INFLUENCE OF ORGANIC AMENDMENTS AND BIO-CONTROL AGENT ON GROWTH AND YIELD OF GERBERA

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INFLUENCE OF ORGANIC AMENDMENTS AND BIO-CONTROL AGENT ON GROWTH AND YIELD OF GERBERA

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CERTIFICATE

*This is to certify that thesis entitled, "**INFLUENCE OF ORGANIC AMENDMENTS AND BIO-CONTROL AGENT ON GROWTH AND YIELD OF GERBERA**" submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE in HORTICULTURE**, embodies the result of a piece of bonafide research work carried out by **MD. ARIFUZZAMAN**, Registration No. 13-05463 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.

Dated: June, 2021
Place: Dhaka, Bangladesh

Khairul Kabir
Associate Professor
Supervisor

Dedicated to
My
Beloved Parents

LIST OF ABBREVIATIONS

FULL WORD		ABBREVIATION
Analysis of variance	=	ANOVA
And others (at elli)	=	*et al.*
Boron	=	B
Carbon: Nitrogen	=	C:N
Centimeter	=	cm
Complete Randomized Design	=	CRD
Cultivar	=	cv.
Days After Transplanting	=	DAT
Degree Celceous	=	^{o}C
Farmyard manure	=	FYM
Gram (s)	=	g
Hectare	=	ha
id est (L), that is	=	i.e.
Kilogram (s)	=	Kg
Least Significant Difference	=	LSD
Litre	=	L
Microgram	=	µg
Milliequivalent	=	meq
Milligram	=	mg
Millileter	=	ml
Millimeter	=	mm
Namely	=	viz.
Parts per million	=	ppm
Percent Coefficient of Variation	=	CV %
Percentage	=	%
Phosphorus	=	P
Potassium	=	K
Recommended Dose of Fertilizers	=	RDF
Species pluralis	=	spp.
Square Centimeter	=	cm^2
Square meter	=	m^2
Sulphur	=	S

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The author

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INFLUENCE OF ORGANIC AMENDMENTS AND BIO-CONTROL AGENT ON GROWTH AND YIELD OF GERBERA

ABSTRACT

The experiment was conducted in the Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka, during the period from December 2019 to July 2020 to study the influence of organic amendments and bio-control agent on growth and yield of gerbera**.** The single factor experiment consisted of five treatments namely: T_1= Farmyard manure (3 t/ha) + ¼ RDF, T_2= Vermicompost (3 t/ha) + ¼ RDF, T_3= Trichocompost (3 t /ha) + ¼ RDF, T_4= Tricholeachate (3000 L/ha) + ¼ RDF and T_5= Control (Recommended doses of fertilizers: N_{150} P_{30} K_{100} S_{20} B_1 Zn_1 kg/ha). 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 maximum vegetative and flowering characters were recorded in T_3= Trichocompost (3 t/ha) + ¼ RDF which were statistically superior to other treatments. T_3 produced maximum plant height, number of leaves per plant, plant spread and number of suckers per plant. Days taken to flower bud initiation and full bloom from bud open varied greatly among cultivars under the study. T_3 took least number of days for bud initiation (68.33 days) and full bloom (7.15 days) respectively. For flower characteristics, T_3 showed the maximum number of ray floret (48.0), the longest flower stalk (57.11 cm), maximum flowers per plant (12.70) and possessed the longest vase life (14.67 days). The largest flower diameter (10.78 cm) was found in T_3 and the smallest was in T_5 (8.07 cm). Considering the important characteristics, the data obtained from the experiment showed that trichocompost with fertilizer enhanced qualitative and quantitative characters of gerbera.

CHAPTER I

INTRODUCTION

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Gerbera (*Gerbera jamesonii* L.) commonly known as Transval Daisy or African Daisy, a prominent member of Asteraceae family. There are about 70 species of Gerbera (Norberto, 2010). The genus *Gerbera* was named in honour of German botanist and medical doctor Traugott Gerber and the species *jamesonii* in honour of Captain Jameson (Noor-E-Alam, 2015). Gerbera produces attractive flowers known as head or capitulum. The plant is dwarf herbaceous perennial and grows in clump with solitary flower heads on a long slender stalk, which grows well above the foliage. Gerbera as a cut flower has tremendous demand in domestic and international markets (Sahu *et al.*, 2017). Thousands of cultivars exist they vary greatly in shape and size. Colours include white, yellow, orange, red and pink. The center of the flower is sometimes black. Often the same flower can have petals of several different colours. Gerbera is also important commercially. It is the fifth most used cut flower in the world (after rose, carnation, chrysanthemum and tulip). It is also used as a model organism in studying flower formation. Gerbera contains naturally occurring coumarin derivatives. It is attractive to bees, butterflies and birds (Ayemi *et al.*, 2017). Variety in colour has made this flowering plant attractive for use in decorations, such as cut flowers, herbaceous borders, bedding and potted plants for its long vase life. It ranks fourth in the international cut flower trade and a popular cut flower in Holland, Germany and USA. With the increase in economic importance of ornamentals in many countries, the international demand for gerbera flowers has also rapidly increased and become one of the most important commercial cut flowers for presentation and interior decoration (Kallol and Biradar, 2016).

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; Mitra, 2010) and improve flower quality.

The eco-friendly nature of organic manures provides healthy environment as sustainability to horticulture. Profit from the cultivation of flowers by application of organic manures, the quality of flowers can be enhanced. Now a days use of organic manures has played significant role in floriculture. Modern agriculture is based on the use of organic manures, which play a major role for producing the good quality and higher yield per unit area. There is need to seek alternative nutrient sources, which should be cheap and eco-friendly so that farmers may be able to reduce the investment made on fertilizer with maintaining good soil environmental conditions leading to ecological sustainable farming. Farmyard manure (FYM) is a store-house of plant nutrients including micronutrients. It improves the physio-chemical properties of the soil, which is very useful for the sustainable crop productivity as well as soil fertility and productivity. Organic manures like FYM, Vermicompost, Nadep compost, Poultry manures and Agrich are very popular among the farmers because of its eco-friendly nature and simply availability. These products are helpful in minimizing the environmental hazards and increase of soil fertility. Vermicompost is an excellent soil conditioning agent. Incorporation of vermicompost in soil improves the texture, structure, permeability and water holding capacity of soil (Singh *et al.*, 2015). Vermicompost is a nutrient-rich, microbiologically-active organic amendment that results from the interactions between earthworms and microorganisms during the breakdown of organic matter. It is a stabilized, finely divided peat-like material with a low C:N ratio, high porosity and high water-holding capacity, in which most nutrients are present in forms that are readily taken up by plants (Domínguez, 2004). Vermicompost also has a positive effect on vegetative growth, stimulating shoot and root development (Edwards *et al.*, 2004). The effects include alterations in seedling morphology such as increased leaf area and root branching (Lazcano *et al.*, 2009). Vermicompost has also been shown to stimulate plant flowering, increasing the number and biomass of the flowers produced (Atiyeh *et al.*, 2002; Arancon *et al.*,

2008). Nitrogen, phosphorus and potassium have a significant effect on flower production and quality. Farmyard manure is an excellent organic fertilizer, as it contains high nitrogen, phosphorus, potassium and other essential nutrients. 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).

Trichoderma spp. are the most frequently isolated soil fungi and present in plant root ecosystems. These fungi are opportunistic, avirulent plant symbionts and functions as parasites and antagonists of many phytopathogenic fungi, thus protecting plants from disease. So far, these are among the most studied fungal bio-control agents and commercially marketed as biopesticides, biofertilizers and soil amendments (Sisodia and Singh, 2015). Root colonization by *Trichoderma* spp. also frequently enhances root growth and development, crop productivity, resistance to abiotic stresses and the uptake and use of nutrients (Harman *et. al.*, 2004). Several *Trichoderma* spp. positively affect plants by stimulating plant growth and protecting plants from fungal and bacterial pathogens. They are used in biological plant protection as biofungicides as well as in bioremediation (Blaszczyk *et al*., 2014). *Trichoderma* spp. can reduce the severity of plant diseases by inhibiting plant pathogens in the soil through their highly potent antagonistic and mycoparasitic activity (Hermosa, 2012). Mishra *et al.* (2004), found that *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.

Mixing of a definite concentration of spore suspension of a *Trichoderma harzianum* strain with measured amounts of processed organic materials (de-composted poultry litter and cow dung, processed water hyacinth, vegetable waste/ kitchen waste, fine sawdust, mushroom waste/ash, maize bran, neem leaf and molasses) is used to develop *Trichoderma*-based compost fertilizer named Trichocompost. The composting process produces drainage enriched with *Trichoderma*, called Tricholeachate which can be collected and reused for composting. Moreover,

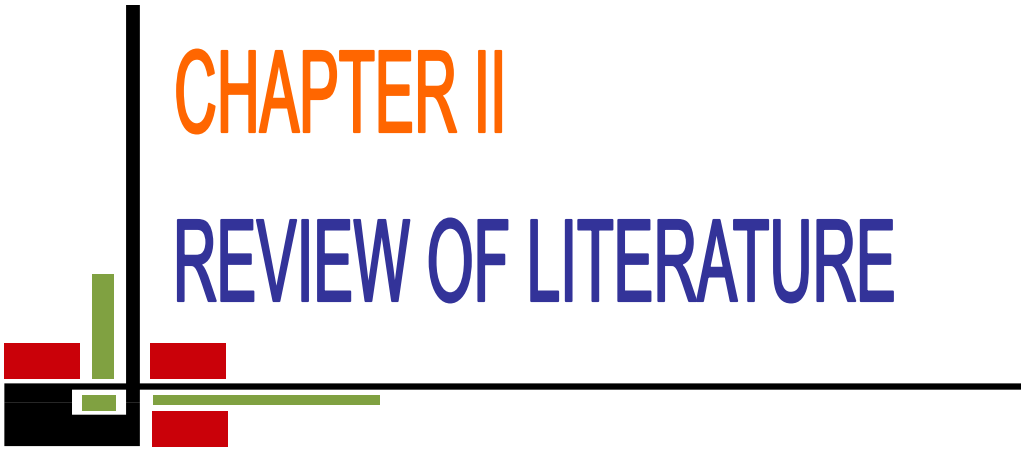
Trichocompost is highly rich in various elements that may enrich soil fertility and provide nutrition to the crops (Naznin *et al*., 2015).

Gerbera is an important flower crop in Bangladesh and popular owing to its diversified colour. It has been investigated earlier that organic amendments are helpful in improving soil productivity and fertility. Again, bio-control agent like *Trichoderma*, tricholeachate increased the microbial diversity of soil, thus, enhancing growth, yield and disease- insect resistance. There are little or no studies regarding organic amendment and bio-control agent on gerbera in Bangladesh. However, a number of investigations were done abroad. Considering the facts, such research is very important for the greater interest of the scientist as well as the growers of our country. Hence keeping above points in view, present investigation has been undertaken with following objectives:

- ✓ Standardization the nutrient for better growth and yield
- ✓ Reducing disease incidence
- ✓ Increasing vase life.

CHAPTER II

REVIEW OF LITERATURE



CHAPTER II

REVIEW OF LITERATURE

Gerbera (*Gerbera jamesonii*) is an herbaceous perennial flower crop with long stalk and daisy like flowers. It is a popular cut flower grown throughout the world in a wide range of climatic conditions. A few numbers of research works have been done all over the world by different workers on the performance of gerbera influenced by organic matter and bio-control agent and no information is available under climatic conditions of Bangladesh. Nevertheless, some of the important and informative works have been done in home and abroad on these aspects have been presented in this chapter.

Giri and Beura (2021) investigated the effect of organic and inorganic sources of nutrients on flowering of hybrid gerbera (*Gerbera jamesonii* B.) cv. Shimmer in open field condition was conducted at Biotechnology cum Tissue Culture Centre, OUAT Bhubaneswar during 2015-16 and 2016-17. The aim of the study was to find out suitable organic and inorganic sources of nutrients for cut flower production of gerbera in open field condition. There were eight treatment combinations consisting of 100% recommended dose of fertilizer (RDF), Vermicompost, 75% RDF, PSB, *Azospirillum*, *Azotobacter* and foliar spray of macro and micro elements. Application of 75% RDF (15:10:30 g NPK/10 plants) + Vermicompost (25 g/10 plants) + *Azospirillum*/ *Azotobacter* (20 g/10 plants) + PSB (20 g/10 plants) + macro and micro element spray recorded earlier flower bud initiation and flowering. The same treatments conducted to maximum length of flower stalk, thickness of flower stalk, flower diameter, number of flowers/ plant and bloom life. It can be concluded that reduced dose of chemical fertilizer (75% RDF) along with application of vermicompost and biofertiizer can improve flower yield of gerbera in open field condition.

Alhasan *et al*. (2021) carried out an experiment under the shade net house conditions in a private farm located in Al-Diwaniyah city, Al-Qadisiyah, Iraq to investigate the influence of applying different rates of seaweed extract (0, 0.5, 1.0, 1.5, 2.0, 2.5, and

3.0 g/L) on different plant growth parameters and flowers production of gerbera (*Gerbera jamesonii* L.) plant. Results showed that there were statistically differences in the levels of seaweed extract that applied as a source of organic fertilizer, and also applying seaweed fertilizer has been increased the agronomic traits and number of flowers produced per plant. It can be concluded that applying of seaweed fertilizer at 3.0 (g/L) had beneficial influenced on the growth and flowering production of gerbera plant grown under the shade net house conditions.

During the years 2017-2018, Padamanabhan (2021) looked into the impact of vermicompost on chrysanthemum growth and flowering. Vermicompost is an outstanding organic manure for improving plant growth and yield. Organic wastes such as cowdung and animal droppings, farm and forest wastes, vegetative waste, and urban municipal solid wastes are aerobically decomposed into vermicompost (MSW). *Eudrilus eugeniae*, also known as the African night crawler, is an earthworm species that was used in the vermicompost. Various experimental plots were examined (Control, T_1, T_2 and T_3). In T_3, the number of plants, flowering plants, and buds per plant are all higher. As a result of the results, it can be concluded that using vermicompost for commercial chrysanthemum cultivation is a good idea.

A research was conducted by Jawaharlal (2021) on standardization of precision production technologies of carnation comprising of growing media consortia, planting density, planting stage, pinching techniques, calyx splitting disorder management are important components for production of quality carnation cut flowers. Growing media consortium at the ratio of 10:1:1 (30 kg of consortia) with 25 kg of farm yard manure, 2.5 kg of vermicompost, 2.5 kg of cocopeat with biofertilizers viz., *Azospirillum*, Phosphobacteria, VAM and biocontrol agents namely *Trichoderma viride*, *Pseudomonas fluorescens* added each @ 20 g/m^2 at bimonthly intervals is the best growing medium to achieve favorable flower yield. The research experimental study on planting density with treatment with 15 × 15 cm spacing having 36 plants in a square meter area may convincingly be followed for obtaining more number of flowers per plant in unit area and value in terms of economic value of the crop. The experiment on planting stage and pinching level for treatment T_8 with 30-days old

rooted cuttings + Single pinch at the 5th node proved to be the best in terms of number of flowers per plant (6.00, 8.30 & 5.40) and flower yield per square meter area (216.00, 298.80 & 194.40). Management of calyx splitting is achieved with the foliar application of 0.1 percent borax at fortnightly intervals till flower bud initiation and at weekly intervals thereafter could reduce percentage calyx split and enhance the yield and quality of flowers.

