D-5730
[1-6]

RESEARCH ARTICLE Agricultural Science Digest

Effect in Growth, Flowering and Corm Yield of Gladiolus by Different Application Methods of Biofertilizers

Jitendra Kumar Sahu[1], Ashwini Kailas Abhangrao[1], Vinay Kumar Mashkey[1], Vishal Tripathi[1]

10.18805/ag.D-5730

ABSTRACT

Background: The current study was carried out to explore the effects of various biofertilizer applications on gladiolus growth, flower production and corms yield in Horticulture Research Farm of Lovely Professional University, Phagwara in winter season of 2022.

Methods: Ten distinct combinations of biofertilizers and their application techniques, together with control, were used in the experiment's Randomized Block Design, which was replicated three times. Corms were sown in the spacing 30×30 cm and treated as T_1 (Control), T_2 (RDF + *Azotobacter* (Corm dipping), T_3 (RDF + *Azotobacter* (Soil application), T_4 (RDF + *Azotobacter* (Foliar application), T_5 (RDF + PSB (Corm dipping), T_6 (RDF + PSB (Soil application), T_7 (RDF + PSB (Foliar application), T_8 (RDF + *Azotobacter* +PSB (Corm dipping), T_9 (RDF + *Azotobacter* + PSB (Soil application) and T_{10} (RDF + *Azotobacter* +PSB (Foliar application) The following data were recorded at different stages *i.e.* days required for sprouting of corms, plant height (cm), number of leaves per plant, number of Shoots per mother corm, days required for spike emergence per plot, length of spike (cm), diameter of floret (cm), number of spikes per plant, number of florets per spike, number of Spikes per hectare, number of cormels per plant, number of corms per plant, diameter of corm (cm), Wt. of corms per plant (g), Wt. of cormels/plant (g) and yield of corms (q/ha).

Result: Among all the 10 treatments given Treatment T_8, which consisted of RDF + Azotobacter + PSB and was used as a soil application, was found to be superior, implying that biofertilizers can improve nutrient availability and absorption, which resulted in improved gladiolus plant growth, blooming, yield, quality and yield.

Key words: Application methods, Azotobacter, Biofertilizers, Gladiolus, PSB.

INTRODUCTION

The gladiolus is a flower of elegance and perfection that is regarded as the queen of bulbous flowers because of its massive flower spikes with showy florets, intense colors, alluring shapes, varied sizes and long shelf life. It holds a prominent position among all commercial flower crops and is in high demand on both the domestic and global markets because it is a significant bulbous ornamental plant (Sharma *et al*., 2013). The absence of various nutrients affects gladiolus flowering and corm production. Due to India's current exploitative agricultural trend, it is no longer possible to sustainably maintain the soil's natural fertility. Apart from the soil fertility and productivity issues, excessive use of chemical fertilizers is also becoming more and tougher for the farmers due to their high costs and shortage during peak season. Application of biofertilizers is contemplates today to limit the use of mineral fertilizers and assist an efficacious tool for land development under less contaminated environments, reducing agricultural costs, enhancing crop yield due to supporting them with an available growth promoting substances and nutritive elements (Turan *et al*., 2010).

There have been positive effects of inoculation in gladiolus with several biofertilizer sources on the spike yields (Rajhansa *et al*., 2010; Singh *et al*., 2014 and Seema *et al*., 2016) concluded that the tuberose bulb treated with PSB and Azotobacter at 2.5 g kg^{-1} bulb gave maximum vegetative growth, good flower quality parameter and highest yield of flowers ha^{-1}. In the rhizosphere Azotobacter naturally fixes atmospheric nitrogen (Seema *et al*., 2016).

[1]Department of Horticulture, Lovely Professional University, Phagwara-144 411, Punjab, India.

Corresponding Author: Vishal Tripathi, Department of Horticulture, Lovely Professional University, Phagwara-144 411, Punjab, India.
Email: vishal.ambro@gmail.com

How to cite this article: Sahu, J.K., Abhangrao, A.K., Mashkey, V.K. and Tripathi, V. (2023). Effect in Growth, Flowering and Corm Yield of Gladiolus by Different Application Methods of Biofertilizers. Agricultural Science Digest. DOI: 10.18805/ag.D-5730.

