Advances in Research

12(3): 1-11, 2017; Article no.AIR.37034
ISSN: 2348-0394, NLM ID: 101666096

Vermicompost and Trichocompost in Combination with Inorganic Fertilizers Increased Growth, Flowering and Yield of Gladiolus Cultivar (GL-031) (*Gladiolus grandiflorus* L.)

N. Akter[1*], K. A. Ara[2], M. H. Akand[3] and M. K. Alam[4,5]

[1]Genetic Resources and Seed Division, Bangladesh Rice Research Institute, Gazipur-1701, Bangladesh.
[2]Floriculture Division, Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur -1701, Bangladesh.
[3]Department of Horticulture, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh.
[4]Land Management Group, School of Vet. and Life Sciences, Murdoch University, Perth, WA-6150, Australia.
[5]Soil Science Division, Bangladesh Agricultural Research Institute, Gazipur- 1701, Bangladesh.

Authors' contributions

This work was carried out in collaboration between all authors. Author NA designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors KAA and MHA managed the analyses of the study. Author MKA managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AIR/2017/37034
Editor(s):
(1) Md. Rezaul Karim, Department of Agricultural Extension, Hajee Mohammad Danesh Science and Technology University, Bangladesh.
(2) Magdalena Valsikova, Horticulture and Landscape Engineering, Slovak University of Agriculrure, Nitra, Slovakia.
Reviewers:
(1) Prakash M. Munnoli, S D M College of Engineering and Technology, India.
(2) Zainal Muktamar, University of Bengkulu, Indonesia.
Complete Peer review History: http://www.sciencedomain.org/review-history/21767

Original Research Article

Received 27th September 2017
Accepted 30th October 2017
Published 6th November 2017

ABSTRACT

The yield and quality of flower is greatly influenced by the quantity and type of fertilizers used. Because of the hazards of long-term chemical fertilizer, more and more farmers all over the world are shifting to organic fertilizers for ensuring sustainable flower production. Keeping these points in view, present investigations were carried out to evaluate the combined impact of organic manure,

**Corresponding author: E-mail: nadia.akter21@yahoo.com;*
E-mail: khairul.krishi@gmail.com;

inorganic fertilizer and bio-control agent on yield and quality of gladiolus at the Floriculture Research Field, Bangladesh Agricultural Research Institute, Gazipur from October, 2014 to May 2015. The single factor experiment consisted of eight treatments namely: T_1: Control (Recommended dose of fertilizer) (N_{200} P_{50} K_{150} S_{30} B_2Zn_3kg/ha), T_2:Tricholeachate (5000 l/ha) + ¼ RDF, T_3:Bokashi (3 t/ha) + ¼ RDF, T_4: Mustard oil cake (500 kg/ha) + ¼ RDF, T_5:Trichocompost (3 t/ha) + ¼ RDF, T_6: Farmyard manure (5 t/ha) + Trichocompost (3 t/ha) + ¼ RDF, T_7: Poultry manure (5 t/ha) + Trichocompost (3 t/ha) + ¼ RDF and T_8:Vermicompost (5 t/ha) + Trichocompost (3t/ha)+ ¼ RDF. The experiment was conducted in Randomized Complete Block Design with three replications. Application of organic manure, chemical fertilizer and bio-control agent showed significant variations on most of the parameters. Result revealed that early sprouting of corm (8 days) was recorded from treatment T_6. The treatment T_7 has taken the minimum period (68 days) for 80% spike initiation. The maximum length of spike (80.0 cm) and rachis (34.0 cm), number of florets/spike (16), number of spikes/ha (200000) was registered with the treatment T_8. However, the highest number (2.5/hill) and weight of corm (60.0 g) and cormel per plant (20.0) was recorded with treatment T_8. So, application of Vermicompost (5 t/ha) and Trichocompost (3t/ha) with ¼ RDF showed best result on yield and quality of gladiolus.

Keywords: Organic manure; inorganic fertilizer; vermicompost; trichocompost; bio-control agent; gladiolus.

1. INTRODUCTION

Gladiolus is a popular flowering plant grown all over the world. The name gladiolus was derived from the Latin word gladiolus, because of its sword-like leaves. It is popularly known as sword lily. It was introduced into cultivation at the end of the 16th century [1]. The modern hybrids are botanically known as *Gladiolus grandiflorus* belonging to family Iridaceae. It is mainly cultivated for cut-flowers because of its elegant appearance with long flower spikes having rich variations of colours and prolonged vase life.

In recent years, there have been serious concerns about long-term adverse effect of continuous and indiscriminate use of inorganic fertilizers on deterioration of soil structure, soil health and environmental pollution [2]. In contrast, to inorganic fertilizer, the use of bio-control agent, green manures, and other organic matter can improve soil structure, maintain soil health, increase nutrient uptake, suppress soil borne fungal pathogens and that is why interests have been raising in organic farming and uses of *Trichoderma* spp. in flowers for bio-control [3,4] and improve flower quality.

