EFFECT OF ORGANIC MANURE, INORGANIC FERTILIZER AND BIO-CONTROL AGENT ON YIELD AND QUALITY OF GLADIOLUS

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This is to certify that thesis entitled, ***"EFFECT OF ORGANIC MANURE, INORGANIC FERTILIZER AND BIO-CONTROL AGENT ON YIELD AND QUALITY OF GLADIOLUS"*** *submitted to the Department of Horticulture Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of* ***MASTER OF SCIENCE (MS) in HORTICULTURE****, embodies the result of a piece of bona-fide research work carried out by* ***NADIA AKTER****, Registration No.* ***07-02196*** *under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

I further certify that such help or source of information, as has been availed of during the course of this investigation has duly been acknowledged.

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ABSTRACT

The present investigation was carried out to study the effect of organic manure, inorganic fertilizer and bio-control agent on yield and quality of gladiolus at the Floriculture Research Field, BARI, 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_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 and T_8: Vermicompost (5 t/ha) + Trichocompost (3 t/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(3 t/ha) with ¼ RDF showed best result on yield and quality of gladiolus.

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The Author

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LIST OF ABBREVIATED TERMS

ABBREVIATIONS	FULL WORD
%	Percent
@	At the rate
AEZ	Agro Ecological Zone
ANOVA	Analysis of variance
B	Boron
BARI	Bangladesh Agricultural Research Institute
cm	Centimeter
CV%	Percentage of Coefficient of Variation
DAP	Days after planting
Dept.	Department
df	Degrees of Freedom
DMRT	Duncan's Multiple Range Test
et al.	And others
etc.	Etcetera
FYM	Farmyard manure
HRC	Horticulture Research Centre
K	Potassium
Kg	Kilogram
Max.	Maximum
mg/L	Miligram per Litre
Min.	Minimum
MoP	Muriate of Potash
^{O}C	Degree Celsius
ppm	Parts per million
RCBD	Randomized Complete Block Design
RDF	Recommended Dose of Fertilizer
RH	Relative Humidity
S	Sulphur
SAU	Sher-e-Bangla Agricultural University
t/ha	Tons per hectare
TSP	Triple Super Phosphate
Viz.	Namely
Zn	Zinc

CHAPTER I
INTRODUCTION

Gladiolus is a popular flowering plant grown all over the world, from South Africa to West Asia. 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 (Parthasarathy and Nagaraju, 1999). The modern hybrids are botanically known as *Gladiolus grandiflorus* belonging to family Iridaceae.

Gladiolus is one of the most popular cut flowers in Bangladesh. The agro ecological conditions of the country are very conducive for its survival and culture as a crop. Regarding the area and production of gladiolus flowers, so far no authentic reports are available in the country. Dadlani (2013) reported that the area of flower production appears to have increased significantly and estimated area of around 10,000 ha and roughly about 1, 50,000 people are directly or indirectly involved in floriculture business for their livelihoods. Flower trading worth of Tk. 51.5 million has been recorded at Godkhali flower market Jhikargacha, Jessore simply on the occasion of spring festival and Valentine's Day this year (Islam, 2015). In the international cut-flower trade gladiolus occupies fourth place (Khan, 2009)**.** Jahan (2009) and Mou (2012) reported that income from gladiolus flower production is six times higher than returns from rice and other horticultural crops.

It is mainly cultivated for cut-flowers because of its elegant appearance and prolonged vase life. Gladiolus spikes are most popular in flower arrangements and for preparing attractive bouquets. Its magnificent inflorescence with various colour have made it attractive for use in herbaceous borders, beddings, rockeries, plot and for cut-flowers. Apart from ornamental value, gladiolus is extensively utilized in medicines for headache, lumbago, diarrhoea, rheumatism and allied pains (Bhattacharjee, 2010). The flowers of different *Gladiolus* sp. are used as uncooked salad by nipping of their anthers.

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 (Sharma *et al*., 2004). 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 (Mazhabi, 2010 and Mitra, 2010) 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 (Papavizas, 1985) and has been extensively studied as potential bio-control agents (Lynch, 1990). However, some studies have also shown that it can stimulate the growth of a number of flower and ornamental crops (Elad *et al*., 1981 and Hadar *et al*., 1979). Mazhabi (2010) 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 Mishra *et al*. (2004), 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 (Bose *et al*, 2003). Fertilizers have great influence on growth, building and flower production in gladiolus (Misra and Kapoor (1992). 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 (Misra and Singh, 1999). Poultry manure is an excellent organic fertilizer, as it contains high nitrogen, phosphorus, potassium and other essential nutrients (Garg and Bahla, 2008). Vermicompost has been shown to have high levels of total and available nitrogen, phosphorus, potassium, micronutrients, microbial and enzyme activities and growth regulators (Chaoui *et al.,* 2003). Mustard oil cake is an excellent source of organic amendment can replace not only the use of chemical fertilizers but also replace the use of pesticides by suppressing pathogens and insects (Bose *et al*., 2003). Research works have shown that compost and other organic manures like bokashi, farmyard manure, cocodust, water hyacinth, mustard oil cake, vermicompost etc. can serve as soil amendments to improve soil nutrient status and water holding capacity (Roe, 1997) particularly in sandy soils. They also stabilize soil pH, increase soil organic matter and ultimately improve plant growth, yields and quality.

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 (Anjana and Singh, 2015; Dongardive *et al*., 2007; Kusuma, 2000; Pandey *et al*., 2013; Shankar *et al*., 2005). 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 following objectives:

i) To find out the optimum dose and combination of organic manure, inorganic fertilizers and bio-control agent for better growth, flowering and yield of gladiolus and
ii) To find out the suitable nutrients for extending flower durability of gladiolus.

CHAPTER II
REVIEW OF LITERATURE

Gladiolus ranked fourth among the cut flowers in the world market and is highly prized for its bright, beautiful and vivid colored flowers. Traditionally, gladiolus is grown with indiscriminate use of inorganic fertilizers which often cause environmental pollution and soil fertility reduction. Organic manure influences the physical, chemical, biological properties of soil, though its quantity in soil is very small. The response of crop to the applied organic manure is slow but the residual effect of these manures last for long time. Application of organic amendments with bio-control agent is a promising technology for crop yield and integrated disease managements. Many research works have been done in different countries. However, the literature regarding growth, yield and vase life of gladiolus as influenced by organic manure, inorganic fertilizers and bio-control agent are scanty. The relevant information available on this area generated from different studies has been reviewed in this chapter.

2.1 Literatures on organic manures, fertilizers and bio-control agent:

Prakash *et al.* (2015) conducted a field trial on gladiolus to see the influence of vermicompost and various bio-control agents on growth and flowering attributed at the Krishi Vigyan Kendra Campus Saharanpur U.P., India. The Treatments were control, *Trichoderma*, *Pseudomonas fluorescens*, Vermicompost, *Trichoderma* + *Pseudomonas*, *Trichoderma* + Vermicompost, *Trichoderma* + *Pseudomonas* + Vermicompost. Experiment was laid out in a randomized block design with three replications. Early sprouting was recorded with treatment *Trichoderma*. Maximum length of longest leaf and maximum number of leaf were recorded with *Trichoderma* + Vermicompost. The earliest opening of first floret and maximum length of spike and maximum number of floret were recorded with Treatment *Trichoderma* + *P. fluorescens* + Vermicompost. It is noted that application of various bio-control agents alone or in combination with vermicompost was found beneficial to improve plant growth and various flowering parameters of gladiolus.

Mazed *et al.* (2015) investigated the effect of manures and fertilizer on growth, flower and bulb production of tuberose at the Horticultural Farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh. The experiment consisted five levels of nutrient sources, viz.: F_0 : Control, F_1: Cowdung 10 t + 250 kg Urea + 190 kg TSP + 190 kg MoP/ha, F_2: Poultry litter 5 t + 250 kg Urea + 190 kg TSP + 190 kg MoP/ha, F_3: Cowdung: 15 t/ha and F_4: Poultry litter: 10 t/ha. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Application of manures and fertilizer showed significant variations on most of the parameters. The highest yield of spike (4, 57, 650/ha), bulb (26.64 ton) and bulblet per hectare (23.63 ton) was recorded from F_1 (Cowdung 10 t + 250 kg Urea + 190 kg TSP + 190 kg MoP per hectare).

An experiment was conducted by Naznin *et al.* (2015) to determine the appropriate dose and combination of organic and chemical fertilizers and to assess the effect of bio-control agent (*Trichoderma*) on qualitative and quantitative characteristics of tuberose (*Polianthes tuberosa* L. cv. Single), including stem length, rachis length, spike length, floret number, flower yield, flower durability, number of bulb, bulb yield etc. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications having eight treatments as follows: T_1: Farmyard manure (5 t/ha) + ¼ RDF, T_2: Poultry refuse (5 t/ha) + ¼ RDF, T_3: Bokashi (3 t/ha) + ¼ RDF, T_4: Mustard oil cake (500 kg/ha) + ¼ RDF, T_5: Vermicompost (5 t/ha) + ¼ RDF, T_6: Trichocompost (3 t/ha) + ¼ RDF, T_7: Tricholeachate (3000 L/ha) + ¼ RDF and T_8: Control (Recommended doses of fertilizer) (N_{150} P_{45} K_{88} S_{10} B_1 Zn_1 kg/ha). Maximum growth, yield and yield contributing characters were recorded in T_6: Trichocompost (3 t/ha) + ¼ RDF which were statistically superior to other treatments. Maximum plants emergence (93.3%) also recorded in T_6 (Trichocompost + ¼ RDF). In case of plant height, number of leaves per plant, plant spread, days to flowering, number of florets, flower yield, bulb production, T_6: Trichocompost (3 t/ha) + ¼ RDF gave superior results over control.

Kejkar *et al.* (2015) conducted a multifactor experiment on ratoon spider lily cv. Local at Instructional Farm of Horticulture Department, Junagadh Agricultural University. All the growth parameters were significantly influenced due to different levels of nitrogen. Application of nitrogen @ 400Kg N/ha with three equal split doses recorded significantly the highest plant height, number of leaves per plant, leaf area, leaf length, diameter and weight of single bulb, number of bulbs per plant, bulb yield/ha, N content in leaves and bulbs. Phosphorus also played a significant role in improving growth parameters at higher level except, number of leaves per plant, bulb yield, P content in leaves and bulb. Potassium doses were significantly increased the P content in leaves and bulb. The optimum vegetative growth and bulb yield were obtained with combined application of 400Kg N/ha and 200 Kg P_2O_5/ha.

Quality flower production in commercial cultivation of gladiolus is need of flower industry. Singh *et al.* (2015) carried out a field experiment on gladiolus to see the influence of vermicompost, trichoderma and inorganic fertilizer on growth, flowering and yield attributes. Experiment was laid out in a randomized block design with a total of 10 treatments replicated three times. The effect of INM was investigated on days taken for complete sprouting, number of sprout per corm, plant height and number of leaves, number of days taken for spike initiation, diameter of floret, length of spike, number of spikes per plant and hectare. Earliest corm sprouting, highest number of sprout per corm, plant height and number of leaves, earliest spike initiations and highest diameter of floret were observed with vermicompost 5 t/ha + *Trichoderma* 3 t/ha + 75% N + 200 kg P_2O_5 + 200 kg K_2O. The same treatment combination also showed highest length of spike (95.60) the number of spikes per plant (1.86) and per hectare (2.33 lakh/ha).

A field experiment was conducted by Anjana and Singh (2015) to see the effect of farmyard manure (FYM), vermicompost and *Trichoderma* alone and in combination on flowering and corm yield in gladiolus. Application of farmyard manure + *Trichoderma* resulted in early spike emergence, opening of first floret and increased diameter of floret. Maximum length of spike, number of florets/spike and duration of flowering was registered with application of vermicompost + *Trichoderma*. Treatment FYM + vermicompost significantly enhanced shelf life of flower. However, maximum weight of corms/plant and diameter of corm recorded with vermicompost + *Trichoderma* and FYM + *Trichoderma* treatments, respectively.

Fertilizer management is an important factor for a successful growth of plants and to identity of suitable fertilizers in plants could have the desirable effects on quantitative and qualitative indices. In order to study the effects of biological fertilizers and NPK fertilizer on growth characteristics, chemical composition of marigold were studied by Arab *et al.* (2015). This experiment was conducted at the research green house of Birjand University, Iran in a completely randomized in factorial design with three replications. Treatments included biological fertilizers (without bio-fertilizer, *Psedomonas fluorescence* 187, *P. fluorescence* 178, *P. fluorescence* 169, *P. putida* 159, *P. fluorescence* 36) with different NPK fertilizer rates (0, 25, 50, 100%). Results showed that by increasing NPK rates up to 100% dose, number of branches, number of flowers, number of leaf, capitulum diameter, capitulum, bracket diameter, phosphorus and potassium content were significantly increased when compared with the zero NPK. The combined treatment of bio-fertilizer and chemical fertilizer significantly increased the flowering stem height, chlorophyll index, nitrogen and flavonoids content. The highest content and the concentration of flavonoids were obtained when plant was treated with *P. fluorescence* 36 strains.

A nursery experiment was carried on Marigold by Hassan *et al.* (2014) to determine the response of organic fertilizers and their extracts. A factorial experiment was conducted involving three factors (2 × 4 × 2) namely, type of compost (the extracts of peat moss and sheep manure), concentrations of foliar application (0%, 20%, 40% and 60%), and the mixed in soil and foliar application. The results showed that the type of organic fertilizer and the application method significantly affected vegetative growth (leaf number/plant, shoot dry weight, leaf chlorophyll content and carbohydrate leaf content) and flowers parameters (length of the flower stem, flower number/plant and flower diameter). This study showed that compared to the other fifteen treatment conditions, the application of extract of sheep manure applied at 40% concentration and as a foliar spray produced superior results on both vegetative growth and flower parameters.