Submitted: 11-01-2023 **Accepted:** 30-09-2023 **Online:** 16-01-2024

The result of organic fertilization on increasing corm diameter, number of new cormels and dry weight of corm and cormels of gladiolus were reported by many investigators, such as (Abdou *et al*., 2018 and Karagoz *et al*., 2019) on gladiolus,(Kabir wt al., 2011, Srivastava *et al*., 2005 and Suseela *et al*., 2016), on tuberose, (Mirkalaei *et al*., 2013 and Lokeshwar *et al*., 2015) on lily, (Pandey *et al*., 2017) on dahlia plant who found that compost fertilizer improved the chemical composition of gladiolus plants. Microbe in biofertilizer (M.B.) treatments were found to have stimulating effect on corm and cormels production and chemical composition of gladiolus such as those raveled by (Hassan *et al*., 2020; Sathyanarayana *et al*., 2018 and Chakradhar *et al*., 2019), on gladiolus (Attia *et al*., 2018) on tuberose plant.

The vegetative attributes, corn and flower production in gladiolus could be positively impact by different organic fertilizers treatments when applied in optimum concentration (Abdou *et al*., 2019 and Ahmed *et al*., 2019). Good quality corms resulted healthy foliage with better vegetative growth and enhanced photosynthetic activity (Sarkar *et al*., 2014). Keeping in mind, the significant role of organic biofertilizers and antioxidants in plants their possible effects on vegetative traits and standard production of gladiolus corms.

MATERIALS AND METHODS

The study entitled "Effect in Growth, Flowering and Corm Yield of Gladiolus by Different Application Methods of Biofertilizers" was carried out at lovely professional university, School of Agriculture, Phagwara, Punjab during 2022. The experiment was laid out in Randomized Block Design with 10 different combinations of biofertilizers and their application methods along with control which were replicated thrice. The treatments were, T_1 (Control), T_2 (RDF + *Azotobacter* (Corm dipping), T_3 (RDF + *Azotobacter* (Soil application), T_4 (RDF + *Azotobacter* (Foliar application), T_5 (RDF + PSB (Corm dipping), T_6 (RDF + PSB (Soil application), T_7(RDF + PSB (Foliar application), T_8 (RDF + *Azotobacter* +PSB (Corm dipping), T_9(RDF + *Azotobacter* +PSB (Soil application) and T_{10} (RDF + *Azotobacter* +PSB (Foliar application) excellence cultural practices recommended for Gladiolus was followed evenly for all the experimental plots.

Biofertilizer *viz. Azotobacter* and PSB have been used according to treatment. Biofertilizers imported from Department of Plant Pathology, Indira Gandhi Krishi Vishwavidyalaya, Raipur, (C.G.). The pure, disease free corms of Gladiolus cultivar 'American Beauty' were used for conducting the studies. For treatment with corm dipping, biofertilizer (*Azotobacter*, PSB and *Azotobacter* + PSB) at the rate of 2 g/half kg of corms, for treatment with soil application, biofertilizer (*Azotobacter*, PSB and *Azotobacter* + PSB) at the rate of 4 kg/ha and for treatment with Foliar Application, biofertilizer (*Azotobacter*, PSB and *Azotobacter* + PSB) at the rate of 0.14 ml/lt. of water was applied at 3 leaf-stage. The manures were mixed uniformly with soil. Phosphate Solubilizing Bacteria (PSB) and *Rhizobium Azotobacter* were treated as corm dip treatment to the concerned treatments. The biofertilizers were mixed with slurry and water was prepared. Then corms were mixed accurately with slurry and kept for 2 hours in shade due to coating is formed on the outermost layer of the corms. These treated corms were planted in 7 cm deep furrows by maintaining a spacing of 30 cm (row-row) and 30 cm (plant-plant) on the season of *Rabi* (17^{th} of October, 2022. After planting, upper surface of corms were covered by soil and light irrigation was given.

The corms with 5 cm diameter were planted at a depth of 7cm in the raised bed at a spacing of 30 × 30 cm. thirty plants were planted in each plot. Upper surface of corms were covered by soil and light irrigation was given. When the first pair of flowers fully opened the flower spikes were harvested and were cut with a sharp knife, leaving the small gripping leaves on the flower spikes to prolong their life. After flowering, the irrigation was turned off and the plants were cut at the ground level, with the corms of the representative sample plants in each treatment pulled out of the soil for recording observations. The following data were recorded at different stages *i.e.* days required for sprouting of corms, Plant height (cm), No of leaves Number of shoots per mother corm, Days required for spike emergence per plot, length of Spike (cm), diameter of floret (cm), number of spikes per plant, number of florets per spike, number of Spikes per hectare, Number of cormels per plant, number of corms per plant, diameter of corm (cm), Wt. of corms per plant (g), wt. of cormels/plant (g) and yield of corms (q/ha).

