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Impact of integrated nutrient management on growth and flowering of gladiolus (*Gladiolus hybrida*) cv Novalux

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ABSTRACT

The present investigation was carried out at Model Floriculture Centre, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, during 2010-11 and 2011-12. The experiment was conducted in simple Randomized Block Design (RBD) with three replications and twenty five treatments consisting of biofertilizers (*Azotobacter*, PSB and KSB), different levels of inorganic fertilizers, and their combinations. Application of 3/4th N, P and K+ *Azotobacter* +PSB + KSB (T_{24}) was found most effective in enhancing plant height (112.84 cm), bud emergence (7.31 days), days taken to spike emergence (87.28 days), size of florets (10.22 cm), length of spikes (109.27 cm), rachis length (52.6 cm), chlorophyll content (70.98 SPAD), photosynthetic rate (17.73 µmol/m^2/sec), and N content (4.43%) in leaves of gladiolus (*Gladiolus hybrida*). Maximum leaf area, number of spikes/plot and number of florets/spike, number of florets/spike and number of florets opened/spike, chlorophyll inflorescence and P and K content of the leaves were recorded with application of 1/2 N, P and K+ *Azotobacter* + PSB + KSB (T_{25}). However, maximum number of leaves and days taken for opening of first floret were obtained when plants were fertilized with 3/4th N, P and K+ *Azotobacter* + PSB (T_{15}). Maximum duration of flowering was obtained with application of 3/4th N, P and K+ *Azotobacter* + KSB (T_{18}). Treatment 3/4th N, P and K+ PSB + KSB (T_{21}) resulted in maximum stomatal conductance of spikes.

Key words: Biofertilizers, Gladiolus, Growth, Flowering, Inorganic fertilizers

Gladiolus (*Gladiolus hybrida*), belongs to family Iridaceae and is a native of South Africa and Asia Minor. It is grown for garden decoration, cut flower production and has year round demand in towns and cities for bouquets, flower vases, garden and interior decoration. Popularity of flower is increasing day by day because of its majestic spikes having florets of huge form dazzling colour which covers the spectrum of white, pink, red, purple, yellow, orange, salmon and even green are available along with many bicolour and multicolour varieties. Out of the various factors affecting the growth and flowering of gladiolus, balanced nutrition is very important. After green revolution the continuous use of fertilizers has led to an increase in crop production but there was a decline in the nutrient-use efficiency making fertilizer consumption uneconomical and producing adverse effects on atmosphere and groundwater quality, causing health hazards. Therefore, it was suggested to replace some of the applied chemical fertilizers by some of the well known biofertilizers. use of biofertilizers along with (viz. *Azotobacter*, phospho and potash bacteria), balanced use of inorganic fertilizers is of paramount importance in horticulture in general and floriculture in particular, as the integrated nutrient management concept is one of the eco-friendly approaches. Biofertilizers have been found beneficial in flower crops like gladiolus, tuberose, rose, chrysanthemum and marigold (Maurya and Beniwal 2003).Keeping in view the need and importance, present study was undertaken to study the impact of integrated nutrient management on growth, flowering and post harvest of gladiolus under Uttarakhand conditions.

MATERIALS AND METHODS

The present experiment was carried out at Model Floriculture Centre, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttarakhand during 2010 to 2012. It was laid out in a Randomized Block Design (RBD) with three replications. The experiment was laid out with twenty five treatments, viz. Control (T_1), Full N, P and K (T_2 = Recommended dose of fertilizer-RDF), 3/4th N, P and K (T_3), 1/2 N, P and K (T_4), *Azotobacter* (T_5), PSB (T_6), KSB (T_7), 3/4th N, P and K+ *Azotobacter* (T_8), 1/2 N, P and K + *Azotobacter* (T_9), 3/4th N, P and K + PSB (T_{10}), 1/2 N, P and K + PSB (T_{11}), 3/4th N, P and K + KSB (T_{12}),