An investigation was carried out by Giri and Beura (2020) on impact of INM practices on growth and flowering of Gerbera in premises of Biotechnology cum Tissue Culture Centre OUAT Bhubaneswar during 2015-16 and 2016-17. The objective of the study was to develop an INM model for cut flower production of gerbera in open field condition. Eight fertilization treatment combinations were used consisting of 100 % RDF, Vermicompost, 75 % RDF, PSB, *Azospirillum*, *Azotobacter*, and foliar application of macro and micro elements. The result revealed that application of 75 % RDF (15:10:30 g NPK/m^2) + Vermicompost + (25 g/m^2) + *Azospirillum*/ *Azotobacter* (20 g/m^2) + PSB + macro and micro element spray increased all of vegetative parameters of gerbera. In flowering parameter, the number of flower/plants was maximum in the same treatment. It can be concluded that reducing level of chemical fertilizer to 75 % RDF along with application of different organic source of nutrient can improve flower yield of gerbera in open field condition.

Khan *et al*. (2020) stated that the chemical fertilizers when applied to soil more than the recommended, it not only affects the yield of flowers but also effects on deterioration of soil health. As an alternative to this, the low-cost bio-fertilizers are one of the solutions which will help the farmers to reduce the cost of cultivation. In view of this, the study was conducted to find out the influence of vermicompost in combination with microbial consortium on reproductive parameters of chrysanthemum (*Dendranthema grandiflora* L.) cv. Marigold. The work was carried out during Kharif 2018-19 consist of 10 treatments and 3 replications. The findings of the study revealed that chrysanthemum supplied with Vermicompost + 50 percent RDF + AMC i.e., treatment 9 recorded significantly higher in numbers and weight of

flowers, which proportionately increased the flower yield when compared to the remaining treatments observed.

Latif and Mustafa (2019) studied the effect of biofertilizer and carbolizer on the growth of *Gerbera jamesonii* cv. Stanza. This experiment was designed according to the Randomized Complete Block Design (RCBD) as factorial with three replications. Comparison among means was done using LSD (Least Significant Difference) test (P=0.05). The experiment consisted of two factors; the first factor was bio-inoculant included four levels [without inoculation (A_0), inoculation with bacteria (*Azotobacter chroococcum* and *Bacillus subtilus*) (A_1), fungal inoculation with mycorrhiza (*Glomus mosseae*) (A_2) and inoculation with both bacteria and mycorrhiza (A_3)], the second factor was liquid organic fertilizer (carbolizer) included three levels (B_0 control, B_1 1.5, B_2 2.5 mlL^{-1}). Effects of bio-inoculants showed that the combination of both mycorrhiza and bacteria (A_3) were significant, increasing in vegetative growth characteristics; includes leaf chlorophyll intensity (44.99 spade unit), leaf area (1305.00 cm^2), number of offsets per plant (6.52), and percentage of leaf dry matter (28.59%). Moreover, they increased concentration of mineral elements N (4.95%), P (0.45%), K (4.39%), Fe (141.70 $mgkg^{-1}$), and Zn (35.29 $mgkg^{-1}$), in gerbera leaves. Also, this treatment showed significant increasing in flowering characters include length of flower stalk (52.35 cm), diameter of flower stalk (9.53 mm), capitulum diameter (17.34 cm), percentage of flower dry matter (17.58%), anthocyanins concentration in flower petals (32.39 $mg100g^{-1}$), number of flowers during the study period (46.45) and vase life (28.52 days). Additionally, the same treatment showed significant increasing in root characters include length of main root (43.28 cm), diameter of main root (3.24 mm), root surface area (86.05 cm^2), N (4.51%), P (0.60%), K (4.64%) and root dry matter (18.41%). Foliar spray with carbolizer especially at concentration 2.5 mgL^{-1} (B_2) had a significant effect in most vegetative growth characters, includes leaf chlorophyll intensity (44.72 spad unit), leaf area (1302.6 ds^2), number of offsets per plant (6.06), and percentage of leaf dry matter (26.92%). Also, it increased the concentration of mineral elements in gerbera leaves like N (4.31%), P (0.38%), K (4.05%), Fe (136.26 $mgkg^{-1}$) and Zn (29.45 $mgkg^{-1}$). Besides it increased significantly all characters of flowering includes length of flower

stalk (48.83 cm), diameter of flower stalk (9.10 mm), capitulum diameter (15.80 cm), percentage of flower dry matter (16.06%), anthocyanins concentration in flower petals (30.11 $mg100g^{-1}$), number of flowers during the study period (42.25) and vase life (26.72 days). Furthermore, the same level of carbolizer showed significant increases in root characteristics such as the length of main root (39.27 cm), diameter of main root (2.98 mm), root surface area (82.14 cm^2), N (4.23%), P (0.59%), K (4.84%) and root dry matter (16.72%). The interaction between the experimental factors (biofertilizer and carbolizer) significantly enhanced vegetative, root and floral growth characteristics, especially ($A_3 \times B_2$).

Karagöz *et al*. (2019) stated that the use of environmental and sustainable ornamental flower production practices with renewable resources has drawn worldwide interest. One of these renewable resources is vermicompost (earthworm castings). In recent years, increasing demand for improving environmental quality has focused on the importance of Plant Growth Promotion Bacteria (PGPBs) in agriculture. Vermicompost also help microbial agents function effectively in soil. In this study, a total of six treatments [A: PGPB formulation, B: Not autoclaved vermicompost, C: Autoclaved vermicompost, D: Not autoclaved vermicompost+PGPBs, E: Autoclaved vermicompost+PGPBs, F: Control (untreated bacteria and vermicompost)] were tested for their effects on the plant growth and development parameters in gladiolus (*Gladiolus grandiflorus* L. 'Red Beauty') in greenhouse condition. Vermicompost was added to the related pots by dissolving in water. After the addition of vermicompost, PGPB formulation was given immediately to related pots. All the treatments were applied to soil once in three leaf stage, close to the plant root zone. Parameters in terms of yield and quality attributes of plant and corm were determined and analyzed. The treatment A increased in plant height of gladiolus of 24.55% rate. The earliest times to flowering was determined in E application (100.48 day), which also increased in corm diameter with rate of 17.41% and number of corms and cormels with rate of 151.83% according to F application. Results indicated that the treatment E promoted overall better performance as compared to other treatments diameter of flowers for number of leaves per plant, number of florets per spike, stem diameter, spike length, fresh and dry weight of flowers, the number and diameter of

corm. Autoclaved vermicompost can be good choice in gladiolus cultivation but it should be enriched with PGPB.

A field experiment was conducted by Kumar *et al*. (2019) during the year 2018-2019 to study the effect of spacing (50×50 cm, 50×60 cm and 50×75 cm), dose of vermicompost (0, 5.0 and 10.0 ton/ha) and foliar application of salicylic acid (0, 100 and 200 ppm) on the growth, flowering and soil health of chrysanthemum. The experiment was laid out in a factorial randomized block design with twenty-seven treatments and three replications. Significant improvement in growth and flowering characters was recorded with closer spacing (50×50 cm) except plant spread, number of flowers/plants, weight of individual flower, diameter of flower, shelf life and stalk length while, plants grown at wider spacing had maximum available NPK in post harvested soil. Gradual increases doses of vermicompost for 0 to 10.0 ton/ha significantly improved plant growth, flowering and yield attributing traits along with higher availability of NPK in postharvested soil. Among the foliar spray of salicylic acid, salicylic acid (100 ppm) significantly produced good plant growth and flower yield except induced early flowering and 50% flowering however, control showed maximum availability of NPK in postharvested soil. Among the combined combinations, maximum flower yield/plant was recorded with treatment combination T_{26} (S_3+VC_2+SA_1) and treatment combination T_8 (S_1+VC_2+SA_1) resulted in maximum flower yield/plot and flower yield/ha during course of study.

A study was conducted by Rizwan *et al*. (2018) to evaluate the efficiency of gerbera cut flower varieties under poly tunnel condition in Pothowar (arid) region. This experiment was designed as Complete Randomized Design with three replications. Four gerbera cut flower varieties (Kilimanjaro, Rosalin, Scapino and Bieber) were subjected under poly tunnel conditions (control). The results of statistical analysis revealed that the Kilimanjaro variety showed significantly different response in all parameters. Maximum plant height (25.806 cm), number of leaves plant^{-1} (28.111), leaf area (277.33 cm^2), flower bud diameter (1.5361 cm), number of flowers plant^{-1} (21.899), flower stalk length (26.417 cm), flower stalk diameter (0.4778 cm), fresh weight of flower (11.458 gm), dry weight of flower (6.0694 gm), spreading of plant

(60.028 cm), vase life (9.6667 days) while minimum days taken to initiate flowering (15.111), days to 50% flower opening (3.2778) and days to 100% flower opening (6.3889) were observed in Kilimanjaro variety under poly tunnel conditions. Among different varieties of gerbera cut flower, Rosalin showed maximum flower diameter (9.7361 cm) while Scapino showed maximum production of suckers (2.8056) and minimum percent weight loss of flower (45.966%). The interaction (poly tunnel conditions and varieties) was non-significant in majority of parameters. Therefore, under poly tunnel conditions Kilimanjaro variety should be recommended for higher yield, quality and shelf life of cut flower.

Saikia *et al.* (2018) studied the effect of different growing media in improving growth, flowering, physiological, soil microbial and bio-chemical properties of gerbera cv. Antibes. The experiment was conducted with five different growing media i.e. partially decomposed rice husk, vermicompost, enriched compost, soil based biofertilizer and control. The experimental design was laid out in Completely Randomized Design with three replications. Among the growing media enriched compost was found to be superior with respect to plant height (66.05 cm), no. of leaves per plant (38.50), plant spread (53.50 cm), leaf area per plant (5828.37 cm^2), leaf area index (2.06), net assimilation rate (0.067 mg cm^{-2} day^{-1}), leaf area duration (64.40 LAI days), leaf relative water content (87.14%). Diameter of flower (10.43 cm), no. of flower per plant (13.50) was recorded the highest in enriched compost. Enriched compost demonstrated clear increase in soil enzymes such as Phosphomonoesterase (374.22 µg p-nitrophenol g^{-1} soil h^{-1}), Fluorescein di-acetate (10.03 µg fluorescein g^{-1} soil h^{-1}), Dehydrogenase (281.82 µg TPF g^{-1} soil 24 hr^{-1}) activity in this experiment. Available N, P_2O_5, K_2O in soil was also increased in application of organic growing media. Application of enriched compost resulted in the highest available P_2O_5 content (33.72 kg ha^{-1}) in soil. The study was done to motivate the growers of Assam to take up application of organic amendments in flower cultivation and to know the impact of it on growth and development of gerbera. The present study revealed that the use of organic amendment is useful to gerbera as it gives significantly higher values than the control plots.

A field experiment was conducted by Kumar *et al.* (2018) at Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Science, Allahabad, India, during 2013-14 rabi season. The experiment was laid out in randomized block design with 13 treatments in three replications. The treatments comprised of FYM, vermicompost and poultry manure with 25% RDF, 50% RDF and 75% RDF in different combinations including control (RDF-N:P:K 100:120:80 kg/ha). The results revealed that among all the treatments, application of (75% RDF + 25% vermicompost) in treatment (T_{11}) produced significantly the tallest plant (105.60 cm) with more number of leaves per plant (8.07), maximum number of shoots per plant (2.47), and also reported maximum with yield parameters like number of spike per plant (2.87), number of spike per hectare (140848.84), number of corms per plant (3.20), number of corms per hectare (241482.28) as compared to control (T_0), and in economic point of view treatment T_{11} (75% RDF + 25% vermicompost) was found to be most economically viable in terms of gross return (6,94,236), net return (3,87,710) and benefit cost ratio (2.26 :1).

Akter *et al*. (2017) found that the yield and quality of flower is greatly influenced by the quantity and type of fertilizers used. Because of the hazards of long-term chemical fertilizer, more and more farmers all over the world are shifting to organic fertilizers for ensuring sustainable flower production. Keeping these points in view, present investigations were carried out to evaluate the combined impact of organic manure, inorganic fertilizer and bio-control agent on yield and quality of gladiolus at the Floriculture Research Field, Bangladesh Agricultural Research Institute, Gazipur from October, 2014 to May 2015. The single factor experiment consisted of eight treatments namely: T_1: Control (Recommended dose of fertilizer) (N_{200} P_{50} K_{150} S_{30} B_2Zn_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 the best result on yield and quality of gladiolus.

Sahu *et al.* (2017) reported that the growth parameters of gerbera are directly dependent on the balanced application of macro and micronutrients. In the present study, foliar application of micronutrients was done after 30, 60, 90 DAP. Foliar application of $ZnSO_4$ (0.2%) + $MnSO_4$ (0.2%) + $FeSO_4$ (0.1%), produced significantly maximum plant height (44.87 cm), plant spread (45.20 cm), number of leaves per plant (16.93), length of leaf (32.14 cm) as well as number of suckers per plant and width of leaf (13.69 cm) were significantly increased as a result of foliar application of $ZnSO_4$ (0.4%) + $MnSO_4$ (0.4%) + $FeSO_4$ (0.3%), compared to the control treatment.

Ayemi *et al.* (2017) examined the response of different doses of N, P and K on plant growth, flower quality and yield of gerbera (*Gerbera jamesonii* L.) in the Department of Horticulture, SHUATS, Allahabad, U.P. during the Rabi season 2016-2017. Eleven treatments were included in the trial viz., T_0 (10:15:20) RDN; T_1 (11:16.5:22); T_2 (12:18:24); T_3 (13:19.5:26); T_4 (14:21:28); T_5 (15:22.5:30); T_6 (16:24:32); T_7 (17:25.5:34); T_8 (18:27:36); T_9 (19:28.5:38); T_{10} (20:30:40) N.P.K g/m^2 were tested in three replication. The experiment of design was Randomized Block Design. The results revealed that fertilizer treatments had significant response on plant height, number of leaves per plant, plant spread, number of suckers per plant, number of flowers per plant, number of flowers per treatment, days to first flower bud appearance, flower diameter, stalk length, stalk diameter and vase life of flower. The maximum plant height (41.47 cm), number of leaves per plant (17.70), plant spread (56.57 cm), days to first flower bud appearance (50.13) were produced by the

treatment (T_7) of N:P:K in the ratio of 17:25.5:34 g NPK/m^2. Maximum number of suckers per plant (6.47) was found in treatment (T_9) in the ratio of 19:28.5:38 g NPK/m^2 and the maximum number of flowers per plant (12.87), number of flowers per treatment (49.03), flower diameter (14.47 cm), stalk length (46.47 cm), stalk diameter (0.90 cm) and vase life of flower (14.87 days) were recorded by treatment (T_{10}) in the ratio of 20:30:40 g NPK/m^2.