An investigation was conducted by Mamta and Ajit (2014) to study the effect of organic manures and bio-inoculants on vegetative and floral attributes of chrysanthemum cv. Little Darling. The treatments comprising of VAM, Trichoderma sp. (each @ 20 g/plant), poultry manure, vermicompost (each @ 300 g/m^2) and their combinations along with control. Among the treatments applied maximum plant height (30.17 cm), number of primary and secondary branches (3.78 and 19.78, respectively), plant spread (28.53 cm) and number of leaves per plant (184.33) were recorded in VAM (20 g/plant) + vermicompost (300 g/m^2) at all stages of plant growth. With respect to flowering, application of VAM (20 g/plant) + vermicompost (300 g/m^2) was found best as it resulted in bud initiation in minimum days (55.78), days to first flowering (73.33), maximum flowering duration (28.33 days), flower longevity (16.33 days), number of flowers per plant (70.56), flower stalk length (7.80 cm) and weight of flower (1.67 g). Maximum days taken to half of leaves (13.67) and flower wilting (17.17) were recorded in vermicompost (300 g/m^2). VAM (20 g/plant) + vermicompost (300 g/m^2) were found best for commercial cultivation of chrysanthemum cv. Little Darling.

The present investigation was carried out by Patanwar *et al.* (2014) to study the effect of integrated nutrient management on the growth, development and yield of chrysanthemum. The experiment was laid out in randomized block design with three replications and twelve treatments with or without combinations of bio-fertilizers and organic manures with inorganic fertilizers. Result revealed that application of Azo + PSB + 50% RDN through VC + 50% RDF (T_{12}) was found to be more effective and at par in increasing the vegetative growth parameters, viz. plant height (57.02 cm), plant spread (41.91 cm), number of branches per plant (23.07), fresh weight of plant (141.13 g/plant), dry weight of plant (41.7 g/plant), fresh weight of root (22.8 g/plant), dry weight of root (4.10 g/plant). Similarly number of flower per plot (992.8), yield of flower per plot (3.19 kg/plot) and total yield of flowers (17.70 t /ha) observed maximum under treatment T_{12} (Azo + PSB + 50% RDN through vermicompost + 50% RDF) followed by T_{11} (Azo + PSB + 50% RDN through FYM + 50% RDF).

The experiment was conducted by Tripathi *et al.* (2013) to study integrated nutrient management of tuberose at the Horticultural Research Centre of Sardar Vallabhbhai Patel University of Agriculture and Technology, Modipuram, Meerut (India) in a randomized block design (RBD), with 12 treatments (T_1: RDF (240:160:100 kg NPK/ha), T_2: 75% RDF/ha, T_3: 125% RDF/ha, T_4: 75% RDF + 250 q FYM/ha, T_5: 75% RDF + 500 q FYM/ha, T_6: 75% RDF + 125 q vermicompost/ha, T_7: 75% RDF + 250 q vermicompost/ha, T_8: 75% RDF + 250 q FYM + 125 q vermicompost/ha, T_9: 75% RDF + 250 q FYM + 250 q vermicompost/ha, T_{10}: 75% RDF + 500 q FYM + 125 q vermicompost/ha , T_{11}: 75% RDF + 500 q FYM + 250 q vermicompost/ha and T_{12}: untreated (control) which were replicated thrice. The plot size was 3.15 m × 2.25 m with spacing of 45 cm × 30 cm. Suvasini variety was used for the experiment. The plant growth, bulb and bublet yield of tuberose significantly increased with the application of 75% RDF with 250 q vermicompost per hectare.

An investigation was carried out by Chaudhary *et al.* (2013) to study the effect of integrated nutrient management on vegetative growth and flowering characters of tuberose with the application of vermicompost and FYM with and without 100, 75 and 50% recommended dose of NPK. The application of 20 t/ha FYM produced maximum number of leaves. The components like diameter of florets, length of rachis, fresh weight of plant and vase life of spike were maximum with 50% RDF (60:40:40 kg/ha NPK) + 10 tones/ha each of vermicompost. Application of integrated nutrients, i.e. 50% RDF (60:40:40 kg/ha NPK) + 10 tones/ha vermicompost also produced significantly maximum length of spike, number of florets per spike, duration of flowering and yield of bulbs. The dry weight of plant was found maximum with the application of 75% RDF + 10 tones/ha each of FYM and vermicompost.

An experiment was conducted by Hadwani *et al.* (2013) to investigate the effect of integrated nutrient management on growth, yield and quality of ratoon tuberose cv. Double at Department of Horticulture, Junagadh Agricultural University, Junagadh, India. Sixteen treatment combinations of different nutrients were comprised with three replications. Result showed the significant result and application of FYM @ 30 t/ha + phosphate solubilizing bacteria (PSB) @ 2 g/m^2 + *Azotobacter* @ 2 g/m^2 took minimum days to sprouting (18.47 days), maximum plant height (61.67 cm) and plant spread at E-W and N-S (37.93 cm and 37.07 cm, respectively). With respect to flowering, significantly maximum length of spike (78.00 cm), number of florets per spike (44.07), number of spikes per plant (4.26), number of spikes per net plot (127.67), number of spikes per hectare (4.73 lacks), longest vase life (12.33 days) and longevity of spike (20.80 days) were recorded in treatment ½ RDF + PSB @ 1 g/m^2 + *Azotobacter* @ 1 g/m^2.

Pandey *et al.* (2013) carried out a field experiment on gladiolus to see the influence of vermicompost and various bio-control agents on growth and flowering attributes. Treatment consisted of control, *Trichoderma harzianum*, *Pseudomanas fluorescens*, *Bacillus subtilis*, Vermicompost, *Trichoderma* + *Pseudomonas*,

Trichoderma + *Bacillus*, *Trichoderma* + vermicompost, *Pseudomonas* + *Bacillus*, *Pseudomonas* + vermicompost, *Bacillus* + *vermicompost* and *Trichoderma* + *Pseudomonas* + *Bacillus* + vermicompost. Experiment was laid out in a Randomised Block Design with three replications at Horticulture Research Farm, B.H.U, Varanasi. Early sprouting was recorded with *Bacillus subtilis*. Maximum number of sprouts and leaves per plant was observed with *Trichoderma harzianum* + vermicompost. Whereas, treatment *T. harzianum* + *P. fluorescens* + *B. subtilis* + vermicompost registered maximum length of leaf, plant height, length of spike and duration of flowering. Application *B. subtilis* + vermicompost registered maximum fresh and dry weight of leaf, early spike emergence and diameter of floret. Early colour show and floret opening were recorded with *T. harzianum* + vermicompost. However, maximum number of florets per spike was recorded with *P. fluorescens* + *B. subtilis*. It is interesting to note that application of various bio-control agents alone or in combination and vermicompost was found beneficial to improve plant growth and various flowering attributes.

A field experiment was carried out by Abdou *et al.* (2013) to study the effect of compost levels (zero, 5, 10, 15 ton/fed.), bio-control agent (*Trichoderma*) and bio-fertilizers (effective microorganisms and active yeast), as well as, some vitamins (vitamin E and vitamin B1) and their interaction on *Gladiolus grandiflorus* cv. Eurovision plant. Results showed that vegetative growth (leaf length, number of leaves/plant and dry weight of leaves/plant), flowering aspects (length of spike, number of florets/spike and lower floret diameter) and corm production (corm diameter, corm dry weight and number of cormels per plant) were gradually increased by increasing the level of compost fertilizer. All bio-fertilizers, bio-control agent and vitamins treatments significantly increased all vegetative growth characters, flowering parameters and corm and cormels production in comparison with the control. However, *trichoderma*, effective microorganisms and active yeast treatment seemed to be more effective than other treatments in this concern.

The present research was conducted by Moghadam *et al.* (2013) to study the effect of vermicompost, bio-control agent, fertilizer and bio- fertilizer applications on growth, yield and quality of petunia *(Petunia hybrida)*. The experiment laid out in randomized block design with 3 replications. The treatment receiving *Azospirillum* sp. + Phosphate solubilizing bacterium + Vermicompost + NPK (25% of recommended dose) recorded the highest plant height, number of branches, plant spread, leaf area index, dry matter accumulation and yield attributes such as number of flowers per plant, number of flowers per plot, flower yield/plant, flower yield/plot. The early flower bud initiation, 50 percent flowering and more flowering duration was achieved in the treatment receiving *Azospirillum* sp. + Trichoderma + Vermicompost + NPK (25% of recommended dose). Application of *Azospirillum* sp. + Trichoderma + Vermicompost + NPK (25% of recommended dose) registered significantly higher quality parameters such as flower diameter, shelf life and colour.

The effects of sugarcane bagasses sewage sludge-based compost (BSC), vermicompost, and fish wastes as different organic fertilizers on the growth and development of lilies and lillium were evaluated by Mirkalaei *et al.* (2013). The pot experiment was carried out in a completely randomized design (CRD). Two levels (0, 10% v/v) of vermicompost, sugarcane bagasses sewage sludge-based compost (BSC) or fish waste were applied. Plants were grouped in four different treatment groups including control (C), sugarcane bagasses sewage sludge-based compost (B), vermicompost (V) and fish waste (F). Application of vermicompost and bagasses compost as fertilizers, especially the first one, had promoting effects on the growth and development of lilies, whereas, the applied fish fertilizer was not only effective treatment but also harmful one. While vermicompost and bagasses compost, especially the first one, had positive effects on root length, root fresh weight, plant height, stem fresh and dry mass, the applied fish waste as fertilizer adversely influenced these mentioned parameters related to the plant growth. The total chlorophyll amounts in the all treated samples were higher than control groups.

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 (Razib *et al.*, 2013) in gladiolus.

Sonmez *et al.* (2013) carried out a research to determine the effects of organic fertilizers on nutrient contents in leaves and corms of hybrid *Gladiolus* sp. used as a cut flower in landscape arrangement. This study was conducted in a randomized experimental design with three replications. Chicken manure, farmyard manure, peat and waste mushroom compost were used as organic fertilizers. As a result, while the highest mean contents of nitrogen (1.97%), iron (160 ppm) and manganese (128 ppm) in leaves were obtained in chicken manure application, the highest mean contents of potassium (2.01%), calcium (1.80%) and magnesium (0.25 ppm) were determined in waste mushroom compost application. The highest mean contents of phosphorus (0.30%), zinc (25.3 ppm) and copper (9.29 ppm) in leaves were found with peat, control and farmyard manure applications, respectively. The highest mean contents of phosphorus (0.83%), potassium (1.47%), calcium (0.57%), manganese (73 ppm) and zinc (67.3 ppm) in corms were obtained in farmyard manure applications. While the highest mean contents of nitrogen (4.86%) and copper (20.9 ppm) in corms were determined in chicken manure application, the highest mean contents of iron (17.6 ppm) and magnesium (0.20 %) in corms were obtained in peat and waste mushroom compost applications, respectively. Application of organic fertilizers increased macro and micro nutrient contents in leaves and corms of hybrid *Gladiolus* sp.

An investigation was carried out by Narendra *et al.* (2013) study the combined effect of integrated nutrient management on vegetative growth and flowering characters of gladiolus cv. Snow Princess with the application of *Azospirillum.* PSB vermicompost and FYM with and without 100, 75 and 50% recommended dose of NPK. the results showed that plant height was maximum with application

of 75% RDF + 20 t ha^{-1} FYM, while number of florets remaining open at a time was recorded maximum under 100% RDF + FYM, 20 t/ha. Days to first floret opening and number of days for 50% plant to sprout were earliest under treatments 75% RDF + FYM, 10 t/ha + vermicompost, 10 t/ha and vermicompost, 20 t/ha, respectively. The application of 20 t ha^{-1} FYM produced maximum number of leaves. the components like diameter of 3rd florets, length of rachis, fresh weight of plant and vase life of spike in tap water were maximum with 50% RDF (60: 40: 40 kg/ha NPK) + 10 t/ha each of FYM and vermicompost; whereas days to first floret opening was minimum with 75% RDF (90: 60: 60 kg/ha NPK) + 10 t/ha each of FYM and vermicompost. Applicationof integrated nutrients, i.e. 50% RDF (60: 40: 40 kg/ha NPK) + 10 t/ha each of FYM vermicompost + 2 g/plant each of *Azospirillum* and PSB produced significantly maximum length of spike, number of florets per spike, duration of flowering and yield of corms. The dry weight of plant was found maximum with the application of 75% RDF + 10 t/ha each of FYM and vermicompost + 2 g/plant each of *Azospirillum* and PBS.

A field experiment was conducted by Tripathi *et al.* (2012) to determine the comparative effect of integrated nutrient management on the cut flower production of tuberose in randomized block design, having 12 treatments: T_1: RDF (240: 160: 100 kg NPK ha^{-1}), T_2: 75% RDF ha^{-1}, T_3:125% RDF ha-^{1}, T_4: 75% RDF + 250 q FYM ha^{-1}, T_5: 75% RDF + 500 q FYM ha^{-1}, T_6: 75% RDF + 125 q Vermicompost ha^{-1}, T_7: 75% RDF + 250 q Vermicompost ha^{-1}, T_8: 75 % RDF + 250 q FYM + 125 q Vermicompost ha^{-1}, T_9: 75% RDF + 250 q FYM + 250 q Vermicompost ha^{-1}, T_{10}: 75% RDF + 500 q FYM + 125 q Vermicompost ha^{-1} , T_{11}: 75% RDF + 500 q FYM + 250 q Vermicompost ha^{-1} and T_{12}: untreated (control) which were replicated thrice. All the treatments had the comparable better floral qualities as well as higher cut flower production than un-treated control. Among all the treatments, the maximum number of shoot $clump^{-1}$ (18.95) and number of leaves $shoot^{-1}$ (19.44) were recorded with the application of 75% recommended dose of

NPK + 500 q FYM ha^{-1} + 250 q Vermicompost ha^{-1}. The maximum spike yield (205030.71 spikes/ha) were recorded with the application of 75% recommended dose of NPK + 500q ha^{-1} FYM + 250 q ha^{-1} Vermicompost followed by 75% recommended dose of NPK + 500q ha^{-1} FYM + 125 q ha^{-1} Vermicompost (199778.50 spikes/ha) although both the treatments did not varied significantly.