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1/2 N, P and K + KSB (T_{13}), *Azotobacter* + PSB (T_{14}), 3/4th N, P and K+ *Azotobacter* + PSB (T_{15}), 1/2 N, P and K + *Azotobacter* + PSB (T_{16}), *Azotobacter* + KSB (T_{17}), 3/4th N, P and K + *Azotobacter* + KSB (T_{18}), 1/2 N, P and K + *Azotobacter* + KSB (T_{19}), PSB + KSB (T_{20}), 3/4th N, P and K+ PSB + KSB (T_{21}), 1/2 N, P and K+ PSB+ KSB (T_{22}), *Azotobacter* + PSB + KSB (T_{23}), 3/4th N, P and K + *Azotobacter*+PSB +KSB (T_{24}), 1/2 N, P and K+ *Azotobacter* + PSB + KSB (T_{25}).Planting material were treated with reduced doses of N, P, K, viz. nitrogen in the form of urea, phosphorus in form of di-ammonium phosphate (DAP), potassium in form of muriate of potash (MoP) and liquid formulation (50 ml/e200ml of water) of *Azotobacter*, Phosphorus solubilizing bacteria (PSB) and Potassium solubilizing bacteria (KSB). All the recommended cultural operations were carried out during the course of study.Data on various parameters like; days taken to bud emergence, plant height, number of leaves, leaf area, days taken to spike emergence, days taken to opening of first floret, spike length, rachis length, diameter of first floret, number of florets per spike, spike yield, duration of flowering and N,P,K content in leaves were recorded. Data of both the years were pooled, analyzed and presented in tabular form. Data were put to statistical analysis as per Gomez and Gomez (1984).

RESULTS AND DISCUSSION

The data presented in Table 1 clearly indicates that different treatment combination of bio-fertilizers with reduced doses of inorganic fertilizer influenced all the vegetative characters studied.Treatment combination of 3/4th N, P and K+ *Azotobacte*r + PSB + KSB (T_{24}) was found to be more effective in enhancing vegetative bud sprouting and plant height than the other treatments. All the treatments hastened the vegetative bud emergence in comparison to control (12.82 days). However, vegetative bud emergence was found to be earliest (7.31 days) in 3/4th N, P and K+ *Azotobacter* + PSB + KSB (T_{24}) on basis of pooled data analysis.The hastening in bud emergence may be attributed to the presence of nitrogen, a constituent of protein which is essential for the formation of protoplasm, thus, enhancing the cell division and cell enlargement and ultimately better vegetative growth.P is essential for the formation of chlorophyll and protoplasm which is essential for life and can exist only if the plants are supplied with sufficient phosphorus. It is essential for cell division and development of merismatic tissues. Potassium has many functions in plants growth,increase drought tolerance, regulate the opening and closing of the stomata and required for osmotic regulation. Besides, potassium is essential for photosynthesis process and acts as a key to activate enzymes to metabolize carbohydrates for the manufacture of amino acids and proteins. Similar enhancement in vegetative bud emergence was also reported by Swaminanthan *et al.* (1999) in tuberose.

The effect of different biofertilizers in increasing plant height was also found to be significant though it varied among treatments in the present investigation. Maximum plant height (118.36 cm) after 90 days of vegetative bud emergence was recorded in 3/4th N, P and K + *Azotobacte*r + PSB + KSB (T_{24}). The increase in the plant height in the treatment T_{24} might be due to the synergistic effect of bio-fertilizers in combination with inorganic fertilizers. *Azotobacter* inoculation showed improved plant growth due to growth substances like gibberellins produced and released continuously in the minor rhizosphere and causes both cell elongation and division that dramatically stimulates internodes elongation and resulted in increase in plant height while the decrease in the plant height may be due to unavailability of sufficient nutrients at critical stages to plant for its luxuriant growth. Similar results of higher plant height due to combined application of biofertilizers and inorganic fertilizers have been reported earlier in gladiolus (Srivastava and Govil 2005).

