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Research Article

EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON GLADIOLUS *Cv.* NOVALUX (*Gladiolus x hortulanus* L.) UNDER SHEVAROY CONDITION

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Abstract- The experiment was conducted to find out the influence of Integrated Nutrient Management on growth, yield and quality of Gladiolus *cv.* Novalux during October 2011 to April 2012 at Horticultural Research Station, Tamil Nadu Agricultural University, Yercaud. The experiment consists of 16 treatments with replicated twice and it includes application of organic, inorganic and biofertilisers. The results of the experiment revealed that the number of days taken for spike emergence was earliest in the treatment T_{12} [75% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant) + PSB (2 g/plant)] - 92.10 days than the control. The number of days taken for first floret opening (104.20) was earliest in the treatment T_{12} [75% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant) + PSB (2 g/plant)] than the control T_{17} (125.47 d).Significant effect on spike length was noticed by the application of T_{16} [50% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant)+ PSB (2 g/plant)] - 83.43 cm than the control (71.10 cm).Rachis length (53.60 cm) observed was higher in the application T_{16} [50% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant) + PSB (2 g/plant)] than the control (40.63 cm).The highest diameter of the floret (10.3 cm) was noticed with the application of T_{12} [75% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant) + PSB (2 g/plant)] than the control (7.18 cm).Lengthier floret (8.56 cm) was also noticed with the application of T_{12} [75% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant) + PSB (2 g/plant)].Spike weight (61.27 g) observed was higher in the application T_{16} [50% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant) + PSB (2 g/plant)] than the control (38.13 g).The application of T_{16} [50% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant) + PSB (2 g/plant)] produced more number of florets per spike (18.13).Marketable spikes per plant (1.79 No.) and flower yield per meter square (19.50 No.) was noticed higher in T_{16} [50% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant) + PSB (2 g/plant)] than the control. The application of T_{16} [50% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant) + PSB (2 g/plant)] had significantly influenced on number of florets remain open at a time (4.67) and also on vase life (6.40 d) of flower. From the results obtained in this experiment, it could be concluded that application of T_{16} [50% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant) + PSB (2 g/plant)] will significantly improve the growth, yield and quality parameters which ultimately result in increased return in Gladiolus *cv.* Novalux under Shervaroy condition.

Key words- Gladiolus *cv.* Novalux, Organic manures, Biofertilizers, Yield and quality parameters.

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Introduction

Gladiolus is the second most important cut flower grown on its storage organ (corms). Gladiolus occupies eighth position in the world for cut flower trade and has a global history.

Totally, 19,900 stems of Gladiolus were imported from European market (Excluding Netherlands) at the rate of 0.52 US$ per stem during 2006.Japan produced 82,760 stems of cut Gladiolus domestically at the price of 0.45 US$ per stem while imported 28,800 stems from Netherlands and Taiwan at a price of 0.27 US$ per stem. Singapore imported gladiolus stems from China and Malaysia at the rate of 0.44 US$ and 0.61 US$. For successful cultivation, nutrient management is of prime importance to obtain good quality flowers. Corms of gladiolus are rich in stored food which is sufficient to sustain for its growth in initial few days. Though, cormels require fairly good amount of fertilizers due to its small size, the macronutrients are needed in large quantity. Organic manure should be mixed through the top soil before planting to improve the structure of the soil. Nitrogen should be applied at 300 kg/ha which may be reduced in medium and heavy soils. It is applied in two doses, first at three leaf stage and second at six leaf stage. Cormels may be given with nitrogen in 4-5 applications at about 3 week intervals starting from one month age of the crop. Mainly N should be applied in nitrate form and application should be stopped at least six weeks prior to harvesting the corms. Gladiolus requires around 120-150 kg K_2O/ha at the time of planting of corms [1].

Kumar (2006) reported that P levels of 200 kg/ha resulted in maximum vegetative growth, number of flowers per plant and number of spikes per corm. Iron deficiency is common in North-West plains of India and causes interveinal yellowing of new leaves. The deficiency is more pronounced in alkaline soils and in severe conditions emerging spikes turn mild green to yellow. This can be corrected by spraying ferrous sulphate at 0.2 per cent, twice or three times at 10 days interval. Hence, the present study was under taken to study the effect of integrated nutrient management on the growth and yield of Gladiolus *cv.* "Novalux" under Shevaroy condition.