A field experiment was carried out by Parya (2017) in Entisol soil at Horticulture Research Station, BCKV, Nadia to study the response of integrated plant nutrient supply system on gerbera under poly house condition. Different combinations of chemical fertilizer (100, 75 and 50% RDF), organic manure (FYM and vermicompost) and bio-fertilizer (*Azotobacter* and PSB) were evaluated in Randomized Block Design. Healthy disease-free tissue culture gerbera plants with uniform growth were planted in the bed of a size 10 × 1 m with a spacing of 50 × 50 cm. The growth attributes, flowering characteristics, flower quality (stalk length and flower size) was improved under the treatment receiving 75% RDF along with FYM, vermicompost and *Azotobacter* + PSB. The maximum numbers of flower with the longest shelf life in field condition and vase life in room condition could be harvested with combined application of 75% RDF, FYM, vermicompost along with or without *Azotobacter* + PSB. The bio-fertilizer had significant role in flower quality improvement.

Kallol and Biradar (2016) carried out an investigation to study the performance of ten cultivars of gerbera (*Gerbera jamesonii* Bolus) under naturally ventilated polyhouse conditions at Hi-Tech Horticulture Unit, UAS Dharwad. Vegetative, flowering and flower characters varied significantly among the cultivars. Among the cultivars, Stanza was the tallest (41.20 cm) and recorded maximum plant spread (47.12 cm). Cultivar Cacharelle produced maximum number of leaves per plant (29.46), the longest flower stalk (58.26 cm) and number of suckers per plant (26.8). Days taken to bud visibility and full bloom varied greatly among cultivars under the study. Cultivar Dana Ellen was early to bud initiation and full bloom (54.32 and 68.00 days, respectively). With respect to flower characters, cv. Cacharelle recorded the

maximum number of flowers per plant (37.10). The cultivar Primrose possessed the longest vase life (14.83 days). The largest flower diameter was found in cv. Rosalin (10.91 cm) which was followed by cv. Winter Queen (10.55 cm). Wide variation in flower colour was also observed among the cultivars. Cultivar Cacharelle expressed the best performance on various growth and flower characters followed by other cultivars viz. Pre Intenzz, Stanza and Winter Queen.

Santos *et al.* (2016) studied to assess the growth of potted gerbera, Florist Red Black cultivar, with mineral and organic fertilization. The experiment was conducted in a greenhouse located at UNIOESTE – Cascavel Campus - PR. The experimental design was composed of randomized blocks with four replicates and five treatments. Treatments were defined according to the fertilization source, which were mineral (NPK) and organic. Organic fertilizers were obtained by diluting in water four organic composts from agroindustrial-waste composting processes. After obtaining composts, water dilution was performed, adjusting the nutritive solution electrical conductivity values. Gerbera plants were assessed fortnightly (0, 14, 28, 42, and 56 days after acclimatization) for leaf area and shoot dry matter, which were adjusted for time using the ANACRES program to obtain the leaf area ratio (LAR), relative growth rate (RGR), and net assimilation rate (NAR). Fifty-six days after acclimatization, plants were assessed for number of leaves, plant diameter, leaf area, leaves and inflorescences dry phytomass, stem height, head diameter, and stem diameter. The highest relative growth rates were obtained in plants grown with organic compost in treatment 3. However, the net assimilation rate, which indicates dry matter conversion efficiency, was highest in plants with chemical fertilization.

An investigation was carried out by Bellubbi *et al*. (2015) at Department of Floriculture and Landscape Architecture, Kittur Rani Channamma College of Horticulture, Arabhavi, Gokak taluk and Belgaum district, to study the effect of INM practices in improving the growth and yield of gerbera (*Gerbera jamasonii* L.) var. Rosalin. The experiment was conducted with six kinds of organic substrates along with inorganic fertilizers. The treatment combination of T_1 (RDF + FYM) viz., plant height (92.6 cm), number of leaves per plant (171.30) and leaf area per plant (1062.06

cm^2) were found to be maximum at 90 DAP. 75% RDF + *Glomus fasciculatum* + *Trichoderma harzianum* + Panchagavya + Amrut pani + Dry mulch + Agnihothra ash favorably influenced flower parameters like minimum number of days taken for 50 per cent flowering (139.87 days), maximum stalk length (75.45 cm), flower diameter (7.15 cm), number of flowers per plant (19.03) and flower yield per m^2 (634.27) were found to be the highest. The results proved that 75% RDF + *Glomus fasciculatum* + *Trichoderma harzianum* + Panchagavya + Amrut pani + Dry mulch + Agnihothra ash improved the growth and flowering attributes in gerbera.

Noor-E-Alam (2015) carried out an experiment to study the performance of gerbera cultivars under protected condition at the Floriculture Research Field, Bangladesh Agricultural Research Institute, Gazipur from March, 2014 to May 2015. The experiment was conducted in Randomized Block Design having 8 cultivar of gerbera which were coded V_1, V_2, V_3, V_4, V_5, V_6, V_7 and V_8 (BARI Gerbera-1) treatments with three replications. Vegetative, flowering and flower characteristics varied significantly among the cultivars. Cultivar V_3 produced maximum number of leaves per plant (20.0), plant spread (15.0 cm) and number of suckers per plant (8.0). Days taken to bud visibility and full bloom varied greatly among cultivars under the study. Cultivar V_3 took least number of days, for bud visibility (69.0) and full bloom (81.0) respectively. For flower characteristics, V_3 showed the maximum number of flowers per plant (20) and possessed longest vase life (15.0 days). The largest flower diameter (10.0 cm) was found in V_3 and the smallest was in V_2 (6.5 cm). the weightiest flower stalk was produced by V_3 (25.0 g) and the lightest was in V_2 (10 g). The longest flower duration was in V_3 (125 days) and shortest duration was in V_2 (105 days). Wide variation in flower colour was also observed among the cultivars. Considering the important characteristics, the cultivar V_3 is the best variety while V_6 and V_7 also exhibited acceptable quality. So, V_3, V_6 and V_7 can be cultivated under protected conditions.

Naznin *et al.* (2015) carried out a study 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 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%) 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 (Recommended doses of fertilizer). The data obtained from the experiment showed that Trichocompost with fertilizer enhanced qualitative and quantitative characters of tuberose flowers.

Soni and Godara (2015) studied the micronutrients requirement of gerbera (*Gerbera jamesonii*, H. Bolus) cv. "Winter Queen" grown under greenhouse condition at CCS, Haryana Agricultural University, Hisar. The treatments consisted of fortnightly and monthly spraying of Borax, FeSO4 and MnSO4 at 0.1 and 0.3 % concentration along with control (distilled water). The result shows that the vegetative and floral character of gerbera tended to improve with the foliar application of Borax, FeSO4 and MnSO4 at both concentration (0.1% and 0.3%) and both the intervals (fortnightly and monthly) over control. The foliar application of FeSO4 at 0.3% at 15 days interval recorded the maximum plant height (45.29 cm), plant spread (63.00 cm), number of leaves (45.23) leaf area (6270.79 cm^2) and number of suckers (6.13). Borax at 0.3% significantly reduced the time taken for flowering among all the treatments. The maximum number of flowers (22.69) with longest stalk length (61.62 cm) and the maximum size (13.82 cm) were recorded with Borax at 0.3% at 15 days interval.

Amin *et al.* (2015) applied phosphorus levels (0, 7.5, 10 and 12.5 g m^{-2}) and potassium levels (0, 10, 12.5, 15 g m^{-2}) to gerbera. More plant height (31.72 cm), number of leaves $plant^{-1}$ (29.76), flowers blooming period (183.18), plant canopy (33.59 cm), number of flowers $plant^{-1}$ (16.63), flower stalk length (25.37 cm), flower diameter (8.05 cm) and vase life (7.32) were recorded in plants received 12.5 g phosphorus m^{-2}, while more days to first flowering (85.50) were noted in the control treatment. The findings further revealed that more plant height (30.04 cm), number of leaves $plant^{-1}$ (28.08), flowers bloom period (182.05), plant canopy (31.00 cm), number of flowers $plant^{-1}$ (15.68), flower stalk length (22.87 cm), flower diameter (7.30 cm) and vase life (7.00 days) were noted in plants treated with 15 K_2O g m^{-2}, while days to first flowering (88.00) were noted in control plots. As the interaction between phosphorus and potassium are concerned, most growth and flowering attributes performed best when treated with 12.5 g P and 15 g K_2O m^{-2}. It is concluded that the combination of 12.5 g P m^{-2} and 15 g K_2O m^{-2} influenced most of growth and flowering parameters of gerbera.

Sisodia and Singh (2015) saw the effect of farmyard manure (FYM), vermicompost and *Trichoderma* alone and in combination on flowering and corm yield in gladiolus. Application of vermicompost + *Trichoderma* resulted in early spike emergence, floret colour show, opening of first floret and increased diameter of first, third and fifth floret. Maximum length of spike, no. of florets/spike and duration of flowering was registered with application of farmyard manure. Treatment FYM + vermicompost significantly enhanced shelf life of first and third floret. However, maximum weight of corms/plant and diameter of corm recorded with FYM + vermicompost + *Trichoderma* and FYM + vermicompost treatments, respectively.

Singh *et al.* (2015) evaluated the performance of marigold var. Pusa Narangi Gainda to various manures and fertilizers levels on growth and flower yield reveal that maximum plant height, girth of stem, number of branches/plant, plant height number of flowers/plant, circulation of flower length, weight of flower, flowers yield/plant, flower yield/ha, gross return, net return and B:C ratio were recorded with recommended dose of 120:80:40 kg NPK/ha along with border strip method of

irrigation, which significantly superior over control, but statically on a par and closely followed by vermicompost @ 5 t/ha and poultry manure @ 3.16 q/hectare, which gave 19.84, 14.57, 30.49, 12.86, 35.01, 27.06, 32.18, 77.94, 78.07, 78.07, 125.68, 61.41 and 104.96% higher growth characters, yield attributing characters, flower yield, gross return, net return, B:C ratio and IBCR ratio, respectively than control plot.

Palanisamy *et al.* (2015) conducted a study at Horticultural Research Station, Yercaud to assess the fertigation levels on cut gerbera cv. Palm Beach along with micro nutrients and humic acid as foliar spray under in Shevaroy hills. The experiment was laid out in Randomized Block Design (RBD) with two replications. The treatments consisted of three levels of fertigation regimes (125, 100 and 75% of recommended dose of fertilizer), foliar spray of micronutrient mixture (0.004%) and humic acid (0.2 %). The results revealed that the morphological parameters namely, plant height, number of leaves, leaf area, plant spread, sucker number and plant density had progressive increase at different stages of plant growth at 100% RDF + 0.004% MN Mixture + 0.2% humic acid (T_{11}) while, the treatment T_{12} (75% RDF + 0.004% MN Mixture + 0.2% humic acid) had induced the first flowering. The treatment T_{11} (100% RDF + 0.004% MN Mixture + 0.2% humic acid) recorded the highest flower yield, longest flower stalk length, flower stalk girth and largest flower diameter. Hence, this treat mental combination could be recommended for commercial cultivation of cut gerbera.

Ajish and Karuppaiah (2015) carried out an experiment on gerbera and found among the different treatment combinations, shade level of 75 per cent and growing media with coir pith + coconut husk envisaged maximum plant height, plant spread, number of flowers per plant, flower stalk length, spathe length and spathe breadth. The number of days taken for flower bud appearance was also earlier in this treatment.

A study was performed by Riaz *et al*. (2015) to investigate the impact of various agricultural wastes as potting media on growth, yield, and quality flower production of *Gerbera jamesonii* L. cv. hybrid mix, and to estimate hazardous impact of chemical fertilizers. The effect of four agricultural substrates viz. farmyard manure, coconut

coir dust, Lahore compost (local produce), and leaf compost combined with conventional media i.e., garden soil, sand, and silt in equal proportion was studied for commercial production of gerbera. All the treatment combinations were arranged into completely randomized design with three replicates. Result visible variations in morphological characters were evidenced among conventional medium and agricultural waste as substrates with significant superiority of flower quality and plant growth. The presented results showed that treatment combination of silt, coconut coir dust, and top soil (SCT) produced maximum plant height while mixture of silt, Lahore compost and top soil (SLT) gave maximum number of leaves per plant and maximum flower stalk thickness. The highest values for leaf area, number of roots, flower fresh to dry weight ratio and number of flowers per plant were achieved in combination of silt, farm yard manure, and top soil (SFT) whereas silt, sand, and top soil (SST) presented maximum flower diameter, maximum fresh, and dry weight of flowers. Chemical characteristics of growing media showed superiority of silt, farmyard manure, and top soil (SFT) and silt, sand, and top soil (STL) for available phosphorus and potassium with values of 27.0 and 500 ppm, respectively. It was concluded that the application of waste materials in combination with silt provided positive results for vegetative and reproductive growth of *Gerbera jamesonii* plants.

Raha (2015) stated that vermicompost is a nutrient-rich, microbiologically active organic amendment which results from the interactions between earthworms and microorganisms in the breakdown of organic matter. It is a stabilized, finely divided peat-like material with a low C:N ratio and high porosity and water-holding capacity that contain most nutrients in forms that are readily taken up by plants. Vermicompost is rich in NKP (nitrogen 2-3%, potassium 1.85-2.25% and phosphorus 1.55-2.25%) and also contain micronutrients, humic acid, plant growth hormones & enzymes. Incorporation of vermicompost has been shown to influence the physical properties of plant growing substrates. In this present trial different proportion of vermicompost was applied to a chrysanthemum variety viz ‘Kasturba Gandhi’. Experimental pots were filled by potting mixes prepared from vermicompost in three replicates in addition to control sets. The plant had shown best vegetative growth and flowering in 40% vermicompost and 60% basal media mixture. Considered collectively, the results

of this study indicate that incorporation of vermicompost of animal origin into a traditional base medium of farm soil enhanced growth and flowering of potted chrysanthemum plants. Vermicompost had a positive effect on fresh and dry weights of shoot, leaf numbers, disease resistance, times to flowering, size, weight and duration of flower of chrysanthemum compared to control media.

Gupta *et al.* (2014) reported the influence of vermicompost prepared from cowdung and household waste on the growth and flowering of marigold crop. A total of seven potting media were prepared containing soil, cowdung, vermicompost and cowdung + household waste vermicompost. The fertility status of soil and vermicompost was quantified. In these media, growth and flowering of marigold plant seedlings was studied for 60 days. Results showed that the vermicomposting process converted the cowdung and household waste into a highly stabilized product having C:N ratio <20.0. The NPK content of vermicompost was higher than soil. The plant grown in vermicompost-containing potting media had 2.3 times more plant height than control. Results showed that the addition of vermicompost, in appropriate quantities, to potting media has significantly positive effects on growth and flowering of marigold seedlings including plant biomass, plant height, number of buds and flowers. It was concluded that addition of vermicompost, in appropriate quantities, to potting media has synergistic effects on growth and yield of marigold.

