



Integrated Effect of Bio-Fertilizers, Organic and Inorganic Fertilizers on Flowering and Quality Attributes of Gladiolus (*Gladiolus grandiflorus* L.) cv. Nova Lux

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The study "Influence of bio-fertilizers on vegetative growth, flower quality and bulb yield of gladiolus (*Gladiolus grandiflorus* L.)", field experiments conducted during 2020-21. Bulbous gladiolus is a very well-liked plant. Pliny the Elder (2379 AD) first used the term "gladiolus" to refer to the blade's sword-like form (Latin word gladiolus means sword). Gladiolus is a delicate perennial herbaceous plant that may be cultivated from seeds or bulbs. The roots of several older leaves that were developed during the previous growing season are covered with 4-6 dry scales or sheaths that cover the bulb. In addition to fixing nitrogen, phosphorus, and other nutrients from organic fertilisers and soil reserves, bio-fertilizers also help plants tolerate drought, boost plant health, and tolerate salt better [1] (Arora, 2013). A randomised block design with three replications was used to apply 14 different treatments, including the application of chemical fertilisers (Urea, SSP, and MOP),

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micronutrients (Zn and Fe), organic sources (FYM and Vermicompost), and bio-fertilizers (Azospirillum, Azotobacter, and PSB). Based upon the results recorded in the investigation it could be concluded that the treatment T10 (75% RDF + 25% Vermicompost + Azospirillum + PSB + Azotobacter), was found best treatment with reference to vegetative, nutritional, and productive parameters in gladiolus cv. Nova lux as compared to control and other treatments.

Keywords: Biofertilizer; gladiolus; manures; Nova Lux flowering and quality.

1. INTRODUCTION

Gladiolus is a very popular bulbous plant. The name gladiolus was coined by Pliny the Elder (2379 AD) to describe the shape of the blade resembling that of the sword (Latin word gladiolus means sword). It has originated from South Africa (tetraploids) and diploid sp. in Europe. Commonly known as the gladiolus, it belongs to the Iridaceae family and the Ixioideae subfamily. It has the base chromosome number 15. There are about 260 species of gladiolus. Most members of the genus are heteroploids with very small chromosomes ranging from $2n = 30$ to 120 (diploids, triploids, tetraploids, pentaploids, hexaploids, octaploids, and hyperaneuploids).

It is an important commercial flower crop and, as a cut flower, occupies a central position in both national and international markets. Flowers are used in flower arrangements, bouquets and interior decorations [2-7]. In the Netherlands and other European countries, this flower ranks after the tulip in the trade as a cut flower for bulb plants and fourth in the international trade in ornamental plants for cut flowers. Gladiolus flowers have been worldwide since ancient times, but it was not until the 18th century that their commercialization peaked in other parts of the world. In the 18th century, travellers from South Africa brought large numbers of African gladiolus flowers to Europe via the Indian trade route. This movement led to the hybridization of this plant for gardening purposes.

Gladiolus Blossoms are a well-known symbol of remembrance and falling in love. In the language of flowers, a gladiolus flower also has the symbolic meaning of honour, loyalty, perseverance, calmness, integrity and strength of character [8-11]. Gladiolus is a flowering perennial that grows from bulbs, which are bulb-like structures. It is an important commercial flower crop and, as a cut flower, occupies a central position in both national and international markets. Flowers are used in flower

arrangements, bouquets and interior decorations. In the Netherlands and other European countries, this flower ranks after the tulip in the trade as a cut flower for bulb plants and fourth in the international trade in ornamental plants for cut flowers [12-15].

Bio-fertilizers, or Microbial inoculants, are a promising technology to reduce the use of conventional inorganic fertilizers [16-20]. Many of them can serve as Bio-fertilizers as they are able to fix nitrogen, help to access nutrients such as phosphorus and nitrogen from organic fertilizers and soil stocks, improve drought tolerance, improve plant health or increase salt tolerance [1] (Arora, 2013). Numerous reviews on microbial inoculants have been published, but quantitative results are scarce. Bio-fertilizers are not only environmentally friendly and cost-effective, but they also increase phosphorus uptake, promote plant growth and yield by providing nutrients in an available form, provide resistance to pests and diseases and strengthen soil structure (Sharma, 2002). Bio-fertilizers have been shown to be beneficial in 4 flower crops such as gladiolus, tuberose, rose, chrysanthemum and marigold (Maurya and Beniwal, 2003).