RESULTS AND DISCUSSION

The various growth and development parameters of gladiolus were found to be significantly affected by biofertilizers application methods.

Days to sprouting

The information given in Table 1 reveled that days required for sprouting of corms have significant affect by different application of biofertilizer. The minimum days (11.22 days after sowing) required for sprouting of corms found by soil application of PSB and Azotobacter with recommended dose of fertilizer. Another application method which is corm dipping having statistically similar effect on corm sprouting with same treatment of biofertilizers. However, maximum days (14.86 days) for corm sprouting were found in application of RDF. The presence of biofertilizer may have enhanced the physiological process and increased corm germination by allowing nutrients to be absorbed more quickly *via* the primary roots or bulb surface. The results are in accordance with the finding of (Srivastava *et al*., 2005), who stated that treatment of (120 kg/ha N, 65 kg/ha P and 62.5 kg/ha RDF + PSB + *Azospirillum* exhibited significant improvement in days needed for corm sprouting in gladiolus.

Growth parameters

In respect of growth parameters *i.e*., plant height (cm), Number of leaves per plant and Number of shoots per mother corm was significantly affected by different treatments of biofertilizers and their method of application. Soil Application of RDF + *Azotobacter* + PSB was found maximum improvement of all vegetative growth factors like plant height (78.0 cm), Number of leaves per plant (7.10) and Number of shoots per mother corm (3.2), While minimum vegetative growth found in control treatment. It might be due to the interaction of conventional fertilizers and bio-fertilizers, which provided more balanced nutrient to the plants. The results are also in accordance of the findings of (Uday *et al*., 2008) in gladiolus, who stated that the treatment with integrated nutrient management had a positive impact on all growth parameters, using *Azotobacter* and Phosphorus Solubilizing

Bacteria in tuberose, (Dongardive *et al*., 2007) with application of NPK (500:200:200 kg/ha) + vermicompost + *Azotobacter* + PSB in gladiolus (Hassan *et al*., 2020).

Flowering parameters

The result in Table 2 showed that the quality parameters *i.e*., days required for spike emergence per plot, length of Spike (cm), diameter of floret (cm) and number of spikes per plant have significant effect with different methods of application of biofertilizers. The data revealed that the earliest days (67.23days) required for spike emergence per plot was found with soil application of recommended dose of fertilizer (120:150:120 kg N:P:K/ha) with PSB which was *at par* with RDF + *Azotobacter* +PSB (Corm dipping) and RDF + *Azotobacter* +PSB (Soil application) while longest days (83.81days) required for spike emergence with application RDF. Soil application of RDF + *Azotobacter* and PSB found longest spike (68.07 cm) in gladiolus. The shortest length (50 cm) of spike found in gladiolus treated with RDF. Diameter of floret was also affected significantly with different methods of biofertilizer treatment. Maximum diameter (7.93 cm) of florets obtained in soil treatment of recommended dose of fertilizer + *Azotobacter* + PSB while minimum diameter found in RDF. Another quality parameter *i.e*., number of spikes per plant was maximum (3.5) when recommended dose of fertilizer, azotobacter and PSB was applied together in soil. This may be due to increased carbohydrates assimilation which resulted in increased vegetative development. As these carbohydrates with the application of biofertilizer in gladiolus (Dubey *et al*., 2010) are translocated to reproductive organs, they are hydrolyzed and transformed into reproductive sugars, which aid in the growth of gladiolus florets. Similar observations were reported in marigold (Thumar *et al*., 2013). Combined application of Phosphorus Solubilizing Bacteria and *Azotobacter* along with N increased flower size in marigold, (Pandhare *et al*., 2009 and Godse *et al*., 2006) found that 80% NPK in addition to biofertilizer enhanced the floret diameter in gladiolus, (Rajadurai *et al*., 2000) in marigold.

Flower yield

Furthermore, quality parameter also has significant effect on application method of biofertilizer and also on different biofertilizers. The data shown in Table 3 indicated that soil

Table 1: Effect of different application method of biofertilizers on vegetative growth.