Trichoderma harzianum is a saprophytic fungus which is generally used as a biological control agent against a wide range of economically important aerial and soil borne plant pathogens [5] and has been extensively studied as potential bio-control agents [6]. Earlier researcher [3] investigated the effect of *Trichoderma* spp. on growth of gladiolus and its ability to control Fusarium rot disease caused by *Fusarium oxysporum*. They observed that *Trichoderma* suppressed soil borne fungal pathogens as well as enhanced quantitative and qualitative traits of gladiolus. They also found that tuberose bulbs planting in Tricho-compost treated plot reduced emergence time compared to controls. From their results and those of other scientists [7], it was concluded that some *Trichoderma* strains have the potential to consistently increase plant growth, spike length, rachis length, floret number as well as flower yield by suppressing soil borne fungal pathogens, root knot nematode and bacterial wilt. Moreover, Trichocompost is highly rich in various elements that may enrich soil fertility and provide nutrition to the crops.

There are many factors which affect plant growth and economic cultivation of gladiolus. Gladiolus is a gross feeder and requires a large quantity of NPK, both in the form of organic and inorganic fertilizers [8]. Fertilizers have great influence on growth, building and flower production in gladiolus [9]. Nitrogen, phosphorus and potassium have a significant effect on spike production and floret quality. Duration of flower in the field was improved through using organic fertilizer [10].

Investigations pertaining to better growth, yield and extend the vase life of gladiolus cut flowers by using organic manures, inorganic fertilizers and bio-control agent in different formulations and combinations have been made with varying success by several authors for different geographical region [11,12,13,14,15]. But in Bangladesh, a very few studies has been done for gladiolus cultivation and to enhance the vase

life of cut flowers. Considering the facts, such research is very important for the greater interest of the scientist as well as the growers of our country. The present study was therefore undertaken with the objective to find out the standard combination of organic manure, inorganic fertilizers and bio-control agent for better growth, flowering and yield of gladiolus.

2. MATERIALS AND METHODS

The present study was conducted at the Floriculture Research Field, Horticulture Research Centre of Bangladesh Agricultural Research Institute (BARI), Gazipur, during November 2014 to May 2015.The soil of the experimental field was silty clay loam in texture and acidic in nature. Medium size (4.0-5.0 cm diameter) corm of gladiolus cultivar (GL-031) was selected as experimental materials. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The 8 treatments were randomly allotted in each block. The unit plot size was 2.0 m $\times$ 1.5 m accommodating 70 plants per plot. Spacing was maintained at 20 cm from row to row and 20 cm from plant to plant. Well-decomposed cowdung, poultry manure, vermicompost, bokashi, trichocompost, tricho-leachate, P, K, B, S and Zn were applied during final land preparation as per treatment. N was applied in two installments at 30 and 60 days after planting of corms. Recommended fertilizer doses used as N-200 kg, P-50 kg, K-150 kg**, S-**20 kg, B-2 kg, Zn-3 kg [16]. The treatments were,T_1: Control, RDF (Recommended dose of fertilizer) (N_{200} P_{50} K_{150} S_{20} B_2 Zn_3 kg/ha), T_2: Tricholeachate (5000 l/ha) + ¼ RDF,T_3: Bokashi (3 t/ha) + ¼ RDF, T_4: Mustard oil cake (500 kg/ha) + ¼ RDF, T_5: Trichocompost (3 t/ha) + ¼ RDF, T_6: Farmyard manure (5 t/ha) + Trichocompost (3 t/ha) + ¼ RDF, T_7: Poultry manure (5 t/ha) + Trichocompost (3 t/ha) + ¼ RDF, T_8: Vermicompost (5 t/ha) + Trichocompost (3 t/ha) + ¼ RDF. The treatment composition and nutrient contents of the materials used are also given in Tables 1 and 2.

2.1 Chemical Analysis

The N, P, K and S contents of plant digest was determined following micro-Kjeldahimethod [17], colorimetrically using molybdate blue ascorbic acid method by spectrophotometry [18], directly by Atomic Absorption Spectrophotometer at 766.5 ηm wavelength (Model No. VARIAN SpectrAA 55B, Australia), by developing turbidity followed by spectrophotometer at 420 ηm wavelength [19].

2.2 Data Collection

Observations were recorded from randomly chosen 10 plants from each plot on following parameters: 1. Days required to 80% emergence of the crop, 2. Plant height, 3. Leaves/plant, 4. Plant/hill, 5. Days required to 80% spike initiation, 6. Florets number/spike, 7. Spike length, 8. Rachis length, 9. Spike weight, 10. Flower durability, 11. Flower yield/ha, 12. Corm number, 13. Corm weight, 14. Corm diameter, 15. Cormel number and 16.Cormel weight.

Table 1. Treatment composition

Treatments	Organic amendments	Composition
T_1	–	N_{200} P_{50} K_{150} S_{20} B_2 Zn_3 kg/ha
T_2	Tricholeachate	Liquid by-product of the Trichocompost which was obtained during decomposition of Trichocompost materials.
T_3	Bokashi	fish meal + oil cake + bone meal + rice bran + poultry refuse + water + fermented cowdung
T_4	Mustard oil cake	by-product of mustard oil seed crop
T_5	Trichocompost	spore suspension of a *Trichoderma harzianum* + processed raw material (cowdung + poultry refuse + water hyacinth + vegetable waste + saw dust + maize bran + molasses)
T_6	Farmyard manure & Trichocompost	cow dung + cow urine + waste straw + other dairy waste & Trichocompost
T_7	Poultry manure & Trichocompost	chicken dropping + bedding material(sawdust and wood shavings) & Trichocompost
T_8	Vermicompost & Trichocompost	Decomposed cowdung +*Eisenia fetida* earthworms and their droppings & Trichocompost