2. MATERIALS AND METHODS

The present investigation entitled "Influence of bio-fertilizers on vegetative growth, flower quality and bulb yield of gladiolus (*Gladiolus grandiflorus* L.)" was carried out during *Rabi* season 2020-2021 at Horticulture Research Center of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh.

2.1 Experimental Design and Treatments

Nova Lux cultivar of gladiolus was used for the experiment. The healthy corms of Nova Lux were procured from NBRI, Lucknow. Nova Lux has been developed by the IARI, New Delhi. The experiment was laid out in Randomized Block Design with three replications. Each replication consists of 14 treatment combinations. The field

was laid the experimental plan with the help of rope and measuring tape and treatments out as pervert randomized separately in each replication. Single corm was sown at spacing of 30 cm plant to plant and 20 cm from row to row with uniform depth 5-6 cm. Neck of the corms were kept pointing to the soil surface. After planting, corms were covered by the soil. Total number of 14 treatments was comprised during course of investigation including Inorganic fertilizers (Urea, SSP and MOP), micronutrients (Fe and Zn), organic manures (FYM and Vermicompost) and bio-fertilizers (Azotobacter, Azospirillum and PSB). The allotment of treatments details are as follows- T₁(Control), T₂(200 qt. FYM + 300KgN₂ +200 Kg P₂O₅+200 Kg K₂O/ha)(RDF), T₃(RDF + 30% FYM), T₄(RDF + 30% Vermicompost), T₅(70% RDF+30% FYM), T₆(70% RDF + 30% Vermicompost), T₇(75% RDF + Azospirillum), T₈(75% RDF+ 25% FYM + Azospirillum), T₉(75%RDF + 25% FYM + Azospirillum + PSB + Azotobacter), T₁₀(75% RDF + 25% Vermicompost + Azospirillum + PSB + Azotobacter), T₁₁(RDF + ZnSO₄ (0.3%) + PSB, T₁₂(RDF + FeSO₄(0.4%) + Azotobacter), T₁₃(RDF + ZnSO₄ (0.3%) + Azotobacter + PSB + Azospirillum), T₁₄(RDF + FeSO₄ (0.4%) + Azotobacter +PSB).The full calculated dose of farmyard manure as per treatment combination was broadcasted as basal dose and mixed in soil to the individual specified plots before two weeks for proper mineralization before sowing of corms. However, vermicompost and bio-fertilizers like PSB, Azotobacter and Azospirillum were mixed with soil at three leaf stages and six leaf stages. Inorganic fertilizers were applied as per the treatment combinations. At the time of planting recommended dose of single super phosphate and muriate of potash was applied as basal dose. The crop was top dressed in Nitrogen dose at three leaves stage and six leaves stage.

2.2 Parameters of Study

2.2.1 Days taken for initiation of first spike

Days required for the first spike emergence were computed from selected five randomly plants from date of planting of corms in each plot and average were worked out in days.

2.2.2 Days taken to opening of first florets

Days taken from the opening of florets on the spike were recorded from the date of visibility of

first spike in each plot and average was calculated.

2.2.3 Number of flowers per plant

Number of flowers per plant was measured by counting from five randomly selected plants and recorded plot wise. 27

2.2.4 Flower diameter(cm)

Diameter of flower of five randomly selected plants was recorded from each plot with the help of Vernier callipers and the average was worked out.

2.2.5 Rachis length (cm)

The length of rachis was calculated from the emerging points of spike to the first basal flower from five randomly selected plants in each plot and average length of rachis was computed in centimetre.

2.2.6 Spike length (cm)

The length of gladiolus spike was recorded from five randomly selected plants in each plot with the help of meter scale and average was worked out.

2.2.7 Spike diameter (cm)

Diameter of spike was recorded at full bloom stage from five randomly selected plants in each plot with the help of Vernier callipers. The mean diameters of spike were calculated and expressed in centimetres.

2.2.8 Longevity of spike (days)

Longevity of spike was presented by counting the number of days taken from the date of opening of first floret to the date fading of the last floret in each plot and the average was worked out.

3. RESULTS AND DISCUSSION

An organic fertilizer complemented with Inorganic fertilizers, bio-fertilizers and Vermi-compost with other sources of nutrients. Accordingly, to develop low-cost input management performs in crop production is urgently required as they have the proficiencies to improve the soil fertility and provide essential plant nutrient to the crop.