Materials & Methods

The present investigation was carried out at Horticultural Research Station, Tamil Nadu Agricultural University, Yercaud. The experimental site is geographically situated between 11° 04" to 11° 05" North latitude and 78° 05" to 78° 23" East longitude and at an altitude of 1500 m above Mean sea level. The average maximum and minimum temperature is 31.0°C and 12.4°C. The soil of the experimental plot was laterite in texture with 0.5 to 1.5 m depth. The land was thoroughly pulverized and enriched with red earth, sand and well decomposed farm yard manure at 2:1:1 proportion. The experiment was laid out in a randomized block design with three replications. The corms used for conducting the research, procured from Indian Horticultural Company, Kalimpong, West Bengal. The manures *viz.,* farm yard manure, vermicompost and bio fertilizers like *Azospirillum* and *Phosphobacteria* were used. As inorganic fertilizers, Nitrogen, Phosphorus and Potassium were also used in different proportion. The experimental field was made ready by removing weeds and stones. Beds were prepared with the size of 1m length and 1m width. Nine Corms were sown in the one square meter bed in a spacing of 30 x 20 cm. NPK fertilizers were applied as basal at 125%, 100%, 75% and 50% based on the recommended dose of fertilizer for Gladiolus based on the recommendation of Crop Production Guide at the time of planting of corms. At the time of planting, the bio-fertilizers like *Azospirillum* and *Phosphobacteria* (PSB) were applied at 2 g/plant to each corm. The Farm yard manure (FYM) was applied at the rate of 2 kg/m^2 and vermicompost applied at 300 g/m^2. Earthing up operation was carried out to prevent lodging of the plants and also to cover up the exposed corms. Staking was done during the spike emergence to withstand the weight of the spike after flowering and also to prevent loddging by wind. The observations are plant height (cm), leaf area (cm2), no. of leaves (No.), no. of lateral shoots per plant (No.), number of days taken for first floret opening (d), spike length (cm), rachis length (cm), spike weight (g), number of florets per spike (No.), number of florets remain open at a time (d), diameter of the floret (cm), length of the floret (cm), marketable spikes per plant (No.), flower yield per square meter (No.). The data recorded were statistically analyzed and the results of the experiments are presented [Table-2 and Table-3]. The treatments are detailed below:

Table-1 *Treat mental details*

Treatments	Particulars
T_1	125% RDF* + FYM (2 kg/m^2)
T_2	125% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2)
T_3	125% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant)
T_4	125% RDF + FYM (2 kg/m^2)+ Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant) + PSB (2 g/plant)
T_5	100% RDF + FYM (2 kg/m^2)
T_6	100% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2)
T_7	100% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant)
T_8	100% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant) + PSB (2 g/plant)
T_9	75% RDF + FYM (2 kg/m^2)
T_{10}	75% RDF + FYM (2 kg/ m^2) + Vermicompost (300 g/m^2)
T_{11}	75% RDF+ FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant)
T_{12}	75% RDF + FYM (2 kg/m^2)+ Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant) + PSB (2 g/plant)
T_{13}	50% RDF + FYM (2 kg/m^2)
T_{14}	50% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2)
T_{15}	50% RDF + FYM (2 kg/m^2)+ Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant)
T_{16}	50% RDF + FYM (2 kg/m^2)+ Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant) + PSB (2 g/plant)
T_{17}	Untreated control

(* RDF – 60:150:150 kg/ha)

Results

The effect of treatments on various growth and yield parameters were recorded and the results are presented. Plant height was ranged from 32.40 cm to 59.30 cm with a mean of 47.32 cm. Maximum plant height was recorded in T_{16} [50% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant) + PSB (2 g/plant)] - 59.30 cm, which was statistically on par with the T_{15} - [50% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant)] - 56.30 cm. The least plant height was recorded in the T_{17} (Untreated control) - 32.40 cm on 60 days after planting.