There was marked increase in the number of leaves and leaf area when the plants were treated with combined

Table 1 Effect of integrated nutrient management on vegetative attributes of gladiolus cv. Novalux (pooled over two years)

Treatment	Days taken to vegetative bud emergence	Plant height (cm)		Number of leaves		Leaf area (cm^2)
		45 DAE	90 DAE	45 DAE	90 DAE	
T_1	12.85	51.53	103.45	4.09	6.08	97.12
T_2	7.77	67.63	113.32	5.68	7.75	89.10
T_3	10.12	61.54	109.87	5.38	6.90	91.30
T_4	11.05	52.79	108.01	4.76	7.11	89.67
T_5	12.75	51.62	104.84	4.16	6.96	96.09
T_6	12.79	53.72	103.82	4.20	6.98	89.64
T_7	11.41	53.69	104.42	4.59	7.12	91.84
T_8	10.81	56.56	108.66	4.88	7.80	90.36
T_9	9.73	56.54	111.08	4.93	7.73	90.53
T_{10}	10.01	56.40	105.74	5.06	7.46	91.55
T_{11}	9.85	57.84	108.73	4.73	7.51	93.36
T_{12}	10.01	58.26	106.27	4.95	7.09	90.92
T_{13}	9.97	57.02	108.62	4.67	7.04	89.86
T_{14}	11.44	55.62	106.00	4.35	7.01	92.68
T_{15}	8.83	64.37	111.11	4.66	8.04	88.82
T_{16}	9.72	56.15	109.45	5.04	8.01	88.87
T_{17}	10.75	55.20	106.85	4.78	7.04	89.68
T_{18}	8.75	59.71	116.24	5.07	8.03	88.86
T_{19}	9.28	60.55	114.38	5.39	7.93	90.63
T_{20}	9.99	58.77	110.05	4.88	7.06	94.19
T_{21}	9.13	62.89	111.82	5.71	8.02	89.13
T_{22}	8.87	63.73	112.84	5.60	7.80	88.61
T_{23}	9.28	60.94	110.90	5.16	7.31	89.28
T_{24}	7.31	64.73	118.36	5.81	8.00	87.28
T_{25}	7.71	65.91	116.54	5.90	8.03	88.61
CD (P=0.05)	0.98	1.89	1.57	0.17	0.13	2.42
Sem+	0.34	0.66	0.55	0.05	0.04	0.85

application of biofertilizers and chemical fertilizers. Highest number of leaves (8.04) was recorded in plants treated with combination of 3/4th N, P and K + *Azotobacter* + PSB (T_{15}). However, minimum number of leaves was observed in T_1 (6.08).The máximum number of leaves in this treatment can be attributed to the increased availability of nutrients (N, P and K) due to biofertilizers application. This may be due the presence of bioactive substances by bio-fertilizers which would have enhanced induction of leaf initial break, i.e. differentiation of leaf primordial in the apical growing region leading to an increased production of leaves. The results of our experiment are in confirmation with the findings of Gayithri *et al.* (2004).They reported that combined application of *Azotobacter,*vermicompost with inorganic fertilizers significantly increased the number of leaves, leaf area and stem girth in limonium.The effect of PSB on increasing the number of leaves is in accordance with the results obtained by Barman *et al.* (2003) in tuberose.