Table 1. Influence of bio-fertilizers, organic and inorganic fertilizers on flowering attributes of gladiolus (*Gladiolus grandiflorus* L.) cv. Nova Lux

Sr. No.	Notation	Treatment	Days to Initiation of First Spike	Days to Opening of First Floret	Number of Flowers Per Plant	Flower Diameter (cm)
1.	T1	Control	51.76	60.02	8.34	7.21
2.	T2	200 qt. FYM+300KgN ₂ +200KgP ₂ O ₅ +200KgK ₂ O/ha (RDF)	50.76	58.36	9.32	8.42
3.	T3	RDF+ 30%FYM	50.01	58.23	10.02	8.13
4.	T4	RDF+ 30%Vermicompost	48.34	56.76	10.68	9.33
5.	T5	70%RDF+30%FYM	48.03	56.76	11.10	9.23
6.	T6	70% RDF+ 30% Vermicompost	46.08	56.03	11.23	8.79
7.	T7	75% RDF+ Azospirillum	47.34	56.03	12.03	9.31
8.	T8	75%RDF+ 25%FYM + Azospirillum	43.65	52.55	10.33	8.56
9.	T9	75%RDF+25%FYM+Azospirillum+PSB+	43.63	51.36	13.33	10.52
10.	T10	Azotobacter 75%RDF+25%Vermicompost+Azospirillum+PSB+	40.87	49.04	13.76	10.26
11.	T11	Azotobacter RDF+ZnSO ₄ (0.3%) + PSB	42.32	50.23	11.87	9.52
12.	T12	RDF+FeSO ₄ (0.4%) + Azotobacter	44.07	51.76	11.44	8.98
13.	T13	RDF+ZnSO ₄ (0.3%) + Azotobacter +PSB+	42.25	50.35	12.67	9.65
14.	T14	Azospirillum RDF+FeSO ₄ (0.4%) +Azotobacter +PSB	43.56	51.02	12.34	9.18
		SEM (±)	0.63	1.07	0.19	0.11
		C.D. At 5%	1.84	3.13	0.56	0.33
		C.V. (%)	2.37	3.42	2.94	2.15

Table 2. Influence of bio-fertilizers, organic and inorganic fertilizers on quality attributes of gladiolus (*Gladiolus grandiflorus* L.) cv. Nova Lux

Sr. No.	Notation	Treatment	Rachis Length (cm)	Spike Length (cm)	Spike Diameter (cm)	Longevity of Spike (Days)
1.	T1	Control	31.28	98.57	0.62	17.10
2.	T2	200 qt. FYM+300KgN ₂ +200KgP ₂ O ₅ +200KgK ₂ O/ha (RDF)	34.85	103.43	0.73	18.23
3.	T3	RDF+ 30%FYM	35.21	108.62	0.81	18.01
4.	T4	RDF+ 30%Vermicompost	36.91	109.56	0.85	19.03
5.	T5	70%RDF+30%FYM	38.09	111.92	0.94	20.54
6.	T6	70% RDF+ 30% Vermicompost	37.56	114.32	0.88	19.34
7.	T7	75% RDF+ Azospirillum	37.32	114.23	0.87	20.68
8.	T8	75%RDF+ 25%FYM + Azospirillum	38.45	115.26	0.76	21.76
9.	T9	75%RDF+25%FYM+Azospirillum	39.07	116.35	1.05	22.76

Sr. No.	Notation	Treatment	Rachis Length (cm)	Spike Length (cm)	Spike Diameter (cm)	Longevity of Spike (Days)
10.	T10	irillum+PSB+ Azotobacter 75%RDF+25%Vermicompost+Azospirillum+PSB+	41.87	119.69	1.09	23.67
11.	T11	Azotobacter RDF+ZnSO4(0.3%) + PSB	37.32	112.79	0.86	19.01
12.	T12	RDF+FeSO4(0.4%) + Azotobacter	37.71	112.92	0.85	18.34
13.	T13	RDF+ZnSO4 (0.3%) + Azotobacter +PSB+	38.64	115.17	0.98	22.05
14.	T14	Azosprillum RDF+FeSO4 (0.4%) +Azotobacter +PSB	38.18	114.15	0.95	21.23
		SEM (±)	0.73	1.14	0.01	0.19
		C.D. At 5%	2.13	3.34	0.02	0.55
		C.V. (%)	3.38	1.77	1.44	1.62

3.1 Flowering Attributes

The combination of bio-fertilizers, organic manures, and inorganic fertilisers significantly improved the gladiolus plant's flower and corm production characteristics. The days taken for opening of first spike was affected by various combinations of chemical fertilizers, organic manure, micronutrients and bio-fertilizers in an improved manner as compared to control.