Table 2. Nutrient contents of organic amendments used in the experiment

Organic amendments	N(%)	P(%)	K(%)	S(%)
Tricholeachete	**Liquid by-product of the Trichocompost which was obtained during decomposition of Trichocompost materials.**			
Bokashi	1.12	0.24	1.1	-
Mustard Oil Cake	5.2	0.79	1	-
Trichocompost	2.42	1.26	1.42	0.41
Farmyard manure	0.5	0.1	0.42	1.1
Poultry manure	3.03	1.15	1.17	1.1
Vermicompost	1.1	0.11	0.42	0.2

The recorded data on different parameters were statistically analyzed using 'MSTAT-C' software. The mean for the treatments was calculated and analysis of variance for each of the characters was performed by F (variance ratio) test. The differences between the treatment means were evaluated by Duncan's Multiple Range Test (DMRT) according to [20] at 5% level of probability.

3. RESULTS AND DISCUSSION

Among different treatments, T_8 (Vermicompost 5 t/ha + Tricho-compost 3 t/ha + ¼ RDF) showed 96.7% emergence of plants followed by T_6 and T_7 (93.3% plant emergence) ($p<0.05$; Fig. 1). The lowest emergence percentage was noted in T_1 and T_2 (86.7%). Pandey et al. (2013) reported that corm planting in Trichocompost + Vermicompost treated plot showed 98.0 % plant emergence in gladiolus crops which support more or less the present findings. Moreover, plant height of gladiolus showed statistically significant differences due to different levels of organic manures, bio-control agent along with quarter recommended dose of fertilizers at 25, 45, 65 and 85 DAP (Fig. 2). The tallest plant (26.0, 38.0, 46.0 and 55.0 cm) was recorded from T_8 at 25, 45, 65 and 85 DAP, respectively, followed by T_7 (25.0, 36.0, 45.0 and 50.0 cm) at same DAP, again, at the same DAP, the shortest plant (18.0, 24.0, 32.0 and 38.0 cm) was recorded from T_1 (recommended dose of chemical fertilizer), respectively. Gladiolus is a gross feeder and requires a large quantity of NPK in the form of organic and inorganic fertilizers [16]. Plant height may be attributed to the presence and synthesis of gibberellins in vermicompost. Gibberellins cause both cell elongation and division that stimulates elongation and resulted in increased plant height. These finding are in conformity with the findings of previous workers [21,22] in gladiolus.

The variation among the treatments in respect of days to sprouting of corm, leaves per plant and plants per hill was found statistically significant (Table 3). The corms under T_6 treatment (Farmyard manure 5 t/ha + Tricho-compost 3 t/ha + ¼ RDF) took minimum time (8 days) to sprouting, followed by T_7 and T_8 (9 days) treatment (Poultry manure 5 t/ha + Trichocompost 3 t/ha + ¼ RDF) and (Vermicompost 5 t/ha + Tricho-compost 3 t/ha + ¼ RDF). Corms under T_1 treatment (control) required maximum time (12 days).The maximum number of leaves were found in T_8 (Vermicompost 5 t/ha + Tricho-compost 3 t/ha + ¼ RDF) treatment (10.5) and also the maximum (2.5) number of plants/hill was recorded at the same treatment. The least value in these parameters was observed in T_1 (control). Increase in vegetative growth may be due to better flow of various macro and micro nutrients along with plant growth substances into the plant system in the plots applied with vermicompost and trichocompost in combination with quarter recommended dose of fertilizer. The observed results are in agreement with the findings of earlier research workers [23,24] in flower crops.

Days required to 80% spike initiation showed variation for different treatment (Fig. 3). The minimum days required for corm planting to 80% spike initiation was recorded in T_7 (68 days) followed by T_8 (70 days). The minimum time as recorded in T_7 (68 days) was similar to those recorded by previous research workers [23,25,26]. Poultry manure, vermicompost and trichocompost might have role in supply of macro and micronutrients, enzymes and growth hormones and provides micronutrients such as Zn, Fe, Cu, Mn etc. in an optimum level which help in proper flower development. Further, increase in absorptive surface area of the roots due to use of organic manure, bio-control agent and fertilizer might have led to enhanced uptake and translocation of available water and nutrients like P, Zn, Fe, Mg and Cl, ultimately resulting in better sink for faster mobilization of

photosynthesis and early transformation of plant parts from vegetative to reproductive phase. Time required to 80% spike initiation (80 days) was found to be delayed in control treatment. Similar results were reported by prior workers [27] in tuberose and [28] in gladiolus. Variation was recorded for number on floret/spike for different treatments under the investigation (Fig. 4). The maximum number of florets was found in T_8 (16). The lowest numbers of floret/plant (11) were found in control treatment (T_1). Increase in number of flowers per plant might be due to presence of growth promotive substances like essential plant nutrients, vitamins, enzymes and antibiotics in vermicompost and trichocompost coupled with ¼ RDF. These findings are in conformity with the findings of earlier workers [29,30] in gladiolus.