Treatment	Days required for sprouting	Plant height (cm)	No. of leaves	Number of shoots per mother corm
T_1: RDF (Control)	14.86^{a}	60.97^{d}	5.1^{c}	1.1^{f}
T_2: RDF + *Azotobacter* (Corm dipping)	12.93^{bc}	68.97^{c}	5.63^{bc}	2.03^{de}
T_3: RDF + *Azotobacter* (Soil application)	13^{bc}	71.27^{c}	5.83^{bc}	2.3^{cd}
T_4: RDF + *Azotobacter* (Foliar application)	13.57^{ab}	61.63^{d}	5.2^{c}	1.2^{f}
T_5: RDF + PSB (Corm dipping)	12.85^{bc}	71.17^{c}	6.2^{ab}	2.4^{bcd}
T_6: RDF + PSB (Soil application)	12.15^{cd}	74.23^{b}	6.23^{ab}	2.67^{abc}
T_7: RDF + PSB (Foliar application)	13.68^{ab}	61.37^{d}	5.1^{c}	1.1^{f}
T_8: RDF + *Azotobacter* + PSB (Corm dipping)	11.42^{d}	76.03^{ab}	6.8^{a}	2.9^{ab}
T_9: RDF + *Azotobacter* + PSB (Soil application)	11.22^{d}	78^{a}	7.1^{a}	3.2^{a}
T_{10}: RDF + *Azotobacter* + PSB (Foliar application)	13.96^{ab}	62.87^{d}	5.3^{bc}	1.5^{ef}
SEM	0.51	2.19	0.27	0.10
CD at 5%	1.51	6.46	0.80	0.30

Table 2: Effect of different application method of biofertilizers on flowering.

Treatment	Days required for spike emergence	Length of spike (cm)	Diameter of floret (cm)	Number of spikes per plant
T_1: Control: RDF	83.81^{a}	50^{d}	5.93^{c}	1.7^{e}
T_2: RDF + *Azotobacter* (Corm dipping)	77.83^{c}	62.2^{c}	6.73^{bc}	2.5^{cd}
T_3: RDF + *Azotobacter* (Soil application)	74.46^{d}	62.17^{c}	6.67^{bc}	2.73^{bc}
T_4: RDF + *Azotobacter* (Foliar application)	80.2^{b}	51.2^{d}	6.17^{c}	1.8^{e}
T_5: RDF + PSB (Corm dipping)	69.33^{ef}	62.4^{c}	6.97^{abc}	2.83^{bc}
T_6: RDF + PSB (Soil application)	67.23^{f}	64.83^{b}	7.43^{ab}	3.2^{ab}
T_7: RDF + PSB (Foliar application)	82.97^{a}	50.67^{d}	6.13^{c}	1.7^{e}
T_8: RDF + *Azotobacter* + PSB (Corm dipping)	69.82^{e}	65.33^{b}	7.63^{ab}	3.27^{ab}
T_9: RDF + *Azotobacter* + PSB (Soil application)	69.07^{ef}	68.07^{a}	7.93^{a}	3.5^{a}
T_{10}: RDF + *Azotobacter* + PSB (Foliar application)	78.99^{bc}	52.17^{d}	6.07^{c}	2^{de}
SEM	1.28	2.02	0.13	0.10
CD at 5%	3.79	5.96	0.39	0.29

Table 3: Effect of different application method of biofertilizers on flowering.

Treatment	Number of florets per spike	Number of spikes per hectare	Number of corms per plant	Number of cormels per plant
T_1: Control: RDF	8.83[d]	177763.5[j]	1.03[d]	42.51[g]
T_2: RDF + *Azotobacter* (Corm dipping)	12.13[c]	228770.0[f]	1.97[c]	51.83[d]
T_3: RDF + *Azotobacter* (Soil application)	12.6[bc]	241072.5[e]	2.17[bc]	52.52[d]
T_4: RDF + *Azotobacter* (Foliar application)	9.83[d]	190120.2[h]	1.16[d]	44.85[f]
T_5: RDF + PSB (Corm dipping)	13.21[abc]	250658.9[d]	2.26[bc]	53.47[cd]
T_6: RDF + PSB (Soil application)	13.57[abc]	267981.6[c]	2.47[abc]	54.82[c]
T_7: RDF + PSB (Foliar application)	9.61[d]	179890.7[i]	1.06[d]	42.61[g]
T_8: RDF + *Azotobacter* + PSB (Corm dipping)	13.73[ab]	291246.1[b]	2.67[ab]	56.81[b]
T_9: RDF + *Azotobacter* + PSB (Soil application)	14.58[a]	298436.6[a]	3.05[a]	58.64[a]
T_{10}: RDF + *Azotobacter* + PSB (Foliar application)	10.17[d]	199335.2[g]	1.34[d]	47.79[e]
SEM	0.45	0.11	1.00	1.00
CD at 5%	1.34	0.34	2.96	2.96

