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Effect of farm yard manure in conjunction with biofertilizers on growth, flowering and yield of gladiolus (*Gladiolus grandiflorus* L.) cv. Oasis in acidic soil condition of Manipur

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Abstract
A field experiment was conducted carried at Horticultural Experimental Field of College of Agriculture, Central Agricultural University, Imphal, Manipur during September, 2020 to January, 2021. The experiment was laid out in Randomized Block Design (RBD) with 3 replications and 7 treatments with spacing 30 x 30 cm. The treatment consists of T_1 (60:60:210kg NPK/ha), T_2 (6 tonnes of FYM/ha + *Azotobacter*), T_3 (6 tonnes of FYM/ha + *Azospirillum*), T_4 (6 tonnes of FYM/ha + *Azotobacter* + *Azospirillum*), T_5 (12 tonnes of FYM/ha + *Azotobacter*), T_6 (12 tonnes of FYM/ha + *Azospirillum*) and T_7 (12 tonnes of FYM/ha + *Azotobacter* + *Azospirillum*). The results of the experiment revealed that among the various treatments, application of T_1 (60:60:210kg NPK/ha) significantly influenced the vegetative parameters *viz*. Plant height (100.12 cm), number of leaves (11.67) and length of leaf (78.19 cm) which is at par with treatment T_7. However, in flowering parameters *viz*. number of days taken for flowering (58.05 days), longevity of intact spike (18.92 days), length of the spike (102.25 cm), fresh weight of the spike (80.81g), vase life of the cut spike (13.55 days), number of florets per spike (17.86), yield of spike per hectare (128633.3 Nos.) and corm parameters *viz*. diameter of the corm (6.24 cm), weight of the corm (64.66 g), number of cormels per plant (22.80) and corm yield per hectare (7.09) was found best in the treatment T_7 (12 tonnes of FYM/ha + *Azotobacter* + *Azospirillum*) which is at par with treatment T_1.

Keywords: Gladiolus, FYM, biofertilizers, growth and flowering, *Azotobacter*, *Azospirillum*

Introduction
Gladiolus commonly known as Sword Lily belongs to the family Iridaceae and is a native of South Africa. It is among the most important cut flower crop grown for its magnificent spike both as cut flower and garden display. Gladiolus is botanically known as *Gladiolus grandiflorus* L., which belongs to the sub family Ixioideae having a chromosome number, n=15. The generic name is derived from the Latin word 'Gladius' meaning 'sword' on account of the sword like shape of its foliage. In India, Gladiolus is commonly grown in Karnataka, West Bengal, Maharastra, Uttar Pradesh, Uttaranchal, Punjab, Haryana, Delhi and Rajasthan. Among the cut flowers, Gladiolus is also an important bulbous cutflower.

Application of fertilizers is one of the important methods to improve the yield and profitability of the flower production. Application of 60 kg/ha N and 60kg/ha P_2O_5 was found best for growth, flowering and yield of Gladiolus cv. Jester for Manipur as reported by Haokip, N (1998) [13]. Application of organic nutrients in soil as well as in foliar form has significantly influenced the plant growth (Anburani and Gayathiri, 2009) [3]. Application of humic substances tend to increase the respiration rate, metabolism rate and growth of plants as reported by Schnitzer and Khan (1972) [22].

The use of biofertilizers in combination with organic manures offers a great opportunity to increase the production as well as quality of gladiolus. Among the nitrogen fixing bacteria, *Azotobacter*, not only provides nitrogen but also synthesizes growth promoting hormones such as IAA and GA. *Azospirillum* also helps in plant growth and increases the yield of crops by improving root development, mineral intake etc. To maintain long term soil health and productivity there is need for integrated nutrient management through manures and biofertlizers apart from the costly chemical fertilizers for better yield of the crop (Mondel *et al*.2003) [19].

