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Response of bio fertilizers on growth and corm production of gladiolus (*Gladiolus grandiflorus* L.) cv. Punjab Dawn

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Abstract
The study was meant to assess the response of bio fertilizers on growth and corm production of gladiolus (*Gladiolus grandiflorus* L.) cv. Punjab Dawn. The experiment was laid out in RBD in ten treatments with three replications. Data revealed that effect of bio fertilizers on performance of gladiolus was statistically significant and among the treatments, T_4 (RDF + Azotobacter + PSB) showed the most excellent results with respect of plant sprouts/hill, plant height, number of foliage/hill, width of longest leaf, number of corm/hill, weight of corm/hill, number of cormels/hill and weight of cormels/hill.

Keywords: Bio fertilizer, azotobacter, PSB, gladiolus

Introduction
Gladiolus (*Gladiolus grandiflorus* L.) is a fashionable bulbous high profit flowering plant with its wonderful inflorescence. It is universally known as 'Queen of the bulbous flowers' with majestic flower spikes having florets of enormous form, bright color, beautiful shapes, changing size and outstanding keeping quality. Its generic name 'Gladius' is derived from the Latin word meaning 'Sword' and hence it is also known as 'Sword Lily'. It belongs to family Iridaceace and comprises about 260 species. Most Gladiolus species are native to the Mediterranean region and South Africa (Buch, 1972) [5]. Gladiolus is commercially propagated by corms. Gladiolus can be grown for good output in any sort of soil and it prefers a sandy loam for good performance. An ideal soil pH of 6-7 is optimum for cultivation of gladiolus. There are so many factors of lower yield, out of which, barren soil fertility is one of the main factors which adversely affects the flowering and corm production. The vital aspects in increase the flower yield and superiority of gladiolus spikes is nutrition (Bhalla *et al.*, 2006) [4]. N, P and K are the three most important nutrients that play an important role in influencing the growth and flowering parameter (Kumari *et al.*, 2014) [14]. Bio-fertilizers and organic supplements can play a very important role, therefore they are being used to improve crop growth and flower quality and enhance the production of phytohormones as well as the absorption of plant nutrients. There by helping in sustainable crop production through maintenance of soil fertility and productivity. In horticulture crops, biofertilizers being used commercially on a large scale are Azotobacter, PSB and VAM. Azotobacter and Azospirillum are nitrogen fixing bacteria that help plants to indirectly improve nitrogen fixation and nutrient accessibility in soils. Phosphorus solubilizing bacteria (PSB) are used to increase the availability of phosphorus in the soil.

Materials and Methods
The research was conducted at Baradari experimental Farm, RVSKVV College of Horticulture Mandsaur (M.P) in 2019-20. The trial was laid out in RBD with 10 treatments replicated thrice. The treatment were T_1 RDF (N: P: K:-120:100:150), T_2 RDF + Azotobacter, T_3 RDF + PSB, T_4 RDF + Azotobacter + PSB, T_5 85% RDF + Azotobacter, T_6 85% RDF + PSB, T_7 85% RDF + Azotobacter + PSB, T_8 75% RDF + Azotobacter, T_9 75% RDF + PSB, T_{10} 75% RDF + Azotobacter + PSB. Preplanning treatment of application of biofertilizers to corms was given 15 minutes before planting and kept in shade. Corm planted in flat bed giving spacing 30×30 cm in plot size $1.2 \times 0.8 = 0.96 m^2$ consisted number of plant per treatment is 16. 1/3 dose of N as per treatment and full dose of P and K was given at the time of planting. Remaining 2/3 dose

of N_2 was applied at 2 leaf stage and 4 leaf stage of the crop. 5 plants were randomly selected from each treatment and observation regarding growth and corm production were recorded.

Results and Discussion

Days taken to sprouting

In the present study the minimum days taken for sprouting of corms (7.67 days) was found in treatment T_4 (RDF + Azotobacter +PSB) followed by 8.33 days with T_3 (RDF + PSB) & T_7 (85% RDF + Azotobacter + PSB). T_4 (RDF + Azotobacter + PSB) shows significantly early sprouting than other tested treatment. However, maximum number of days required for corm sprouting (11days) was found in T_1 (RDF) followed by 9.67 days with T_8 (75% RDF + Azotobacter). These results are confirmed with the finding of Srivastava and Govil (2005) [17] in *Gladiolus grandiflorus*. Kumar *et al* (2016) [10] also observed that inoculation of corms with *Azotobacter* gave significantly earliness in corms sprouting as compared to control.