Table 4: Effect of different application method of biofertilizers on corms and cormels.

Treatment	Diameter of corm (cm)	Wt. of corms per plant (g)	Wt. of cormels/ plant (g)	Yield of corms (q/ha)
T_1: Control: RDF	4.24[b]	53.38[d]	8.4[d]	86.77[f]
T_2: RDF + *Azotobacter* (Corm dipping)	4.99[ab]	65.69[c]	10.73[bc]	107[d]
T_3: RDF + *Azotobacter* (Soil application)	5.03[ab]	66.69[c]	10.8[bc]	107.73[d]
T_4: RDF + *Azotobacter* (Foliar application)	4.26[b]	55.05[d]	8.6[d]	89.5[ef]
T_5: RDF + PSB (Corm dipping)	5.1[ab]	72.43[b]	11[bc]	114.13[c]
T_6: RDF + PSB (Soil application)	5.47[a]	73.53[b]	10.9[bc]	117.97[b]
T_7: RDF + PSB (Foliar application)	4.26[b]	54.46[d]	8.7[d]	86.87[f]
T_8: RDF + *Azotobacter* + PSB (Corm dipping)	5.68[a]	80.34[a]	13.33[a]	124.07[a]
T_9: RDF + *Azotobacter* + PSB (Soil application)	5.88[a]	77.95[a]	11.4[b]	120.33[b]
T_{10} RDF + *Azotobacter* + PSB (Foliar application)	4.35[b]	56.4[d]	9.8[cd]	91.4[e]
SEM	0.22	3.18	0.67	2.30
CD at 5%	0.66	9.41	1.98	6.81

application of RDF + *Azotobacter* + PSB maximized the number of florets per spike (14.58) which was statistically similar with another method of application *i.e.*, corm dipping in *Azotobacter* + PSB as well as RDF while control treatment found minimum number of florets per spike. The number of spikes per ha have significant effect among different method of application of biofertilizer as well as recommended dose of fertilizer and biofertilizers. Maximum number of spikes per ha (298436.6) found with application RDF + *Azotobacter* + PSB (Soil application) and minimum spikes found in control treatment.

Yield of corms and cormels (q/ha)

The number of corms (3.05) and Cormels (58.64) per plant was found significantly more with treatment of corms with *Azotobacter* + PSB after that application of recommended dose of fertilizes and minimum number corms and cormels found in control treatment. When we talk about diameter of corm and yield attributes *i.e.*, weight of cormels per plant (g), corms per plant (g) and Yield of corms (q/ha) also affect significantly by different biofertilizers as well as their application methods. Data (Table 3 and 4) revealed that soil application of biofertilizer like *Azotobacter* and PSB with recommended dose of fertilizer has largest size of corms 5.88 which was *at par* with RDF + *Azotobacter* +PSB (Corm dipping) and RDF + PSB (Soil application) while smallest corm found with controlled treatment. The weight of Cormels/ plant (g), weight of corms per plant (g) and Yield of corms (q/ha) also found maximum with same treatment *i.e.*, *Azotobacter* and PSB with recommended dose of fertilizer but corms yield was increase by corms treated with biofertilizer instead of soil application of biofertilizers. The results are almost similar with the result of with application of 50% N and P + 100% K + Vermicompost+ PSB in statice, (Dhanumjaya *et al*., 2015) using 75% RDF + FYM + vermicompost + *Azospirillum*+ PSB in tuberose, (Meena *et al*., 2018) with application of RDF 75% + *Azotobacter* + PSB + Mycorrhiza in gladiolus and (Godse *et al*., 2006) in gladiolus.