Days taken for initiation of first spike: The minimum number of days taken for opening of first spike (40.87 days) was recorded in treatment T10 (75% RDF+ 25% Vermi-compost + Azospirillum + PSB + Azotobacter). Moreover, the delayed opening of spike (51.76 days) was observed in treatment T₁ (control) during the year of Seri mentation.

Days taken to opening of first florets: The effect of various treatments, minimum number of days taken to opening floret was recorded with T10 (75% RDF + 25% Vermi-compost + Azospirillum + PSB +Azotobacter) i.e., 49.04 days during the year. However, the control plants had maximum number of days taken to opening of florets (60.02 days).

Number of flowers per plant: The maximum number of flowers per plant (13.76) was recorded with T10 (75% RDF + 25% Vermicompost + Azospirillum + PSB + Azotobacter) which was significantly superior to T13 (RDF + ZnSO₄ + Azotobacter + PSB + Azospirillum) viz. (12.67) during the experimentation. In case of control, it has given the minimum number of flowers per plant (8.34).

Flower diameter(cm): The effect of treatments, diameter of flower ranges from 7.21 cm to 10.52cm during the experiment. The maximum diameter of flower (10.52 cm) was recorded in treatment T9 (75% RDF + 25% FYM + Azospirillum + PSB + Azotobacter) followed by treatment T10 (75%RDF + 25% Vermicompost + Azospirillum + PSB + Azotobacter) viz. (10.26 39 cm). However, in case of control it has given minimum diameter of flower (7.21 cm).

3.2 Quality Attributes

The integration of bio-fertilizers, organic manures with inorganic fertilizers showed significant response towards quality attributes of gladiolus.

Rachis length (cm): In terms of rachis length and it has range between 31.28 to 41.87 cm during of investigation. The maximum rachis length (41.87cm) was verified in T10 (75% RDF + 25% Vermi-compost + Azospirillum + PSB + Azotobacter). However, minimum rachis length i.e. (31.28 cm) was noted under treatment T1 (control).

Spike length (cm): The spike lengths range from 98.57 to 119.69 cm. The maximum spike length (119.69 cm) was recorded with treatment T10 (75% RDF+ 25% Vermi-compost + Azospirillum + PSB + Azotobacter) followed by treatment T13 (RDF+ ZnSO₄ + Azotobacter + PSB + Azospirillum) viz. (115.17 cm). However, the minimum spike length (98.57 cm) was noticed in treatment T1 (control).

Spike diameter (cm) The ranges of spike diameter i.e., 0.62 to 1.09 cm were observed.

The maximum diameter of spike (1.09 cm) was determined under treatment T10 (75% RDF + 25% Vermi-compost + Azospirillum + PSB + Azotobacter) while the minimum diameter of spike (0.62 cm) was reported in treatment T₁ (control).

Longevity of spike (days): the longevity of spike was significantly increased due to the application of chemical fertilizers, organic manure and bio-fertilizers. In the present study, the maximum longevity days of spike was recorded under treatment T10 (75 % RDF + 25% Vermi-compost + Azospirillum + PSB + Azotobacter), while the minimum days for longevity of spike was showed under treatment T₁ (control). The improvement concerning longevity might be due the additions of organic manures lead to increased flower longevity which may be due to increase in nutrient uptake by the plants and due to better development of water conducting tissues [21-27].

4. CONCLUSION

Based upon the results recorded in the investigation it could be concluded that the treatment T10 (75% RDF + 25% Vermicompost + Azospirillum + PSB + Azotobacter), was found best treatment with reference to Flowering and Quality attributes in gladiolus cv. Nova lux as compared to control and other treatments. The availability of nutrient and B:C ratio were also giving the noteworthy results with an application of (T10) (75% RDF+ 25% Vermicompost + Azospirillum + PSB + Azotobacter), followed by treatment T13 (RDF + ZnSO₄ (0.3%) + Azotobacter + PSB + Azospirillum) with assessment under control and other treatments. Therefore, it is recommended that an application of chemical fertilizers, organic manure.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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