Leaf area ranged from 64.67 cm^2 to 93.0 cm^2 with a mean of 83.76 cm^2. Maximum leaf area was recorded by T_{16} - [50% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant) + PSB (2 g/plant)] – 93.0 cm^2 which was statistically on par with the treatment such as T_{14} [50% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2)] - 92.67 cm^2. The minimum leaf area was recorded in T_{17} (Untreated control) - 64.67 cm^2.

Production of leaves varied significantly due to the treatments at 60th DAP and it ranged from 3.43 No. to 5.87 No. with a mean of 4.72 No. Maximum number of leaves (5.87) was recorded in the treatment T_{16} - [50% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant) + PSB (2 g/plant)], which was statistically on par with the treatments such as T_{15} [50% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant)], – 5.81 No., T_8 [100% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant) + PSB (2 g/plant)] - 5.73 No. The least number of leaves was produced in the T_{17} (Untreated control) - 3.43 No.

Flowering attributes

The data on number of days taken for emergence of spike as influenced by different treatments of gladiolus are given in [Table-3]. Significant differences were observed among the treatments with respect to number of days taken for emergence of spike and it ranged from 92.10 d to 116.87 d with a mean of 107.36 d. The earliness in emergence of spike was observed in the treatment T_{12} [75% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant) + PSB (2 g/plant)] - 92.10 d and it was followed by T_{15} [50%RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant)] - 96.57 d. The delayed emergence of spike was recorded in the T_{17} (Untreated control) - 116.87 d.

Significant differences were observed in days taken for opening of first floret among the treatments. It ranged from 104.20 d to 125.47 d with a mean of 116.35 d. The treatment T_{12} [75% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant) + PSB (2 g/plant)] - 104.20 d registered the minimum number of days for opening of first floret, while the T_{17} (Untreated control) - 125.47 d took the maximum number of days taken for opening of first floret. The treatment T_{16}-[50% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant) + PSB (2 g/plant)] – 107.17 d, T_5 [100% RDF + FYM (2 kg/m^2)] - 107.17 d were on par with T_{12}.

Significant differences were observed among treatments with respect to length of spike and it ranged from 71.10 cm to 83.43 cm with a mean of 76.32 cm. The treatment T_{16} - [50% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant) + PSB (2 g/plant)] produced significantly the longest length of spike (83.43 cm), which was on par with the treatment T_{15} [50%RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant)] - 80.85 cm. The shortest length of spike (71.10 cm) was recorded in T_{17} (Untreated control).

Significant differences with respect to length of rachis were observed among the treatments. It ranged from 40.63 cm to 55.60 cm with a mean of 46.87 cm. The treatment T_{16} - [50% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant) + PSB (2 g/plant)] recorded the longest length of rachis of 55.60 cm and it was followed by the treatment T_{15} [50% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant)] - 53.73 cm. The length of rachis was minimum in the treatment T_{17} (Untreated control) - 40.63 cm.

Significant differences with respect to weight of spike were observed among the treatments. It ranged from 38.13 g to 61.27 g with a mean of 50.13 g. The treatment T_{16} - [50% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant) + PSB (2 g/plant)] recorded the maximum weight of spike 61.27 g and it was followed by the treatment T_8 [100% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant) + PSB (2 g/plant)] - 60.50 g. The minimum weight of spike was recorded in the treatment T_{17} (Untreated control) - 38.13 g.