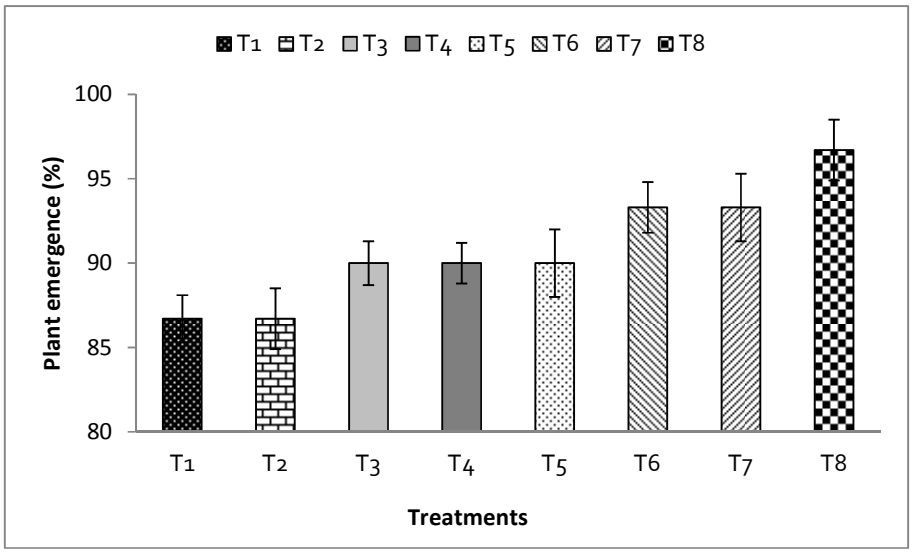

Fig. 1. Effect of different treatments on plant emergence of gladiolus (%)

Here,T_1: Control (Recommended dose of fertilizer), T_2:Tricholeachate (5000 l/ha) + ¼ RDF, T_3:Bokashi (3 t/ha) + ¼ RDF, T_4: Mustard oil cake (500 kg/ha) + ¼ RDF, T_5:Trichocompost (3 t/ha) + ¼ RDF, T_6: Farmyard manure (5 t/ha) + Trichocompost (3 t/ha) + ¼ RDF, T_7: Poultry manure (5 t/ha) + Trichocompost (3 t/ha) + ¼ RDF and T_8:Vermicompost (5 t/ha) + Trichocompost (3t/ha)+ ¼ RDF. The vertical bars represent standard error of means

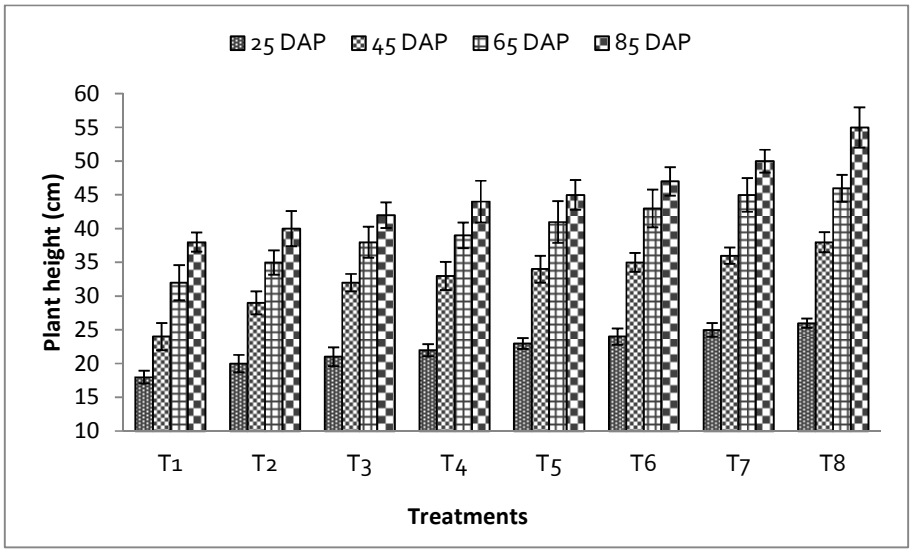

Fig. 2. Effect of different treatments on plant height of gladiolus

Here, the treatments already stated in Fig. 1. and in materials and methods section. The vertical bars represent standard error of means

Table 3. Effect of organic manure, fertilizer and bio-control agent on vegetative growth of gladiolus

Treatments	Days to sprouting	Leaves/plant	Plants/hill
T_1	12.0 a	8.0 b	1.0 b
T_2	11.0 ab	9.2 ab	1.3 ab
T_3	10.0 ab	9.3 ab	1.4 ab
T_4	10.0 ab	9.3 ab	1.5 ab
T_5	10.0 ab	9.3 ab	1.6 ab
`T_6	8.0 b	10.3 a	1.8 ab
T_7	9.0 ab	10.4 a	1.8 ab
T_8	9.0 ab	10.5 a	2.5 a
LSD (0.05)	**2.1**	**2.4**	**2.0**
CV%	**9.2**	**10.4**	**9.8**

Here, the treatments already stated in Fig. 1. and in materials and methods section. Column with the different letter(s) is significantly different @ 5% level of significance