The higher leaf area (85.92 cm^2) values were recorded in the treatment 1/2 N, P and K + *Azotobacter* + PSB + KSB (T_{25}) compared to other treatments, which may be due to optimum level of nutrient availability to plant from chemical and biofertilizers and presence of growth promoting substances in the biofertilizers. These growth promoting substances might have resulted in increased cell division and elongation leading to enhanced leaf expansion, thus leading to increase in the leaf area. These findings were similar to that of Mostafa (2002) in *Calendula officinalis.*

On the basis of pooled data presented in Table 2 treatment 3/4th N, P and K + *Azotobacter* + PSB + KSB (T_{24}) was found most effective in improving the floral characters like days taken to spike emergence, spike length and rachis length, size of floret and spike weight, whereas control resulted in minimum values. This could be due to better nutrient uptake, higher photosynthetic efficiency, source-sink relationship besides excellent physiological and biochemical activities due to the presence of biofertilizers application. This in turn, helped in reducing 25% of recommended NPK. Pooled data shows that earliest spike emergence (87.28 days) was observed in 3/4thN, P and K + *Azotobacter* + PSB + KSB (T_{24}), while, the longest time was taken by T_1 (97.12 days).The similar results in respect to earliness to spike emergence due to application of biofertilizers were also reported in tuberose by Barman *et*

Table 2 Effect of integrated nutrient management on floral attributes of gladiolus cv. Novalux (pooled over two years)

Treatment	Days taken to first spike emergence	Days taken to opening of first floret	Number of spikes/square meter	Spike length (cm)	Rachis length (cm)	No. of florets/ spike	Diameter of the first floret (cm)	Duration of flowering (days)
T_1	97.12	105.91	14.19	90.38	43.75	13.13	8.43	8.23
T_2	89.10	98.50	19.72	104.11	51.18	15.03	9.60	13.45
T_3	91.30	99.33	17.70	97.76	50.56	14.81	9.04	11.30
T_4	89.67	100.20	16.91	95.97	47.68	14.73	9.28	9.88
T_5	96.09	103.39	14.89	94.37	45.37	13.92	9.07	9.69
T_6	89.64	105.53	15.52	93.23	44.26	13.24	8.82	9.77
T_7	91.84	104.44	14.79	94.51	45.02	13.88	8.87	10.42
T_8	90.36	104.96	15.59	101.14	47.55	15.44	9.12	12.19
T_9	90.53	101.78	17.12	100.42	47.25	15.36	9.62	13.11
T_{10}	91.55	100.94	19.05	98.90	46.79	15.25	9.82	12.92
T_{11}	93.36	99.71	19.07	101.51	47.22	14.73	8.81	12.61
T_{12}	90.92	100.83	18.22	98.34	48.66	15.81	9.77	13.16
T_{13}	89.86	100.51	19.18	100.01	48.03	15.35	8.82	13.04
T_{14}	92.68	102.86	15.27	94.47	45.14	14.56	8.39	9.95
T_{15}	88.82	98.16	20.65	103.38	51.20	15.77	9.92	13.02
T_{16}	88.87	100.28	20.00	100.47	48.43	15.05	9.81	13.23
T_{17}	89.68	102.15	17.83	98.06	45.41	14.46	9.16	10.22
T_{18}	88.86	100.61	21.46	107.24	48.72	16.08	9.72	11.48
T_{19}	90.63	100.05	20.60	107.14	50.02	14.61	9.38	12.14
T_{20}	94.19	101.33	16.96	97.81	46.00	14.28	9.43	11.54
T_{21}	89.13	99.06	20.41	104.13	51.25	15.35	10.00	13.56
T_{22}	88.61	98.83	19.31	102.12	48.61	14.56	8.95	12.74
T_{23}	89.28	99.19	19.87	101.79	46.83	14.12	8.44	12.83
T_{24}	87.28	98.62	21.56	109.27	52.63	16.28	10.22	13.35
T_{25}	88.61	99.73	22.13	108.94	51.47	16.38	10.14	13.03
CD (P=0.05)	2.42	1.66	1.24	1.66	1.54	0.71	0.18	0.48
Sem+	0.85	0.58	0.43	0.58	0.54	0.25	0.06	0.17

al. (2003).