CONCLUSION

The obtained results from the study revealed that corms treated with Treatment T_8 comprised of RDF + Azotobacter + PSB, used as soil application, produced a considerable increase in both growth as well as yield attributes, concluding that biofertilizers may boost the nutrient availability and absorption, which further got reflected in enhanced growth, flowering quality and yield. Similarly, Azotobacter and phosphorus solubilizing bacteria applied as foliar application and corm dipping also improved the growth and yield characters compared to control. Therefore, it can be concluded that microbial inoculation in rhizosphere (soil application) facilitated efficient nutrient's uptake which ultimately produce plants of superior quality. An additional research is required for confirmation of the result as the conclusion is based on one season of research.

Conflict of interest: None.

REFERENCES

Abdou, M.A., Aly, M.K., El-Sayed, A.A., Ahmed, A.S. (2019). Influence of organic manure, biofertilizer and/or some vitamin treatments on: A. vegetative growth and flowering aspects of *Gladiolus grandiflorus* var. Gold field plants. Scientific Journal of Flowers and Ornamental Plants. 6(2): 113-124.

Abdou, M.A., Badran, F.S., Ahmed, E.T., Taha, R.A., Abdel-Mola, M.A. (2018). Effect of compost and some natural stimulant treatments on: I. Vegetative growth and flowering aspects of (*Gladiolus grandiflorus* cv. Peter Pears) plants. Scientific Journal of Flowers and Ornamental Plants. 5(2): 105-114.

Ahmed, M., Rab, A. (2019). Exogenous application of calcium improved the vegetative attributes and corm production in gladiolus. Sarhad Journal of Agriculture. 35(3): 1011-1019.

Attia, K.E., Elbohy, N.F., Ashour, N.A. (2018). Response of tuberose plants (*Polianthes tuberosa* L.) To chemical and bio fertilization and their effect on vegetative growth, flowering and chemical composition under sandy soil conditions. Scientific Journal of Flowers and Ornamental Plants. 5 (3): 261-273.

Chakradhar, P., Bohra, M.B.K.G.K, Upadhyay S. (2019). Response of biofertilizers on floral and yield attributing parameters of gladiolus (*Gladiolus grandiflorus* L.) var. arka amar under hill conditions of Uttarakhand. International Journal of Pure and Applied Bioscience. 7(1): 157-161.

Dhanumjaya, Rao, K., Kameswari, Lalitha, P. and Rani, Baby, T. (2015). Impact of integrated nutrient management on growth, flowering, yield and economics of tuberose. Agric. Sci. Digest. 35(1): 66-69.

Dongardive, S.B., Golliwar, V.J., Bhongle, S.A. (2007). Effect of organic manure and biofertilizers on growth and flowering in Gladiolus cv. white prosperity. Plant Archives. 7(2): 657-658.

Dubey, R.K., Misra, R.L., Singh, S.K. (2010). Efficacy of bio-and chemical fertilizers on certain floral qualities of gladiolus. Indian Journal of Horticulture. 67(4): 382-385.

Godse, S.B., Golliwar, V.J., Neha, C., Bramhankar, K.S., Kore, M.S. (2006). Effect of organic manures and biofertilizers with reduced doses of inorganic fertilizers on growth, yield and quality of gladiolus. Journal of Soils and Crops. 16(2): 445-449.

Hassan, A.A., El-Azeim, A. (2020). Impacts of compost, biofertilizer and/or some antioxidant treatments on gladiolus (*Gladiolus grandifloras*) a. Vegetative growth and flowering aspects. Scientific Journal of Flowers and Ornamental Plants. 7(3): 269-83.

Kabir, A.K., Iman, M.H., Mondal, M.M., Chowdhury, S. (2011). Response of tuberose to integrated nutrient management. Journal of Environmental Science and Natural Resources. 4(2): 55-9.

Karagöz, F.P., Dursun, A., Tekiner, N., Kul, R., Kotan, R. (2019). Efficacy of vermicompost and/or plant growth promoting bacteria on the plant growth and development in gladiolus. Ornamental Horticulture. Aug 12; 25(2): 180-188.

Lokeshwar, P.S.S, Lall, D., Singh, V.K. (2015). Effect of organic manure and inorganic fertilizer on plant growth and flower yield of Asiatic lily (*Lilium longiflorum*) sp. Zephyranthes. Environment and Ecology. 35(2A): 929-932.

