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Effect of organic manures and biofertilizers on growth and yield of gladiolus (*Gladiolus grandiflorus* L.)

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Abstract
A field experiment was conducted at the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat during the period of 2015-2016 and 2016-2017 to study the effect of organic manures and biofertilizers on growth and yield of gladiolus**.** Pooled data analysis over two years revealed that the highest number of leaves per plant (3.40, 6.13, 8.70 at 30, 60 and 90 DAP) with least number of days taken to emergence of shoot (9.39 days), emergence of spike (69.30 days), and opening of first florets (84.52 days) was recorded in treatment T_8 (Enriched Compost @ 5t ha^{-1}) which is followed by treatment T_4 (T_2 + Vermicompost @ 5t ha^{-1}). However, the highest number of sprout per corm planted (1.46) was recorded by T_4. Among the yield parameters number of spike per corm planted (1.74), fresh weight of spike (100.41 g), weight of corm (91.19 g) and diameter of corm (7.86 cm) were also recorded highest in treatment T_8 (Enriched Compost @ 5t ha^{-1}) which is at par with treatment T_4. The study led to the conclusion that maximum growth parameters and the highest yield and yield attributes of gladiolus could be achieved by judicious application of organic manures and biofertilizers.

Keywords: Corm, cormel, spike, organic manure, enrich compost, RDF

Introduction
Among the flowers used for domestic and international trade, gladiolus is one of the important commercial flowers. Gladiolus is commonly known as sword lily and corn flag. It belongs to the family Iridaceae and native to Europe, Mediterranean region and Tropical and South Africa. Gladiolus ranks next to tulip in the Netherland and fourth in international trade of ornamental cut flowers (Singh, 2006) [15]. Area and production of gladiolus in India is 11.16 thousand ha and 102.91 thousand ton respectively (NHB, 2014-15) [11]. The continuous and unbalanced use of conventional fertilizers leads to decreased nutrient uptake efficiency of plants resulting in decreased crop yield. It also causes serious threat to soil health. Problems like leaching, volatilization, denitrification of nitrogen and deposition of non-available phosphorus in soil are also the result of heavy use of chemical fertilizers (Maurya and Beniwal, 2003) [9]. To cope with all these problems a cheaper, better and safer way is necessary in order to improve soil fertility status, maximize the agricultural productivity with minimum eco hazards. All these criteria can be achieved through application of organic manures and biofertilizers for restoring the soil fertility and improve physio-chemical and biological properties of soil. Organic fertilizers can be used to reduce the amount of toxic compounds (such as nitrates) produced by conventional fertilizers in crops, hence improving the quality of produce as well as human health. Increased consumer awareness of food safety issues and environmental concerns have contributed to the development of organic farming over the last few years (Worthington, 1998; Worthington, 2001) [16, 17]. Few workers reported that the production of quality flowers with maximum yield in gladiolus is possible under organic cultivation.

Materials and methods
An investigation was carried out during the period of 2015-2016 and 2016-2017 to study the Effect of organic manures and biofertilizers on growth, yield and economics of gladiolus (*Gladiolus grandiflorus* L.) in the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat. The experiment was laid out with 8 treatments in Randomized Block Design and replicated 3 times.

