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Response of bio-fertilizers and commercial formulations on growth, yield and corm production of gladiolus

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ABSTRACT

Field experiments were conducted to study the effect of various bio-fertilizers and commercial formulations on growth and development of gladiolus. The results showed that early sprouting of corm (17.10 days) was obtained by *Azotobacter*, maximum number of leaves (11.33) was produced by *Azospirillum*, maximum plant height (161.8 cm) was obtained by phosphorus solubilizing bacteria (PSB), early flowering (81 days) was recorded by Annapurna®, maximum diameter of floret (9.43 cm) was observed by PSB, maximum number of florets per spike (12.33) was recorded by Annapurna®. Significant increase in spike length (80.33 cm) was obtained by Sumangala®, maximum rachis length (54.67 cm) was obtained by both Annapurana® and *Azotobacter*, maximum number of corms per plant (2.90) was observed by *Azospirillum*, maximum number of cormels (7.30), maximum weight of corm (44.93 g), maximum weight of cormels per plant (10.40 g), maximum volume of corm (51.17 cm^3), maximum corm diameter (5.67 cm) and maximum value of propagation co-efficient (231%) was obtained by the application of Flower Booster®. Application of bio-fertilizers and commercial spray formulation products not only improved the qualitative and quantitative parameters but also improved the soil fertility and productivity.

Key words: Bio-fertilizers, commercial spray formulations, yield, gladiolus.

INTRODUCTION

Gladiolus is a very popular bulbous flowering plant with its magnificent inflorescence. It is grown in herbaceous border, bed, rockery, pot and also for cut flowers. The flowers, varying in colour with attractive shades as cut flowers, are most suitable as the flowers last long. Flowering and corm production in gladiolus are affected by non-availability of various nutrients. Bio-fertilizers and organic supplements can play very significant role and are being used for improving crop growth and quality of products, producing phytohormons, enhancing the uptake of plant nutrients thus help in sustainable crop production through maintenance of soil fertility and productivity. However, very little information is available until now with regard to use of bio-fertilizers in floricultural crops especially in gladiolus for which the present study was initiated to find out the alternative sources of chemical fertilization.

MATERIALS AND METHODS

The experiment was conducted for two consecutive years at the Division of Floriculture and Landscaping, IARI, New Delhi, on gladiolus variety Pusa Shabnam. Healthy corms of uniform size (8-10 cm circumference) were planted at 30 cm x 20 cm spacing replicated thrice in RBD. In total, there were 13 treatments, *viz*., control, Annapurna®, phosphorus solubilizing bacteria (2 kg/acre), *Azospirillum* (2 kg/acre), *Azotobacter* (2 kg/acre), Prokissan®, Sumangala®, General liquid®, Chamak®, Twin®, Samaras®, Multinol® and Flower Booster® (Table 1). The commercial formulations were obtained from Multiplex, Bangalore. Data were recorded on various parameters of growth and development of gladiolus.

RESULTS AND DISCUSSION

Earliness in corm sprouting was recorded with *Azotobacter* (17.1 days) followed by Samras® (17.6 days). The possible reason for induced sprouting might be due to synthesis and secretion of thiamin, riboflavin, pyridoxine, nicotinic acid, pantothenic acid, indole-acetic acid (IAA) and gibberellins like substances in addition to the production of antifungal antibiotics by the *Azotobacter*, which inhibit harmful soil fungi. Beneficial effect of *Azotobacter* in seed germination was in accordance with the work of Ukey (12) in onion. Samras® is a natural bio-product containing mixture of 17 amino acids, which promote uptake of nutrients and enzymatic activity. Late sprouting was observed by Flower Booster®. Maximum number of shoots per corm was recorded by Flower Booster® (2.53) followed by *Azotobacter* (2.5) The possible reason may be due to Flower Booster®, which contains all essential

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Table 1. Chemical composition, dose and method of application of the commercial formulations.

Commercial formulation	Composition	Dosage	Method of application
Annapurna®	Well decomposed organic matter fortified with neem cake, castor cake, pongamia cake, vermicompost, *Azotobacter, Azospirillum,* phosphorus solubilizing bacteria and *trichoderma*	120 kg/ acre	Soil application 30 days after sowing
Prokissan®	Micronutrients like Zn, Fe, Mn, Cu in chelated form while B and Mo are in non-chelated form	1.0 g/l	3 Foliar sprays at 30 days after sowing, 20 days after first spray and 20 days after second spray
Sumangala®	Secondary and micronutrients	3.0 g /l	3 foliar sprays 20 days after sowing, 250 days after first spray and during blooming
General Liquid®	Secondary nutrients like Ca M, Sr and micronutrients like M, Z, Cu, Fe, B and Mo	2.5 ml/l	Two sprays 30 days after sowing and 20 days after first spray
Chamak®	Ca and B	3.0 g/l	2 sprays 30 days after sowing and 20 days after first spray
Twin®	13% N and 45% Kin 100% soluble form	3.0 g/l	Foliar spray 2 times 30 days after sowing and 20 days after first spray
Samras®	Mixture of 17 natural amino acids	3.0 ml/l	Spraying on both sides of leaves 30 days after sowing and second spray done 20 days after first spray
Multinol®	Plant hormone- Triacantanol	0.5 ml/l	Three sprays at an interval of 30, 45 and 60 days after sowing
Flower Booster®	All essential nutrients like major, secondary and trace elements	4.0 g/l	Two sprays 30 days after sowing and 20 days after first spray