During both the years, maximum spike length (109.27 cm) and rachis length (52.63 cm) was noticed in treatment 3/4thN, P and K+ *Azotobacter* + PSB + KSB (T_{24}), whereas minimum spike length (90.38 cm) and rachis length (43.75 cm) was found in control (T_1). The significant increase in these floral characters might be due to the production of auxins by microbial inoculants which brought about an increase in cell division and cell elongation. The results were also in agreement with the findings of Dalve *et al*. (2009) who found that the quality parameters (length and diameter of fully opened florets, length of spikes, length of rachis and vase life of spikes) of gladiolus were affected significantly by the application of 75% N + 100% PK (375:200:200 kg N: P: K/ha) + *Azotobacter* + *Azospirillum*, hence there was 25% saving in N fertilizer due to application of the biofertilizers. Pooled data of both the years reveals that maximum floret diameter (10.22 cm) was observed in treatment 3/4th N, P and K + *Azotobacter* + PSB + KSB (T_{24}). Floret diameter was minimum (8.43 cm) in control ($T_{1)}$. Increase in floret size may be ascribed to early breaking of apical dominance followed by easy and better translocation of nutrients to flowers, which were brought about by the activity of beneficial microorganisms in the biofertilizer formulations.

However, opening of first floret was found to be earliest (98.16 days) in treatment 1/2 N, P and K+ *Azotobacter* +PSB (T_{15}), whereas it was most delayed in control (105.91 days). The earliness in floret opening may be attributed to the presence of biofertilizers which result into easy uptake of nutrients and simultaneous transport of growth promoting substances like gibberllins and cytokinins to the buds. Ultimately, they resulted in better sink for faster mobilization of photosynthates and early transformation of plant parts from vegetative to reproductive phase. These results were in line with the findings in marigold (Chandrikapure *et al.* 1999).

Maximum number of spikes/plot (22.13) and number of florets/spike (16.38) was observed under 1/2th N, P and K + *Azotobacter* + PSB + KSB (T_{25}). However, lowest number of spikes/plot (14.19) and florets/spike (13.13) were found in control (T_1). The increase in number may be due to possible role of biofertilizers through atmospheric nitrogen fixation, better root proliferation, uptake of nutrients and water, more photosynthesis enhanced food accumulation and increased ability towards cell division which might have resulted in better plant growth and subsequently higher number of spikes and florets. These findings were in line with those of Kathiresan and Venkatesha (2002) and Godse *et al*. (2006) in gladiolus.

Longest duration of flowering (13.31 days) was noticed under treatment combination of 3/4th N, P and K +*Azotobacter* + KSB (T_{18}). Control (T_1) resulted in minimum flowering duration (8.14 days).The increase in flowering duration can be attributed to increased protein synthesis, rapid nutrient mobilization and prevention of chlorophyll degradation due to the sufficient amount of nutrients (N, P and K) availability in this treatment due to combined application of biofertilizers and chemical doses. Shashidhara and Gopinath (2005) in *Calendula officinalis* and Chopde *et al.* (2007) in tuberose reported similar results.

The conjunctive effect of biofertilizers with reduced doses of chemical fertilizers in enhancing biochemical characters was also found to be significant though it varied among the treatments in present investigation. The applied biofertilizer contains plant growth promoting bacteria (PGPB). These non-infecting PGPB rhizosphere bacteria might affect mineral nutrition of plants through their influence on growth, morphology and physiology of roots, the physiology and development of plants, the availability of nutrients and nutrient uptake processes. During both the years, maximum chlorophyll content (70.98) and photosynthetic rate (17.73) was obtained under treatment 3/4th N, P and K+ *Azotobacter* +PSB + KSB (T_{24}). However, minimum chlorophyll content (52.40) and photosynthetic rate (7.31) was noticed under control (T_1).These biofertilizer can enhance production by increasing the efficiency of photosynthesis. Increase in chlorophyll content was due to increase in nitrogen and phosphorus content due to biofertilizers application which is the chief constituent of protein and protoplasm resulting in increased photosynthetic activity. Cytokinin produced by microbial inoculants might have become a greater sink to attract nutrients like Mg, Fe and K which, in turn have resulted in greater synthesis of chlorophyll (Lalitha *et al.* 2004). P-solubilizing micro-organisms (bacteria or fungi) are able to solubilize unavailable soil P and increase the yield of crops (Adesemoye and Kloepper 2009). The results were also in conformity with the findings of Rodriguez *et al*. (1998) who reported that under P deficiencies sunflower showed a reduction in the rate of leaf expansion and in photosynthetic rate per unit of leaf area. However, P application produced greater and more consistent effects on crop performance as P fertilization allowed more efficient use of supplied N (soil + fertilizer). The increased chlorophyll content might also be due to enhanced stomatal conductance, photosynthesis and transpiration (Hayman 1983).