Sardoei (2014) reported that the effects of vermicompost of an animal manure origin on the growth and flowering of *Calendula officinalis* grown under glasshouse conditions were determined. Marigold seeds were germinated, transplanted into media and grown-on for 150 days. The traditional base medium [control] was a mixture of 70% farm soil and 30% sand [v/v]. Treatments were either vermicompost incorporated at 10, 20, 30, 40, 50 and 60% into the base medium. Vermicompost had significant [$P<0.05$] positive effects on total parameter compared to both controls amended media. The highest root volume, fresh weight of petal and shoot was achieved in 30% compost treatment. Plant performance was best in the 60% vermicompost medium.

Tapas (2014) carried out a study to evaluate seven varieties of gerbera (Dune, Goliath, Cacharelle, Forza, Danaellen, Lan- caster and Malibu) for growth and flowering under polyhouse at Mondouri Horticulture Research Station of Bidhan Chandra Krishi Viswavidylaya under subtropical plains. The experiment was laid out in Randomized Block Design (RBD) with three replications having ten plants each in raised beds under polyhouse. Among the varieties studied, there were highly significant variations observed for growth, yield and quality parameters. The data revealed that among all the seven varieties under study, Dune had significantly highest plant height (54.70 cm) followed by Cacharelle (51.27 cm) and Malibu (46.13 cm). The same cultivar also required minimum days (40.23) for visibility of flower bud, maximum flower size (13.40 cm), flower number (9.37) and stalk length (80.13 cm). With respect to vegetative parameters like number of leaves per plant was recorded the highest in variety Lancastar (42.20) followed by Cacharelle (33.30). the highest number of suckers per plant was found in variety Malibu (4.43) followed by Forza (4.10). On the basis of overall performance, varieties Dune, Goliath, Cacharelle, Malibu were found superior with respect to growth and flowering characteristics under polyhouse in West Bengal condition.

An experiment was conducted by Singh *et al.* (2014) on evaluation of gerbera (*Gerbera jamesonii*) cultivars under shade net house condition at Floriculture unit, Department of Horticulture, Allahabad. The experiment was laid out in a Randomized Block Design having 14 treatments with three replications. The treatments comprised of 14 different cultivar of gerbera. The results revealed that cultivar Danaellen was found best for obtaining maximum plant height (47.33 cm), flower diameter (11.91 cm), vase life (14.20 days) and longevity of flower (23.53 days). While, plant spread (50.97 cm) and fresh weight of flower (30.65 g) found maximum in cultivar Rosalin. The maximum number of suckers (6.33) and minimum number of days (51.45) for flower bud initiation as found in cultivar prime rose. The highest number of leaves (25.47) as found in cultivar Sangria and maximum stalk length (71.67 cm) was found in cultivar Intense. Maximum number of flower (10.22), flowers per plot (204.47) and flower yield per hectare (681333) and gross return, net return and benefit cost ratio (2043999.00 Rs./ha, 590999 Rs./ha and 1.41, respectively) in Malibu.

An investigation was carried out by Anand *et al.* (2013) to evaluate performance of 36 cultivars of cut gerbera (*Gerbera jamesonii* Bolus ex Hooker F.) in a polyhouse at Horticultural Research Station, Tamil Nadu Agricultural University, Yercaud, during 2008-2010. Significant differences were observed for all the characters studied. Maximum plant-spread (78.02 cm) was observed in cv. Robusta. Higher number of leaves was recorded in cv. White Tibet (41.54). Maximum leaf length and leaf width was recorded in cvs. Golden Gate and Yanara. Maximum number of suckers produced was recorded in cv. Junkfru (7.60). Maximum stalk length was observed in cv. White Tibet (62.62 cm), while flower diameter, cut flower production and vase-life were higher in cv. Rosalin. Correlation and path coefficient analysis showed that plant height, number of leaves per plant and number of suckers per plant were the important components of cut-flower yield in gerbera. It may be concluded that cultivars Rosalin, White Tibet, Junkfru and Golden Gate were found to be the best for floral quality and yield, and are recommended for cut-flower production under Shevaroy condition of Eastern Ghats.

Bashir *et al.* (2013) showed the significant effect of foliar application of micronutrients on gerbera. The height of plants in T_2 increases by 5 ml/1000 ml solution. The application of micronutrients solution increases the number of branches per plant in T_3 (6.69) by 5 ml/l000 ml solution of water as compare to control followed by T_2 (7.77), T_1 (6.21), and T_0 (4.87) respectively. Foliar fertilization improves the growth and development by providing essential nutrients. The T_2 (35.87 cm) showed the maximum length of branches per plant. Therefore, plants that received no fertilization of micro nutrients, show less length of branches per plant. Data regarding number of leaves per plant depicted significant results for treatments. These results have similarity to results of number of branches per plant indicated that plant which fertilized with essential micro nutrients that represent a greater number of leaves per plant as compared to other treatments levels. Application of micro nutrients solution increases the number of leaves per plant in T_2 (8.10). A significant superiority of T_2 treatment over T_1 was observed. Emergence days was shorter for plants fertilized with T_3 of micro nutrients solution compared to those received no fertilization but was longer compared to plants receiving other fertilization treatments.

Fertilization had greater effect on the flower emergence as compared to control. Therefore, we can conclude that plant which received fertilization of micro nutrients solution show significant results as compared to those which received no fertilization.

Keditsu (2012) operated a study on on response of gerbera to inorganic fertilization versus organic manuring during 2007-09 on Alfisol showed that as much as 50% of RDF, if substituted with organic manures (25% RDF with Cocopith 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.

Nahar *et al.* (2012) reported that 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. Tricholeachate, a liquid by-product of the Trichocompost, was obtained during decomposition of Trichocompost materials. These bioproducts were tested both in the laboratory and in seedbed nurseries to evaluate their effectiveness against soil-borne pathogens for growing cabbage seedlings. Application of Trichocompost and Tricholeachate reduced the seedling mortalities of cabbage caused by *Sclerotium rolfsii* by about 98%. In laboratory tests, *Trichoderma harzianum*, after re-isolation from Trichocompost and tricholeachate, was also found to be highly effective to arrest the growth of *S. rolfsii. T. harzianum* destroyed the radial growth of *S. rolfsii* mycelium by 59.7% after five days, and effected total destruction of the mycelium in 10 days. In seedbed nurseries, soil applications of Trichocompost and Tricholeachate significantly increased the seedling germination rate and reduced the incidence of soil-borne diseases and infestation of root-knot nematodes. Field experiment showed that combined application of Trichocompost and Tricholeachate reduced the seedling mortalities by 40.9% to 64.5% in Gazipur and 53.3% to 62.1% in Bogra. Application of Tricho-leachate at 500 ml per square metre increased plant

weight by about 55.6%, and reduced the seedling mortality by about 84.0% in Gazipur. Seedbed nurseries treated with Trichocompost and Tricholeachate had only *Pythium* spp as a soil-borne pathogen, whereas, the control plot had as many as four soil-borne pathogens- *Pythium, Rhizoctonia, Sclerotium* and *Fusarium* spp. Use of Trichocompost and Tricho-eachate also reduced the infestation of root-knot nematode by about 80.7% to 91.0%. The results clearly showed that use of Trichocompost and Tricholeachate is highly effective for production of healthy cabbage seedlings.

Ahmad *et al.* (2012) evaluated the growth and flowering of gerbera grown in various horticultural substrates combined with conventional media (composed of garden soil, silt and sand in equal proportions) which is commonly used for its commercial production in the country. Two horticultural by-products viz. coconut coir and spent mushroom compost were tested for their suitability to be used as growing media for cut flower production. No major differences in yield were observed between conventional media and both horticultural by-products; however, flower quality was improved when both of the substrates were used in combination with conventional media. Growing substrate choice also influenced flower stalk length and diameter which revealed positive correlation of these substrates with various attributes of flower quality but not flower yield. Moreover, incorporation of coconut coir and mushroom compost lowered pH and increased available organic matter and electrical conductivity of conventional media which improved nutrient uptake by the plants.

Sarojani *et al*. (2012) studied to know the impact of vermicompost on yield, economics and quality of flowers of chrysanthemum. Vermicompost was used alone and with fertilizers and farmyard manure (FYM). The use of vermicompost drastically reduced the cost of cultivation, the petals of flowers did not wither for a longer period and the flower luster was also good. Thus, the flowers could fetch higher price in the market. The highest net return was obtained from the treatment receiving vermicompost and 50 percent recommended doses of fertilizers. This is attributed to integrated soil fertility management which resulted in higher productivity and also higher market price for the flowers due to their better quality.

Das (2010) conducted an experiment during the period from July 2009 to February 2010 at Horticulture Farm, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh to find out the influence of light intensity on different cultivars of potted gerbera. The experiment consisted of two factors: Factor A: Light intensity: L_0; Full sunlight; L_1; 40% reduced sunlight; L_2; 60% reduced sunlight and Factor B: Cultivars: 5 different colored cultivars namely, C_1; White colored flower; C_2; Pink colored flower; C_3; Light pink colored flower; C_4; Yellow colored flower and C_5; Orange colored flower. The two factors experiment was laid out in Complete Randomized Design (CRD) with three replications. Significant variation was recorded for different growth and flower character due to different light intensity, cultivars and their interaction effect. The maximum number of flowers per plant (15.64) was found from L_1 and the lowest (11.90) from L_2. Maximum flowers (15.20) per plant were produced by C_5 and the lowest (12.48) from C_1. For combined effect L_1C_5 produced the highest number of flowers (18.98) and L_2C_1 produced the lowest. So, it may be concluded that orange colored flower under 40% reduced sunlight gave the best results.

Lazcano and Dominguez (2010) evaluated the feasibility of incorporating vermicompost as a potting amendment into a commercial ornamental production system. Pansies (*Viola* × *wittrockiana* subsp. Delta) and primulas (*Primula acaulis* subsp. Oriental) were grown in peat-based conventional greenhouse medium substituted with 5%, 15% and 25% (v/v) commercial and pig slurry vermicompost. Vegetative growth and flowering were evaluated and compared to plants grown with 0% vermicompost. We observed a general reduction of growth in both species with increasing concentrations of commercial and pig slurry vermicompost. The highest percentage of vermicompost (25%) showed 20% of plant mortality, high levels of stress and damage to the photosynthetic apparatus, as well as a significant reduction in the number and biomass of leaves and in flower production. Most likely, the increase in electrical conductivity and pH interacted synergistically with the decrease in air space produced after the application of vermicompost and were magnified under sub-irrigation, causing the observed effects on plant growth. Therefore, the cultivation system must be taken into account when incorporating vermicompost as a growing media constituent in commercial conditions.

An experiment was conducted by Sindhu *et al*. (2010) to study the effects of different amendments in growing medium on growth and flowering in gerbera under greenhouse condition using available materials viz. soil, farm yard manure (FYM), vermicompost, samridhi (a soil conditioner) and sawdust. The experiment was conducted using completely randomized design (CRD) with three replications having five plants per replication with single plant per pot. The results revealed that the medium amended with soil + FYM + vermicompost + samridhi + sawdust took maximum number of days (9.81 days) for the appearance of first new leaf. Leaf length (35.45 cm) and leaf width (17.24 cm) was found to be significantly higher in medium amended with samridhi. Maximum plant height (29.89 cm), number of leaves per plant (31.10 leaves), number of flowers produced per plant (10.03 flowers), flower head diameter (10.82 cm), flower stalk length (59.20 cm) and vase life (13.17 days) was found highest in medium amended with samridhi. Based on the results obtained, samridhi was found to be a better soil conditioner for enhanced growth and flowering in gerbera.

Bhuiyan (2008) conducted an experiment to study the improvement of petal coloration and flower production of potted gerbera through foliar feeding and traditional mulches at Horticulture Farm, Sher-e-Bangla Agricultural University, Dhaka during the period from May, 2008 to December, 2008. The trial consisted of Factor A: Mulching viz. Mo; control; M_1; straw and M_2; black polythene and Factor B: Foliar feeding viz. F_0; control; F_1; wuxol and F_2; agro-grow. Mulching and foliar feeding had significant effect on flower color, yield and yield contributing characters of potted gerbera, In case of mulching, the longest plant (37.8 cm), the highest leaf length (27.7 cm), maximum number of leaf (37.3 / plant) and maximum number of flower (15.3 / plant) was recorded from M_1 while these parameters were the lowest at M_0. For foliar feeding, the longest plant (36.0 cm), the highest leaf length (26.l cm), maximum number of leaf (32.6 / plant) and maximum number of flower (14.0 / plant) was recorded from F_1 while all the above parameters were the lowest at F_0. For combined effect the longest plant (40.1 cm), the highest leaf length (30.8 cm), maximum number of leaf (43.5 / plant) and maximum number of flower (17.5 / plant) was recorded from M_1F_1 while all the above parameters were the lowest with M_0F_0.

Treatment combinations of straw mulch with wuxol were more effective for quality production of potted gerbera.

Asciutto *et al.* (2006) worked to evaluate the effect of different proportions of vermicompost on the growth and health of patience-plant (*Impatiens wallerana*). The experiment was carried out in a polyethylene greenhouse. Treatments were defined as follows: infested substrate, substrate, sterilized substrate, vermicompost, and vermicompost mixed with infested substrate at 75, 50 and 25% by volume. Seeds of *I. wallerana* were sown in plugs containing the different substrates. Percentage of healthy seedlings was evaluated since emergence, and growth parameters were recorded at day 51. The concentration of pathogen in the different treatments was estimated at the beginning and end of the experiment. Treatments with 100-75% of vermicompost showed important increases of leaf area, plant height and fresh and dry weight of aerial and subterranean organs. Root length was not modified by compost addition. Vermicompost at 75% provided slight control of damping-off caused by *R. solani.*

Hasanuzzaman (2006) studied with fifteen different gerbera genotypes viz., GJ-01, GJ-02, GJ-03, GJ-04, GJ-05, GJ-06, GJ-07, GJ- 08, GJ-09, GJ-10, GJ-11, GJ-12, GJ-013, GJ-14, and GJ-15 and laid out in Randomized Complete Block Design (RCBD) with three replications. Vegetative and floral traits were significantly varied for all the genotypes. Among the different genotypes, GJ-02, GJ-11 and GJ-13 were superior for their better vegetative and floral characters to other genotypes. The characters plant height, number of side shoot per hill, number of flowers per plant, stalk diameter and vase life exhibited high heritability (90.37%, 74.58%, 65.71%, 93.94% and 83.66% respectively) accompanied by high genetic advance (44.10%, 53.21%, 48.43%, 92.61% and 46.88% respectively). These characters had also shown medium to high genotypic and phenotypic coefficients of variation. Days to flower displayed the lowest heritability (32.96%) and genetic advance (5.74%), genotypic and phenotypic coefficients of variation were also the lowest. In general, genotypic correlation coefficients were found to be high than their corresponding phenotypic ones. The characters plant spread, number of side shoot per hill, number of flowers per plant,

flower size, stalk diameter and vase life showed significant positive correlation with spike length. Path coefficient analysis suggested that plant spread contributed maximum (0.84) to spike length through positive direct effect. Number of leaves per plant, number of side shoots per hill, flower size, stalk diameter and vase life had also positive direct effect (0.08, 0.70, 0.23, 0.69, and 0.009 respectively) on spike length.