Organic manures play a vital role in improving the soil structure as well as also increasing the growth and yield of the crops. The application of organic materials has potential to increase yields in flower (Kabir *et al*., 2012).

The application of Trichocompost in soil is a promising technology for higher crop yield and integrated disease managements. Studies conducted by Nahar *et al.*, (2012) in crops revealed increased growth and yield of plants using trichocompost instead of applying inorganic chemicals.

Keditsu (2012) conducted a field experiment on response of gerbera to inorganic fertilization versus organic manuring showed that as much as 50% of RDF, if substituted with organic manures (25% RDF with Cocopit and 25% RDF with Pig manure) out of 100% RDF, produced the best response on floral characteristics, flower yield in addition to leaf nutrient composition and available pool of nutrients in soil. These results were far superior to exclusive use of inorganic fertilizers. Study, hence, advocated the possibility of dual manuring having bipolar nutrient release pattern in order to extend nutrient dynamics in soil.

Kabir *et al.* (2011) conducted a field experiment at the farmer's field of Sutiakhali, Mymensingh Sadar Upazilla, Mymensingh, to investigate the effect of organic fertilizers along with half chemical fertilizers on the growth, bulb and flower yield of tuberose cv. single. The experiment consisted of four different sources of fertilizers, viz. (i) recommended chemical fertilizers @ 400, 300, 300, and 100 kg ha^{-1} of urea, TSP, MoP and gypsum respectively; (ii) vermicompost @ 5 t ha^{-1}

along with half of chemical fertilizers; (iii) poultry litter @ 20 t ha^{-1} along with half of chemical and (iv) cowdung @ 20 t ha^{-1} along with half of chemical fertilizers. The experiment was laid out in a randomized complete block design with three replications. Results revealed that plant height, number $plant^{-1}$, leaf length and breadth, number of side shoots $plant^{-1}$, bulb length, bulb diameter and bulb yield both per plant and per hectare, rachis length, spike length and diameter, number of florets $spike^{-1}$ and flower yield both per spike and per hectare were greater in organic fertilizers along with half chemical fertilizers than absolute use of chemical fertilizers. The highest bulb and flower yield both per plant and per hectare were recorded in poultries followed by cowdung.

A field experiment was carried out at by Gupta *et al.* (2011) to quantify the effect of integrated nutrient management (INM) on yield of tuberose. The yield of tuberose increased with integrated application of inorganic and organic nutrients. A significant increase in tuberose yield was observed with 75% recommended NPK + 2.5 tons ha^{-1} vermicompost + bio-fertilizers followed by 75% recommended NPK + 2.5 tons ha^{-1} vermicompost.

An investigation was carried out by Verma *et al.* (2011) at Floriculture Unit of new orchard, Department of Horticulture, College of Agriculture, University of Agriculture Sciences, Dharwad, to standardize the integrated nutrient management on growth, yield and quality of chrysanthemum (*Chrysanthemum morifolium* Ramat.) cv. Raja. The experiment was laid out in randomized block design (RBD) with 8 treatments replicated three times. Individual plot size was 3.0 m × 3.0 m. The treatment receiving *Azospirillum*, phosphate solubilising bacteria, vermicompost and 50 per cent recommended NPK (T_8) recorded the highest plant height, number of branches, plant spread, dry matter accumulation and yield attributes such as number of flower $plant^{-1}$ and flower yield.

Organic materials are the safer sources of plant nutrients which have no detrimental effect to crops and soil. Regular addition of organic matters overcomes the extremes physico-chemical properties of the soil which plays a vital role in crop production. Poultry manure and EM treatments produced the highest yield in gladiolus in comparison to inorganic fertilizer application (Islam, 2011).

The effects of *Trichoderma harzianum* on tuberose were investigated by Mazhabi *et al.*, (2011) in Iran. The results showed that using *Trichoderma harzianum* increased quality, yield and income.

Trichoderma was effective in the promotion of growth and yield including stem length, stem diameter, bud diameter, petal length, flower number, bulb number, bulblet number etc. in tulip (Mazhabi *et al.*, 2011).

Khosa *et al.* (2011) reported that foliar fertilization provided important nutrients for plant growth and flowering of gerbera. The fertilizer solution macro nutrients containing 1g, 1.5g and 2g of nitrogen, potassium and phosphorus, respectively and micro nutrients contain 5000±200, 4000±200 and 5000 ± 200mg/100ml solution of Zn, B, Fe and Mn. Different concentration of macro nutrients i.e. 12.5ml + 987.5ml water, 18.75ml + 981.25ml water and 25ml+975ml water taken and sprayed fifteen days intervals on potted gerbera. Spray of micro power (solution of different micronutrients) was also being applied at constant rate of 5ml/1000 ml solution of water. Plant height, number of branches per plant, length of branches per plant, number of leave per plant, leaf area, stock length, days to first flower emergence, flower diameter and flower quality increased with increasing fertilization level and began to turn down when fertilization level exceed beyond the above given levels of macro and micro nutrients. Foliar fertilization influenced the days to first flower emergence as compared to control where no foliar spray of macro and micro nutrients was applied.

A field experiment was carried out by Shahnewaz (2011) at the Horticulture Farm, Bangladesh Agricultural University, Mymensingh to study the effect of organic manures and lines on growth, flowering, corm and cormel production and vase life of gladiolus. The two-factor experiment had different doses of organic manures viz., T_1 = 5 t/ha paragon compost; T_2 = 7.5 t/ha paragon compost; T_3 = 10 t/ha paragon compost; T_4 = 10 t/ha cowdung; T_5 = 15 t/ha cowdung; T_6 = 20 t/ha cowdung; T_7 = Inorganic fertilizer (recommended); T_8 = Control and three lines of gladiolus viz., L_1 (Pink), L_2 (Light yellow) and L_3 (Violet). The experiment was set up in the Randomized Complete Block Design with three replications. The highest number of spikes (1.44 lac/ha) and yield of corms (11.76 t/ha) were produced from the treatment of 20 t/ha cowdung, whereas the lowest number of spikes (0.83 lac/ha) and lowest yield of corms (7.55 t/ha) were found from control. The maximum number of spikes (1.30 lac/ha) and corm yield (10.92 t/ha) were obtained from the line-2, and the minimum number of spikes (0.89 lac/ha) and corm yield (9.74 t/ha) were under the line-3. The highest yields of spikes (1.74 lac/ha) and corm (12.76 t/ha) were recorded from the treatment combination of 20 t/ha cowdung with the line-2 and the lowest yields of spikes (0.74 lac/ha) and corm (6.91 t/ha) were obtained from the treatment combination of control with the line-3. However, the combination of 20 t/ha cowdung with the line-2 was found to be the best for the production of good quality spike, corm, cormel and vase life of gladiolus at Horticulture Farm condition of Bangladesh Agricultural University, Mymensingh.

Mazhabi (2010) tested effects of five isolates of Trichoderma (*Trichoderma harzianum* Bi, *T. virens* Et_4, *T. virens* Rabi, *T. Virens* Et_6, *T. virens* 65 Amar) and concluded that *T. harzianum* was more effective on qualitative traits like fresh and dry weight, stem length, flower number and floret diameter of gladiolus, tuberose, tagetes, gaillardia and zinnia.

The experiment was conducted on African marigold by Radhika *et al.* (2010) at College Horticulture Nursery, Department of Horticulture, Anand Agricultural University, Anand. The treatments comprised of three bio-fertilizers (*Azotobacter*, *Azospirillum* and PSB), three levels of vermicompost (2.0, 3.0 and 4.0 t/ha^{-1}) and three levels of NPK (60, 70 and 80% of RDF) including control (RDF). The experiment was laid out in a randomized block design with ten treatments replicated thrice. The results revealed that application of 70% RDF + 3 t/ha vermicompost + *Azotobacter* + *Azospirillum* + PSB produced significantly maximum plant height, number of branches per plant, plant spread in N-S and E-W directions, average flower weight, number of flowers per plant, flower yield per plant (g) and flower yield per hectare (t) as compared to control.

Field experiments were conducted by Kadu *et al.* (2009) to study the effect of four levels, each of nitrogen (0, 100, 200 and 300 kg/ha) and phosphorus (0, 100, 150 and 200 kg/ha) with a fixed level of potassium @ 100 kg/ha in tuberose cv. Single. Among all the NPK combinations, treatment of 300:150:100 kg NPK/ha, showed more spike length (106.32 cm), maximum number of florets/plant (41.58) and number of spikes plant^{-1} (2.47). Further, its effect was also good in parameters such as fresh weight of flowers/plant (90.89 g) and yield of flowers/ha (15.15 tones).

The field experiment with sixteen treatment combinations of inorganic, farm yard manure and vermicompost were conducted on heliconia by Dalve *et al.* (2009) and it was noted that all the INM treatments increased significantly the fresh weight of marketable and unmarketable rhizomes, number of rhizomes and spikes as compared to treatment 100% RDF of NPK. Out of sixteen treatment combinations, 75% RDF of NPK + 10 t/ha^{-1} vermicompost application enhanced the yield and flowering duration as compared to other treatments.

Sushma and Aruna (2008) studied the effects of bio-fertilizers, chemical fertilizers, vermicompost, poultry manure and their combination on the productivity of gladilus. The experiment was conducted in a completely randomized block design with 4 treatments i.e. T_1: RDF + Vermicompost), T_2: ($^1/_2$ RDF + Vermicompost 5 t/ha), T_3: (RDF + Poultry manure) and T_4: ($^1/_2$ RDF + Poultry manure 5 t/ha). A significant increase in flower and corm yield was observed with ½ RDF + 10 t/ha Vermicompost of gladiolus.

Nitrogen, phosphorus and potassium have a significant effect on spike production and floret quality. Poultry manure is an excellent organic fertilizer, as it contains high nitrogen, phosphorus, potassium and other essential nutrients (Garg and Bahla, 2008) and increase shelf life in flowers.

Chaitra and Patil (2007) observed significant increase in plant height, number of leaves, number of branches, total dry matter production and also flower yield in China aster with the application of vermicompost @ 2.5 t ha^{-1} with 50 per cent RDF.

Warade *et al.* (2007) observed that, the growth of dahlia in respect of height of plant, number of leaves $plant^{-1}$, spread of plant, earliness of flowering and yield of flowers was superior in the plants receiving vermicompost 500 g with PSB 25 $g/plot^{-1}$.

An application of vermicompost as 50% recommended dose of nitrogen (RDN) along with 50% recommended dose of fertilizer (RDF) recorded significantly higher plant height (100.3 cm), maximum number of primary branches (13.1), flowers (66.2), seed yield (499.0 kg/ha) and recorded higher 1000 seed weight (3.7 g), root length (6.2 cm), shoot length (5.5 cm) and vigour index (1047) compared to RDF alone in African marigold (Sunita *et al.*, 2007).

Yadav (2007) conducted an experiment in Bikaner, Rajasthan, India, to study the effect of N (0, 10 and 20 g) and P (0, 6 and 12 g) fertilizers on the growth and flowering of tuberose cv. Shringar. Plant height, number of leaves per plant, number of flowers per spike, length of spike, length of rachis, number of spike per plot and weight of flower per spike were remarkably increased with N and P application alone and in combination.

A field study of boron and zinc on flower production of tuberose was conducted by Halder *et al.* (2007) at Floriculture Research Farm of Horticulture Research Centre, BARI, Joydebpur, Gazipur. The objectives were to evaluate the response of tuberose to B and Zn micronutrients and to find out the optimum dose of boron and zinc for maximizing flower yield and quality of tuberose. Sixteen treatments comprising four levels of B (1.0, 2.0 and 3.0 kg ha^{-1}) and four levels of Zn (0, 1.5, 3.5 and 4.5 kg ha^{-1}) along with blanket does of N_{300} P_{90} K_{170} S_{20} kg/ha and cow dung 5 t/ha were used in the trial. Tuberose (cv. Double) was taken as a test crop. It was revealed that B and Zn and their combination had a profound effect on flower characters and flower yield of Tuberose.

Dongardive *et al. (*2007) reported the effects of organic fertilizers on the performance of gladiolus (*Gladiolus hybridus*) cv. White Prosperity were studied in Nagpur, Maharashtra, India. The treatments consisted of NPK (500:200:200 kg/ha), FYM [farmyard manure] (4 t/ha), vermicompost (8 t/ha), neem cake (6 t/ha), FYM + Azotobacter (5 kg/ha), vermicompost + Azotobacter (5 kg/ha), neem cake + Azotobacter, FYM + PSB [phosphate-solubilizing bacteria] (5 kg/ha), vermicompost + PSB, neem cake + PSB, FYM + Azotobacter + PSB, vermicompost + Azotobacter + PSB, and neem + Azotobacter + PSB. NPK resulted in the lowest number of days to corm sprouting (8.56), number of days to 50% spike initiation (64.90) and number of days to opening of the first 2 florets (69.12 days), and greatest plant height (88.26 cm), leaf length (74.33 cm), number of leaves per plant (7.50), spike length (95.57 cm), number of spikes per plant

(1.41), number of florets per spike (13.92) and floret diameter (8.78 cm), followed by vermicompost + Azotobacter + PSB (8.91, 67.12, 71.69, 85.22 cm, 69.92 cm, 6.84, 90.10 cm, 40.96, 12.87 and 7.91 cm, respectively).

A field trial of corm and cormel production of gladiolus was carried out Halder *et al.* (2007) at Floriculture field of Horticulture Research Centre, BARI, Gazipur. The objectives were to evaluate the response of B and Zn on corm and cormel production and to find out the optimum dose of B and Zn for maximizing yield of corms for gladiolus cultivation. Treatments comprising each four levels of B (0, 1, 2 and 3.0 kg/ha) and four levels of Zn (0, 1.5, 3.0 and 4.5 kg/ha) along with blanket dose of N_{375}, P_{150}, K_{250}, S_{20} and CD 5 t/ha were used in the study. It was felt in the study that B-Zn integration contributed more than their single applications. The interaction effects of B and Zn @ $B_{2.0}$, and $Zn_{4.5}$ kg/ha significantly contributed to the yield of individual corm weight (26.07 g) and number of cormels (9.78) and weight of cormels/plant (31.94 g) than other B-Zn combination along with control (B_0Zn_0). Single application of B and Zn also contributed to the yield parameters but their response was not pronounced as their integration performed.