Flower characters

The flower characters like number of florets per spike, number of florets opened at a time, length and diameter of first floret were recorded. The data pertaining to these characters are presented in Table.The treatments showed significant differences with respect to number of florets per spike. It ranged from 16.40 No. to 18.13 No. with a mean of 17.21 No. The maximum number of florets per spike (18.13) was recorded in the T_{16} - [50% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant) + PSB (2 g/plant)] treatment, which was followed by T_{15} [50% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant)], T_{12} [75% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant) + PSB (2 g/plant)] and T_8 [100% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant) + PSB (2 g/plant)] produced (17.73 No.). The minimum number of florets per spike was recorded in the treatment T_{17} (Untreated control)- 16.40 No. The treatments showed significant differences with respect to number of florets opened at a time. It ranged from 3.43 No. to 4.67 No. with a mean of 4.11 No. The maximum number of florets opened at a time was recorded in the T_{16} - [50% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant) + PSB (2 g/plant)] - 4.67 No., which was followed by T_{15} [50% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant)] - 4.43 No. The minimum number of florets opened at a time was recorded in the T_{17} (Untreated control) - 3.43 No. It is evident from the data that the treatments varied significantly with respect to the diameter of floret. It ranged from 7.18 cm to 10.3 cm with a mean of 7.89 cm. Florets with maximum diameter was recorded in the treatment T_{12} [75% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant) + PSB (2 g/plant)] - 10.3 cm which was on par with the treatments, T_{15} [50% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant)] - 8.35 cm and T_{14} [50% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2)] - 8.33 cm. The least diameter of floret was recorded in the treatment T_{17} (Untreated control) - 7.18 cm. The treatments showed significant ranging from 6.29 cm to 8.56 cm and with a mean of 7.04 cm in the length of first floret. Florets with the maximum length were recorded in the treatment T_{12} [75% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant) + PSB (2 g/plant)] - 8.56 cm and it was on par with the treatment like T_{11} [75% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant)] – 7.60 cm. The minimum length of floret was recorded in the treatment T_{17} (Untreated control) - 6.29 cm.

Table-2 *Effect of Integrated Nutrient Management on morphological characters in Gladiolus cv. Novalux*

Treatments	Plant height (cm)	Leaf area (cm^2)	No. of leaves (No.)	No. of lateral shoots per plant (No.)
T_1 - 125% RDF + FYM (2 kg/m^2)	48.74	88.67	4.40	1.63
T_2 - T_1 + Vermicompost (300 g/m^2)	50.53	82.00	4.40	1.46
T_3 - T_2 + Azospirillum (2 g/plant)	50.00	89.67	4.19	1.73
T_4 - T_3 + PSB (2 g/plant)	47.28	83.67	5.07	1.78
T_5 - 100% RDF + FYM (2 kg/m^2)	46.52	78.00	5.00	1.80
T_6 - T_5 + Vermicompost (300 g/m^2)	47.00	77.67	4.67	1.96
T_7 - T_6 + Azospirillum (2 g/plant)	41.48	85.00	4.60	1.65
T_8 - T_7 + PSB (2 g/plant)	49.51	81.33	5. 73	2.01
T_9 - 75% RDF + FYM (2 kg/m^2)	49.34	81.67	5.13	1.59
T_{10} - T_9 + Vermicompost (300 g/m^2)	43.53	79.00	4.20	1.46
T_{11} - T_{10} + Azospirillum (2 g/plant)	45.56	83.00	4.40	1.64
T_{12} - T_{11} + PSB (2 g/plant)	54.70	87.67	4.80	1.40
T_{13} - 50% RDF + FYM (2 kg/m^2)	40.01	84.00	3.93	1.49
T_{14} - T_{13} + Vermicompost (300 g/m^2)	42.17	92.67	4.60	1.53
T_{15} - T_{14} + Azospirillum (2 g/plant)	56.30	92.33	5.81	1.98
T_{16} - T_{15} + PSB (2 g/plant)	59.30	93.00	5.87	2.26
T_{17} – Untreated control	32.40	64.67	3.43	1.08
Mean	47.32	83.76	4.72	1.67
SEd	0.62	1.34	0.53	0.15
C.D. (P = 0.05)	1.26	2.73	1.08	0.31

Table-3 *Effect of Integrated Nutrient Management on flower charatcers in Gladiolus cv. Novalux*