Singh and Mandhar (2004) studied an experiment on the performance of 9 exotic cultivars of gerbera (*Gerbera jamesonii*) (Diablo, Lyonella, Ornella, Sunset, Tara, Thalassa and Tiramisu, Twiggy and Whitsun) under fan and pad cooled greenhouse environments at the Indian Institute of Horticulture Research, Bangalore, Karnataka, India. The greatest plant height (48.83 cm) and number of suckers (5.16) and leaves (46.27) per plant were obtained with Tiramisu, Lyonella and Ornella, respectively, while the lowest values of the aforementioned parameters were recorded for Whitsun (47.88 cm), Sunset (3.82) and Tiramisu (26.74), respectively. Flowering was the earliest (47.88 and 57.47 days for 50 and 100% flowering, respectively) in Whitsun and the latest (83.10 and 88.30 days) in Tiramisu. The greatest diameter of flower (10.70 cm) and length of flower stalk (58.27 cm) were recorded for Tiramisu and Lyonella, respectively. The thickest (0.70 cm diameter) and the heaviest (22.20 g) flower stalks were observed in Twiggy, whereas, the thinnest (0.60 cm diameter) and lightest (13.94) stalks were observed in Whitsun. The highest total number of flowers produced per plot in a year, and the mean number of flowers per plant and per month in a year were obtained with Ornella (1058.00, 47.26 and 5.02, respectively), followed by Thalassa (988.00, 44.52 and 4.61), whereas the lowest were obtained with Tara (591.33, 29.48 and 2.82), followed by Sunset (600.00, 31.15 and 3.11).

CHAPTER III

MATERIALS AND METHODS

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Gerbera crop has little tolerance to high rainfall and cool temperature; grows well under partial shade and the exotic ones have to be cultivated in a partially modified structure (polytunnel) to produce quality blooms. This chapter illustrates the information concerning methodology that was used for execution of the experiment. The experiment was conducted during the period from December 2019 to July 2020. The materials and methods those were used and followed for conducting the experiment have been presented under the following headings.

3.1 Location of the experimental site

This study was conducted at the Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh. The location of the experimental site is 23°74′ N latitude and 90°35′ E longitude at an altitude of 8.6 meter above the sea level (Appendix I).

3.2 Climatic condition of the experimental site

The experimental site is situated in the subtropical monsoon climatic zone, which is characterized by heavy rainfall during the months from April to September (Kharif season) and scanty of rainfall during rest of the year (Rabi season). Maximum and minimum temperature, humidity and rainfall during the study period were collected from the Bangladesh Meteorological Department (Climate Division), Agargaon and have been presented in Appendix II.

3.3 Characteristics of soil

The soil of the experimental field was silty clay loam in texture and acidic in nature. The soil of the experimental area belongs to the Madhupur Tract under AEZ No. 28 (Appendix III).

3.4 Planting materials

Tissue cultured plantlets of Rosalin variety of gerbera were collected from India. The plantlets were 1 month aged.

3.5 Treatments of the experiment

It was a single factor experiment. The experiment consisted of 5 treatments comprising of different level of organic amendments and bio-control agent.

T_1= Farmyard manure (3 t/ha) + ¼ RDF

T_2= Vermicompost (3 t/ha) + ¼ RDF

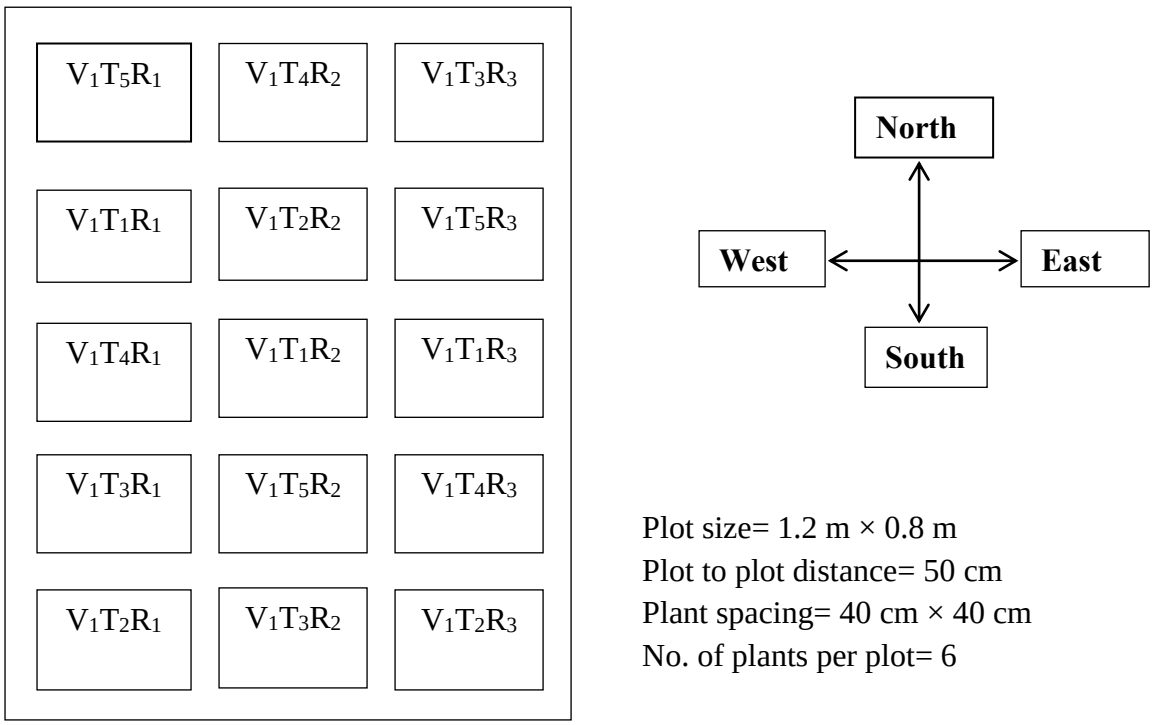
T_3= Trichocompost (3 t/ha) + ¼ RDF

T_4= Tricholeachate (3000 L/ha) + ¼ RDF

T_5= Control (Recommended doses of fertilizers: N_{150} P_{30} K_{100} S_{20} B_1 Zn_1 kg/ha)

3.6 Experimental design

The experiment was laid out in Randomized Complete Block Design with three replications. The unit plot size was 1.2 m × 0.8 m. The plots were raised up to 0.20 meter.



Plot size= 1.2 m × 0.8 m
Plot to plot distance= 50 cm
Plant spacing= 40 cm × 40 cm
No. of plants per plot= 6

Figure 1. Layout of the experiment

3.7 Land preparation

The experimental plot was first opened on December 2019 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.

3.8 Preparation of nethouse

A nethouse was prepared for partial shading. The side-height of the nethouse was 2 meter and the center-height was 3 meter. Two types of net were used. The ceiling-net permitted 70% light penetration and the side-net permitted 50% light penetration. Three feet space was kept open over side-net for air movement.

3.9 Application of manure and fertilizer

All farmyard manure, vermicompost, trichocompost, P, B, Zn and half of K mixed up well with the soil during final land preparation according to treatments. Rest of K was applied at 40 DAT. N was applied in three equal installments at 40, 60 and 80 DAT. Tricholeachate was applied at foliar region from 20 DAT at seven installments with 10 days interval.

3.10 Planting of plantlets

Tissue cultured plantlets were planted on February 2020 at 5 cm depth in furrows which were filled with cocodust by following the spacing of 40 cm × 40 cm.

3.11 Intercultural operations

3.11.1 Weeding

The experimental field was kept weed free by intercultural operations at every 15 days interval started three weeks after transplanting.

3.11.2 Irrigation

Gerbera needs through irrigation instead of light sprinkling at frequent intervals as it blocks capillary tubes. So, irrigation was followed from the day of transplanting in the field and maintained as required. The surface of the experimental plot kept dry between irrigations to avoid dampness that encourages the development of Botrytis and Crown rot.

Plate 1. Experimental shade

Plate 2. Tissue cultured plantlets

Plate 3. Vermicompost

Plate 4. Farmyard manure

Plate 5. Trichocompost

Plate 6. Tricholeachate

Plate 7. Planting of gerbera plantlets

Plate 8. Gerbera plantlet

Plate 9. Flower bud initiation

Plate 10. Flower bud opening

Plate 11. Flower blooming

Plate 12. Fully bloomed flower

Plate 13. Tricholeachate application

Plate 14. Data collection

Plate 15. Experimental field

3.11.3 Disease and pest management

Diseases and insects can be a major limiting factor for gerbera production. To prevent plants from insect infection, Volume Flexi was applied @ 0.5 ml/L of water at the early stage of gerbera. It was sprayed twice at 10 days interval. The experimental crop was affected by Whitefly. Control measures were taken by spraying Ripcord @ 2 ml/L against the insect. The insecticide was sprayed twice at 15 days interval. The crop was also attacked by mites during the growing stage. The mite was controlled by spraying Abom @ 1.5 ml/L of water. The miticide was sprayed two times at 15 days interval. Mealy bug attacked the crop at flowering stage. Control measures were taken by spraying detergent @ 200g/L of water. The detergent was sprayed twice at 15 days interval. Virtako was also applied for virus infection @ 0.3 g/L of water.

3.11.4 Harvesting of flowers

The flowers were harvested when the flower attained commercial stage (outer two rows of disc florets are perpendicular to the stalk).

3.12 Data Collection

Data were collected from each plant taken from each unit plot. Gerbera generally start flowering in about three months after transplanting. Data were collected on the following parameters:

3.12.1 Plant height (cm)

Plant height refers to the length of the plant from ground level to tip of shoot apex. Height of each plant of each unit plot was measured and the mean was calculated. It was measured in cm at every 15 days interval from 15 days of transplanting (DAT) and continued upto 60 DAT.

3.12.2 Number of leaves per plant

Number of leaves per plant was recorded by counting all the leaves from each plant of each plot and the mean was calculated. It was measured in number at every 15 days interval from 15 days of transplanting (DAT) and continued upto 60 DAT.

3.12.3 Plant spread (cm)

The plant spread was measured in cross way (North-South and East-West) by measuring scale. The average of the two measurements was done and expressed in centimetre (cm). It was measured at every 15 days interval from 15 days of transplanting (DAT) and continued upto 60 DAT.

3.12.4 Leaf length (cm)

Length of leaf was recorded by measuring length of 5 leaves from each plant of each plot and the mean was calculated. It was measured in cm at 60 DAT.

3.12.5 Leaf breadth (cm)

Breadth of leaf was recorded by measuring breadth of 5 leaves from each plant of each plot and the mean was calculated. It was measured in cm at 60 DAT.

3.12.6 Number of suckers per plant

Number of suckers per plant was recorded by counting suckers from each plant and then mean was calculated. It was measured two times in number at 90 DAT and 180 DAT.

3.12.7 Diameter of flower bud (cm)

Diameter of flower bud was recorded by using slide calipers of each flower bud from each plot and the mean was calculated.

(a) Leaf length

(b) Leaf breadth

(c) Bud diameter

(d) Flower diameter

(e) Stalk diameter

Plate 16. Data collection of different parameters

3.12.8 Flower diameter (cm)

Flower size was measured in cross way following North-South and East-West position by using slide calipers and the average of the two measurements was done and expressed in cm for a single flower. Later on, the mean of individual flower size was calculated.

3.12.9 Flower stalk length (cm)

Stalk length of the flowers was measured from the point of origin of stalk to the point just below the flower head and the average stalk length of flowers was recorded and expressed in cm.

3.12.10 Flower stalk diameter (cm)

Diameter of stalk was determined at base of stalk by slide calipers and the mean was calculated and expressed in cm.

3.12.11 Number of flowers per plant

Number of flowers per plant was measured by counting the total number of flowers that bloomed from a plant from 90 DAT to 180 DAT and recorded.

3.12.12 Number of flowers per plot

Number of flowers per plot was measured by counting the total number of flowers that bloomed in a plot from 90 DAT to 180 DAT and recorded.

3.12.13 Number of ray florets per flower

Number of ray florets produced per flower was counted.

3.12.14 Days to flower bud initiation

It was recorded by counting the days from transplanting to first initiation of flower bud in the plant from each unit plot.

3.12.15 Days from flower bud initiation to bud opening

It was recorded by counting the days from bud visibility to bud opening of flowers.

3.12.16 Days from flower bud opening to full bloom

It was recorded by counting the days from bud opening to full bloom of flowers.

3.12.17 Shelf life

It was recorded by counting the days from first visibility of flower bud to senescence in the field (Negi *et al*., 1983).

3.12.18 Vase life

Two spikes were used from each plot. For good vase life, cut flowers should be placed in fresh water immediately after harvest. The flower spikes were harvested at late afternoon with sharp sterile knife when the outer two rows of disc florets remained perpendicular to the flower stalk or two whorls of ray florets open. The flower spikes were then carried out to the FABLAB, SAU and placed in the glass bottles partially filled with 100 ml fresh water to study the vase life of gerbera and expressed in days. In laboratory the maximum temperature was 28.04°c and minimum temperature was 23.45°c. The maximum relative humidity was 89.09% and minimum was 65.08%.

3.13 Statistical analysis

The collected data for various traits were statistically analyzed using Statistix 10 computer package programme. The mean for all the treatments was calculated and the analysis of variance for each of the characteristics was performed by F (variance ratio) test. The differences between treatment means were separated by Duncan's Multiple Range Test according to Steel *et al.* (1997) for the interpretation of the results.