Meena, M.K., Byadwal, R.K., Meena, M.K., Sharma, A.K. and Rathore, J.K. (2018). Impact of integrated nutrient management on vegetative growth and flowering quality of gladiolus (*Gladiolus hybridus* Hort.) cv. American Beauty. Archives of Agri. and Environ. Sci. 3(3): 310-316.

Mirkalaei, S.M., Ardebili, Z.O., Mostafavi, M. (2013). The effects of different organic fertilizers on the growth of lilies (*Lillium longiflorum*). International Research Journal of Applied and Basic Sciences. 4(1): 181-186.

Pandey, S.K., Kumari, S., Singh, D., Singh, V.K., Prasad, V.M. (2017). Effect of biofertilizers and organic manures on plant growth, flowering and tuber production of dahlia (*Dahlia variabilis* L.) Cv. SP Kamala. International Journal of Pure and Applied Bioscience. 5 (2): 549-555.

Pandhare, K.S., Deshmukh, M., Rathod, N.G., Padgilwar, T. (2009). Effect of bioinoculants with reduced doses of inorganic fertilizers on flower quality and yield of tuberose. Journal of Plant Disease Sciences. 4(1): 84-87.

Rajadurai, K.R., Beaulah, A. (2000). The effect of inorganic fertilizers, Azospirillum and VAM on yield characters of African marigold (*Tagetes erecta*). Journal of Ecotoxicology and Environmental Monitoring. 10(2): 101-105.

Rajhansa, K.C., Chaurasia, P.C., Tirkey, T., Verma, K.N. (2010). Effect of integrated nitrogen management on growth, yield and flower quality of gladiolus (*Gladiolus grandiflorus*) cv. Candyman. Journal of Ornamental Horticulture. 13(3): 243-245.

Sarkar, M.A., Hossain, M.I., Uddin, A.F., Uddin, M.A., Sarkar, M.D. (2014). Vegetative, floral and yield attributes of gladiolus in response to gibberellic acid and corm size. Scientia Agriculturae. 3: 142-146.

Sathyanarayana, E., Patil, S., Bahubali, M., Chawla, S.L. (2018). Effect of INM on gladiolus (*Gladiolus grandiflorus*, L.) cv. American beauty under Navsari and Tansa conditions. International Journal of Pure and Applied Bioscience. 6(4): 48-55.

Seema, K., Shalini, P., Nammi, M., Hemlata, K., Khobragade, Y.R. (2016). Effect of organic manure and biofertilizer on growth, flowering and yield of tuberose cv. Single. Journal of Soils and Crops. 16(2): 414-6.

Sharma, J., Gupta, A.K., Kumar, C., Gautam, R.K. (2013). Influence of zinc, calcium and boron on vegetative and flowering parameters of gladiolus cv. Aldebran. The Bioscan. 8(4): 1153-8.

Singh, A., Singh, A.K., Yadava, L.P. (2014). Integrated nutrient management induces flowering duration and flower quality of gladiolus. Research on Environment and Life Sciences. 7(1): 49-52.

Srivastava, R., Govil, M. (2005). Influence of biofertilizers on growth and flowering in gladiolus cv. American beauty. International Conference and Exhibition on Soilless Culture: ICESC 742(pp. 183-188).

Suseela, T., Chandrasekha, R., Vijaya, V., Bhaskar, D.R., Suneetha, S., Umakrishna, K. (2016). Effect of organic manures, inorganic fertilizers and micronutrients on vegetative and floral characters of tuberose (*Polianthes tuberosa*, L.) cv.'Suvasini'. International Journal of Scientific and Research Publications. 6(2): 170-3.

Thumar, B.V., Barad, A.V., Neelima, P., Nilima, B. (2013). Effect of integrated system of plant nutrition management on growth, yield and flower quality of African marigold (*Tagetes erecta* L.) cv. Pusa Narangi. Asian Journal of Horticulture. 8(2): 466-469.

Turan, M., Gulluce, M., Cakmakci, R., Oztas, T., Sahin, F., Gilkes, R.J., Prakongkep, N. (2010). The Effect of PGPR Strain on Wheat Yield and Quality Parameters. In: Proceedings of the 19th World Congress of Soil Science: Soil solutions for a changing world, Brisbane, Australia. 209: p. 212.

Uday, S., Chaudhary, S.V., Rajesh, T. (2008). Response of gladiolus to integrated plant nutrient management. Haryana Journal of Horticultural Sciences. 37(3/4): 285-6.