The treatments were T_1 {RDF(20:20:20g m^{-2} NPK + 4kg m^{-2} FYM)}, T_2 {Rock phosphate + Microbial consortium}, T_3{T_2 + Vermicompost (2.5 t ha^{-1})}, T_4 {T_2 + Vermicompost (5 t ha^{-1})}, T_5 {T_2 + Compost (2.5 t ha^{-1})}, T_6 {T_2 + Compost (5 t ha^{-1})}, T_7 {Enriched compost (2.5 t ha^{-1})}and T_8 {Enriched compost (5t ha^{-1})}. Standard cultural practices recommended for Gladiolus was followed uniformly for all the experimental plots. As per the treatment schedules, two days prior to planting; the exact quantity of compost, vermicompost, enriched compost, rock phosphate and FYM were applied directly to the prepared ridges of the experimental plot. The manures were mixed uniformly with soil. *Rhizobium Azotobacter, Azospirillum* and Phosphate Solubilizing Bacteria (PSB) were applied as corm dip treatment to the concerned treatments. The biofertilizers were mixed with water and slurry was prepared. Then corms were mixed properly with slurry and kept for 2 hours in shade so that a coating is formed on the outer layer of the corms. These treated corms were planted in 7cm deep furrows by following a spacing of 30cm (row-row) and 30cm (plant-plant). After planting, corms were covered by fine soil and light irrigation was given. For inorganic plot Four days prior to planting, recommended doses of fertilizers i.e. half of urea and full dose of SSP and MOP (NPK @ 20:20:20g m^{-2}) were applied in the experimental units as basal and thoroughly mixed at the first fifteen centimetre depth. The remaining half of urea was applied as top dressing at 4-leaf stage i.e. 30 days after planting and another dose at 6-leaf stage i.e. 60 days after planting. Healthy uniform disease free corms of gladiolus variety American Dust were taken. The corms having 5cm diameter were planted at a depth of 7cm in the raised bed at a spacing of 30 cm ×30 cm. Forty plants were accommodated in each plot. After planting, corms were covered by fine soil and light irrigation was given. The flower spikes were harvested when the first pair of flowers fully opened and were cut with a sharp knife, retaining the small clasping leaves for prolonging the life of flower spikes. After the flowering was over, the irrigation was withheld, when leaves turned yellow, the plants were cut at the ground level and the corms of the representative sample plants in each treatment were dug out of the soil for recording observations. All results were statistically analyzed using method advocated by Panse and Sukhatme (1985) [12]. When ANOVA showed significant differences, mean separation was carried out using critical difference (C.D) test at 5% level of significance to draw the valid conclusion.

Results and Discussion

Growth

Days to emergence of shoot

The lowest number of days for emergence of shoot recorded was 9.39 days for the treatment T_8 (Enriched compost 5t ha^{-1}) and 9.46 days for T_4 (Rock phosphate + Consortium + Vermicompost 5t ha^{-1}). This might be due the fact that the supply of different nutrients from enriched compost and vermicompost helped in enriching the emergence of shoots in optimum level. Also the decomposition of organic manures in the soil releases energy, which results into high temperature of soil and it is the fact that high soil temperature improves sprouting of corms under proper moisture condition (Shankar *et al.,* 2010) [13].

Number of sprouts per corm planted

The highest number of sprouts (1.46) were recorded for the treatment T_4(Rock phosphate + Consortium + Vermicompost 5t ha^{-1}) and 1.45 for T_8 (Enriched compost 5t ha^{-1}). This might be due to the increased vegetative growth as a result of adequate soil moisture and steady uptake of nutrients. The presence of various micronutrients in vermicompost also acts as a chelating agent and regulates the availability of metabolic micronutrients to the plant (Kale *et al.,* 1987) [5]. Organic sources, on application to the soil, improve the physical properties of soil such as aggregation, aeration, permeability and water holding capacity (Govindarajan and Thangaraju, 2001) [3] which promote growth and development of plants.

Number of leaves per plant

The number of leaves was increased at all growth stages. The leaves serve as the active site for food synthesis in plant. The highest number of leaves per plant was recorded in enriched compost (8.70) and vermicompost (8.54). The increase in number of leaves per plant under enriched compost could be attributed to the increased availability of nutrients to the plants thereby manufacturing more carbohydrates. Vermicompost provides various micronutrients. Production of more number of leaves might also be due to the increased availability of N in soil, which is an important component of chlorophyll and protein thus causing more growth (Kumar and Singh, 2007) [7].

Days to emergence of spike

The treatment T_8 (Enriched compost 5t ha^{-1}) resulted in the earliest period of 69.30 days for emergence of spike. It might be due to the congenial environment caused by organic inputs. The earliness for this characters might be attributed to the better performance in case of all vegetative characters by enriched compost contributing to early growth. The induction of earliness was due to better nutritional status of soil including various micronutrients in which ultimately increases the nutritional status of the plants. Increased production of leaves might have helped to elaborate more photosynthates and induce flowering, thus effecting early emergence of spike. The results are in conformity with the reports of Sharma (1995) [14] in tomato.

Days to opening of first floret

The least days taken for the opening of first floret (69.30 days) was recorded in treatment T_8 (Enriched compost 5t ha^{-1}). This might be due to the balanced supply of nutrients through organic sources promotes the translocation of phytohormones to the shoots (Marchner, 1983) [8]. As the organic manure help in supplying the major nutrients, it allows rapid export of sucrose to the shoots which had a positive influence in flower intination leading to subsequent emergence of spike and opening of floret.