CHAPTER IV

RESULTS AND DISCUSSION

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

4.1 Plant height

Plant height of gerbera showed statistically significant differences due to different organic manures, bio-control agent along with quarter recommended dose of fertilizers at 15, 30, 45 and 60 DAT (Figure 2 and Appendix IV). At the different days

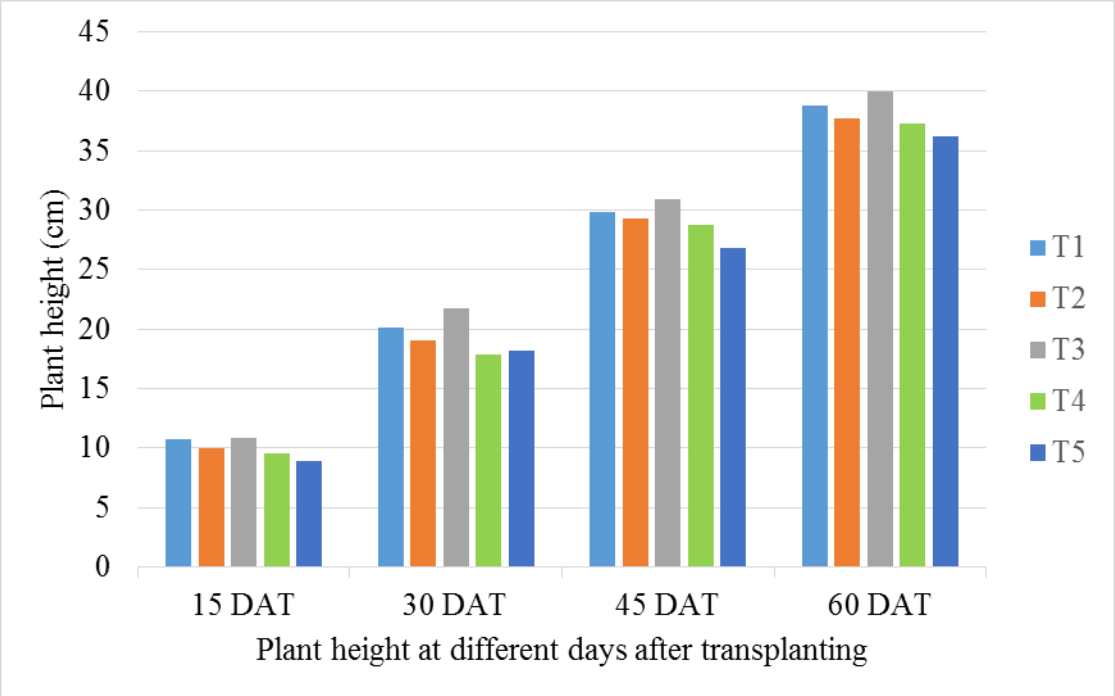


Figure 2. Influence of organic amendments and bio-control agent on plant height of gerbera

[T_1= Farmyard manure (3 t/ha) + ¼ RDF, T_2= Vermicompost (3 t/ha) + ¼ RDF, T_3= Trichocompost (3 t /ha) + ¼ RDF, T_4= Tricholeachate (3000 L/ha) + ¼ RDF and T_5= Control (Recommended doses of fertilizers: N_{150} P_{30} K_{100} S_{20} B_1 Zn_1 kg/ha)]

after transplanting (DAT) the tallest plant (10.89, 21.77, 30.92 and 39.94 cm) was recorded from T_3 (Trichocompost 3 t/ha + ¼ RDF) at 15, 30, 45 and 60 DAT, respectively which is followed by T_1 (10.73, 20.15, 29.85 and 38.82 cm) at same DAT. Again, at the same DAT, the shortest plant (8.95, 18.15, 26.78 and 36.18 cm) was recorded from T_5 (control i.e. absolute use of chemical fertilizer). These results indicate that application of organic manures with chemical fertilizer had tremendous effects on plant height in gerbera. But the effect was more pronounce in Trichocompost. These findings are in conformity with the findings of Bhuiyan (2008); Kallol and Biradar (2016) and Soni and Godara (2015) in gerbera.

4.2 Number of leaves per plant

Significant variation was recorded in number of leaves per plant at 15, 30, 45 and 60 days after transplanting due to the effect of different treatments of organic amendments and bio-control agent (Table 1). The maximum number of leaves (6.50, 7.83, 10.93, 13.83) were found in T_3 at 15, 30, 45 and 60 DAT, respectively which is followed by T_2 (6.20, 7.33, 10.07 and 12.50) at same DAT. The lowest number of leaves per plant was found in control treatment (4.17, 6.03, 8.50 and 10.67) at the same DAT, respectively. The results indicated that nitrogenous element in organic fertilizer enhanced to constitute chlorophyll which leads to better leaves over control treatment. Trichocompost is a rich source of micro and macro nutrients, which changes in the microfloral composition on roots, enhanced nutrient uptake (not limited to nitrogen), solubilization of soil nutrients, enhanced root development which might increase plant growth (Mazhabi *et al.*, 2011). Similar results were reported by Sahu *et al*. (2017) and Noor-E-Alam (2015) in gerbera.

Table 1. Effect of organic amendments and bio-control agent on number of leaves of gerbera

Treatments	Number of leaves			
	15 DAT	**30 DAT**	**45 DAT**	**60 DAT**
T_1	5.33 bc	6.83 bc	9.67 bc	12.17 bc
T_2	6.20 ab	7.33 ab	10.07 b	12.50 b
T_3	6.50 a	7.83 a	10.93 a	13.83 a
T_4	4.33 cd	6.33 cd	9.40 c	11.83 c
T_5	4.17 d	6.03 d	8.50 d	10.67 d
$LSD_{0.05}$	1.07	0.5348	0.6612	0.6431
CV%	11.15	4.13	3.62	2.80

[In a column means having similar letter(s) is/ are statistically identical and those having dissimilar letter(s) differ significantly as per as 0.05 (%) level of probability; Here, T_1= Farmyard manure (3 t/ha) + ¼ RDF, T_2= Vermicompost (3 t/ha) + ¼ RDF, T_3= Trichocompost (3 t /ha) + ¼ RDF, T_4= Tricholeachate (3000 L/ha) + ¼ RDF and T_5= Control (Recommended doses of fertilizers: N_{150} P_{30} K_{100} S_{20} B_1 Zn_1 kg/ha)]

4.3 Plant spread

The plant spread of gerbera is an important morphological character that influences the yield, because it is correlated with photosynthesis by the higher leaf area. Different treatments of organic manure, fertilizer and bio-control agent had significant effect on plant spread of gerbera at 15, 30, 45 and 60 DAT (Figure 3 and Appendix V). The maximum plant spread was obtained in T_3 (14.67, 18.28, 23.89, 29.50 cm) at 15, 30, 45 and 60 DAT, respectively and while the minimum length was found in T_5 (12.11, 16.65, 20.12, 26.08 cm) at the same DAT, which differed significantly from all other treatments. The observed results are in agreement with the findings of Amin *et al*. (2015) and Sahu *et al*. (2017) in gerbera. The plant spread was found maximum in Trichocompost treatment might be due to getting optimum nutrients resulting higher vegetative growth compared to other treatments. Mashaldi (2000) and Rabby (2008) have also reported similar results in case of marigold and broccoli, respectively.

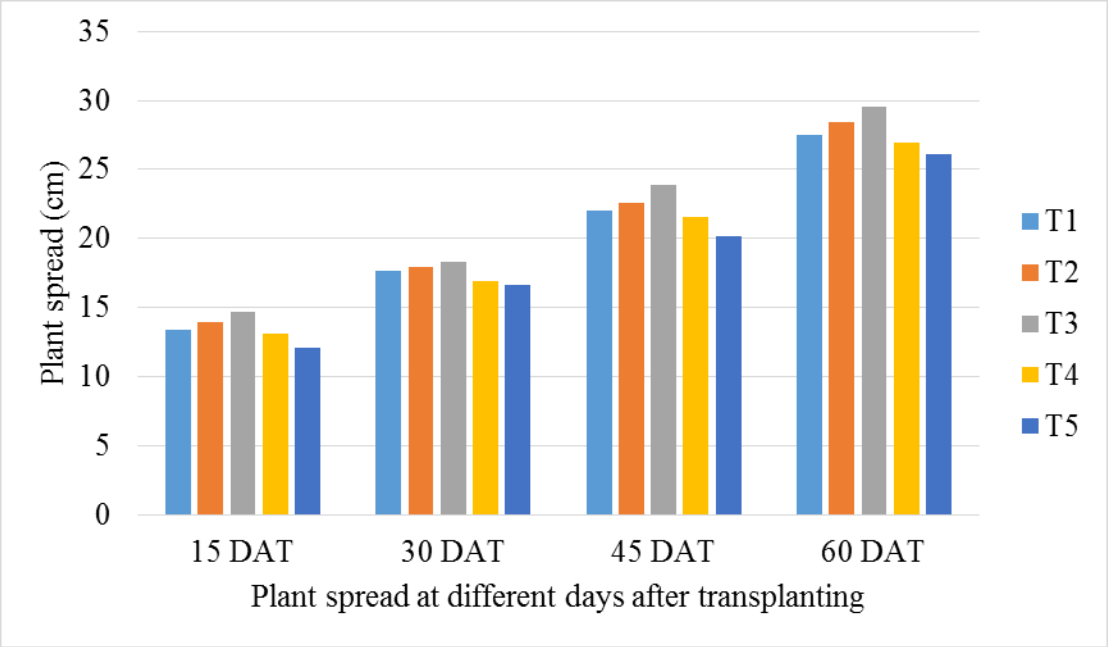


Figure 3. Influence of organic amendments and bio-control agent on plant spread of gerbera

[T_1= Farmyard manure (3 t/ha) + ¼ RDF, T_2= Vermicompost (3 t/ha) + ¼ RDF, T_3= Trichocompost (3 t /ha) + ¼ RDF, T_4= Tricholeachate (3000 L/ha) + ¼ RDF and T_5= Control (Recommended doses of fertilizers: N_{150} P_{30} K_{100} S_{20} B_1 Zn_1 kg/ha)]

4.4 Leaf length

Leaf length was significantly different from T_5 to T_3. The longest (23.89 cm) leaf was recorded from T_3 which is closely similar to T_1 (23.28 cm) and the shortest (22.17 cm) leaf was obtained from T_5 at 60 DAT (Table 2 and plate 17). 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 Trichocompost and quarter recommended dose of fertilizer. The findings of present study are also confirmed with the results of Noor-E-Alam (2015) and Bhuiyan (2008) in gerbera.

Plate 17. Effect of organic amendments and bio-control agent on leaf length of gerbera

[T_1= Farmyard manure (3 t/ha) + ¼ RDF, T_2= Vermicompost (3 t/ha) + ¼ RDF, T_3= Trichocompost (3 t /ha) + ¼ RDF, T_4= Tricholeachate (3000 L/ha) + ¼ RDF and T_5= Control (Recommended doses of fertilizers: N_{150} P_{30} K_{100} S_{20} B_1 Zn_1 kg/ha)]

Table 2. Effect of organic amendments and bio-control agent on vegetative growth of gerbera

Treatments	Leaf length (cm)	Leaf breadth (cm)	Number of sucker	
			90 DAT	180 DAT
T_1	23.28 ab	10.13 ab	2.42 ab	2.78 b
T_2	23.04 ab	9.82 bc	2.08 b	2.57 b
T_3	23.89 a	10.50 a	2.84 a	3.67 a
T_4	22.55 bc	9.32 cd	1.94 bc	2.33 bc
T_5	22.17 c	9.06 d	1.56 c	2.00 c
$LSD_{0.05}$	0.8656	0.5939	0.5138	0.4480
CV%	2.00	3.23	12.58	8.91

[In a column means having similar letter(s) is/ are statistically identical and those having dissimilar letter(s) differ significantly as per as 0.05 (%) level of probability; Here, T_1= Farmyard manure (3 t/ha) + ¼ RDF, T_2= Vermicompost (3 t/ha) + ¼ RDF, T_3= Trichocompost (3 t /ha) + ¼ RDF, T_4= Tricholeachate (3000 L/ha) + ¼ RDF and T_5= Control (Recommended doses of fertilizers: N_{150} P_{30} K_{100} S_{20} B_1 Zn_1 kg/ha)]

4.5 Leaf breadth

Distinct variation was observed in respect of leaf breadth within the treatments (Table 2). The widest leaf was produced by T_3 (10.50 cm) which was closely followed by T_1 (10.13 cm) whereas T_5 produced the narrowest leaf (9.06 cm). The phenomenon of more leaf breadth 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 leaf breadth. Noor-E-Alam (2015) and Bhuiyan (2008) supports the present findings in gerbera.

4.6 Number of suckers per plant

Variation regarding number of suckers per plant among the treatments was observed at 90 and 180 DAT. The highest number of 2.84 and 3.67 suckers per plant was produced by T_3 at 90 and 180 DAT where T_5 produced the lowest number of 1.56 and 2 suckers per plant at the same DAT (Table 2). The higher number of suckers in organic amendments and Trichocompost applied plants along with chemical fertilizers (¼ RDF) might be produced more sucker by greater number of leaves. Soni and Godara (2015) and Sahu *et al*. (2017) also found the variation in number of suckers per plant of gerbera that represent the resemblance of the present study.

4.7 Diameter of flower bud

Flower bud of gerbera exhibited statistically significant variation (Table 3). But the diameter of flower bud was almost similar in all the treatments. The diameter of flower bud (1.83 cm) of T_3 was larger than the diameter (1.61 cm) of T_5. 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 flower bud for their development. These results are similar to the work of Bhuiyan (2008) who found that flower bud diameter was increased with the application of Trichocompost along with ¼ RDF fertilizers in gerbera.

Table 3. Effect of organic amendments and bio-control agent on flower characteristics of gerbera

Treatments	Diameter of flower bud (cm)	Flower diameter (cm)	Flower stalk diameter (cm)	Number of flowers per plant
T_1	1.73 b	9.56 b	0.30 b	11.90 b
T_2	1.74 b	9.43 b	0.32 ab	11.33 b
T_3	1.83 a	10.78 a	0.34 a	12.70 a
T_4	1.69 b	9.02 b	0.29 bc	10.36 c
T_5	1.61 c	8.07 c	0.27 c	9.44 d
$LSD_{0.05}$	0.0795	0.61	0.026	0.737
CV%	2.45	4.99	5.78	3.51

[In a column means having similar letter(s) is/ are statistically identical and those having dissimilar letter(s) differ significantly as per as 0.05 (%) level of probability; Here, T_1= Farmyard manure (3 t/ha) + ¼ RDF, T_2= Vermicompost (3 t/ha) + ¼ RDF, T_3= Trichocompost (3 t /ha) + ¼ RDF, T_4= Tricholeachate (3000 L/ha) + ¼ RDF and T_5= Control (Recommended doses of fertilizers: N_{150} P_{30} K_{100} S_{20} B_1 Zn_1 kg/ha)]

4.8 Flower diameter

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. The variation among the treatments in respect of flower diameter was found significant (Table 3 and plate 18). The highest flower diameter was found in T_3 (Trichocompost 3 t/ha + ¼ RDF) treatment (10.78 cm) which was closely followed by T_1 (9.56 cm), T_2 (9.43 cm) and T_4 (9.02 cm). The lowest flower diameter was found in control treatment (8.07 cm). Fayaz *et al.* (2016) recorded flower diameter ranged from 8.6-11.9 cm and Kallol and Biradar (2016) recorded from 7.98-10.91 cm in gerbera showed similarity with the present investigation.