macro & micro-nutrients in well balanced and in easily available form. Chamak® recorded minimum number of shoots. Maximum number of leaves was produced by use of *Azospirillum* (11.33) followed by *Azotobacter* (11.0). Increased number of leaves could be attributed to the proper availability of nitrogen fixed by *Azospirillum* and *Azotobacter*. Since nutrients like N and Fe are important constituents of chlorophyll, increased availability of these nutrients as a result of bio-fertilizer activity might have led to higher chlorophyll content. Moreover, Fe is important for the synthesis of pheophytin, which acts as precursor for chlorophyll synthesis. Owing to the direct involvement of chlorophyll and leaf area in photosynthesis the corresponding increase in vegetative growth rate can be reasoned act. The minimum number of leaves was produced by Flower Booster®. Maximum leaf area was recorded by Flower Booster® (366.3 cm^2) followed by Samaras® (343.7 cm^2). The possible reason may be due to increased uptake of all essential macro-micro-nutrients, enzymatic activity, protein synthesis and stimulate photosynthesis, result promote leaf area. Minimum leaf area (220.63 cm^2) was recorded by Sumangala®. The maximum plant height (161 cm) was obtained by PSB followed by Annapurna® (141.67 cm). Better plant height may be due to enhanced availability of phosphorus at presence of PSB in rhizosphere stimulates the root systems through efficient translocation to roots of certain growth stimulating compounds formed in the plants, which further enhanced the absorption of nutrients, thus resulting in a vigorous growth. Increase in plant height may also be the result of increased meristematic activities and increase in number as well as size of cells due to the effect of growth promoting substances produced by PSB. The present results are in conformity with those of Ghosh and Das (4) in potato, Altaff (1) in onion and Gupta *et al.* (5) in marigold. The minimum plant height (66.5 cm) was observed by both Chamak® and Twin®.

Early flowering observed by plants treated with Annapuna® (81 days) followed by Prokissan® (85.33 days). This is because Annapurna® contains well decomposed organic matter fortified with neem cake, castor cake, pongamia cake, *Trichoderma, Azotobacter* and PSB in balanced manner, which helps in improving the soil structure, rich humus, enriched with millions of beneficial nitrogen fixing bacteria and promote uptake of nutrients. Late flowering was observed by Flower Booster® (126.67 days). The maximum diameter of the floret was recorded by phosphorus solubilizing bacteria (9.43 cm), whereas minimum floret diameter (7.67 cm) was observed by Chamak®. The maximum floret length (12.33 cm) was observed by Flower Booster®, whereas minimum (8.7 cm) was observed in the control. Maximum number of florets per spike (13.0) was observed by Annapurna®, whereas minimum (6.33) was obtained due to *Azospirillum.* Maximum longevity of floret was obtained by Flower Booster® (19 days). This may be due to increased availability of all essential macro- and micro-nutrients in easily available form, whereas minimum longevity of spike was recorded by both Prokissan® and Sumangala® (10.67 days). Significant increase in spike length was obtained with Sumangala® (80.33 cm) followed by *Azotobacter* and *Azospirillum*. The possible reason may be that Sumangala ® consists of all secondary and micro-nutrients, which help the pace of absorption and utilization of other nutrients like NPK from the soil by plants, thereby increasing the spike length. *Azotobacter* and *Azospirillum* also increased the spike length. The reason may be due to increased availability of nitrogen and production of phytohormones. These results are in agreement with the work done by Misra (7) and Dubey *et al.* (3) in gladiolus. Minimum spike length (61.67 cm) was obtained by Multinol®. Maximum rachis length was obtained by both Annapurna® and *Azotobacter* (54.67 cm). It might be due to increased availability of nitrogen and better mobilization, solubilization of phosphate and better uptake of N and P as well as micronutrients like Zn, which is precursor of auxin which improved the vegetative growth, dry matter accumulation and their partitioning towards the developing spikes. These results are in confirmity with Kathiresan and Venkatesh (6), and Dubey *et al.* (3) in gladiolus; Rajadurai and Beaulah (10), and Swaroop (11) in marigold, and Kumar (9) in China aster.

The maximum number of corms per plant was produced by *Azospirillum* (2.9) followed by phosphorus solubilizing bacteria. This may be due to more in accumulation of assimilates and partitions to the developing corms and cormels thus increasing the number of corms. The present findings are in line with the results by Kathiresan and Venkatesh (6), and Dubey *et al.* (3) in gladiolus; Wange *et al.* (13) in tuberose; Banerjee and Das (2) in potato; Thilakavathy and Ramaswamy (12), and Muthuramalingam *et al.* (8) in onion. The maximum number of cormels, maximum weight of corm, maximum weight of cormels per plant, maximum volume of corm, maximum diameter of the corm and maximum value of propagation co-efficient was obtained by the application of Flower Booster®. The possible reason may be due to increased availability of all essential macro- and micronutrients in easily available form, which increased dry matter production and partitioning to developing corms.

