	110.34	7.06	68.72	28.50	0.28
T_9	37.95	118.18	7.58	72.55	30.03	0.30
S. Em±	1.27	3.55	0.29	2.56	0.85	0.01
C.D. at 5%	3.81	10.64	0.86	7.68	2.54	0.03
C.V. %	5.38	6.11	7.82	7.07	6.69	7.45

Table 4: Effect of organic manures and biofertilizers on flower yield of rose

Treatment	No. of flowers per plant	No. of flowers per plot	No. of flowers per ha. (lac)	Flower yield per plot (kg plot^{-1})	Flower yield per hectare (kg ha^{-1})
T_1	50.72	240.40	3.38	3.55	5227.72
T_2	58.67	293.35	3.91	4.60	6129.05
T_3	56.72	283.60	3.78	4.25	5671.99
T_4	60.82	304.10	4.05	4.99	6653.70
T_5	61.32	306.60	4.09	5.18	6900.53
T_6	62.08	310.40	4.14	5.30	7064.69
T_7	60.28	301.40	4.02	4.83	6433.87
T_8	62.98	314.90	4.20	5.50	7335.06
T_9	64.83	324.15	4.32	5.82	7753.66
S. Em+	2.10	10.78	0.15	0.22	273.86
C.D. at 5%	6.29	32.32	0.44	0.67	821.04
C.V. %	6.07	6.27	6.38	7.89	7.21

Economics

The economics of treatments indicating gross realization and net realization per hectare have been worked out from the flower yield of rose, taking into account the prevailing market price of flowers at the time of harvesting of crop (Table 4). As per economics point of view, treatment T_9 - Castor cake @ 0.8 kg + *Azotobacter* @ 1 ml + PSM @ 1 ml + KSB @ 1 ml / plant was found maximum gross realization (Rs. 8.64 Lac ha^{-1}) and net return (Rs. 5.39 Lac ha^{-1}) but the highest cost benefit ratio was obtained under the treatment T_7 - Farm yard manure @ 4 kg + *Azotobacter* @ 1 ml + PSM @ 1 ml + KSB @ 1 ml / plant (1:2.70) followed by T_9 (1:2.66). It leads to treatment cost is low as compare to other treatment.

Table 5: Economics and cost benefit ratio as influence by different organic manures and biofertilizers in rose.

Treatment	Yield (Number of flower/ha) (lac)	Gross realization (Rs. lac/ha)	Total cost of cultivation (Rs. lac/ha)	Net return (Rs. lac/ha)	CBR
T_1	3.38	6.77	2.72	4.03	1:2.48
T_2	3.91	7.82	3.26	4.56	1:2.40
T_3	3.79	7.59	2.94	4.64	1:2.58
T_4	4.05	8.10	3.19	4.90	1:2.54
T_5	4.08	8.17	3.22	4.94	1:2.53
T_6	4.13	8.27	3.29	4.97	1:2.51
T_7	4.01	8.02	2.97	5.05	1:2.70
T_8	4.20	8.40	3.22	5.18	1:2.61
T_9	4.32	8.64	3.25	5.39	1:2.66

Average price of flower sale: Rs.2/flower

Conclusion

Based on the results obtained from the present experimentation, it can be concluded that Castor cake @ 0.8 kg + *Azotobacter* @ 1 ml + PSM @ 1 ml + KSB @ 1 ml / plant was found superior for growth, flowering, flower yield and net return of rose.

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