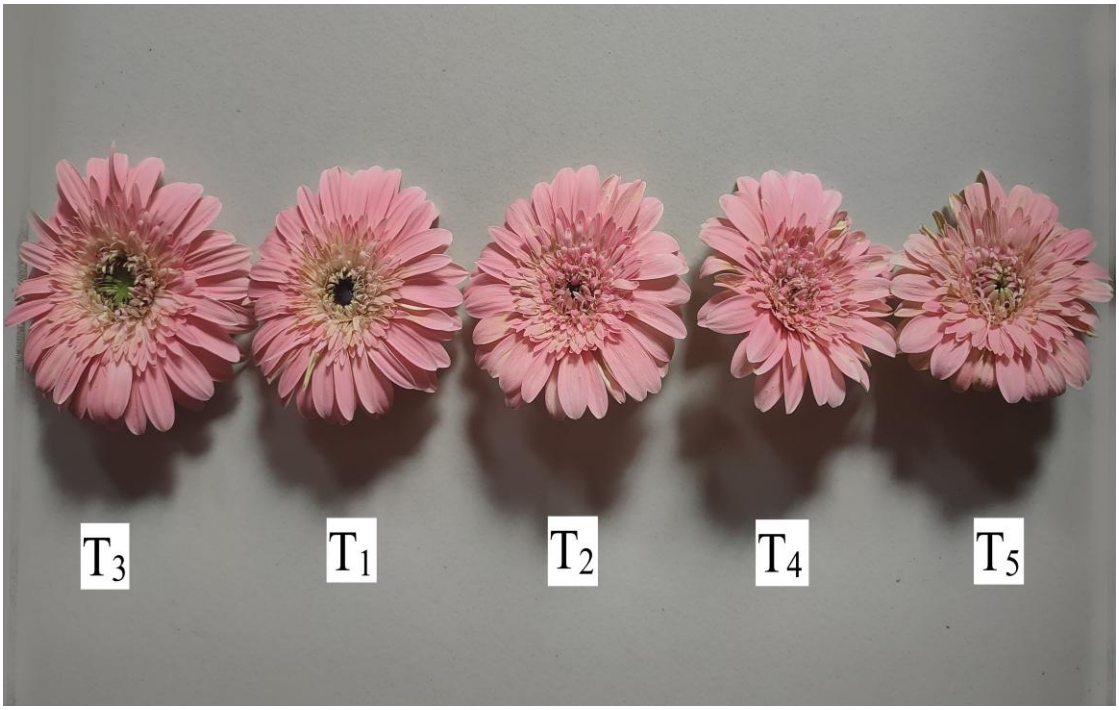


Plate 18. Effect of organic amendments and bio-control agent on flower diameter of gerbera

[T_1= Farmyard manure (3 t/ha) + ¼ RDF, T_2= Vermicompost (3 t/ha) + ¼ RDF, T_3= Trichocompost (3 t /ha) + ¼ RDF, T_4= Tricholeachate (3000 L/ha) + ¼ RDF and T_5= Control (Recommended doses of fertilizers: N_{150} P_{30} K_{100} S_{20} B_1 Zn_1 kg/ha)]

4.9 Flower stalk length

Variation in respect of stalk length of flower was observed among the treatments (Figure 4 and Appendix VI). The longest stalk of 57.11 cm was produced by T_3 followed by T_2 (54.56 cm) and T_1 (54.11 cm) while the shortest stalk of 51.22 cm was produced by T_5, which differed significantly from all other treatments. The increased stalk length was probably due to the better vegetative and reproductive growth of gerbera in T_3. The increased stalk length was probably due to presence of macro and micro nutrients in Trichocompost and its efficient absorption. The present findings more or less agreed with Fayaz *et al.* (2016). Similar results were also reported by Soni and Godara (2015) in gerbera.

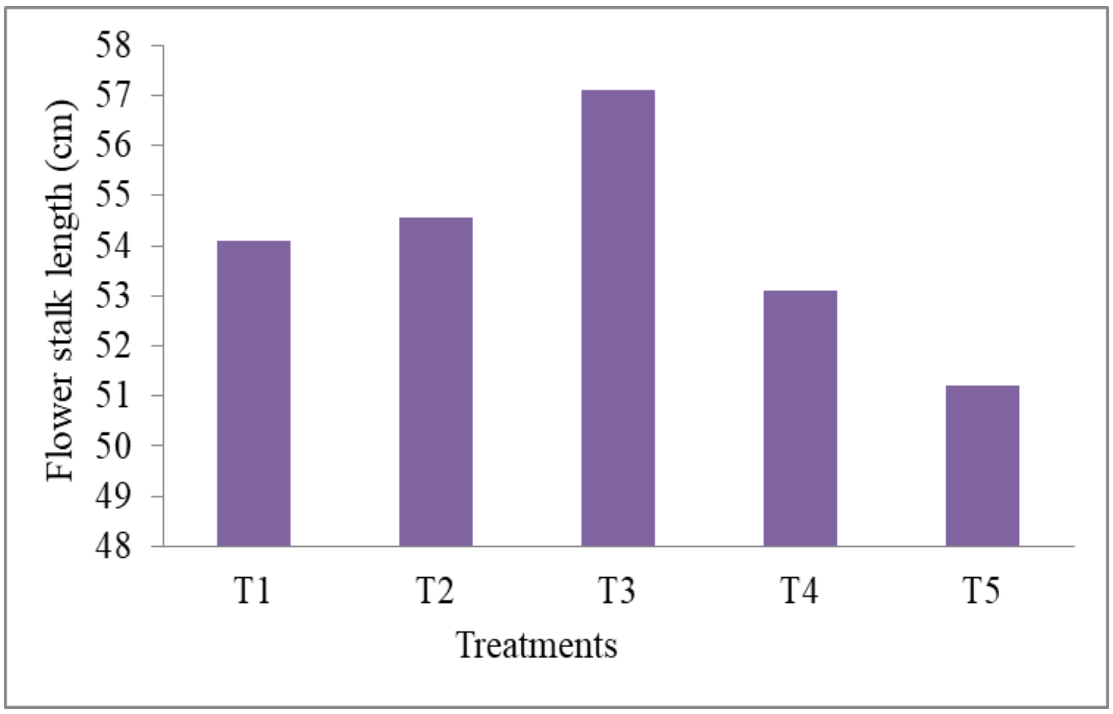


Figure 4. Influence of organic amendments and bio-control agent on flower stalk length of gerbera

[T_1= Farmyard manure (3 t/ha) + ¼ RDF, T_2= Vermicompost (3 t/ha) + ¼ RDF, T_3= Trichocompost (3 t /ha) + ¼ RDF, T_4= Tricholeachate (3000 L/ha) + ¼ RDF and T_5= Control (Recommended doses of fertilizers: N_{150} P_{30} K_{100} S_{20} B_1 Zn_1 kg/ha)]

Plate 19. Effect of organic amendments and bio-control agent on flower stalk length of gerbera

[T_1= Farmyard manure (3 t/ha) + ¼ RDF, T_2= Vermicompost (3 t/ha) + ¼ RDF, T_3= Trichocompost (3 t /ha) + ¼ RDF, T_4= Tricholeachate (3000 L/ha) + ¼ RDF and T_5= Control (Recommended doses of fertilizers: N_{150} P_{30} K_{100} S_{20} B_1 Zn_1 kg/ha)]

4.10 Flower stalk diameter

It was revealed that flower stalk diameter varied significantly and ranged from 0.27 to 0.34 cm. The treatment T_3 (Trichocompost 3 t/ha + ¼ RDF) showed the highest stalk diameter (0.34 cm) followed by T_2 (0.32 cm) and T_1 (0.30 cm). The lowest stalk diameter (0.27 cm) was observed in T_5 (Table 3). Maximum healthy flowers were produced by plants which received ¼ RDF along with Trichocompost. These healthy flowers are of maximum length and diameter. 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 flowers for their development. Variation in flower stalk diameter has been reported by Ahmad *et al.* (2012) and Noor-E-Alam (2015) in gerbera.

4.11 Number of flowers per plant

Number of flowers per plant varied significantly for different treatments of organic manure, fertilizer and bio-control agent (Table 3). The maximum number of flowers per plant (12.70) was found from T_3 which was closely followed by T_1 (11.90) and T_2 (11.33) and the lowest (9.44) was recorded from T_5. These results indicated that, number of flowers per plant was increased with the increases of nutritional element from trichocompost. Maximum number of leaves was produced by the application of Trichocompost which enhanced to constitute chlorophyll that leads maximum number of flowers per plant in gerbera. The significant differences in flower production when Trichocompost applied along with fertilizers might be due to the fact that it presents the nutrients in most available form, which made it possible for the plants to grow and put forth luxuriant growth which in turn helped the plants to produce more photosynthates that promoted number of flowers per plant in gerbera to produce higher flower yields.

4.12 Number of flowers per plot

It was observed that different treatments of organic amendments and bio- control agent had significant effect on number of flowers per plot (Figure 6 and Appendix

VI). The maximum number of flowers per plant was produced by T_3 (76.20) closely followed by T_1 (71.40) and T_2 (67.98). T_5 produced the lowest number of flowers per plot. Increase in number of flowers per plot might be due to increased number of flowers per plant. This might be due to presence of growth promotive substances like essential plant nutrients, vitamins, enzymes and antibiotics in trichocompost coupled with ¼ RDF.

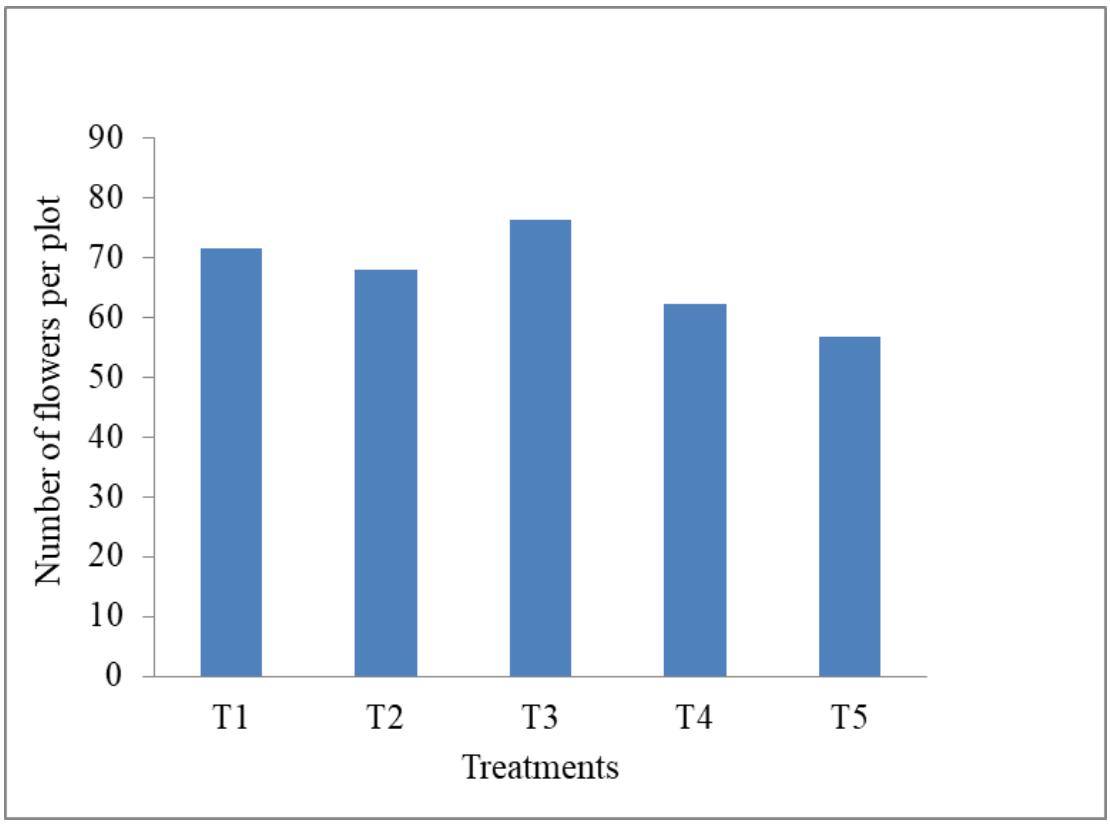


Figure 5. Influence of organic amendments and bio-control agent on number of flowers per plot of gerbera

[T_1= Farmyard manure (3 t/ha) + ¼ RDF, T_2= Vermicompost (3 t/ha) + ¼ RDF, T_3= Trichocompost (3 t /ha) + ¼ RDF, T_4= Tricholeachate (3000 L/ha) + ¼ RDF and T_5= Control (Recommended doses of fertilizers: N_{150} P_{30} K_{100} S_{20} B_1 Zn_1 kg/ha)]

4.13 Number of ray florets per flower

Data recorded in respect of number of ray florets per flower in gerbera influenced by different organic manures, bio-control agent along with quarter recommended dose of fertilizers are presented in Figure 5 and Appendix VI. The number of ray florets per flower was the highest in T_3 (48.0) followed by T_1 (46.67) and T_2 (45.33). The lowest

number of ray florets (42.67) was produced by the T_4, which differed significantly from all other treatments. The improvement in number of ray florets per flower was mainly due to castings of *Trichoderma* which consists of plant growth hormones, various enzymes along with macro and micronutrients. Noor-E-Alam (2015) conducted an experiment with 15 genotypes of gerbera and found number of ray florets per flower varied from 40.0-55.0 cm which was at par with the present investigation.