Plant sprouts/hill

The sprouts/hill was varied from 1.87 to 2.40. The maximum number of plant sprouts/hill (2.40) was found in treatment T_4 (RDF + Azotobacter + PSB) followed by 2.33 with T_3 (RDF + PSB) and T_7 (85% RDF + Azotobacter + PSB). T_4 (RDF + Azotobacter + PSB) having significantly better sprouts/hill than other tested treatment. However minimum number of plant sprouts/hill (1.87) was observed in treatments T_8 (75% R.D.F. + Azotobacter) which was found statistically at par with treatment T_9 (2.07) and T_1 (2.00). The maximum number of sprouts may be due to early absorption of N.P.K through the surface of corms or main roots which might be encouraged early sprouting. The related finding was also reported by Adhikari *et al.* (2018) [1].

Plant height (cm) at 60 days after planting

The maximum plant height (50.33 cm) was recorded in T_4 (RDF + Azotobacter + PSB) which was followed by T_3 (RDF + PSB), T_6 (85% RDF + PSB) and T_7 (85% RDF + Azotobacter +PSB) with the values of 49.93 cm, 49.73 cm and 49.33 cm respectively. The minimum plant height (45.67cm) was recorded with T_1 (75% RDF + Azotobacter). The increase in plant height was due to the occurrence of a readily available form of nitrogen. It also improves N.P.K. and micro nutrients absorption resulting increase in growth. These results are in line with the findings of Deshmukh *et al.* (2008). Who reported that biofertilizers increase the height of plants by increasing the availability of nitrogen and the rate of photosynthesis. These findings were consistent with the findings of other researchers, such as Singh *et al.* (2003) [16] in rose, Dalve *et al* (2009) [6], Ahmad *et al*. (2013) [2] and Hassan *et al.* (2016) [9] and Meena *et al*. (2018) [12] in *Gladiolus grandiflorus*.

Number of leaves/hill at 60 DAP

In the present study the greatest number of leaves (13.44) was observed by T_4 (RDF + Azotobacter + PSB) followed by T_3 (RDF + PSB) which recorded the value of 13.05. However, the minimum number of leaves (9.60) was recorded by T_1 (RDF). All of the treatment show statistically better performance over T_1 (RDF). Increase in number of leaves on the whole may be due to the production of more nitrogen by *Azotobacter* continuously during the growth period resultant into abundant vegetative growth. These findings were consistent with the findings of other researchers Dalve *et al.*, (2009) [6].

Width of longest leaf (cm) at 60 DAP

In the present study the maximum width of longest leaf (2.93 cm) was observed by T_4 (R.D.F. + Azotobacter + PSB) followed by T_7 (85% R.D.F. + Azotobacter + PSB), T_3 (R.D.F. + PSB) which observed values of 2.85 cm and 2.78 c.m. respectively. All of these three treatments showed the significant effect with respect of width of longest leaf over T_1 treatment. However, the minimum width of longest leaf (2.52 cm) was recorded by T_1 (R.D.F.).This may be due to that application of R.D.F. with bio-fertilizers promoting the leaf width influenced with nitrogen application, because N is an crucial part of nucleic acid, which play very important role in promoting leaf area (Meena *et al*., 2018) [12]. These results are confirmed with the finding of Sharma *et al*., (2008) [15] and Srivastava and Govil (2005) [17].

Number of corm per hill

The highest no of cormels / hill (93.67) was observed by T_4 (R.D.F. + Azotobacter + PSB) followed by T_7 (85% RDF + Azotobacter + PSB), T_8 (85% RDF + Azotobacter) which observed values of 88.33 and 82.67 respectively. However, the lowest no of cormels /hill (29.00) was recorded by T_{10} (75% RDF + Azotobacter + PSB). This may be due to the fact that the use of biofertilizers increase number of microorganisms in soil which result into improved root explosion, Due to increased photosynthesis and absorption of ions and water from the soil increased food storage and better vegetative growth resulted in increased yield. These results were advocated by Kumari *et al.*, (2014) [14], Godse *et al.*, (2006) [8] and Pansuriya *et al*., (2016) [13] in gladiolus.