Treatments	Number of days taken for first floret opening (d)	Number of days taken for first floret opening (d)	Spike length (cm)	Rachis length (cm)	Spike weight (g)	Number of florets per spike (No.)	Number of florets remain open at a time (d)	Diameter of the floret (cm)	Length of the floret (cm)	Marketable spikes per plant (No.)	Flower yield per square meter (No.)
T_1	122.30	122.30	76.57	42.08	43.40	17.13	4.10	7.22	6.54	1.27	13.33
T_2	124.00	124.00	76.19	48.60	44.47	17.40	4.10	7.50	6.30	1.23	14.23
T_3	125.17	125.17	73.20	43.79	40.20	17.00	4.17	8.14	7.28	1.40	14.67
T_4	120.50	120.50	79.52	50.46	53.13	16.80	4.20	7.94	6.95	1.43	13.20
T_5	107.17	107.17	77.48	49.59	47.17	17.40	3.80	7.67	6.76	1.37	14.50
T_6	123.77	123.77	77.94	49.83	51.33	17.27	4.13	7.59	6.64	1.40	16.33
T_7	123.63	123.63	75.16	46.49	57.27	16.60	3.80	7.77	6.80	1.37	16.20
T_8	114.67	114.67	73.89	45.07	60.50	17.73	4.37	7.89	6.93	1.50	15.67
T_9	114.23	114.23	74.57	46.33	41.13	16.53	4.10	7.87	6.88	1.40	16.03
T_{10}	111.40	111.40	71.99	42.37	50.50	17.60	4.17	7.75	6.74	1.27	16.07
T_{11}	120.63	120.63	74.85	45.47	45.67	16.87	4.30	8.21	7.60	1.40	16.30
T_{12}	**104.20**	**104.20**	74.66	42.90	60.63	17.73	4.40	**10.3**	**8.56**	1.47	14.67
T_{13}	114.00	114.00	76.54	44.90	47.17	16.73	3.63	7.84	7.03	1.40	18.50
T_{14}	116.20	116.20	79.53	48.90	58.43	17.60	4.10	8.33	7.73	1.37	15.67
T_{15}	104.40	104.40	80.85	53.73	51.83	17.73	4.43	8.35	7.36	1.51	15.93
T_{16}	107.17	107.17	**83.43**	**55.60**	**61.27**	**18.13**	**4.67**	7.83	7.23	**1.79**	**19.50**
T_{17}	125.47	125.47	71.10	40.63	38.13	16.40	3.43	7.18	6.29	1.10	13.00
Mean	**116.35**	**116.35**	**76.32**	**46.87**	**50.13**	**17.21**	**4.11**	**7.89**	**7.04**	**1.39**	**15.52**
SEd	**3.53**	**3.53**	**3.29**	**2.90**	**3.81**	**0.64**	**0.24**	**0.30**	**0.35**	**0.13**	**1.62**
C.D. (P = 0.05)	**7.18**	**7.18**	**6.71**	**5.91**	**7.76**	**1.31**	**0.49**	**0.61**	**0.72**	**0.26**	**3.29**

The yield of spike in terms of marketable spikes per plant and flower yield per m^2 are presented in Table. Significant differences were observed among the treatments with respect to marketable spikes per plant. It ranged from 1.10 No. to 1.79 No. with a mean of 1.39 No. The T_{16} - [50% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant) + PSB (2 g/plant)] recorded the maximum number of spikes per plant (1.79), which was on par with the T_{15} [50% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant)] - (1.51 No). The minimum number of marketable spikes per plant (1.10) was recorded in the treatment T_{17} (Untreated control). Significant differences were observed among the treatments with respect to marketable spike per m^2. It ranged from 13.00 No. to 19.50 No. with a mean of 15.52no. The treatment T_{16} - [50% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant) + PSB (2 g/plant)] recorded the maximum number of spikes per m^2 (19.50), which was followed by treatment T_{13} [50% RDF + FYM (2 kg/m^2)] - 18.50 No. The minimum number of marketable spikes per m^2 (13.00) was recorded in the treatment T_{17} (Untreated control).

Cost Economics

Significant differences exhibited among the different treatments for cost economics. The treatment, T_{16} - [50% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant) + PSB (2 g/plant)] registered higher benefit cost ratio of 2.17**.** The lower benefit cost ratio was obtained in the treatment T_{17} (0.63). Significant differences were observed among the treatments with respect to number of days taken for emergence of spike and it ranged from 92.10 d to 116.87 d with a mean of 107.36 d. The earliness in emergence of spike was observed in the treatment T_{12} [75% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant) + PSB (2 g/plant)] - 92.10 d and it was followed by T_{15}.