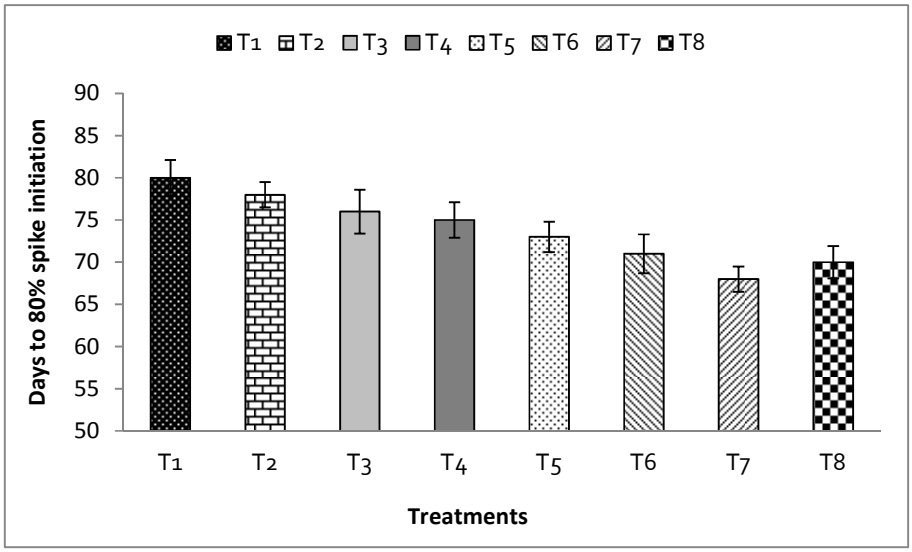

Fig. 3. Effect of different treatments on 80% spike initiation of gladiolus

Here, the treatments already stated in Fig. 1. and in materials and methods section. The vertical bars represent standard error of means

The longest (78.0 cm) length of flower spike was recorded in T_8 and the shortest spike length was found in control, T_1 (68.5 cm) treatment (Table 4).These results are similar to the work of previous researchers [31] who found that spike length was increased with the application of vermicompost and trichocompost along with ¼ RDF fertilizers. The rachis length ranged from 43.5 to 43.5 cm. Maximum length of rachis was obtained in T_8 (43.5 cm) and while the minimum length was found in T_1 (34.0 cm), which differed significantly from all other treatments. The same treatment (T_8) contributed to maximum weight of spike (65.0 g), which was closely followed by T_7 (63.0 g) treatment and the minimum value found in treatment T_1 (55.0 g).The improvement in quality of spikes was mainly due to castings of earthworms which consists of plant growth hormones, various enzymes along with macro and micronutrients [32].

Maximum duration of flowering was observed in T_8 (Vermicompost 5 t/ha + trichocompost 3 t/ha + ¼ RDF) (17 days) followed by T_7 (16 days) (Poultry manure 5 t/ha + trichocompost 3 t/ha + ¼ RDF) (Fig. 5). Application of vermicompost and trichocompost with ¼ RDF as well as poultry manure and trichocompost with ¼ RDF influenced flower longevity due to increased nutrient uptake by plant and greater development of water conducting tissues. Again, the maximum number of flowering spike 200000/ha was produced inT_8 (Vermicompost 5 t/ha + trichocompost 3 t/ha+ ¼ RDF) which was

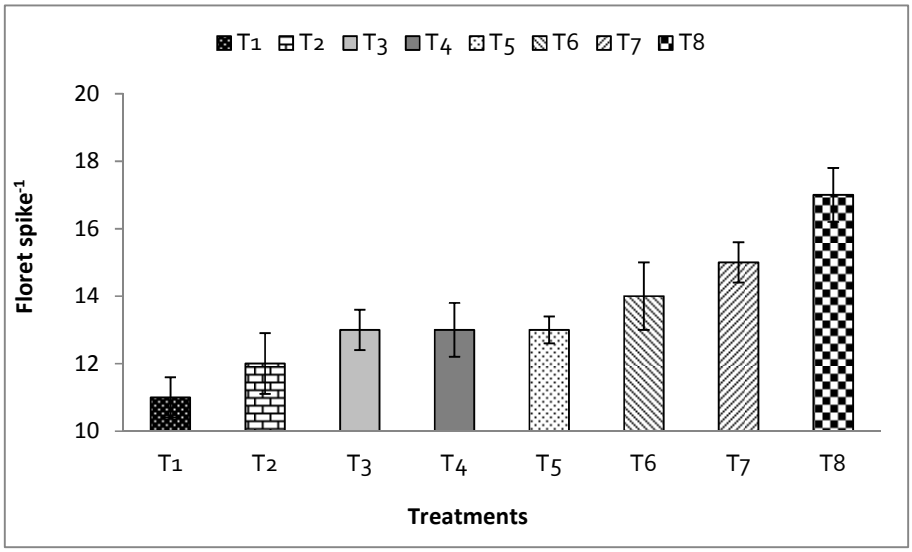

Fig. 4. Effect of different treatments on floret number of gladiolus

Here, the treatments already stated in Fig. 1. and in materials and methods section. The vertical bars represent standard error of means

Table 4. Effect of organic manure, fertilizer and bio-control agent on flowering of gladiolus

Treatments	Spike length (cm)	Rachis length (cm)	Spike weight (g)
T_1	68.5 c	34.0 c	55.0 c
T_2	70.0bc	35.0bc	56.8 bc
T_3	71.8 bc	37.6 b	57.0 bc
T_4	71.6 bc	38.0 b	58.0 bc
T_5	73.0 b	39.8 ab	60.0 b
T_6	74.8 ab	41.0ab	62.8ab
T_7	75.2ab	41.3ab	63.0 ab
T_8	78.0 a	43.5 a	65.0 a
LSD (0.05)	**1.2**	**1.1**	**1.4**
CV%	**13.1**	**12.0**	**11.4**