Yield and yield attributes

Number of spikes per corm planted

The highest number of spikes 1.74 was found to be significantly higher in T_8 (Enriched compost 5t ha^{-1}) followed by T_4{T_2 + Vermicompost (5 t ha^{-1})}. This might be due to the higher availability of nutrients especially nitrogen, phosphorus and improved physical, chemical and biological properties of soil might have contributed to higher yield of spikes. The solubilisation of rock phosphate in enriched compost by PSB is attributed to the excretion of organic acids. In addition to P solubilisation, these microorganisms can mineralize organic P into soluble forms. These reactions take place in the rhizosphere and as the organism render more P into solution than that required for their growth and

metabolism, the surplus is available for plants, thereby increasing the uptake.

Fresh weight of spike

There was significant increase in the fresh weight of spike (100.41g) for the treatment T_8 (Enriched compost 5t ha^{-1}). This might be due to increased availability of nutrients. This might also be due to increased mineralization and absorption of nitrogen. Similar findings have been reported by Johnson *et al.* (1982) [4] in *Chrysanthemum morifolium* and Bagyaraj and Powel (1985) [2] in marigold. Fresh weight might be increased due to biological fixation of nitrogen and phosphorus in root portion of plants resulting in absorption of more nutrients and its utilization. Moreover, *Azospirillum* has a role in nitrogen fixation and is also involved in the production of GA and cytokinin like substances which enhance the growth of plants.

Weight of corm and diameter of corm

Application of Enriched Compost 5t ha^{-1} in treatment T_8 was found to have marked improvement on corm production in terms of weight and diameter of corms. The improvement in corm parameters might be due to better plant growth and more number of sprouts per corm. The increased corm size might be due to better root proliferation, more uptakes of nutrients and water, luxuriant vegetative growth, more photosynthesis and enhanced food accumulation. These findings are in conformity with those of Kumar *et al.* (2012) [6] in gladiolus. Acharya *et al.* (1988) [1] reported that maintenance of organic matter is improving the nutrient and structural status of soil and this helped in improving the number and weight of corm and cormels. The beneficial effect of organic manures in improving plant growth and yield has been reported in china aster (Mogal *et al.,* 2006) [10].

The results of the present investigation revealed that application of organic manure resulted in good yield with better quality of gladiolus. It is also seen that use of inorganic fertilizers in larger amount not only increased the cost of cultivation but it has also negative effect on the environment. Organic manure which is cheap and locally available not only helped in giving good yield but it also reduced the total cost of cultivation. Continuous use of organic manure and bio fertilizers improve physical, chemical and biological properties of soil. Considering all these positive effect it is advisable to use organic manure and bio fertilizers for good harvest with better sustainability of the environment.

Table 1: Effect of organic manures and biofertilizers on growth, and yield of gladiolus

Treatment	Emergence of shoot (days)	Sprouts per corm	Number of leaves (DAP)			Emergence of spike (days)	Opening of first floret (days)	Spikes per corm	Fresh weight of spike (g)	Weight of corm (g)	Diameter of corm (cm)
			30	60	90						
T_1 : RDF(20:20:20 g m^{-2} NPK + 4 kg m^{-2} FYM)	10.37	1.34	2.90	5.26	7.79	73.93	88.10	1.54	82.30	77.25	7.09
T_2 : Rock phosphate + Consortium	11.33	1.24	2.72	5.05	7.51	75.41	88.79	1.44	84.43	76.83	6.73
T_3 : T_2 + Vermicompost (2.5t ha^{-1})	9.65	1.41	3.12	5.41	8.12	71.29	86.17	1.61	91.60	82.09	7.36
T_4 : T_2 + Vermicompost (5t ha^{-1})	9.46	1.46	3.43	6.00	8.54	69.33	84.81	1.72	96.33	90.37	7.57
T_5 : T_2 + Compost (2.5t ha^{-1})	10.82	1.27	2.92	5.31	7.88	74.74	88.47	1.51	86.93	80.33	6.89
T_6 : T_2 + Compost (5t ha^{-1})	10.64	1.33	3.12	5.39	8.24	74.23	87.73	1.58	88.06	81.29	7.18
T_7 : Enriched Compost (2.5t ha^{-1})	9.60	1.40	3.20	5.45	8.00	71.52	86.28	1.59	94.57	83.51	7.39
T_8 : Enriched Compost (5t ha^{-1})	9.39	1.45	3.40	6.13	8.70	69.30	84.52	1.74	100.41	91.19	7.86
S.Ed (±)	0.34	0.03	0.10	0.22	0.20	0.66	0.58	0.04	1.55	2.36	0.18
CD (5%)	0.73	0.07	0.20	0.46	0.44	1.42	1.25	0.08	3.32	5.05	0.39

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