Materials and Methods

A field experiment entitled "Effect of Farm Yard Manure in conjunction with Biofertilizers on Growth, Flowering and Yield of Gladiolus (*Gladiolus grandiflorus* L.) cv. Oasis in Acidic soil condition of Manipur" was carried out during September, 2020 to January, 2021 at Horticultural Experimental Field of College of Agriculture, Central Agricultural University, Imphal, Manipur.

The experiment was laid out in Randomized Block Design (RBD) with 3 replications and 7 treatments with spacing 30 x 30 cm. The treatment consists of T_1 (60:60:210kg NPK/ha), T_2 (6 tonnes of FYM/ha + *Azotobacter*), T_3 (6 tonnes of FYM/ha + *Azospirillum*), T_4 (6 tonnes of FYM/ha + *Azotobacter* + *Azospirillum*), T_5 (12 tonnes of FYM/ha + *Azotobacter*), T_6 (12 tonnes of FYM/ha + *Azospirillum*) and T_7 (12 tonnes of FYM/ha + *Azotobacter* + *Azospirillum*).

The calculated required doses of FYM of each plots were applied at the time of field preparation fifteen days ahead of planting. The required quantity of N @ 60kg/ha was applied in 2 splits, half as basal and remaining half applied 30 days after planting. Full dose of P_2O_5 @ 60kg/ha and K_2O@210kg/ha was applied to all the required plots as basal dose before planting. The corms were inoculated with *Azotobacter* and *Azospirillum* mixed with jaggery and water right before planting of the corms.

Results and Discussion

Growth parameters

It was observed that the plants applied with inorganic fertilizers 60:60:210 kg NPK/ha (T_1) recorded the maximum plant height and significantly remained as the best over the rest of the treatments at all the observation stages. The maximum plant height (100.12 cm) was observed in T_1 (60:60: 210 kg NPK/ha) which was statistically at par with T_7 (12 tonnes of FYM/ha + *Azotobacter* + *Azospirillum*) with value 98.43cm. The increase in plant height may be because of active and quick response at a higher rate through the supply of nitrogen by nitrogenous fertilizers and supply of other nutrients, secretion of bacteria, production of hormone and provides antibacterial and antifungal compounds, which results on the growth and increase in yield. These findings corroborate with those of Afify, M.M. (1989) [2] and Abou EI-yazeid A *et al*., (2007) [9]. Growth parameters like the length of leaf and number of leaves per plant also positively responded to the different treatments combinations. The present findings indicated that the plants treated with T_1 (60:60: 210 kg NPK/ha) recorded the maximum values of length of the leaf (78.19 cm) and number of leaves per plant (11.67 Nos.) followed by T_7 (12 tonnes of FYM/ha + *Azotobacter* + *Azospirillum*), while the minimum values were recorded in T_3 (6 tonnes of FYM + *Azospirillum*). Application of the inorganic fertilizers in T_1 (60:60: 210 kg NPK/ha) might have provided adequate nitrogen availability during the early stages of plant growth. It gives balanced nutrition to the plants thus leading to higher number of leaves per plant to promote the rate of photosynthesis and enhance vegetative growth and development of plant. Similar findings were reported by Mohanty *et al*., (2013) [4] and Gaur *et al*., (2006) [10] in gladiolus.

Flowering parameters

The minimum number of days to first flowering (58.08 days) was observed in T_7 (12 tonnes of FYM/ha + *Azotobacter* + *Azospirillum*) which was statistically at par with T_1 (60:60: 210 kg NPK/ha) (58.29 days), while the longest number of days to first flowering was observed in T_3(6 tonnes of FYM/ha + *Azospirillum*) (63.66 days). The earliness in first flowering might be due to the balanced supply of nutrients through organic sources which encourages the translocation of phytohormones to the shoots. This finding is in harmony with that of Marchner, 1983. The organic manures and biofertilizers helps in supplying major nutrients, allowing rapid export of sucrose to the shoots which had a beneficial impact in flower initiation leading to subsequent emergence of spike and opening of florets.