Here, the treatments already stated in Fig. 1. and in materials and methods section. Column with the different letter(s) is significantly different @ 5% level of significance

superior to other treatments (Fig. 6). Minimum values in both cases were found in T_1 treatment (control). The phenomenon of more number of spikes might be due to slow and unremitting discharge of nitrogenous element from bulky organic manure and bio-control agent with ¼ RDF which influenced to increase chlorophyll content importing dark green colour foliage resulted more food reserve that promoted number of spike per hill (Table 2). The reason might also be the timing of release of nutrients by the two types of organic manures is different, so plants don't suffer from starvation for any duration. Moreover, the combined application of inorganic fertilizers and organic manure was more effective in enhancing the yield contributing characters which resulted in higher flower yield, possibly due to the increased availability of primary and secondary nutrients in soil during the entire crop growth period and their subsequent uptake by the plants. In addition, the integrated nutrient supply involving organic and inorganic components resulted in greater stimulation of the rates of various physiological and metabolic processes leading to better plant growth and floral characteristics and ultimately flower yield [33]. Similar trend has also been reported by earlier workers [34] in tuberose flower and [35] in gladiolus flower.

The data presented in Table 5 clearly indicated that, corm and cormel number per hill, corm diameter, corm weight and 10 cormel weight were greatly influenced by different combinations

of organic and inorganic fertilizers.Treatment T_8 (Vermicompost 5 t/ha + trichocompost 3 t/ha+ ¼ RDF) were recorded with maximum number of corm/hill (2.0), cormel/hill (20.0), largest corm (5.8 cm), maximum weight (60.0 g) of individual corm and highest value (42.0 g) of 10 cormel weight than all the other treatment combination tried. In all cases, control treatment (T_1) showed the least values regarding corm and cormel attributes. Beneficial effect of nutrient sources like vermicompost, trichocompost have great influence of corm production in gladiolus [36]. In an experiment, treatment with vermicompost, trichocompost with fertilizer as well as poultry manure, trichocompost with fertilizer both proved very effective for the development of corms stated by [32,24] in gladiolus.These findings are almost similar with the findings of previous workers [37,38] in gladiolus.

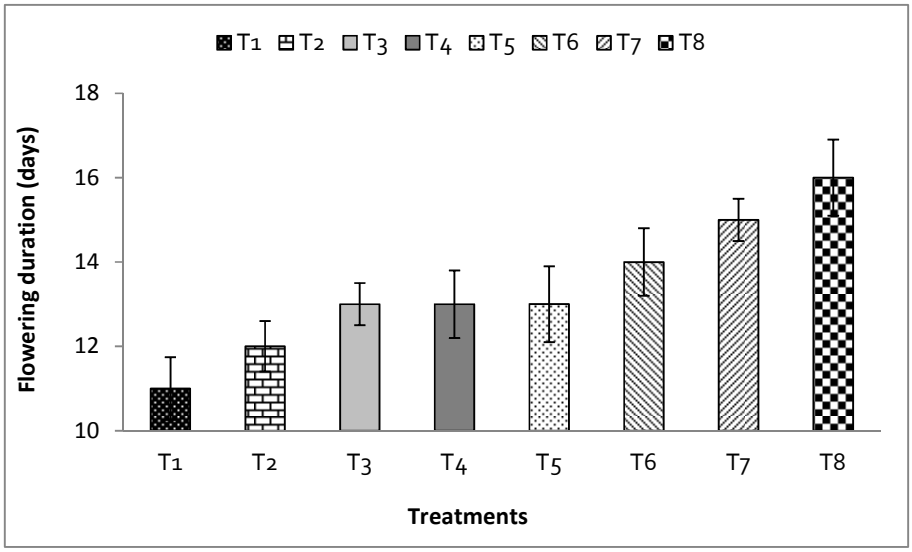

Fig.5. Effect of different treatments on flowering duration of gladiolus

Here, the treatments already stated in Fig. 1. andin materials and methods section. The vertical bars represent standard error of means

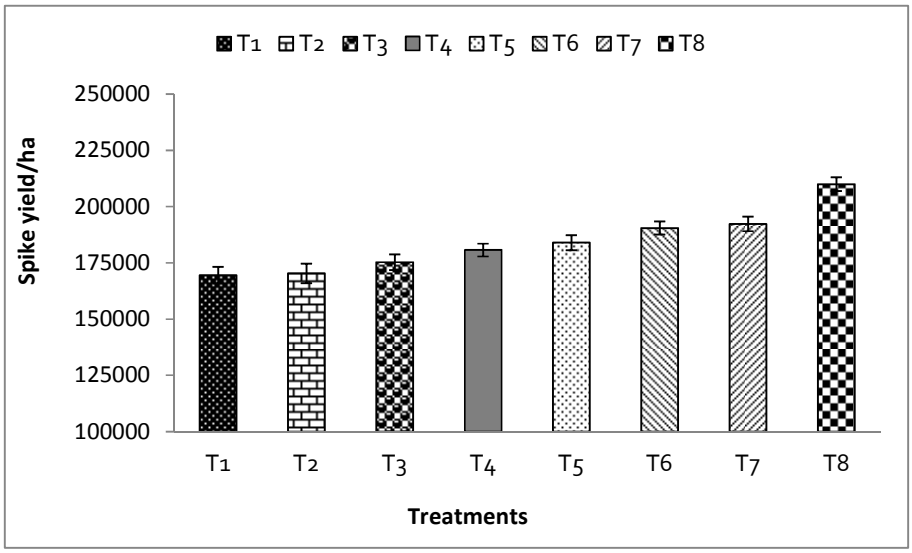

Fig.6. Effect of different treatments on spike yield of gladiolus per hectare

Here, the treatments already stated in Fig. 1. and in materials and methods section. The vertical bars represent standard error of means