Treatment 1/2 N, P and K + *Azotobacter* + PSB + KSB (T_{25}) resulted in maximum chlorophyll fluorescence (0.65), whereas maximum stomatal conductance was found in treatment 1/2 N, P and K + PSB + KSB (T_{21}) (Table 3). The applied biofertilizer contains advantageous plant growth promoting bacteria (PGPB) which affect physiological processes in the roots and, consequently, in the shoot. The results obtained in present investigation are in accordance with the results of Szilvia *et al*. (2007) in maize who observed the effects of application of biofertilizers exercise on the parameters of chlorophyll-fluorescence. He reported that the different nitrogen deficiency level cause reduction in the potential photochemical activity (Fv/Fm) compared to the normal nitrogen amount. The applied biofertilizer could compensate the effect of nitrogen deprivation. The applied bio-fertilizer could compensate the effect of nitrogen deprivation. The potential photochemical activity was 5-8%

Table 3 Effect of integrated nutrient management on bio-chemical attributes of gladiolus cv. Novalux (pooled over two years)

Treatment	Chlorophyll content (SPAD Value)	Chlorophyll fluorescence (fv/fm ratio)	Photo-synthetic rate (µ mol/m²/s)	Stomatal conductance (mmol/ m²/s)
T_1	52.40	0.45	7.31	187.50
T_2	68.07	0.54	13.63	249.70
T_3	66.83	0.61	12.30	235.03
T_4	59.21	0.55	11.56	217.81
T_5	53.25	0.48	10.88	202.61
T_6	52.70	0.46	9.37	199.04
T_7	53.94	0.48	8.88	193.68
T_8	57.09	0.60	10.95	219.39
T_9	57.35	0.53	9.97	203.13
T_{10}	59.10	0.54	10.47	215.93
T_{11}	61.72	0.65	11.02	216.41
T_{12}	59.18	0.53	10.34	244.44
T_{13}	63.87	0.61	11.11	241.24
T_{14}	60.74	0.52	10.70	237.67
T_{15}	64.73	0.65	14.69	275.16
T_{16}	63.41	0.63	14.96	253.17
T_{17}	61.42	0.52	13.19	241.57
T_{18}	65.14	0.61	15.57	286.24
T_{19}	68.54	0.60	12.70	274.48
T_{20}	60.57	0.59	11.99	232.55
T_{21}	66.32	0.60	16.82	291.24
T_{22}	66.56	0.62	16.36	249.77
T_{23}	62.05	0.57	14.75	255.66
T_{24}	70.98	0.65	17.73	276.47
T_{25}	69.74	0.66	16.62	289.54
CD (P=0.05)	1.72	0.17	0.88	6.77
Sem+	0.60	0.06	0.31	2.38

higher if the reduced nitrogen supply was supplemented with bio-fertilizer as compared to the values of different nitrogen deficiency levels without bio-fertilizer treatments.