There was significant differences among the various treatments in longevity of intact spike. The maximum longevity of intact spikes was recorded in treatment T_7 (12 tonnes of FYM/ha + *Azotobacter* + *Azospirillum*), with value 18.92 days which was statistically at par with T_1 (60:60: 210 kg NPK/ha) (18.16 days) and T_5 (12 tonnes of FYM/ha + *Azotobacter*) (16.86 days), while the minimum longevity of intact spike (12.80 days) was recorded in T_3(6 tonnes of FYM + *Azospirillum*). This might be due to the improvement of the soil health and availability of micoorganisms as a result of the combined application of biofertilizers. The present result are in close conformity of Godse *et al*., (2006) [11] and Dalve *et al*., (2009) [8] in gladiolus.

The application of FYM and Biofertilizers i.e 12 tonnes FYM/ha + *Azotobacter* + *Azospirillum* (T_7) significantly influenced length of spike. The highest length of the spike was recorded in T_7 (12 tonnes of FYM/ha + *Azotobacter* + *Azospirillum*) with value 102.25 cm which was statistically at par with T_1 (60:60:210 kg NPK/ha) and T_6 (12 tonnes of FYM/ha + *Azospirillum*) with the values recording 101.04 cm and 100.09 cm respectively. The minimum length of spike (88.83 cm) was observed in T_3 (6 tonnes of FYM + *Azospirillum*). The increase in spike length might be due to the higher amount of food material stored from large corm resulting in larger spike length. Similar results were observed by Dod *et al*.,(1989) [7] and Bhattacharjee (1981) [6].

The present findings indicated that the fresh weight of the spike was also significantly influenced by the application of different levels of FYM and Biofertilizers and recorded maximum fresh weight of the spike (80.81g) in T_7 (12 tonnes of FYM/ha + *Azotobacter* + *Azospirillum*) which was statistically at par with T_1 (60:60:210 kg NPK/ha) and T_6 (12 tonnes of FYM/ha + *Azospirillum*) with values 79.73 g and 77.05 g respectively, while the minimum fresh weight of the spike (59.67g) was recorded in T_3 (6 tonnes of FYM + *Azospirillum*). The improvement in fresh weight might be because of fixation of nitrogen and phosphorus biologically in the root portion of plants leading to absorption of more nutrients and its utilization. Moreover, *Azospirillum* encompasses a role in biological process and is additionally involved in the production of IAA, GA and cytokinin like substances which enhance the plant growth. These findings are in accordance with the results of Rajesh *et al*., (2006) [21]. in carnation.

Maximum number of florets per spike (17.86) was recorded in T_7 (12 tonnes of FYM/ha + *Azotobacter* + *Azospirillum*) which was statistically at par with T_1 (60:60:210 kg NPK/ha) (17.24) and T_6 (2 tonnes of FYM/ha + *Azospirillum*) (16.46), while the minimum in T_3 (6 tonnes of FYM + *Azospirillum*) (12.67). The increased in number of florets per spike could be resulted because the height of the plant and length of spike

had direct impact on number of florets per spike and increase in spike length and plant height directly increased number of florets per spike. These results are in close conformity with Mahesh *et al*., (2011) [17].

The longest vase life of the cut spikes was observed in T_7 (12 tonnes of FYM/ha + *Azotobacter* + *Azospirillum*) recording 13.55 days which was statistically at par with T_1 (60:60:210 kg NPK/ha) and T_5 (12 tonnes of FYM/ha + *Azotobacter*) recording 13.07 days and 13.13 days. The minimum vase life was recorded in T_3 (6 tonnes of FYM + *Azospirillum*) with value 8.71 days. Biofertilizers regulates the process of nutrient uptake of nutrient uptake and hence prolonging vase life. Increase in vase life might be due to reduction in ethylene synthesis which has a harmful effect of flower life. The similar result in vase life was also reported by Khan *et al*.,(2009) [15].