Weight of corms per hill (g)

The maximum weight of corms per hill (80.99 g) was recorded by T_4 (RDF + Azotobacter + PSB) followed by T_3 (RDF + PSB), T_7 (85% RDF + Azotobacter + PSB) which recorded values of 76.61 g and 68.67 g respectively. T_4 (RDF + Azotobacter +PSB) having significantly better weight of corms/hill than other tested treatment. However, the minimum weight of corms per hill (39.73) was recorded by T_8 (75% RDF + Azotobacter). Improved vegetative growth of plants resulting in better absorption of nutrients from the soil and enhanced photosynthetic efficiency during the entire crop growth period could be attributed to the increased gladiolus corm weight. (Priyadarshini *et al*., 2018) [14]. These results were advocated by the finding of Ali *et al.* (2014) [3].

Number of cormels per hill

The maximum number of cormels per hill (18.80) was recorded by T_4 (RDF + Azotobacter + PSB). However, the minimum number of cormels per hill (3.80) was recorded by T_{10} (75% RDF + Azotobacter + PSB). The production of better cormels in gladiolus may be due to corms containing biofertilizers, which have stored more food materials like carbohydrates through effective photosynthesis. The related finding was also reported by Srivastava *et al*., (2005) [17].

Weight of cormels per hill (g)

The maximum weight of cormels per hill (11.07 g) was observed with T_4 (RDF + Azotobacter + PSB) followed by T_7 (85% RDF + Azotobacter + PSB), T_1 (RDF). However, the minimum weight of cormels per hill (6.93 g) was recorded by T_8 (75% RDF + Azotobacter). Increased weight of cormels might be due to better uptake of nutrients, enhanced growth parameters, accumulation of metabolites, leading to more proliferation of cormels with a higher individual weight (Priyadarshini *et al.*, 2018) [14]. Similar results were also reported by Kumari *et al.* (2014) [14] and Godse *et al.* (2006) [8].

Table 1: Impact of bio-fertilizers on various growth characters of gladiolus

Symbol	Treatments	Days taken to sprouting	Plant sprouts /hill	Plant height in cm	No. of leaves/hill	Width of longest leaf in cm	No of corm/hill	Weight of corms/hill	Number of cormels/hill	Weight of cormels/hill
T_1	RDF (Recommended dose of fertilizer N:P:K:-120:100:150)	11.00	2.00	45.67	9.60	2.52	2.13	61.26	17.67	9.93
T_2	RDF + Azotobacter	9.00	2.27	47.87	12.11	2.75	2.40	63.77	11.33	7.13
T_3	RDF + PSB	8.33	2.33	49.93	13.05	2.78	2.60	76.61	9.33	8.00
T_4	RDF + Azotobacter + PSB	7.67	2.40	50.33	13.44	2.93	2.73	80.99	18.80	11.07
T_5	85% RDF + Azotobacter	9.33	2.13	47.40	11.36	2.70	1.87	58.57	15.67	9.87
T_6	85% RDF + PSB	8.67	2.13	49.73	11.22	2.76	2.33	62.39	6.60	9.13
T_7	85% RDF + Azotobacter + PSB	8.33	2.33	49.33	12.58	2.85	2.53	68.67	12.30	10.47
T_8	75% RDF + Azotobacter	9.67	1.87	46.80	10.00	2.68	1.60	39.73	16.53	6.93
T_9	75% RDF + PSB	9.00	2.07	47.20	10.76	2.74	1.73	58.01	7.67	7.33
T_{10}	75% RDF + Azotobacter + PSB	8.67	2.20	48.00	11.88	2.77	2.20	60.20	3.80	8.33
SEM±		0.23	0.09	0.99	0.35	0.06	0.09	0.83	1.14	1.26
CD		0.65	0.24	2.78	0.98	0.18	0.25	2.35	3.22	3.57

Conclusion

In the present experiment on the basis of above findings it may be concluded that effect of bio-fertilizers on performance of gladiolus was statistically significant. Among the treatments T_4 (RDF + Azotobacter + PSB) sowed the best results with respect of days taken to sprouting, plant sprouts /hill, plant height (cm), no. of leaves/hill, width of longest leaf (cm), no of corm/hill, weight of corm/hill, no. of cormels/hill and weight of cormels/hill.There is a small effort to improve soil structure and texture, reduce chemical pollution in soil and atmosphere which is beneficial to the current problems of high cost of fertilizers and environmental pollution. Our findings provide farmers with suitable advice and alternative methods for nutrient management in crop production.

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