Nursery experiments were conducted by Vijayananthan *et al.* (2007) at the Forest College and Research Institute of India. Uniform size cuttings were collected from two years old mother plant. Cuttings were planted in polythene bags (20 cm × 15 cm) containing nursery mixture of sand: red soil: farmyard manure (1: 1: 1). For treatments involving vermicompost, farmyard manure was replaced with the same. To fine out the effect of introduction of earthworms, the bags were filled with a mixture of cowdung and soil and mulch at 1: 1: 1 ratio and to each bag five earthworms belonging to the species *Eudrillus* engeniae were released. This study was conducted with eight treatments replicated thrice in a completely randomized design. The treatments were T_1= Recommended doses of fertilizer application (1 g

N, 2 g P and 1 g K per bag), T_2=Vermicast application @ 100 g per bag, T_3=Earthworm + cowdung + mulch, T_4= Mulch + cowdung, T_5= Vermicomost (sand: soil: vermicompost) at (1:1:1), T_6= Vermicompost (sand: soil: vermicompost) at (1: 2: 1), T_7= Vermicompost (sand: soil: vermicompost) at (1: 2: 1) + VAM (Glomos mosseae) @ 10 g per bag and T_8= Control. The treatment T5induced significant imporvement in growth parameters like shoot and root length, shoot and root fresh and dry weight, total dry weight and number of leaves in jasmine.

Rajesh *et al.* (2006) in a gladiolus experiment laid out in common basal dose consisting of Trichoderma viride, FYM, bio-fertilizers namely, Azospirillum, VAM and PSB and decomposed coir was applied in all the treatments except one which consisted of general media and required fertilizer dose. Maximum plant height (102.8 cm) was recorded when plants were treated with 4% Manchurian Mushroom Tea + 6% Panchagavya, maximum duration of flowering (14.70 day) with 6% Panchagavya, largest number of florets per spike (13.53) with 4% Panchagavya, largest florets (10.67 cm) with 6% Manchurian Mushroom Tea + 6% Panchagavya and maximum vase life (8.20 day) with 4% Manchurian Mushroom Tea. The maximum corm weight (29.63 g), number of cormels per plants (113.5) and cormels weight per plant (19.10 g) were recorded when plants were treated with 2% Manchurian Mushroom Tea + 6% Panchagavya. However, days to first flowering, spike length, weight of spike, number of corms per plant and corm diameter were found to be non-significant.

Regular application of organic amendments may solve the problems of low soil fertility, low water holding capacity and low organic matter content of soil. Significant increase in plant height, leaf number, spike length and number of florets per spike in gladiolus in the plots treated with a combination of vermicompost @ 10 tonnes per hectare + 80 per cent recommended NPK (100:60:60 kg/ha) was stated by Godse *et al.* (2006).

An investigation was carried out by Waheeduzzaman *et al.* (2006) at Department of Floriculture and Landscaping, Botanic Gardens, Horticultural College and Research Institute, TNAU, Coimbatore, to study the effect of INM practices in improving the flower yield of *Anthurium andreanum* cv. Meringue. The experiment was conducted with six kinds of organic substrates along with inorganic fertilizers. The treatment combination of Panchagavya 4% + 50% recommended dose of fertilizers (RDF) favorably influenced the spathe length (7.50 cm) spathe breadth (7.00 cm), spadix length (4.50 cm) and spike length (32.10 cm). The treatment combination of vermicompost 100 g/plant + 50 % RDF (T_1) recorded the highest value of inflorescence longevity (88.30 day), number of days for exhibiting gloss loss, spathe bluing and spadix necrosis with the values of respectively 17.50, 18.50 and 21.6 day. The results proved that Panchagavya 4% foliar spray + 50% RDF improved the flower size whereas better vase life was observed in the treatment combination of vermicompost 100 g/plant + 50% RDF.

Shashikanth (2005) noticed in marigold that application of vermicompost @ 5.0 t ha^{-1} along with recommended dose of fertilizer had increased flower yield (13.9 t ha^{-1}). In the same crop maximum number of flower buds/plant, individual flower weight and flower yield/m^2 were recorded with the application of vermicompost at 1000 g/m^2.

Application of vermicompost (10 t/ha) with N, P_2O_5, K_2O @ 20, 15 and 20 g/m^2 resulted maximum leaf area, length of first order lateral shoots, number of flowers/m^2, flower diameter and weight of flowers/m^2 in rose production (Singh, 2005).

Padaganur *et al.* (2005) conducted a field experiment at the University of Agricultural Sciences, Dharwad, to study the response of tuberose to vermicompost at different levels (1, 2, 3 kg/sq m) alone and in combination with

50 per cent recommended dose of fertilizer (RDF) and recommended dose of FYM revealed that plants which received vermicompost either alone or in combination with ½ RDF were early to initiate flowering. Significantly higher flower spike yield (1.16 lakhs/ha) was obtained with the application of 3 kg vermicompost/sq m along with 50 per cent RDF.

Shankar and Dubey (2005) conducted an experiment of gladiolus in Horticultural nursery, IGAU, Raipur, Madhya Pradesh, India. Results indicated that the growth characteristics such as plant height, number of leaves per plant, leaf area, fresh weight of plant, weight of corm, diameter of corm and yield of corms were influenced by the treatment 400 kg N, 200 kg P_2O_5 with N in three splits, which was found to be superior over all other treatments. The leaf width, weight of cormels per plant, dry weight of plant and yield of cormels were found maximum in the treatment, 400 kg N, 200 kg P_2O_5 and 200 kg K_2O + 50 tones farmyard manure with N in two splits and it was found to be superior for these traits over other treatments.

As the use of inorganic chemicals like fertilizers, pesticides etc. are causing the troubles like environmental pollution and reduce soil productivity; agricultural scientists are trying in find out suitable alternative to agro-chemicals. Their thinking has given rise of formation of the organic agriculture movement in many parts of the world so as to grow crops by using vermicompost (Chauhan *et al.*, 2005).

Microbial populations in the soil increased by applying *Trichoderma harzianum* as well as found significant influences for increased yield and reduced needs of agro-chemicals in gladiolus flowers. Moreover, Tricho-compost is highly rich in various elements that may enrich soil fertility and provide nutrition to gladiolus (Mishra *et al.*, 2004).

Farmyard manure, vermicompost, mustard oil cake and poultry manure which supply organic nitrogen significantly influences for increased yield and reduced needs of agro-chemicals in flowers. Bose *et al.* (2003) reported that gladiolus yield increased with combined application of vermicompost with NPK and B. The application of poultry manure and bokashi at the rate of 3 t/ha produced better yield in flower crops than with inorganic fertilizers (Patil, 2000).

Farm yard manure (FYM) occupies an important position among bulky organic manures. The cattle extract based FYM in India can potentially supply approximately 33 million tonnes of N, P and K per year.

Gladiolus is a gross feeder and requires a large quantity of NPK, both in the form of organic and inorganic fertilizers (Bose *et al.*, 2003). Fertilizers have great influence on growth, building and flower production in gladiolus.

Arsey *et al.* (2002) studied the effect of vermicompost (0.5, 1.0 or 1.5 kg/m^2), farmyard manure (3, 4 or 5 kg/m^2), NPK fertilizers (0.2, 0.3 or 0.6 kg/m^2), cotton cake (1.00, 1.25 or 1.50 kg/m^2), and cut flower preservatives (silver nitrate at 30, 60 or 90 ppm, and 8-hydroxyquinoline) on the vase life of gladiolus cv. Traderhom. The fertilizers were applied during land preparation. Harvested spikes were placed in conical flasks containing 300 mg/ml of mineral salts and maintained at room temperature and at relative humidity. The soil application of cotton cake followed by treatment of spikes with 150 ppm 8-hydroxyquinoline resulted in the longest vase life over the control. Silver nitrate at 90 ppm also enhanced the vase life of cut flowers harvested from plots treated with cotton cake, vermicompost and farmyard manure. The NPK fertilizers were less effective than the organic amendments.

Prakash *et al.* (2002) reported that phosphorus and potassium content in the leaves increased with addition of 5 and 10 per cent FYM whereas, nitrogen content was

increased in the leaves only with addition of 5 per cent FYM. Addition of FYM to the soil also increased the yield parameters.

Conte-e-Castro *et al.* (2001) conducted an experiment in Santa Helena, Parana, Brazil, to evaluate the effect of different organic fertilizers on the yield of gladiolus (*Gladiolus grandiflorus* cv. Red Beauty). The treatments consisted of (i) standard chemical fertilizer, (ii) poultry manure at 10 t/ha, (iii) hog manure at 10 t/ha, (iv) bovine manure at 10 t/ha, and (v) urban waste compost at 10 t/ha. All organic fertilizers provided satisfactory results and can, therefore, be used than chemical fertilizers.

Kusuma (2000) observed that the golden rod plants supplied with vermicompost (10 tonnes per hectare) and 100 per cent recommended NPK (100:50:50 kg/ha) produced greater plant height, maximum number of leaves and highest flower yield.

Application of organic matters essential for promoting growth and higher production of spikes and flowers of good quality gladiolus. Farmyard manure, mustard oil cake and poultry manure are the best organic form for this flower. Farmyard manure, mustard oil cake, tricho-compost and poultry manure which supply organic nitrogen significantly influences for increased yield and reduced needs of agro-chemicals in gladiolus flowers (Mishra *et al*., 2000).

Yadav *et al.* (2000) opined that application of FYM @ 10 t/ha improved growth and flower characters of gladiolus like plant height, plant spread, spike length, rachis length and floret number flower yield and quality.

Significant increased in plant height, leaf number, spike length and number of florets per spike in gladiolus in the plots treated with a combination of vermicompost @ 10 tonnes per hectare + 80 per cent recommended NPK (100:60:60 kg/ha was stated by Gangadharan and Gopinath (2000).

Atiyeh *et al.* (2000) reported that relatively low concentration of vermicompost promoted plant growth in marigold. In the same crop plants applied with vermicompost (15 tonnes per hectare) + 100 per cent recommended NPK produced maximum number of flowers per plant with greater flower diameter and flower yield than plants without vermicompost and fertilizer application.

Poultry wastes contain higher concentrations of N, Ca and P than wastes from other farm animals. The application of poultry manure and trichoderma at the rate of 3 t/ha produced better yield in flower crops than with inorganic fertilizers (Patil, 2000).

An important reason for adding some organic amendments, EM and bio-control agent to soils is to recycle nutrients without damaging the environment. Bokashi, poulty manure and tricho-compost can be very useful because they provide a steady and slow release of plant nutrients (Allaway, 1996).

Kulkarni (1994) recorded increased growth and dry weight in China aster with application of vermicompost @ 2.5 to 5.0 tons per hectare alone or in combination with inorganic fertilizers.

Although chemical based conventional farming practices have substantially increased crop yield, they create numerous problems to mankind. Modern agricultural farming using excessive amounts of chemical fertilizers has contributed to the destruction of our natural resources and degradation of the environment. Studies conducted by Belorkar *et al.* (1993) in gladiolus revealed many beneficial effect of using bokashi and effective microorganism instead of applying inorganic chemicals.

Kleifield and Chet (1992) reported that addition of *Trichoderma harzianum* in soil increased nutrient uptake, suppression of plant pathogens and ultimately promoted the growth of crop plant.

The growth and physio-morphological characters of lily were positively and significantly influenced by organic amendment. Mishustin (1990) reported that bokashi increased flower yield in lily and economically profitable.

Vermicompost besides being a rich source of micronutrients also acts as a chelating agent and regulates the availability of metabolic micronutrients like iron and Zinc to the plants apart from increasing the plant growth and yield by providing nutrients in the available forms (Kale *et al.*, 1987).

Trichoderma harzianum was found to be an effective biological control agent of F. *oxysporum* on gladiolus and of F. *oxysporum*. sp. *nevium* on watermelon (Sivan and Chet, 1986). The antagonist applied under field condition as a wheat-peat bran preparation or as a seed coating, decreased disease incidence and increased yields of both crops.

Studies conducted by Jacobs and Alles (1986) revealed many beneficial effect of organic farming instead of applying inorganic chemicals. The treatment having farmyard manure and poultry manure produced higher yield and better shelf life in flower crops.

The application of compost to the soil increased the water holding capacity, reduced soil erosion and improved the physico-chemical and biological conditions of the soil besides providing plant with nutrients (Okigbo, 1983).

Nambisan and Krishran (1983) reported that the requirement of manures and fertilizers for gladiolus vary with climatic conditions and soil types. They recorded from an experiment with gladiolus that flower yield increased by using FYM with combined application of inorganic fertilizers under South Indian condition.

Azad and Yousuf (1982) opined that soil productivity could be enhanced through the utilization of mineral fertilizer as well as organic materials. The growth and physio-morphological characters of lily were positively and significantly influenced by organic amendments.

Application of *T. harzianum* after soil fumigation gave field control of *S. rolfsii* in carnation. An isolate of *T. harzianum* was found to be capable of reducing mycelia of *S.* rolfsii and *R. solani* in soil naturally infested with those pathogens. Under greenhouse conditions, incorporation of wheat-bran colonized with *T. harzianum* in pathogen infested soil significantly reduced carnation disease caused by *S. rolfsii, R. solani* or both (Elad *et al*., 1981).

It is well known that the benefit of the soil from organic materials is due to their effects on microbial activity followed by increased humus content and an increased supply of available nutrients, particularly NPK (Shaw and Robinson, 1980).

Nanjan *et al.* (1980) studied the effects of nitrogen, phosphorus and potash on the production of gladiolus in a neutral clay soil having high amount of potassium. They recommended a nutrient combination of 200 kg nitrogen, 60 kg phosphorus and 50 kg potash/ha are soils low in potassium.

Pathak and Choudhuri (1980) studied that gladiolus plants were supplied with 50 or 75 kg P/ha along with B 1 or 2 kg/ha resulted the greatest plant height (58.93 cm), highest mean number of leaves (41.34) and number of side suckers/clump and flower yield.