Flower yield parameters

Maximum yield of the spike her hectare was recorded in T_7 (12 tonnes of FYM/ha + *Azotobacter* + *Azospirillum*) recording 128633.3 Nos. followed by T_1 (60:60:210 kg NPK/ha) and T_6 (12 tonnes of FYM/ha + *Azospirillum*) with the value 126166.7 Nos. and 122433.3 Nos. respectively. The lowest yield of spike per hectare (108833.3 Nos.) was observed in T_3(6 tonnes of FYM + *Azospirillum*). The increase in the yield of spike per hectare might be due to the highest and maximum vegetative parameters along with the highest flower parameters and also due to the increase in numbers of spike per plot. These findings were closely related with Gupta and Dikshit (2012) [12] and Parya *et al*., (2010) [20] in Golden rod.

Corm and cormels parameters

Maximum diameter of the corm was observed in T_7 (12 tonnes of FYM/ha + *Azotobacter* + *Azospirillum*) with value 6.24 cm followed by T_1 (60:60:210 kg NPK/ha), T_6(12 tonnes of FYM/ha + *Azospirillum*), T_5 (12 tonnes of FYM/ha + *Azotobacter*) and T_4 (6 tonnes of FYM/ha + *Azotobacter* + *Azospirillum*) with values 6.03 cm, 5.99 cm, 5.92 cm and 5.54 cm respectively. The minimum diameter of corm (4.97) was found in T_3(6 tonnes of FYM + *Azospirillum*). This might be due to better root proliferation, increased uptakes of water and the nutrients and amplified food accumulation. These findings are in conformity with those of Kumar *et al*., (2012) [16] in gladiolus and Acharya *et al*., (1988) [1].

The result indicated that there was significant difference in the weight of the corm among the treatments. The maximum weight of the corm was found in T_7 (12 tonnes of FYM/ha + *Azotobacter* + *Azospirillum*) recording 64.66 g which was statistically at par with T_1 (60:60:210 kg NPK/ha) and T_6 (12 tonnes of FYM/ha + *Azospirillum*) recording 63.73g and 63.50 g respectively, while the minimum weight of the corm was observed in T_3 (6 tonnes of FYM + *Azospirillum*) with value 54.61 g. This might be due to biofertilizers inoculated corms contains more stored carbohydrates and nitrogen compounds in the corms. The soluble nitrogen and carbohydrates transfers from leaves to corms. Similar findings have been reported by Baboo and Singh (2006) [5] in gladiolus.

The data showed significant variation among various treatments with respect to number of cormels per plant. The maximum number of cormels (22.80 Nos.) was recorded in T_7 (12 tonnes of FYM/ha + *Azotobacter* + *Azospirillum*) which was statistically at par with T_1 (60:60:210 kg NPK/ha) and T_6 (12 tonnes of FYM/ha + *Azospirillum*) recording 22.55 Nos. and 21.67 Nos. respectively. The minimum number of cormels per plant (12.41 Nos.) was recorded in T_3(6 tonnes of FYM + *Azospirillum*). Corms inoculated with Bio-fertilizers have more stored carbohydrates by effective photosynthesis and thus increasing in number of cormels per plant. These findings are in line with Baboo and Singh (2006) [5] in gladiolus.

Corm yield parameters

The present findings indicated that there is significant effect on yield of corm per hac in tonnes with the application of organic fertilizers. The highest yield was recorded in T_7 (12 tonnes of FYM/ha + *Azotobacter* + *Azospirillum*) with value 7.09 tonnes which was statistically at par with T_1 (60:60:210 kg NPK/ha) with value 6.92 tonnes. The minimum yield of corms per hectare was found in T_3 (6 tonnes of FYM + *Azospirillum*) with the value 5.66 tonnes. The notable increase in the corm yield might be due to the combined application of FYM and bio-fertilizers as they had combined effects that gives higher corm yield. These findings are in agreement with Karthiresan and Venkatesh (2002) [14] in gladiolus.