It is clear from the Table 4 that treatment combination of 3/4th N, P and K + *Azotobacter* + PSB + KSB (T_{24}) resulted in maximum nitrogen content in the leaves (4.43%). However, nitrogen content in the leaves was observed minimum (3.12%) under control (T_1). Application of 1/2 N, P and K+ *Azotobacter* +PSB + KSB (T_{25}), resulted in maximum phosphorus content (1.15%) and potassium content (2.95%) in leaves. Minimum phosphorus content (0.44%) and potassium content (2.28%) in leaves was obtained in control (T_1). Similarly in field trials conducted by Alagawadi and Gaur (1992) revealed that a significant increase in yield and nutrient uptake of sorghum were obtained due to combined inoculation of *Azospirillum brasilense* and *Psuedomonas straita* or *Bacillus polymyxa*

Table 4 Effect of integrated nutrient management on N, P and K (%) content in gladiolus leaves (pooled over two years)

Treatment	Pooled		
	N	P	K
T_1: Control	3.12	0.44	2.28
T_2 : Full N, P and K	4.24	0.88	2.94
T_3 : 3/4th N, P and K	3.87	0.74	2.74
T_4 : 1/2 N, P and K	3.95	0.69	2.60
T_5 : *Azotobacter*	3.34	0.52	2.40
T_6 : PSB	3.28	0.54	2.38
T_7 : KSB	3.24	0.64	2.32
T_8: 3/4th N, P and K+ *Azotobacter*	4.03	0.75	2.44
T_9 : 1/2 N, P and K+ *Azotobacter*	3.76	0.72	3.42
T_{10}: 3/4th N, P and K+ PSB	3.66	0.67	2.56
T_{11}: 1/2 N, P and K+ PSB	3.51	0.58	2.53
T_{12}: 3/4th N, P and K+ KSB	3.75	0.82	2.51
T_{13}: 1/2 N, P and K + KSB	3.38	0.68	2.43
T_{14}: *Azotobacter* + PSB	3.28	0.50	2.44
T_{15}: 3/4th N, P and K+ *Azotobacter* + PSB	4.07	0.67	2.69
T_{16}: 1/2 N, P and K + *Azotobacter* + PSB	4.06	0.58	2.66
T_{17}: *Azotobacter* + KSB	3.43	0.63	2.50
T_{18}: 3/4th N, P and K+ *Azotobacter*+ KSB	4.15	0.95	2.69
T_{19}: 1/2 N, P and K+ *Azotobacter*+ KSB	4.00	0.81	2.59
T_{20}: PSB + KSB	3.20	0.69	2.58
T_{21}: 3/4th N, P and K+ PSB + KSB	3.76	0.82	2.72
T_{22}: 1/2 N, P and K+ PSB+ KSB	3.70	0.75	2.63
T_{23}: *Azotobacter* + PSB + KSB	3.59	0.64	2.61
T_{24}: 3/4th N, P and K+ *Azotobacter* + PSB +KSB	4.43	1.12	2.88
T_{25}: 1/2N, P and K+ *Azotobacter* + PSB + KSB	4.42	1.15	2.95
CD (P=0.05)	0.08	0.05	0.18
Sem+	0.03	0.01	0.06

when compared to inoculation of individual organisms. Increase in yield and P uptake of rice due to inoculation with phosphate solubilizing microorganisms in combination with rock phosphate or single super phosphate has been reported (Anthoniraj *et al.* 1997). Seed bacterization with *Pseudomonas striata* and *Bacillus polymyxa* when used as single and mixed inoculants, increased the yield and P uptake in potato (Kundu and Gaur 1980). When the phosphobacteria were inoculated together, the increase was 35.20 per cent followed by *Pseudomonas striata* (30.8%) and *B. polmyxa* (22.90%).

It can be concluded that application of 3/4th N, P and K+ *Azotobacter* + PSB + KSB is most effective among various treatments in enhancing the growth and flowering attributes of gladiolus cv. Novalux, under *Tarai* condition. Application of biofertilizers along with inorganic fertilizers also indicates the possibility of reducing the dose of chemical fertilizers, which is cost effective and eco friendly for the cultivation.

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