Organic matter increases the pore spaces of soil and thus improves the rate of gas exchange. Regular application of organic amendments may solve the problems of low soil fertility, low water holding capacity and low organic matter content of soil (Edmond *et al.,* 1977).

Singh *et al.* (1976) recommended that flower yield of tuberose should receive a dose of 180 kg nitrogen, 260 kg phosphorus, 40 kg potash per hectare along with vermicompost (3 t/ha) under Uttar Pradesh, India conditions to have optimum flower yield. According to them nitrogen with vermicompost increased the yield of fresh flowers through increasing the number of spike, number and weight of flower per hill and also the weight of flower per hill and per spike.

Trichoderma harzianum is a saprophytic fungus against a wide range of economically important aerial and soil borne plant pathogens and has been extensively studied as potential bio-control agents. However, some studies have also shown that it can stimulate the growth of a number of bedding plant crops (Baker and Cook, 1974).

CHAPTER III

MATERIALS AND METHODS

The field experiment was conducted to study the "Effect of organic manures, inorganic fertilizers and bio-control agent on yield and quality of gladiolus" during November 2014 to May 2015 at the Floriculture Research Field, Horticulture Research Centre of Bangladesh Agricultural Research Institute (BARI), Gazipur. The materials and methods that were used for conducting the experiment are presented in this chapter under the following headings.

3.1 Experimental site

The experiment was conducted at the Floriculture Research Field, Horticulture Research Centre of Bangladesh Agricultural Research Institute (BARI), Gazipur. The location of the site was about 35 km North of Dhaka city with $24^0 09'$ N latitude and $90^0 26'$ E longitude and elevation of 8.40 m from the sea level (Naznin *et al.*, 2015).

3.2 Agro-ecological Zone

The experimental field belongs the Agro-ecological zone of AEZ-28 under Modhupur Tract.

3.3 Soil

The soil of the experimental field was silty clay loam in texture and acidic in nature. Soil sample of the experimental plot was collected from a depth of 0-30 cm before conducting the experiment and analyzed in the Soil Science Division, Bangladesh Agricultural Research Institute (BARI), Gazipur and have been presented in Appendix-I.

3.4 Climate

The climate of experimental site was under the subtropical, characterized by three distinct seasons, the monsoon or the winter season from November to February and the pre-monsoon, period or hot season from March to April and the monsoon, period from May to October. The weather data of the growing period are presented in Appendix I.

3.5 Planting materials

Medium size (4.0-5.0 cm diameter) corm of gladiolus cultivar (GL-031) was selected as experimental materials.

3.6 Treatments

The experiment consisted of 8 treatments comprising different level of organic manure, fertilizer and bio-control agent:

T_1= Control (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

3.6.1 Farm yard manure

Farm yard manure is prepared basically using cow dung, cow urine, waste straw and other dairy wastes. Cow dung which gets in abundance was collected after cleaning cowshed in a pit close by and was allowed to decompose over a period of time. Every month this manure (compost) was applied to the plants or the field to enrich the soil (Plate1a).

3.6.2 Poultry manure

Poultry manure is basically a waste material which is organic in nature and comprises of urine and feces of animals which are related to poultry e.g. chicken. Poultry manure is a mixture of certain types of bedding material such as sawdust or wood shavings. The manure is acquired by cleaning of the poultry houses on regular basis where thin bedding layers are removed along with such manure (Plate 1b). So the manure which is basically the waste from chicken dropping and other mixtures, when used as fertilizer is called Chicken fertilizer.

3.6.3 Vermicompost

The cowdung collected from local cowshed was decomposed for 10 days before putting into vermicompost process. These were kept in a chari. Twenty kg of decomposed cowdung substrate was taken in a chari for vermicomposting. Two hundred gram of *Eisenia fetida* earthworms were introduced on the top of the substrate in the chari. The chari was covered on the top by jute cloth cover to prevent and protect the earthworms from predators. After 60-70 days, when the substrate looks tea like structure, the vermicompost was ready for use. This vermicompost was collected from Soil Science Division of BARI (Plate 1c).

3.6.4 Bokashi

Bokashi was made comprising fish meal, oil cake, bone meal, rice bran, poultry refuse @ 20 kg, 40 kg, 20 kg, 100 kg and 100 kg, respectively. After adding 50% water, the components were mixed together and 5 kg half fermented cowdung were added which contained effective micro-organism. Then the mixtures were piled for fermentation for several weeks. During fermentation temperature was raised upto 70^0C. While the temperature exceeded 55^0C the piled was broken for removing heat. Therefore, fermented compost namely ‘Bokashi’ ready to apply in the tuberose field collected from Vegetable Division of HRC, BARI which is high in NPK and other micronutrients (Plate 1d).

3.6.5 Trichocompost

Trichocompost, a Trichoderma based compost fertilizer, was developed by mixing a definite concentration of spore suspension of a *Trichoderma harzianum* strain with measured amounts of processed raw materials, such as cowdung, poultry refuse, water hyacinth, vegetable wastes, sawdust, maize bran and molasses (Plate 1e) collected from pathology section of HRC, BARI which is highly rich in various elements that may enrich soil fertility and provide nutrition to the crops and suppress soil borne fungal pathogens.

3.6.6 Tricholeachate

Tricholeachate, a liquid by-product of the Trichocompost, was obtained during decomposition of Trichocompost materials. Tricholeachate was collected from Plant Pathology Section of Horticulture Research Centre (HRC), BARI (Plate 1f).

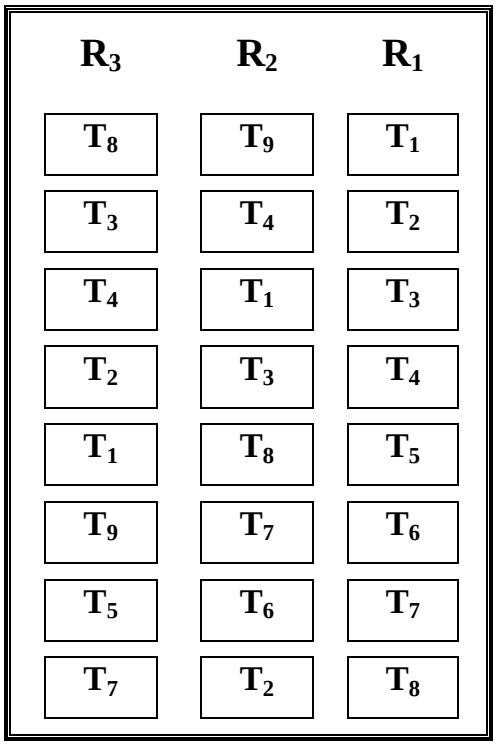
3.6.7 Mustard oil cake

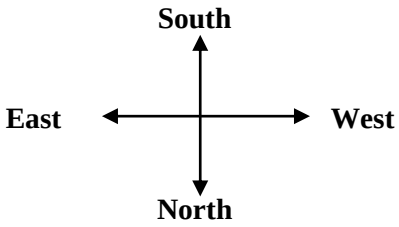
Mustard oil cakes are the by-products of mustard oil seed crop. Oil cakes are the important and quick acting organic nitrogenous manure. It also contain small amount of phosphorous and potassium. After drying and grinding it is ready for use in field (Plate 1g).

Plate 1. Organic manure and bio-control agent in gladiolus. (A) Farm yard manure ready for use. (B) Poultry manure ready for use. (C) Vermicompost ready for use. (D) Bokashi ready for use. (E) Mustard oil cake after grinding ready for use. (F) Tricho-compost ready for use. (G) Tricho-leachate ready for use

3.7 Design and Layout

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 × 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. Two adjacent unit plots were separated by 60 cm space and there was 80 cm space between the blocks.





Plot size = 2.0 × 1.5
Plant spacing = 20 × 20 cm
Block to block distance = 80 cm
Plot to plot distance = 60 cm

T_1= Control (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 and
T_8= Vermicompost (5 t/ha) + Trichocompost (3 t/ha) + ¼ RDF

Figure 1. Layout of the experiment

3.8 Land preparation

The experimental plot was first opened on last week of October 2014 with a power tiller for sun curing for 7 days before next ploughing. The land was then ploughed and cross ploughed several times using power tiller to obtain a good tilth. Ploughing was followed by laddering for breaking large soil clods and for leveling the land surface. The weeds and stubbles were removed from the land just after laddering with special care to remove the rhizomes of mutha grass.

3.9 Application of manure, fertilizer and bio-control agent doses

Well-decomposed cowdung, poultry manure, vermicompost, bokashi, tricho-compost, 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

Fertilizers	Dose/ha
N	200 kg
P	50 kg
K	150 kg
S	20 kg
B	2 kg
Zn	3 kg

(Source: Halder *et al*., 2007)

3.10 Planting of corms

Corms were thoroughly treated with fungicide Bavistin for 30 minutes and planted at a depth of 7 cm in furrows on March, 2014. Spacing was maintained at 20 cm from row to row and 20 cm from plant to plant.

3.11 Intercultural Operation

3.11.1 Weeding

Weeding was done periodically whenever necessary.

3.11.2 Irrigation

The experimental plot was irrigated as and when necessary during the whole period of plant growth following flood method.

3.11.3 Mulching

The soil was mulched frequently after irrigation by breaking the crust for easy aeration and to conserve soil moisture.

3.11.4 Earthing up

Three earthing ups at 30, 50 and 70 days after planting were done throughout the growing period.

3.11.5 Selections and tagging of plants

Ten plants from each plot were selected randomly and marked by tagging for recording data.

3.11.6 Harvesting

The spikes of gladiolus were harvested from January to February, 2015 at the tight bud stage and when three basal flower buds showed colour so that these may easily open indoors one by one (Bose *et al.*, 2003). Corm and cormel were harvested on May, 2015 when leaves turned brown (Khan, 2009).

3.11.7 Plant protection measure

Leaf blight disease is a serious problem for gladiolus cultivation. But the severity of this disease was not so prominent during the study period. Score @ 0.5 ml/L was applied once in a fortnight interval. Compared to disease, the insects of gladiolus are not so serious. Malathion @ 1 ml/L was applied to protect aphids and thrips.

3.12 Data collection

Observation were recorded from randomly chosen 10 plants from each plot on following parameters.

3.12.1 Days required to 80% emergence of the crop

It was recorded by counting the days from corm planting to 80% completion of emergence of the crop and expressed in days.

3.12.2 Plant height

Plant height refers to the total length of the 10 randomly selected plants from ground level to tip of erect leaf measured by a meter scale and the mean was calculated and expressed in centimeter.

3.12.3 Leaves/plant

Number of leaves per plant was recorded by counting all the leaves from 10 randomly plants of each unit plot and the mean was calculated.

3.12.4 Plant/hill

Number of plant per hill was recorded by counting all the plant per hill from 10 randomly plants of each unit plot and the mean was calculated.

3.12.5 Days required to 80% spike initiation

It was recorded by counting the days from corm planting to 80% spike initiation from randomly selected 10 plants in each plot, then averaged and expressed in days.

3.12.6 Florets number/spike

It was recorded by counting number of florets from 10 randomly selected spikes and then mean was calculated.

3.12.7 Spike length

It was measured from the end where from it was cut off at the base to the tip of the spike by measuring scale from 10 randomly selected spikes and then mean was calculated and expressed in centimeter.

3.12.8 Rachis length

Length of rachis refers to the length from the axils of first floret up to the tip of inflorescence.

3.12.9 Spike weight

Ten spikes were cut from randomly selected plants from each unit plot and the weights of spikes were recorded to calculate their mean and expressed in grams.

3.12.10 Flower durability

Flower durability was recorded from the time of first floret opening to the maximum freshness in 10 randomly selected spikes and expressed in days.

3.12.11 Flower yield/ha

Flower yield per hectare was computed by counting numbers of spikes per plot and converted to hectare.

3.12.12 Corm number

It was calculated from the number of corm obtained from ten randomly selected plants and mean was calculated.

3.12.13 Corm weight

It was determined by weighting the corm from ten randomly selected plants, their mean weight was calculated and expressed in grams.

3.12.14 Corm diameter

Diameter of harvested corm was measured by using slide calipers from 10 randomly selected plants, averaged and expressed in centimeter.

3.12.15 Cormel number

It was calculated from the number of cormel obtained from ten randomly selected plants and mean was calculated.

3.12.16 Cormel weight

Weight of cormel/plant was recorded from the mean weight of cormel randomly selected sample plants and expressed in grams.

3.13 Statistical Analysis

The recorded data on different parameters were statistically analyzed using 'MSTAT-C' software to find out the significance of variation resulting from the experimental treatments. 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 Steel *et al*. (1997) at 5% level of probability. The analysis of variance (ANOVA) of the data on different characters of gladiolus is given in Appendix III-V.

CHAPTER IV

RESULTS AND DISCUSSION

The experiment was carried out to study effect of organic manure, inorganic fertilizer and bio-control agent on yield and quality of gladiolus. The analysis of variance (ANOVA) of the data on different growth parameter, flowering duration, yield of flower and corm are presented in Appendix III-V. The results have been presented and discussed, and possible interpretations given under the following headings:

4.1 Plant emergence (%)

The effect of different organic manure, inorganic fertilizer and bio-control agent on percent emergence of gladiolus plant is shown in Figure 2. 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). 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.