Table 1: Effect of FYM in conjunction with Biofertilizers on growth parameters of Gladiolus cv. Oasis

Treatment	Plant height (cm)	Number of leaves	Length of the leaf (cm)
T1	100.12	8.22	78.19
T2	83.52	9.33	66.80
T3	79.74	10.21	65.31
T4	86.88	10.77	68.94
T5	90.63	11.21	74.08
T6	90.44	11.41	73.87
T7	98.43	11.95	76.80
S. Ed (±)	2.61	0.30	1.80
CD (0.05)	5.70	0.66	3.93

Table 2: Effect of FYM in conjunction with Biofertilizers on flowering parameters of Gladiolus cv. Oasis

Treatment	Days to first flowering	Longevity of intact spike (days)	Length of the spike (cm)	Fresh weight of the spike (g)	Number of florets	Vase life of the cut spike (days)
T1	58.29	18.16	101.04	79.73	17.24	13.07
T2	62..72	13.49	91.30	62.83	13.98	9.88
T3	63.66	12.80	88.83	59.66	12.67	8.71
T4	61.27	14.27	94.42	65.14	14.75	10.50
T5	59.83	16.86	97.52	72.17	14.63	13.13
T6	60.16	16.55	100.09	77.05	16.46	12.02
T7	58.05	18.92	102.25	80.81	17.86	13.55
S. Ed (±)	0.55	1.07	2.12	2.02	0.79	0.33
CD (0.05)	1.21	2.35	4.63	4.41	1.73	0.72

Table 3: Effect of FYM in conjunction with Biofertilizers on flower yield parameters of Gladiolus cv. Oasis

Treatment	Yield of spike per m² (Nos.)	Yield of spike per hectare (Nos.)
T1	12.61	126166.7
T2	11.12	111266.7
T3	10.88	108833.3
T4	11.87	118766.7
T5	11.74	1174667
T6	12.24	122433.3
T7	12.86	128633.3
S. Ed (±)	0.40	4008.74
CD (0.05)	0.87	8735.05

Table 4: Effect of FYM in conjunction with Biofertilizers on corm and Cormels parameters and corm yield parameters of Gladiolus cv. Oasis

Treatment	Diameter of the corm (cm)	Weight of the corm (g)	No. of cormels per plant	Corm yield per hac (tonnes)
T1	6.03	63.73	22.55	6.92
T2	5.24	55.38	14.55	5.80
T3	4.97	54.61	12.41	5.66
T4	5.54	58.99	16.33	6.11
T5	5.92	62.87	19.91	6.67
T6	5.99	63.50	21.67	6.73
T7	6.24	64.66	22.80	7.09
S. Ed (±)	0.34	0.61	1.23	0.13
CD (0.05)	0.75	1.34	2.68	0.28

Conclusion

The results may be concluded that the application of T_1 (60:60: 210 kg NPK/ha) resulted in maximum plant height, number of leaves and length of leaf. However, T_7 (12 tonnes of FYM/ha + *Azotobacter* + *Azospirillum*) was found to be best treatment to increase the flowering parameters. It was noticed that application of T_7 (12 tonnes of FYM/ha + *Azotobacter* + *Azospirillum*) took minimum days to first flowering. Similarly, in corm and cormel parameters, application of T_7 (12 tonnes of FYM/ha + *Azotobacter* + *Azospirillum*) resulted in maximum diameter of the corm, maximum weight of the corm, maximum number of cormels and maximum yield of the corm per hectare. The present study clearly stated that organic manures like FYM and Biofertilizers are effective alternatives as a source of nutrients and have the ability to improve the growth, yield and quality of Gladiolus and hence avoiding the use of harmful chemical fertilizers.

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