Discussion

Application of T_{16} (50% RDF + FYM 2 kg/m^2 + Vermicompost 300 g/m^2 + *Azospirillum* 2 g/plant + *Phosphobacteria* (PSB) 2 g/plant) had resulted in higher plant height - 59.30 cm, length and width of leaf - 38.59 cm and 4.66 cm, number of leaves per plant - 5.87, number of lateral shoots per plant- 2.26 compared to control. . Better availability of nutrients would have helped in protein synthesis resulting in production of taller plants with larger leaves and more number of branches. The application of T_{12} (70% RDF + FYM 2 kg/m^2 + vermicompost 300 g/ m^2 + *Azospirillum* 2 g/plant + PSB (*Phosphobacteria*) 2 g/plant) induces earliness in spike emergence - 92.10 d and number of days taken for first floret opening - 104.20**.** Balanced dose of nitrogen, phosphorus and potassium seemed to have increased the vegetative growth, favourable for the synthesis of peptide bond, protein and carbohydrate metabolism that are essential for flower development [2].

Application of T_{16} (50% RDF + FYM 2 kg/m^2 + Vermicompost 300 g/m^2 + *Azospirillum* 2 g/plant + *Phosphobacteria* (PSB) 2 g/plant) increased the) spike length- 83.43 cm, rachis length-55.60 cm and spike weight- 61.27 g compared to control. One of the main functions of nitrogen is the initiation of meristematic activity of the plant and thus the size of the plant is largely the measure of nitrogen metabolism [3]. This might be due to the presence of calcium in CAN and sulphur in SSP which might have participated in higher protein synthesis and thus improved the vegetative growth, dry matter accumulation and partitioning of nutrients towards the developing spikes. Paradhan *et al.*(2004) on gladiolus in India, mentioned that combined application of N at 40 g/m^2 and K at 30 g/m^2 recorded the highest values of spike length and number of florets per spike [4]. Nitrogen applied as alone or combined with P or K or both, was added into the soil had showed increase in the spike length and the yield of the bulbs [5].

Application of T_{16} (50% RDF + FYM 2 kg/m^2 + Vermicompost 300 g/m^2 + *Azospirillum* 2 g/plant + *Phosphobacteria* (PSB) 2 g/plant) increased number of florets per spike - 18.13 and number of florets remain open at a time **-** 4.67. For the good appearance of a spike, number of florets that open at a time is important. Khan and Iftikhar (2004) in Pakistan on gladiolus concluded that N application rate combined with moderate P and K rates enhanced vegetative growth characteristics while moderate of NPK exhibited more pronounced effect on floral characteristics and corm development [6]. Hilal *et al*. (2001) on gladiolus recorded that applying NK at the rate of 1:1 significantly improved quality of flowers [7,8].

Conclusion

From the results obtained in this experiment, it could be concluded that application of T_{16} [50% RDF + FYM (2 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum* (2 g/plant) + PSB (2 g/plant)] will significantly improve the growth, yield and quality parameters which ultimately result in increased return in Gladiolus *cv.* Novalux under Shervaroy condition.

Application of research

The experiment on Integrated Nutrient management in Gladiolus conducted at Horticultural Research Station, Tamil Nadu Agricultural University, Yercaud, Tamil Nadu would be applied to the gladiolus growers for getting more income. Since, it is being cultivated by open field small farmers it is more useful for increasing the yield and ultimately improving the economic conditions of the growers.

Author Contributions

The first author is a Post graduate student and it the part of her research and she conducted the experiment in the field at HRS, Yercaud. The second, third and fourth authors provided the inputs for conducting the experiment in well planned manner. Third author is the member of the advisory committee and fourth author is the chairman of the advisory committee.

Abbreviations

RDF – Recommended dose of fertilizers
Azo – Azospirillum
PSB - Phosphobacteria

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Conflict of Interest: None declared

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