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Table 2. Effect of bio-fertilizers and commercial spray formulations on vegetative growth of gladiolus (pooled data).

Treatment	No. of days taken for 50% plants to sprout	No. of shoots per corm	No. of leaves per plant	Leaf area (cm^2)	Plant height (cm)
Control	17.60	1.00	7.67	211.83	68.33
Phosphorus solubilizing bacteria	17.83	1.83	8.00	260.97	161.83
Azospirillum	17.63	1.73	11.33	236.53	82.17
Azotobacter	17.10	2.50	11.00	257.13	135.00
Annapurna®	18.43	2.00	9.17	230.50	141.67
Prokissan®	17.93	1.83	9.00	227.50	93.17
Sumangula®	17.77	2.33	8.00	220.63	100.33
General liquid®	21.57	1.73	10.17	265.97	88.00
Chamak®	20.47	1.67	8.00	289.53	66.50
Twin®	20.17	2.40	7.00	312.97	66.50
Samaras®	17.60	1.90	7.67	343.37	110.83
Multinol®	18.13	2.00	9.83	293.93	102.33
Flower Booster®	22.43	2.53	6.67	366.30	91.33
F-test	**	**	**	**	**
Mean	18.82	1.96	8.73	270.55	100.62
CD (P = 0.5)	3.67	0.86	2.66	39.69	50.75
CV (%)	8.53	19.33	13.34	6.42	22.09

Table 3. Effect of bio-fertilizers and commercial spray formulations on flowering of gladiolus (pooled data).

Treatment	No. of days required for blooming	Floret dia. (cm)	Floret length (cm)	No. of florets per spike	Durability of whole spike (days)	Spike length (cm)	Rachis length (cm)
Control	96.00	7.43	8.70	7.50	10.33	47.33	32.33
Phosphorus solubilizing bacteria	96.33	9.43	9.53	10.67	11.17	66.00	51.67
Azospirillum	116.00	7.80	8.97	6.33	15.33	77.00	49.00
Azotobacter	86.67	8.67	9.97	12.33	11.00	78.67	54.67
Annapurna®	81.00	8.80	9.43	13.00	11.00	67.00	54.67
Prokissan®	85.33	8.13	11.30	9.33	10.67	76.33	47.00
Sumangula®	89.33	7.77	11.37	11.00	10.67	80.33	53.33
General liquid®	104.67	8.33	11.57	8.00	15.33	73.33	47.00
Chamak®	97.67	7.67	11.73	11.33	14.33	67.33	44.67
Twin®	86.00	9.40	10.30	9.33	12.33	71.33	49.00
Samaras®	109.67	9.37	12.03	12.00	17.67	68.00	48.33
Multinol®	98.33	8.67	10.33	11.00	15.33	61.67	43.33
Flower Booster®	126.67	9.00	12.33	11.67	19.00	65.33	42.00
F-test	**	*	**	**	**	**	*
Mean	97.97	8.50	10.58	10.27	13.40	69.21	47.46
CD (P = 0.5)	15.71	1.21	1.82	4.18	3.04	17.51	10.71
CV (%)	7.02	8.43	7.55	17.84	9.95	11.08	13.38

Table 4. Effect of bio-fertilizers and commercial spray formulations on corm production of gladiolus (pooled data).

Treatment	No. of corms/ plant	No. of cormels/ plant	Weight of one corm (g)	Weight of cormels/ plant (g)	Corm dia. (cm)	Volume (cm^3)	Propagation co-efficient (%)
Control	1.03	1.57	11.00	3.60	2.67	25.33	40.67
Phosphorus solubilizing bacteria	2.47	4.70	36.80	8.27	4.50	45.17	206.33
Azospirillum	2.90	4.83	25.53	7.30	2.67	31.33	138.00
Azotobacter	2.20	4.00	39.90	6.70	4.00	46.17	210.67
Annapurna®	1.23	3.50	29.63	6.77	4.30	47.50	122.67
Prokissan®	1.90	6.87	32.70	10.10	3.33	38.33	154.50
Sumangula®	1.97	4.00	32.13	6.90	4.00	35.17	146.17
General liquid®	1.97	4.00	22.97	7.20	3.67	30.00	105.33
Chamak®	1.70	2.93	14.53	5.60	3.00	26.00	55.70
Twin®	2.00	7.10	33.60	10.30	4.67	37.17	180.33
Samaras®	1.33	4.80	29.53	7.40	3.67	30.83	120.67
Multinol®	2.03	3.73	35.53	6.70	5.17	36.67	146.03
Flower Booster®	2.03	7.30	44.93	10.40	5.67	51.17	231.00
F-test	**	**	**	**	**	**	**
Mean	1.91	4.56	29.91	7.48	3.95	36.99	142.93
CD (P = 0.5)	0.50	1.20	8.76	1.49	0.91	6.36	25.35
CV (%)	11.40	11.73	12.83	8.70	10.08	7.53	7.77

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