Table 5. Effect of organic manure, inorganic fertilizer and bio-control agent on corm and cormel production of gladiolus

Treatments	Corm number/hill	Cormel number/hill	Corm diameter (cm)	Corm weight (g)	10 cormel weight (g)
T_1	1.0 b	10.0 c	4.5 b	50.0 c	30.0 c
T_2	1.1 b	11.0 c	5.0 ab	51.8 bc	32.0 bc
T_3	1.5 ab	13.0 bc	5.2 ab	53.4 bc	35.0 bc
T_4	1.5 ab	13.0 bc	5.2 ab	53.8 bc	36.0 b
T_5	1.6 ab	13.0 bc	5.3 ab	55.0 b	38.5 ab
T_6	1.8 ab	15.0 b	5.4 ab	57.0 ab	39.0 ab
T_7	1.9 ab	17.0 ab	5.4 ab	58.0 ab	40.5 ab
T_8	2.5 a	20.0 a	5.8 a	60.0 a	42.0 a
LSD (0.05)	**2.1**	**2.0**	**1.9**	**2.2**	**2.4**
CV%	**9.8**	**9.5**	**8.6**	**10.4**	**11.2**

Here, the treatments already stated in Fig. 1. and in materials and methods section. Column with the different letter(s) is significantly different @ 5% level of significance

4. CONCLUSION

It was observed from the results that, application of Vermicompost 5 t/ha + Trichocompost 3 t/ha along with $^1/_4^{th}$ RDF showed significant result in vegetative growth, flowering, corm and cormel attributes in gladiolus. Hence, application of organic amendments in this combination is considered as the best to get highest yield of gladiolus flower.

ACKNOWLEDGEMENTS

The authors would like to thank the Ministry of Science and Technology, Government of the People's Republic of Bangladesh for financial support for this research.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Parthasarathy VA, Nagaraju V. Gladiolus. *In:* Floriculture and landscaping. (Eds.) Bose, T. K., R. G. Maiti, R. S. Shua and P. Das. Naya Prokash. 1999;467-486.
2. Sharma JR, Gupta RB, Panwar RD. Growth flowering and corm production gladiolus cv. Friendship as influenced by foliar application of nutrients and growth regulators. J. Ornament. Hort. 2004;7(3): 154–158.
3. Mazhabi M. Effect of *Trichoderma harzianum* Bi on vegetative and qualitative traits of some ornamental plants, MSC Thesis, Ferdowsi Univ. Mashhad, Mashhad, Iran. 2010;99.
4. Mitra M. Response of tuberose to integrated nutrient management. Int. Conf. biodiversity, livelihood and climate change in the Himalaya. Bot. Dept. Tribhuvan Univ. India Held on 12-14 December; 2010.
5. Papavizas GC. *Trichoderma* and *Gliocladium*: biology, ecology and the potential for biocontrol. Annu. Rev. Phytopathol. 1985;23:23–54.
6. Lynch JM. Fungi as antagonists. In: New directions in biological control: Alternatives for Suppressing Agricultural Pests and Diseases ed. Baker, R.R. and Dunn, P. E. New York. 1990;243–253.
7. Mishra PK, Mukhopaddhay AN, Singh US. Suppression of *Fusarium oxysporum f. sp. gladioli* populations in soil by application of *Trichoderma virens* and *in vitro* approaches for understanding biological control mechanisms. Indian Phytopath. 2004;57(1):44-47.
8. Bose TK, Yadav LP, Pal P, Das P, Parthasarathy VA. Tuberose. Commercial Flowers. Nayaprakash, Calcutta, India. 2003;603-644.
9. Mishra MM, Kapoor KK. Importance of chemical fertilizers in sustainable agriculture in India. Fertilizer News. 1992; 37:47-53.
10. Misra RL, Singh B. Gladiolus cultivation. *In:* Commercial Flowers (Eds.) Naya Prokash, Calcutta, India. 1999;20-25.
11. Anjana S, Singh AK. Effect of farmyard manure, vermicompost and *Trichoderma*on flowering and corm attributes in gladiolus. Bangladesh J. Bot. 2015;44(2):309-314.