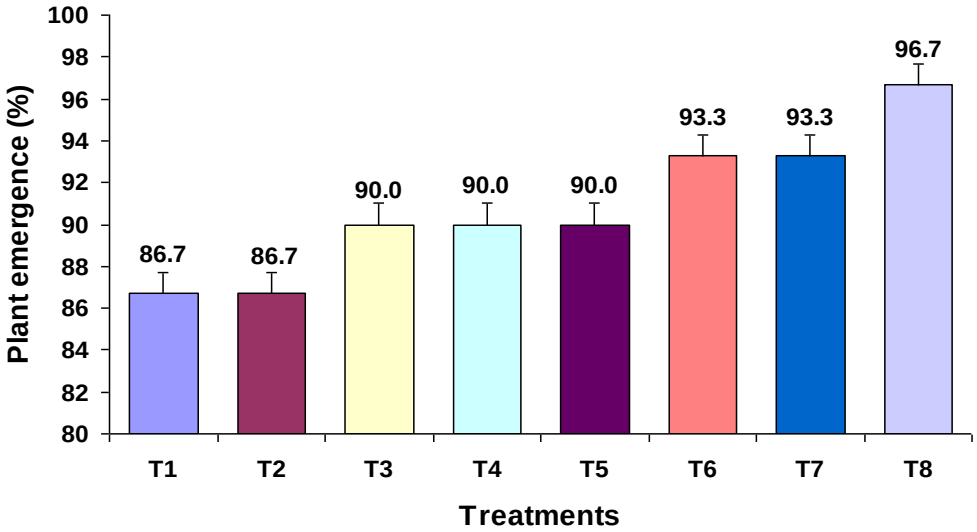


Figure 2. Effect of organic manure, fertilizer and bio-control agent on plant emergence of gladiolus

T_1= Control (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 and T_8= Vermicompost (5 t/ha) + Trichocompost (3 t/ha) + ¼ RDF

4.2 Plant height

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 (Appendix III). At the different days after planting (DAP) 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 (control i.e. absolute use of chemical fertilizer) respectively (Fig. 3). Gladiolus is a gross feeder and requires a large quantity of NPK in the form of organic and inorganic fertilizers (Halder *et al.* 2007). 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 Shankar *et al.* (2010) and Prakash *et al.* (2015) in gladiolus.

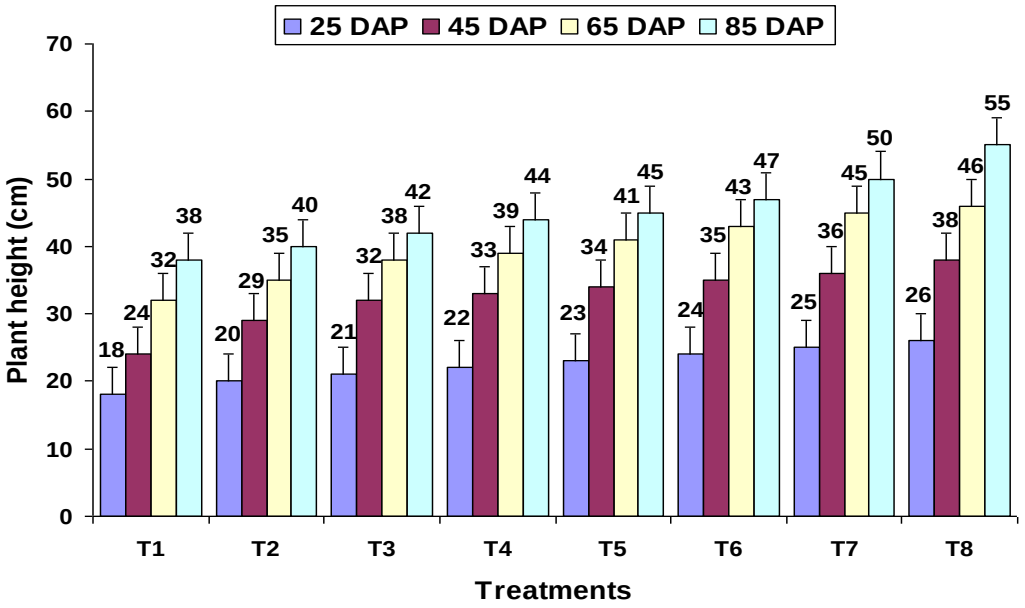


Fig. 3: Effect of organic manure, fertilizer and bio-control agent on plant height of gladiolus

T_1= Control (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 and T_8= Vermicompost (5 t/ha) + Trichocompost (3 t/ha) + ¼ RDF

4.3 Days to sprouting

The variation among the treatments in respect of days to sprouting of corm per plant was found significant (Table 1). 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)) while the corms under T_1 treatment (control) required maximum time (12 days). The earliest emergence of corms in T_6, T_7 and T_8 might be due to the early absorption of N, P and K increased the availability of micronutrients as well as plant hormones due to which the time taken for emergence of corms was reduced significantly. Singh *et al.* (2015) reported similar results in gladiolus flowers.

Table 1. 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**

T_1= Control (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 and T_8= Vermicompost (5 t/ha) + Trichocompost (3 t/ha) + ¼ RDF

4.4 Number of leaves per plant

The result revealed that there was a significant variation in number of leaves per plant due to the effect of different treatments (Table 1). The maximum number of leaves were found in T_8 (Vermicompost 5 t/ha + Tricho-compost 3 t/ha + ¼ RDF) treatment (10.5) which was statistically similar to T_7 (10.4). The lowest numbers of leaves/plant were found in control treatment (8.0). The results indicated that nitrogenous element in organic form enhanced to constitute chlorophyll which leads to better leaves over control treatment. Dubey *et al.* (2008) and Singh (2005) reported that the profound effect of nitrogen fertilization on anatomical structure of gladiolus resulted production of more number of leaves.

4.5 Number of plant per hill

Different levels of organic manure, fertilizer and bio-control agent showed a statistically significant difference for number of plants/hill at flower harvest under the present study (Appendix III). The maximum (2.5) number of plants/hill was recorded at T_8 (Vermicompost 5 t/ha + Trichocompost 3 t/ha + ¼ RDF) followed by T_7 (Poultry manure 5 t/ha + Trichocompost 3 t/ha + ¼ RDF) (1.8). On the other hand the minimum (1.0) number of plants/hill was recorded in the plot with control condition i.e. absolute use of chemical fertilizer. 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, trichocompost and quarter recommended dose of fertilizer. The observed results are in agreement with the findings of Naznin *et al.* (2015) and Reshma *et al.* (2013) in flower crops. They reported that application of vermicompost, and trichocompost along with fertilizer had tremendous effects on plant growth and development in gladiolus.

4.6 Days required to 80% spike initiation

Days required to 80% spike initiation showed variation for different treatment (Fig. 4). 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 Naznin *et al*. (2015); Nambisan and Krishran (1983) and Gupta *et al.* (2008). 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 Tripathi *et al.* (2013) in tuberose and Narendra *et al*. (2013) in gladiolus.

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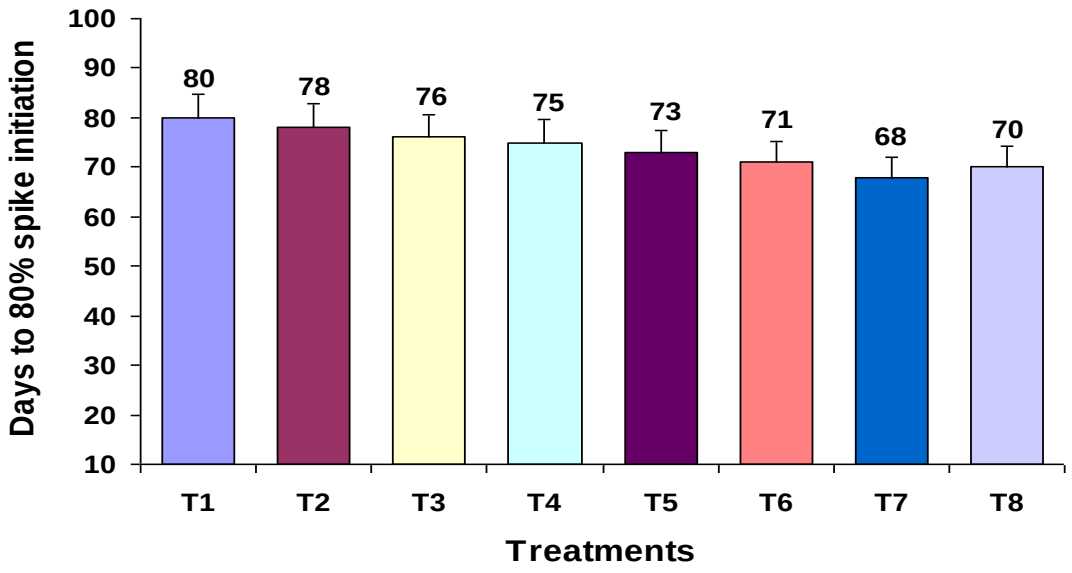

Figure 4. Effect of organic manure, fertilizer and bio-control agent on 80% spike initiation of gladiolus

T_1= Control (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 and T_8= Vermicompost (5 t/ha) + Trichocompost (3 t/ha) + ¼ RDF

4.7 Spike length

Length of flower spike for different treatments showed variation due to different treatments in gladiolus (Table 2). The longest (78.0 cm) length of flower spike was recorded in T_8 and the shortest spike length was found in control (68.5 cm) treatment (Plate 2). The increased spike length was probably due to presence of macro and micro nutrients in vermicompost and their efficient absorption due to presence of vermicompost in the media which showed the better vegetative and reproductive growth of the plant in T_8. These results are similar to the work of Tripathi *et al.* (2012) who found that spike length was increased with the application of vermicompost and trichocompost along with ¼ RDF fertilizers.

Plate 2. Effect of organic manure, fertilizer and bio-control agent on spike length of gladiolus

T_1= Control (Recommended dose of fertilizer) (N_{200} P_{50} K_{150} S_{20} B_2 Zn_3 kg/ha) ;
T_8= Vermicompost (5 t/ha) + Trichocompost (3 t/ha) + ¼ RDF

Table 2. 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	70.0 bc	35.0 bc	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	41.0 ab	62.8 ab
T_7	75.2 ab	41.3 ab	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**

T_1= Control (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 and T_8= Vermicompost (5 t/ha) + Trichocompost (3 t/ha) + ¼ RDF

4.8 Rachis length

Different treatments of organic manure, fertilizer and bio-control agent had significant effect on the length of rachis in gladiolus (Plate 3). The rachis length ranged from 43.5 to 43.5 cm. The 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 results are in partial agreement with Gupta *et al.* (2008) and Rajiv and Misra (2003), where they reported that the length of rachis in flowers was increased with the use of organic manure with trichocompost instead of synthetic fertilizer.

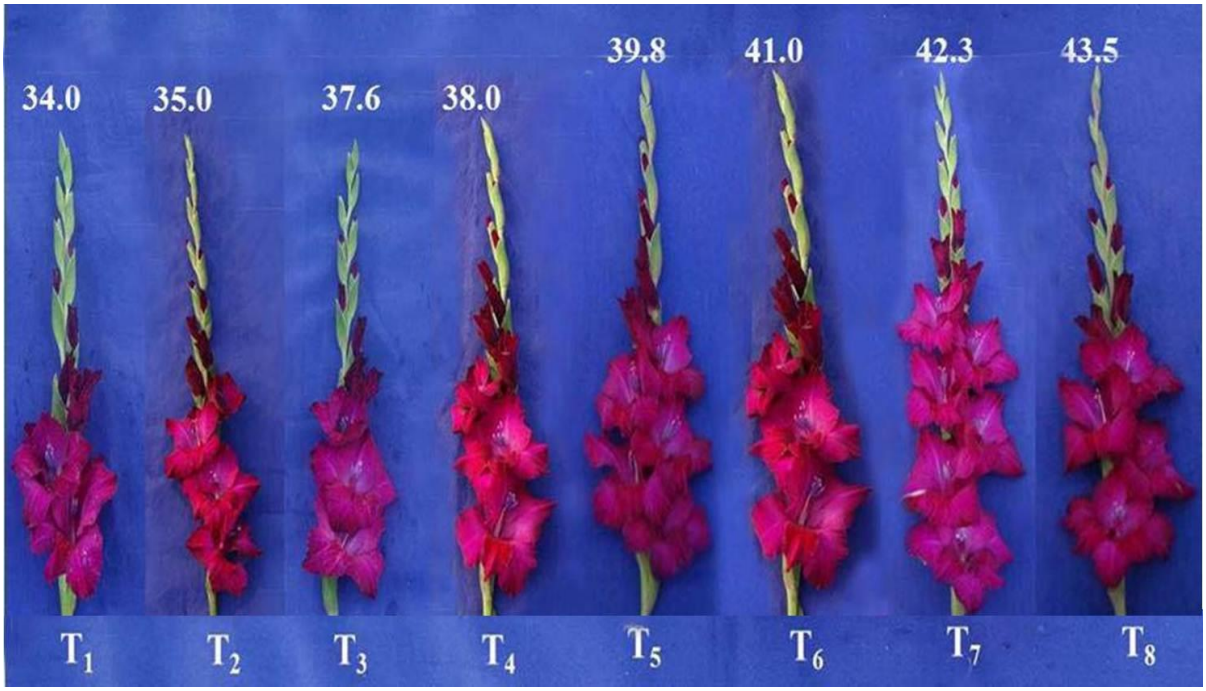

Plate 3. Effect of organic manure, fertilizer and bio-control agent on rachis length of gladiolus

T_1= Control (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 and T_8= Vermicompost (5 t/ha) + Trichocompost (3 t/ha) + ¼ RDF

4.9 Floret number

The floret number is an important parameter of gladiolus. Variation was recorded for number on floret/spike for different treatments under the investigation (Fig. 5). The maximum number of florets was found in T_8 (16) (Plate 4). 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 Pathak and Kumar (2009) and Preethan *et al*. (2010) in gladiolus.

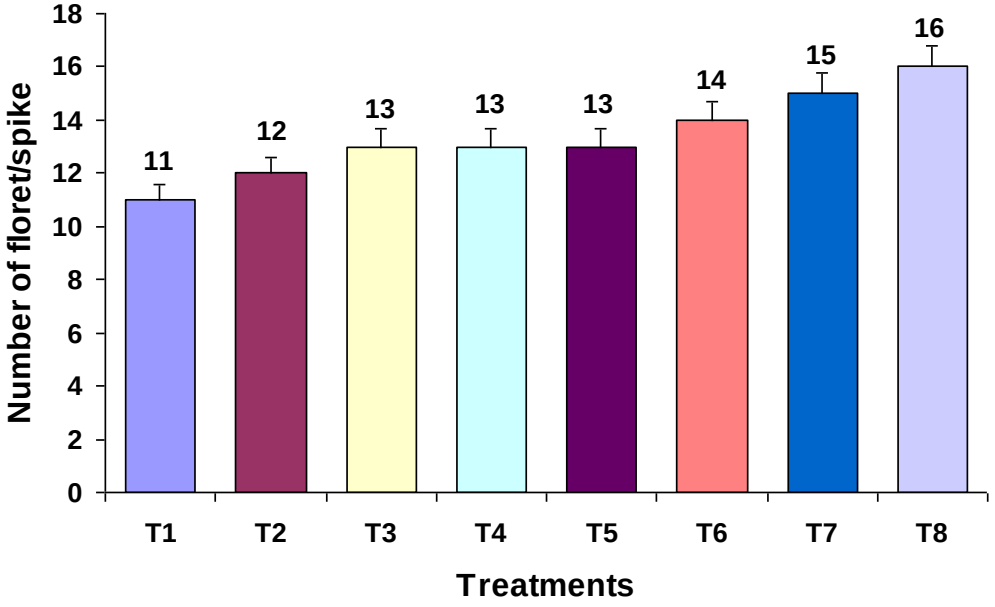

Figure 5. Effect of organic manure, fertilizer and bio-control agent on floret number of gladiolus

T_1= Control (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 and T_8= Vermicompost (5 t/ha) + Trichocompost (3 t/ha) + ¼ RDF

Plate 4. Floret number of gladiolus influenced by vermicompost 5 t/ha + trichocompost 3 t/ha+ ¼ RDF

4.10 Spike weight

It was revealed from Table 2 that different treatment of organic manure, fertilizer and bio-control agent had significant effect on spike weight. The maximum weight of spike was obtained in T_8 (65.0 g) treatment closely followed by T_7 (63.0 g) treatment and the minimum in treatment T_1 (55.0 g) and was statistically comparable to the remaining treatments. This might be due to the fact that the spikes obtained from plants supplied with vermicompost and trichocompost with ¼ RDF fertilizer had more number of florets per spike. Spike with good quality attributes like spike length, rachis length inturn had increased number of florets with increased length and diameter which inturn increased their fresh weight (Table 2). This might be due to the fact that these plants had put forth good vegetative growth which enabled the plants to produce more photosynthates and supply to spikes for their development. 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 (Padaganur *et al*. 2005). Similar improvement in quality by the incorporation of vermicompost was reported by Dongardive *et al.* (2007) and Ranjan and Manse (2007) in gladiolus.

4.11 Yield of spike

The maximum number of flowering spike 200000/ha was produced in T_8 (Vermicompost 5 t/ha + trichocompost 3 t/ha+ ¼ RDF) which was superior to other treatments. The second highest number of flowering spikes per hectare (195000) was recorded in T_7 (Poultry refuse 5 t/ha + trichocompost 3 t/ha+ ¼ RDF). 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. Similar trend has also been reported by Sisodia *et al.* (2015) in tuberose flower and Rajiv *et al*. (2006) in gladiolus flower.

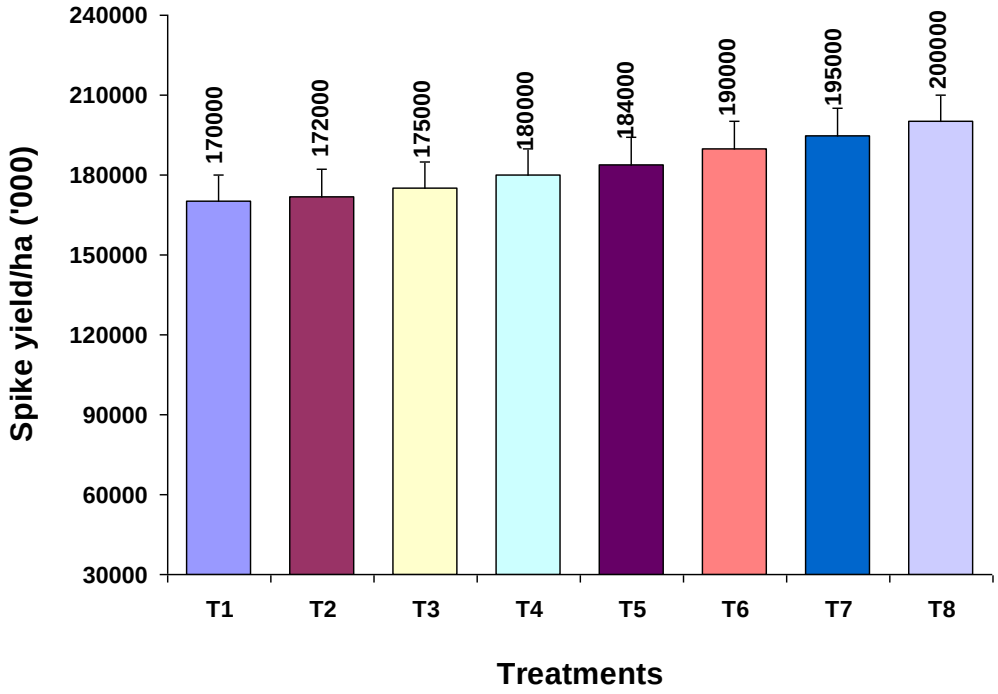

Figure 6. Effect of organic manure, fertilizer and bio-control agent on spike yield of gladiolus

T_1= Control (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 and T_8= Vermicompost (5 t/ha) + Trichocompost (3 t/ha) + ¼ RDF

4.12 Flower durability

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). 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. It might also be due to the presence of ethylene inhibitors or due to presence of cytokinins which delay senescence of florets. The findings were in conformity with the finding of Kusuma (2000) and Dongardive (2007) in gladiolus. The minimum flowering duration was in T_1 (11 days).

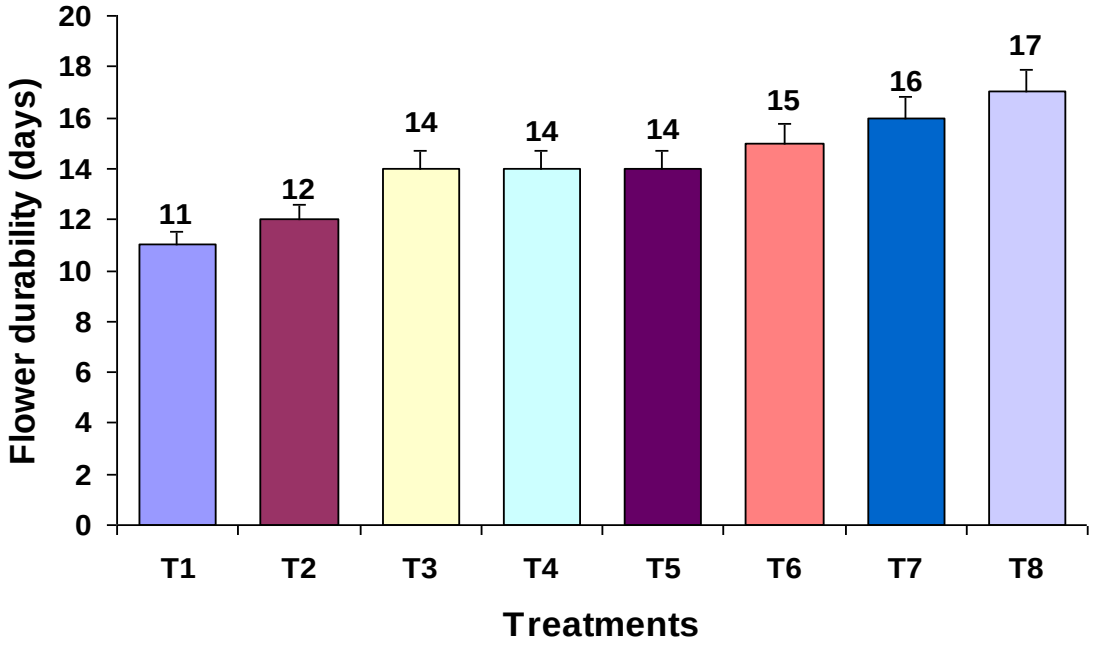

Figure 7. Effect of organic manure, fertilizer and bio-control agent on flower durability of gladiolus

T_1= Control (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 and T_8= Vermicompost (5 t/ha) + Trichocompost (3 t/ha) + ¼ RDF

4.13 Number of corm/hill

Number of corm per hill showed significantly difference among the treatments (Table 3). The maximum number of corm/hill (2.0) was found in T_8 (Vermicompost 3 t/ha + trichocompost 3 t/ha + ¼ RDF) which was significantly higher than all other treatments. The lowest number of corm per hill (1.0) was observed in T_1 (control). Beneficial effect of nutrient sources like vermicompost, trichocompost have great influence of corm production in gladiolus (Kukde *et al.* 2006). The higher number of corm in organic amendments and trichocompost applied plants along with chemical fertilizers (¼ RDF) might be produced more assimilates by greater number of leaves. These results were in line as reported by Gupta *et al.* (2008) and Prokash *et al.* (2015) in gladiolus.

4.14 Number of cormel/hill

Number of cormel /hill showed a statistically significant variation for different treatments under present study (Appendix V). The maximum number of cormel/hill (20.0) was recorded in T_8 (Vermicompost 5 t/ha + trichocompost 3 t/ha + ¼ RDF) (17 days) followed by T_7 (17.0) (Poultry manure 5 t/ha + trichocompost 3 t/ha + ¼ RDF) (Plate 5). This may be due to improvement of nutrient availability to the plants. The findings of present study are also confirmed with the results of Sushma and Aruna (2008) in gladiolus. The treatment T_1 produced minimum number of cormel (10.0) (Table 3).

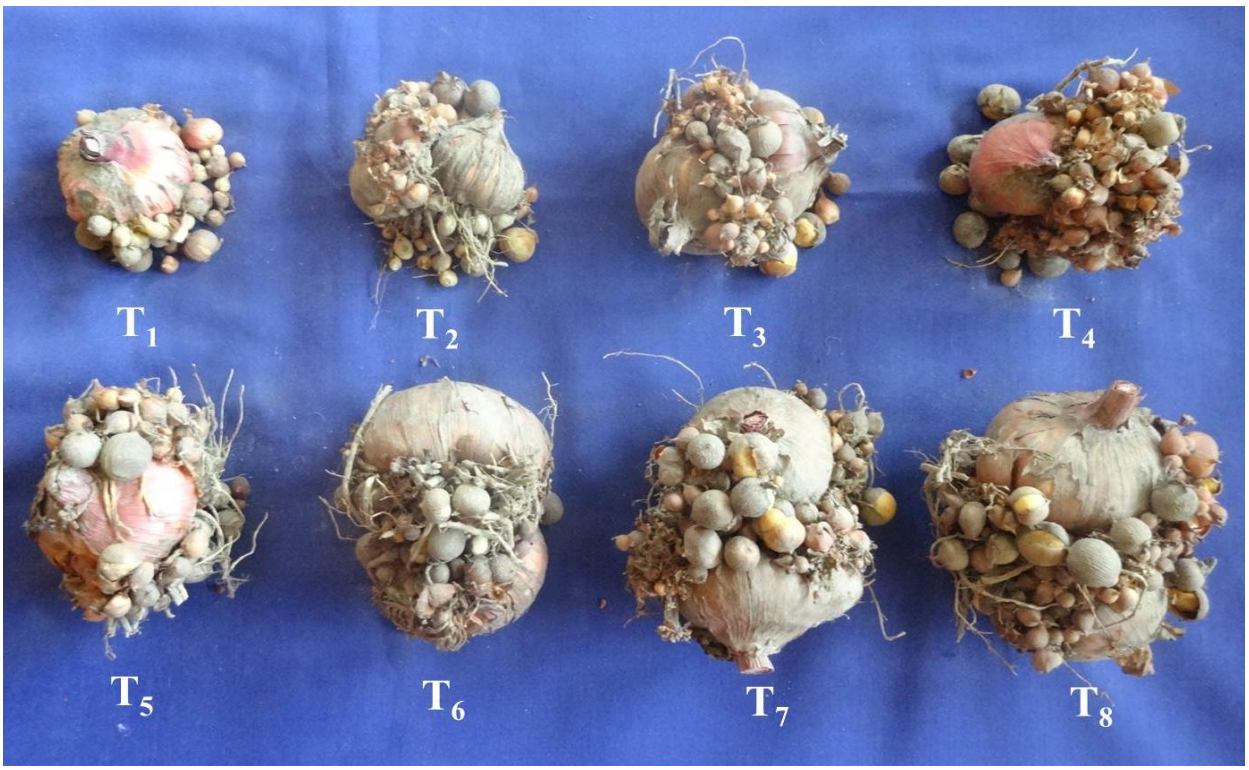

Plate 5. Cormel number of gladiolus influenced by organic manure, fertilizer and bio-control agent

T_1= Control (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 and T_8= Vermicompost (5 t/ha) + Trichocompost (3 t/ha) + ¼ RDF

Table 3. 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**

T_1= Control (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 and T_8= Vermicompost (5 t/ha) + Trichocompost (3 t/ha) + ¼ RDF

4.15 Corm diameter

Data on the effect of different level of organic manure, fertilizer and bio-control agent on gladiolus corm diameter are presented in Table 3. The largest corm (5.8 cm) was produced in T_8 (Vermicompost 5 t/ha + trichocompost 3 t/ha + ¼ RDF) which were different from other treatments (Plate 6). The smallest corm (4.7 cm) obtained from control. According to Shankar and Dubey *et al.* (2005), the corm diameter was enhanced when vermicompost and trichocompost along with organic fertilizer (¼ RDF) was applied in gladiolus field.