12. Dongardive SB, Golliwar VJ, Bhongle SA. Effect of organic manure and biofertilizers on growth and flowering in Gladiolus cv. white prosperity. Plant Archives. 2007;2: 657-658.
13. Kusuma G. Effect of organic and inorganic fertilizers on growth, yield and quality of tuberose. An MS Thesis. Univ. Agric. Sci. Bangalore, India. 2000;60.
14. Pandey A, Singh AK, Sisodia A. Effect of vermicompost and bio-control agents on growth and flowering of gladiolus cv. Gold. Asian J. Hort. 2013;8(1):46-49.
15. Shankar D, Dubey P. Effect of NPK, FYM AND NPK+FYM on growth, flowering and corm yield of gladiolus when propagated through cormels. J. Soils Crops. 2005; 15(1):34-38.
16. Halder NK, Siddiky MA, Ahmed RR, Sharifuzzaman SM, Ara KA. Performance of tuberose as Influenced by boron and zinc. South Asian J. Agric. 2007;2(1&2):51-56.
17. Bremner JM, Mulvaney CS. Total nitrogen, In: Methods of Soil Analysis, Part 2, 2nd Edition, Page AL, Miller RH, Keeney DR, American Society of Agronomy Madison, USA. 1982;599-622.
18. Olsen SR, Sommers LE. Phosphorus, In: Methods of soil analysis, Part 2. 2nd Edition, Page AL, Miller RH, Keeney DR, American Society of Agronomy Madison, USA. 1982;403-427.
19. Chapman CA, Pratt PF. Methods of analysis for soil, plant and water, Division of Agricultural Science, University of California, USA; 1964.
20. Steel RGD, Torrie JH, Dickey DA. Principles and procedures of statistics. a biometric approach. 3rd ed. McGraw Hill Book Co. Inc., New York. 1997;107-109.
21. Shankar L, Lakhawat SS, Choudhary MK. Effect of organic manures and bio-fertilizers on growth, flowering and bulb production in tuberose. Indian J. Hort. 2010;64:554-556.
22. Prakash S, Kushwahsa IK, Singh M, Shahi BP. Effect of vermicompost and bio-control agents on growth and flowering of gladiolus cv. Pusa Kiran. Ann. Hort. 2015;8(1):110-112.
23. Naznin N, Hossain M, Kabita A, Azizul H, Mazadul I, Tuhina H. Influence of organic amendments and bio-control agent on yield and quality of tuberose. J. Hort. 2015;2(4):1-8.
24. Reshma M, Sushma K, Aruna J. Effect of integrated supply of different fertilizers andorganic manure on yield of tuberose. J. Biol. Agric. 2013;3(14):100-101.
25. Nambisan KMP, Krishnamm BM. Better cultural practice for high yield of tuberose. South Indian Hort. 1983;28(3):17-20.
26. Gupta P, Neeraj R, Dheeraj R. Effect of different levels of vermicompost, NPK and FYM on performance of gladiolus (*Gladiolus grandiflorus* L.) cv. Happy End. Asian J. Hort. 2008;3:142-143.
27. Tripathi SK, Malik S, Kumar A, Kumar V. Effect of integrated nutrient management on bulb yield of tuberose (*Polianthes tuberosa* L.). cv. Suvasini. Asian J. Hort. 2013;3(1):150-154.
28. Narendra C, Swaroop K, Janakiram T, Biswas DR, Singh G. Effect of integrated nutrient management on vegetative growth and flowering characters of gladiolus. Indian J. Hort. 2013;70(1):156-159.
29. Pathak G, Kumar P. Influence of organics on floral attributes and shelf life of gladiolus (*Gladiolus hybrida)* cv. white prosperity. Prog. Hort. 2009;41(1):116-119.
30. Preetham SP, Kumar P, Sha H. Effect of organic manures and bio-fertilizers on growth, yield and flower quality of gladiolus (*Gladiolus hybrida*) cv. white prosperity. Annals Hort. 2010;3(2):195-198.
31. Tripathi SK, Malik S, Singh P, Dhyani BP, Kumar V, Dhaka SS, Singh JP. Effect of integrated nutrient management on cut flower production of tuberose (*Polianthes tuberosa* L.) cv. Suvasini. Ann. Hort. 2012;6(1):149-152.
32. Padaganur VG, Mokashi N, Patil VS. Flowering, flower quality and yield of tuberose (*Polianthes tuberosa* L.) as influenced by vermicompost, farmyard manure and fertilizers. Karnataka J. Agric. Sci. 2005;18(3):729-734.
33. Singh R, Kumar M, Raj S, Kumar S. Effect of integrated nutrient management (INM) on growth and flowering in gladiolus (*Gladiolus grandiflorus* L.) cv. white prosperity. Annals of Horticulture. 2013; 6(2):242-251.
34. Sisodia A, Singh AK. Effect of farmyard manure, vermicompost and

*Trichoderma*on flowering and corm attributes in gladiolus. Bangladesh J. Bot. 2015;44(2):309-314.

35. Rajiv K, Yadav DS, Ray AR. Effect of organic amendments and nitrogen, phosphorus and potassium on growth, flowering and corm production of gladiolus cv. Pusa Shabnum under Meghalaya conditions. Environ. Ecol. 2006;24:939-942.
36. Kukde S, Pillewan S, Meshram N, Khobragade H, Khobragade YR. Effect of organic manure and bio-fertilizer on growth, flowering and yield of tuberose cv. Single. J. Soils Crops. 2006;16:414-416.
37. Khanam R, Kundu D, Patra SK. Integrated nutrient management on growth, quality, yield and soil fertility of gladiolus in lower gangetic plain of India. Int. J. Curr. Microbiol. App. Sci. 2017;6(4):453-459.
38. Satapathy SP, Toppo R, Dishri M, Mohanty CR. Impact of integrated nutrient management (INM) on flowering and corm production in gladiolus. Biom BiostatInt J. 2016;4(7):00119.

Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/21767