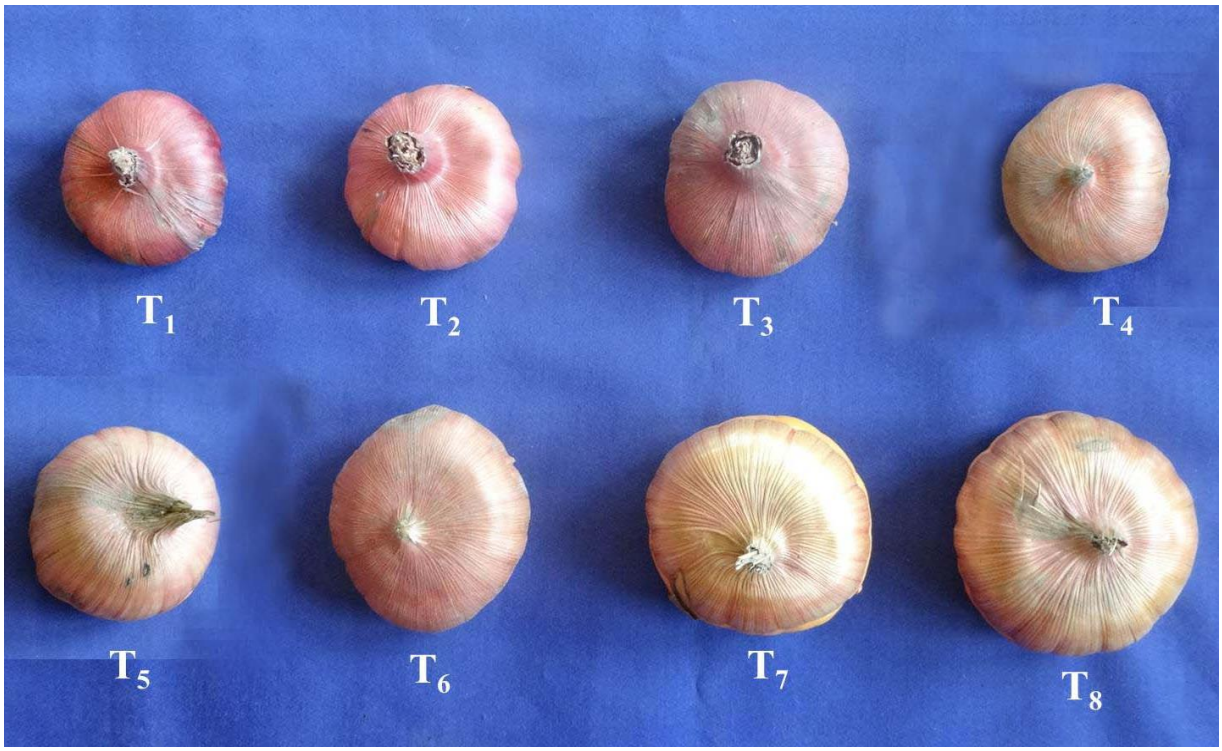

Plate 6. Corm diameter influenced by organic manure, fertilizer and bio-control agent

T_1= Control (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 and T_8= Vermicompost (5 t/ha) + Trichocompost (3 t/ha) + ¼ RDF

4.16 Corm weight

Weight of individual corm showed statistically significant variation for different treatments under the present investigation (Table 3). The maximum weight (60.0g) of individual corm was recorded in T_8 (Vermicompost 5 t/ha + trichocompost 3 t/ha + ¼ RDF) which was statistically different from other treatments and the minimum weight (50.0 g) of individual corm was recorded in T_1 (Control). 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 Padaganur *et al.* (2005) and Reshma *et al.* (2013) in gladiolus.

4.17 Cormel weight

A statistically significant variation was recorded for different treatments in terms of 10 cormel weight. The highest weight (42.0 g) of 10 cormel weith was recorded in T_8 (Vermicompost 5 t/ha + trichocompost 3 t/ha + ¼ RDF). On the other hand, the lowest (30.0 g) weight was recorded in control condition. Shashikanth (2005) and Kazal *et al.* (2011) which supports the present findings in gladiolus.

4.18 Insect and disease reaction

Gladiolus is susceptible to several insect and disease which adversely affect the quality and quantity of the crop. The crop is mostly infested by aphid, thrips and mites (Bose *et al.*, 2003). The major diseases like *Fusarium* rot, leaf spot occurred in gladiolus (Rabbi, 2008). Misra and Singh (1999) reported very few diseases and pest occur in gladiolus. Fusarium rot, leaf spot disease, aphid and mite infestation in gladiolus were not found in case of treatment T_8 (Vermicompost 5 t/ha + trichocompost 3 t/ha + ¼ RDF), T_7 (Poultry manure 5 t/ha + trichocompost 3 t/ha + ¼ RDF) and T_6 (Farmyard manure 5 t/ha + trichocompost 3 t/ha + ¼ RDF). The highest disease incidence and insect infestation was observed in T_1 (Recommended fertilizer dose) (Table 4). The results are in partial agreement with Sharma *et al.* (2004), Islam (2011) and Dubey *et al.* (2008) in gladiolus.

Table 4. Disease incidence and insect infestation in gladiolus

Treatments	Disease incidence			Insect infestation		
	Fusarium rot	Leaf spot	Powdery mildew	Mite	Aphid	Thrips
T_1	+++	+++	Nil	3	3	Nil
T_2	++	++	Nil	2	2	Nil
T_3	+	+	Nil	1	1	Nil
T_4	+	+	Nil	1	1	Nil
T_5	+	+	Nil	1	1	Nil
T_6	-	-	Nil	0	0	Nil
T_7	-	-	Nil	0	0	Nil
T_8	-	-	Nil	0	0	Nil

0 = No population; 1 = Less, 2= Medium, 3 = High and - = Nil; + = Less; ++ = Medium; +++ = High

CHAPTER V
SUMMARY AND CONCLUSION

Summary

An investigation was carried out at Floriculture Experimental Field of Horticulture Research Centre, Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur during November 2014 to May 2015 to study the growth, yield and quality of gladiolus as influenced by organic manure, fertilizer and bio-control agent namely T_1= Control (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 and T_8= Vermicompost (5 t/ha) + Trichocompost (3 t/ha) + ¼ RDF.

The experiment was laid out in a Randomized Complete Block Design with three replications. The unit plot size was 2.0 m × 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. The spikes of gladiolus were harvested from January to February, 2015 at the tight bud stage and when three basal flower buds showed colour so that these may easily open indoors one by one. Corm and cormel were harvested on May, 2015 when leaves turned brown.

Data were collected from 10 randomly selected plants of each unit plot. Observation were made on plant emergence (%), plant height, days to sprouting, number of leaves, number of plant per hill, plant spread, spike length, rachis length, number of florets per spike, spikes weight, days to 80% spike initiation, flower durability, spike yield, number of corm, cormel number, 10 cormel weight, corm and cormel yield etc.

Analysis of variance data revealed that all the studied growth, yield (flowering as well as corm and cormel production) and yield contributing characters of gladiolus varied significantly at 5% level of probability due to influence of organic manure fertilizer and bio-control agent. The variation among the treatments in respect of plant emergence %, and days to sprouting of corm was found significant. The corms under T_8 treatment (Vermicompost 5 t/ha + Trichocompost 3 t/ha + ¼ RDF) showed highest emergence of plants (96.7%) followed by T_7 and T_6 (93.3% plant emergence). The lowest emergence percentage was noted in T_1 and T_2 (86.7%).The corms under T_6 treatment (Farmyard manure 5 t/ha + Trichocompost 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 + Trichocompost 3 t/ha + ¼ RDF) while the corms under T_1 treatment (control) required maximum time (12 days).

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. At the different days after planting (DAP), 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 (control i.e. absolute use of chemical fertilizer) respectively.

The maximum number of leaves were found in T_8 (Vermicompost 5 t/ha + Trichocompost 3 t/ha + ¼ RDF) treatment (10.5) which was statistically similar to T_7 (10.4). The lowest numbers of leaves/plant were found in control treatment (8.0). Maximum plants/hill was recorded in T_8 treatment (2.5) which was statistically different from the other treatments. The second highest plants/hill (1.8) was recorded in T_7 treatment. The minimum plants/hill (1.0) was observed in control treatment.

Days required to 80% spike initiation showed variation for different treatment. The minimum days required for corm planting to 80% spike initiation was recorded in T_7 (68 days) followed by T_8 (70 days).

Length of flower spike for different treatments showed variation due to different treatments in gladiolus. The longest (78.0 cm) length of flower spike was recorded in T_8 and the shortest spike length was found in control (68.5 cm) treatment. The rachis length ranged from 34.0 to 43.5 cm. The 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 floret number is an important parameter of gladiolus. Variation was recorded for number on floret/spike for different treatments under the investigation. 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).

It was revealed that different treatment of organic manure, fertilizer and bio-control agent had significant effect on spike weight. The maximum weight of spike was obtained in T_8 (65.0 g) treatment closely followed by T_7 (63.0 g) treatment and the minimum in treatment T_1 (55.0 g) and was statistically comparable to the remaining treatments.

The maximum number of flowering spike 200000/ha was produced in T_8 (Vermicompost 5 t/ha + Trichocompost 3 t/ha+ ¼ RDF) which was superior to other treatments. The second highest number of flowering spikes per hectare (195000) was recorded in T_7 (Poultry refuse 5 t/ha + Trichocompost 3 t/ha+ ¼ RDF). 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).

Number of corm per hill showed significantly difference among the treatments. The maximum number of corm/hill (2.5) was found in T_8 (Vermicompost 3 t/ha + Trichocompost 3 t/ha + ¼ RDF) which was significantly higher than all other treatments. The lowest number of corm per hill (1.0) was observed in T_1 (control). Number of cormel /hill showed a statistically significant variation for different treatments under present study. The maximum number of cormel/hill (20.0) was recorded in T_8 (Vermicompost 5 t/ha + Trichocompost 3 t/ha + ¼ RDF) followed by T_7 (17.0) (Poultry manure 5 t/ha + trichocompost 3 t/ha + ¼ RDF).

The largest corm (5.8 cm) was produced in T_8 (Vermicompost 5 t/ha + Trichocompost 3 t/ha + ¼ RDF) which were different from other treatments. The smallest corm (4.5 cm) obtained from control.

Weight of individual corm showed statistically significant variation for different treatments under the present investigation. The maximum weight (60.0g) of individual corm was recorded in T_8 (Vermicompost 5 t/ha + Trichocompost 3 t/ha + ¼ RDF) which was statistically different from other treatments and the minimum weight (50.0 g) of individual corm was recorded in T_1 (Control). A statistically significant variation was recorded for different treatments in terms of 10 cormel weight. The highest weight (42.0 g) was recorded in T_8 (Vermicompost 5 t/ha + trichocompost 3 t/ha + ¼ RDF). On the other hand, the lowest (30.0 g) weight of ten cormels was recorded in control condition.

Gladiolus is susceptible to several insect and disease which adversely affect the quality and quantity of the crop. Fusarium rot, leaf spot disease, aphid and mite infestation in gladiolus were not found in case of treatment T_8 (Vermicompost 5 t/ha + Trichocompost 3 t/ha + ¼ RDF), T_7 (Poultry manure 5 t/ha + Trichocompost 3 t/ha + ¼ RDF) and T_6 (Farmyard manure 5 t/ha + Trichocompost 3 t/ha + ¼ RDF). The highest disease incidence and insect infestation was observed in T_1 (Control).

Conclusion

- 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.

- Therefore, it is beneficial for gladiolus cultivation and may be recommended for flower, corm and cormel production and flower durability of gladiolus.

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APPENDICES

Appendix I. Mean monthly weather data during October 2014 to May 2015

Year	Month	Air temperature (°C)		Relative Humidity (%)	Rainfall (mm)
		Max.	Min.		
2014	October	29.75	26.80	85.28	183.40
2014	November	26.22	22.75	80.17	07.50
2014	December	19.90	15.45	89.05	00.00
2015	January	16.38	11.55	90.15	00.00
2015	February	25.70	19.70	88.50	06.54
2015	March	32.25	25.98	70.30	06.60
2015	April	33.10	29.00	75.00	58.50
2015	May	35.40	28.42	77.50	240.10

Source: Bangladesh Agricultural Research Institute, (BARI), Gazipur

Appendix II. Analytical data of soil sample at Floriculture field of HRC, BARI

Year	p^H	Total N	OM	Ca	Mg	K
		%		Meq/100g		
2014	6.1	0.077	1.46	4.76	1.97	0.15
Critical level	-	-	-	2.0	0.8	0.2

Appendix II. Cont'd.

Year	p^H	P	S	B	Cu	Fe	Mn	Zn
		µg/g						
2014	6.1	15	38	0.32	6.0	232	10	3.30
Critical level	-	14	14	0.2	1.0	10.0	5.0	2.0

Source: Soil Science Division, Bangladesh Agricultural Research Institute, (BARI), Gazipur

Appendix III. Analysis of variance of the data on different plant characters of gladiolus as influenced by organic manure, fertilizer and bio-control agent

Sources of variation	Degrees of freedom	Mean sum of square				
		Plant emergence %	Days to sprouting	Plant height	Leaf number	Plant/ hill
Replication	2	04.65	05.50	10.15	22.63	03.81
Treatment	7	105.40*	110.15*	236.40*	390.12*	213.12*
Error	14	06.20	05.50	07.30	04.50	05.52

* = Significant at 5% level of probability

Appendix IV. Analysis of variance of the data on different flower characters of gladiolus as influenced by organic manure, fertilizer and bio-control agent

Sources of variation	Degrees of freedom	Mean sum of square						
		Days to 80% spike initiation	Spike length	Rachis length	Floret number	Spike weight	Flower durability	Flower yield
Replication	2	4.50	2.06	2.40	2.57	7.58	11.00	1.28
Treatment	7	45.30*	219.30*	472.56*	640.50*	265.21*	19.25*	615.20*
Error	4	4.25	4.93	3.46	4.30	3.45	4.65	4.73

* = Significant at 5% level of probability

Appendix V. Analysis of variance of the data on different corm characters of gladiolus as influenced by organic manure, fertilizer and bio-control agent

Sources of variation	Degrees of freedom	Mean sum of square				
		Corm number	Corm diameter	Corm weight	Cormel number	10 Cormel weight
Replication	2	0.81	9.35	13.50	2.25	27.75
Treatment	7	11.04*	10.45*	17.50*	20.40*	65.45*
Error	14	4.50	4.21	10.25	11.58	6.27

* = Significant at 5% level of probability