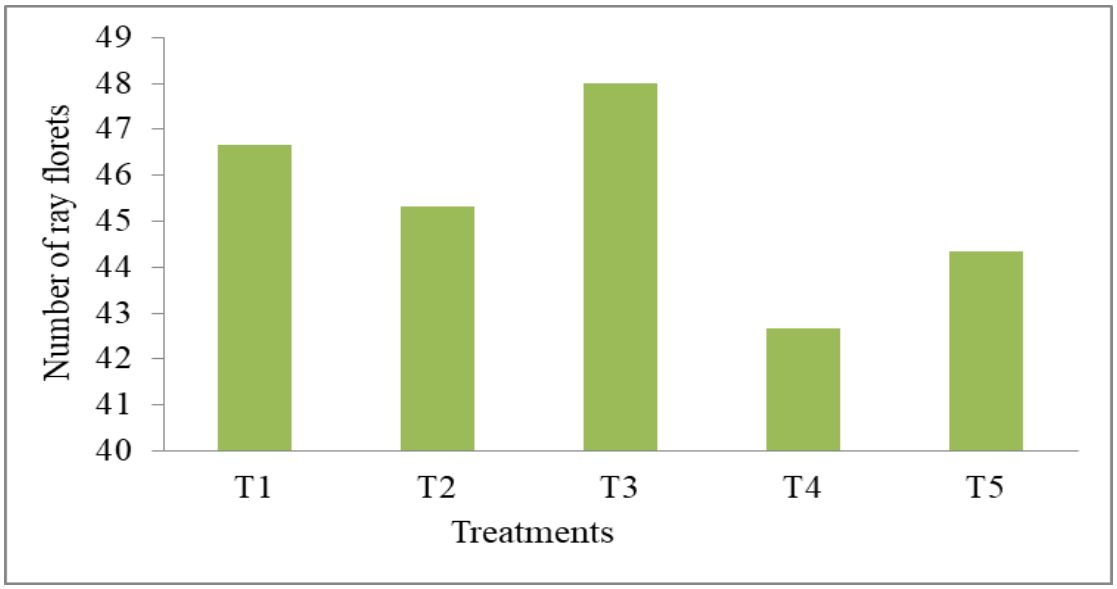


Figure 6. Influence of organic amendments and bio-control agent on number of ray florets per flower of gerbera

[T_1= Farmyard manure (3 t/ha) + ¼ RDF, T_2= Vermicompost (3 t/ha) + ¼ RDF, T_3= Trichocompost (3 t /ha) + ¼ RDF, T_4= Tricholeachate (3000 L/ha) + ¼ RDF and T_5= Control (Recommended doses of fertilizers: N_{150} P_{30} K_{100} S_{20} B_1 Zn_1 kg/ha)]

4.14 Days to flower bud initiation

Marked differences were recorded in respect of number of days required for first flower bud initiation among the treatments under protected condition (Table 4). The treatment T_3 took minimum of 68.33 days to first flower bud initiation followed by T_2 (70.67 days) and T_1 (72.33 days). The control treatment (75.67 days) took maximum duration to initiate flower bud. 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. This was in accordance to the findings of Noor-E-Alam (2015) in gerbera under protected condition and partial agreement with Kallol and Biradar (2016).

4.15 Days from flower bud initiation to bud opening

Different treatments exhibited statistically significant variation in respect of days for flower bud initiation to bud opening (Table 4). T_4 took maximum time (9.67 days) to open flower bud from initiation where T_3 (6.0 days) took minimum time. The minimum time requirement from bud initiation to opening might be due to presence and release of more food and nutrients in Trichocompost.

4.16 Days from flower bud opening to full bloom

Significant variation in respect of days from flower bud opening to full bloom was observed among the treatments (Table 4). T_3 took minimum duration of 7.15 days to

Table 4. Effect of organic amendments and bio-control agent on flower characteristics of gerbera

Treatments	Days to flower bud initiation	Days to flower bud open	Days to full bloom	Shelf life (Days)	Vase life (Days)
T_1	72.33 c	7.67 bc	8.85 bc	15.67 b	12.67 bc
T_2	70.67 d	6.67 cd	8.33 c	16.33 b	13.33 b
T_3	68.33 e	6.00 d	7.15 d	17.67 a	14.67 a
T_4	74.67 b	9.67 a	9.93 a	15.33 b	12.19 c
T_5	75.67 a	8.00 b	9.33 ab	14.07 c	11.33 d
$LSD_{0.05}$	0.81	1.1139	0.94	1.1443	0.8376
CV%	2.37	7.78	5.95	3.84	3.47

[In a column means having similar letter(s) is/ are statistically identical and those having dissimilar letter(s) differ significantly as per as 0.05 (%) level of probability; Here, T_1= Farmyard manure (3 t/ha) + ¼ RDF, T_2= Vermicompost (3 t/ha) + ¼ RDF, T_3= Trichocompost (3 t /ha) + ¼ RDF, T_4= Tricholeachate (3000 L/ha) + ¼ RDF and T_5= Control (Recommended doses of fertilizers: N_{150} P_{30} K_{100} S_{20} B_1 Zn_1 kg/ha)]

full bloom of flower from the bud initiation which is followed by T_2 (8.33 days) and T_1 (8.85 days). T_4 took maximum duration (75.67 days) to full bloom of flower. The full bloom of flower from the opening of bud was generally early in plants with a greater number of leaves, higher leaf length and breadth and a greater number of suckers.

4.17 Shelf life

Significant variation in respect of shelf life was observed among the treatments. The shelf life ranged from 14.07 to 17.67 days. It was evident from Table 4 that the T_3 recorded maximum shelf life (17.67 days) closely followed by cultivar T_2 (16.33 days). Minimum shelf life was recorded in T_5 (14.07 days). Application of 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 observed results are in agreement with the findings of Bellubbi *et al*. (2015) and in partial agreement with Fayaz *et al.* (2016) and Noor-E-Alam (2015).

4.18 Vase life

It was revealed from Table 4 that different treatment of organic manure, fertilizer and bio-control agent had significant effect on vase life. The maximum vase life was obtained in T_3 (14.67 days) treatment closely followed by T_2 (13.33 days) treatment and the minimum in treatment T_5 (11.33 days) and was statistically comparable to the remaining treatments. The variation in vase life might be attributed to the stalk length and stalk diameter which will have stored food material. Trichocompost exhibits longer vase life as possess better water uptake capacity and higher accumulation of metabolic sugars (reducing and non-reducing) in the plant as well as in the flower stalk. Noor-E-Alam (2015) and Kallol and Biradar (2016) reported partially as par with the present findings.

4.19 Disease and insect infestation

Gerbera is susceptible to several insects and diseases which adversely affect the quality and quantity of the flower. The crop is mostly infested by aphid, thrips and mites. The major diseases like powdery mildew, *Fusarium* rot and leaf spot occurred in gerbera (Noor-E-Alam, 2015). Leaf spot disease, aphid and mite infestation in gerbera were not found in case of treatment T_3 (Trichocompost 3 t/ha + ¼ RDF). The highest disease incidence and insect infestation was observed in T_5 (control) (Table 4). The results are in partial agreement with Naznin *et al.* (2015) in tuberose and Akter (2015) in gladiolus.

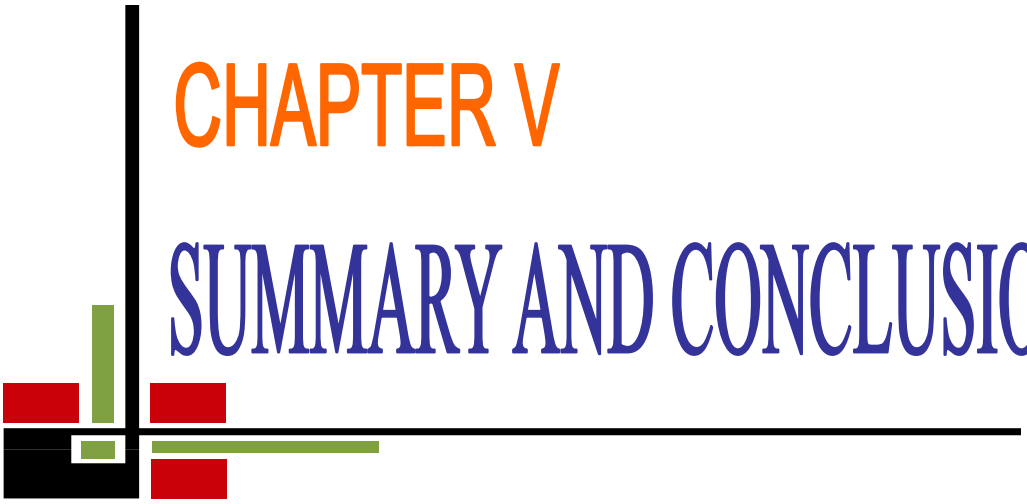
Table 5. Disease incidence and insect infestation in gerbera

Treatments	Insect infestation			Disease infestation		
	Aphid	Mite	Thrips	Fusarium rot	Powdery mildew	Leaf spot
T_1	1	+	-	-	-	+
T_2	1	+	-	-	-	+
T_3	0	-	-	-	-	-
T_4	1	++	-	-	-	-
T_5	2	+++	-	-	-	++

[0= No population; 1= a small colony of 10-20 aphid/plant; 2= a colony with > 20 aphid/plant; 3= > one colony; 4= Severe infestation of maximum plants and - = Nil; + = Less; ++ = Medium; +++ = High]

CHAPTER V

SUMMARY AND CONCLUSION



CHAPTER V
SUMMARY AND CONCLUSION

Summary

The field experiment was conducted in the Horticulture Farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207 during the period from December 2019 to July 2020 to study the growth, yield and quality of gerbera as influenced by organic manure, fertilizer and bio-control agent namely, T_1= Farmyard manure (3 t/ha) + ¼ RDF, T_2= Vermicompost (3 t/ha) + ¼ RDF, T_3= Trichocompost (3 t/ha) + ¼ RDF, T_4= Tricholeachate (3000 L/ha) + ¼ RDF and T_5= Control (Recommended doses of fertilizers: N_{150} P_{30} K_{100} S_{20} B_1 Zn_1 kg/ha).

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The unit plot size was 1.2 m × 0.8 m accommodating 6 plants per plot. Spacing was maintained at 40 cm from row to row and 40 cm from plant to plant. The plots were raised up to 0.20 meter. The flowers of gerbera were harvested when the flower attained commercial stage (outer two rows of disc florets are perpendicular to the stalk).

Data were collected from each plant taken from each unit plot. Observation were made on plant height (cm), leaf number, plant spread (cm), number of sucker, flower diameter (cm), stalk length (cm), number of ray florets per flower, days to flower bud initiation, days to full bloom, shelf life (days), vase life (days), number of flowers per plant, disease & insect reaction etc.

Analysis of variance data revealed that all the studied of growth and yield of gerbera varied significantly at 5% level of probability due to influence of organic manure fertilizer and bio-control agent.

Plant height of gerbera showed statistically significant differences due to different organic manures, bio-control agent along with quarter recommended dose of fertilizers at 15, 30, 45 and 60 DAT. At the different days after transplanting (DAT)

the tallest plant (10.89, 21.77, 30.92 and 39.94 cm) was recorded from T_3 (Trichocompost 3 t/ha + ¼ RDF) at 15, 30, 45 and 60 DAT, respectively which is followed by T_1 (10.73, 20.15, 29.85 and 38.82 cm) at same DAT. Again, at the same DAT the shortest plant (8.95, 18.15, 26.78 and 36.18 cm) was recorded from T_5 (control i.e. absolute use of chemical fertilizer).

The maximum number of leaves (6.50, 7.83, 10.93, 13.83) were found in T_3 at 15, 30, 45 and 60 DAT, respectively which is followed by T_2 (6.20, 7.33, 10.07 and 12.50) at same DAT. The lowest number of leaves per plant was found in control treatment (4.17, 6.03, 8.50 and 10.67) at the same DAT, respectively. The maximum plant spread was obtained in T_3 (14.67, 18.28, 23.89, 29.50 cm) at 15, 30, 45 and 60 DAT, respectively and while the minimum length was found in T_5 (12.11, 16.65, 20.12, 26.08 cm) at the same DAT.

The longest (23.89 cm) leaf was recorded from T_3 which is closely similar to T_1 (23.28 cm) and the shortest (22.17 cm) leaf was obtained from T_5 at 60 DAT. Distinct variation was observed in respect of leaf breadth within the treatments. The widest leaf was produced by T_3 (10.50 cm) which was closely followed by T_1 (10.13 cm) whereas, T_5 produced the narrowest leaf (9.06 cm).

The highest number of 2.84 and 3.67 suckers per plant was produced by T_3 at 90 and 180 DAT where T_5 produced the lowest number of 1.56 and 2 suckers per plant at the same DAT. The diameter of flower bud (1.83 cm) of T_3 was larger than the diameter (1.61 cm) of T_5. The variation among the treatments in respect of flower diameter was found significant. The highest flower diameter was found in T_3 (Trichocompost 3 t/ha + ¼ RDF) treatment (10.78 cm) which was closely followed by T_1 (9.56 cm), T_2 (9.43 cm) and T_4 (9.02 cm). The lowest flower diameter was found in control treatment (8.07 cm).

The longest stalk of 57.11 cm was produced by T_3 followed by T_2 (54.56 cm) and T_1 (54.11 cm) while the shortest stalk of 51.22 cm was produced by T_5. It was revealed that flower stalk diameter varied significantly and ranged from 0.27 to 0.34 cm. The

treatment T_3 (Trichocompost 3 t/ha + ¼ RDF) showed the highest stalk diameter (0.34 cm) followed by T_2 (0.32 cm) and T_1 (0.30 cm). The lowest stalk diameter (0.27 cm) was observed in T_5.

The number of ray florets per flower was the highest in T_3 (48.0) followed by T_1 (46.67) and T_2 (45.33). The lowest number of ray florets per flower (42.67) was produced by the T_4, which differed significantly from all other treatments.

The treatment T_3 took minimum of 68.33 days to first flower bud initiation followed by T_2 (70.67 days) and T_1 (72.33 days). The control treatment (75.67 days) took maximum duration to initiate flower bud. T_4 took maximum time (9.67 days) to open flower bud from initiation where T_3 (6.0 days) took minimum time.

Significant variation in respect of days from flower bud opening to full bloom was observed among the treatments. T_3 took minimum duration of 7.15 days to full bloom of flower from the bud initiation which is followed by T_2 (8.33 days) and T_1 (8.85 days). T_4 took maximum duration (9.93 days) to full bloom of flower.

The maximum number of flowers per plant (12.70) was found from T_3 which was closely followed by T_1 (11.90) and T_2 (11.33) and the lowest (9.44) was recorded from T_5. The maximum number of flowers per plot was produced by T_3 (76.20) closely followed by T_1 (71.40) and T_2 (67.98). T_5 produced the lowest number of flowers per plot.

Significant variation in respect of shelf life was observed among the treatments. The shelf life ranged from 14.07 to 17.67 days. It was evident from that the T_3 recorded maximum shelf life (17.67 days) closely followed by cultivar T_2 (16.33 days). Minimum shelf life was recorded in T_5 (14.07 days). The maximum vase life was obtained in T_3 (14.67 days) treatment closely followed by T_2 (13.33 days) treatment and the minimum in treatment T_5 (11.33 days) and was statistically comparable to the remaining treatments.

Gerbera is susceptible to several insects and diseases which adversely affect the quality and quantity of the flower. Leaf spot disease, aphid and mite infestation in gerbera were not found in case of treatment T_3 (Trichocompost 3 t/ha + ¼ RDF). The highest disease incidence and insect infestation was observed in T_5 (control).

Conclusion

- Application of Trichocompost (3 t/ha) along with ¼ RDF showed significant result in vegetative growth and flowering of gerbera.
- Trichocompost (3 t/ha) along with ¼ RDF reduced disease incidence of gerbera.
- Trichocompost (3 t/ha) along with ¼ RDF increased the vase life of gerbera.

Recommendation

Considering the situation of the present experiment, further studies in the following areas may be suggested:

1. Another experiment may be carried out with various organic amendments and bio-control agent.
2. Such study is needed in different agro-ecological zones (AEZ) of Bangladesh for regional compliance and other performance.

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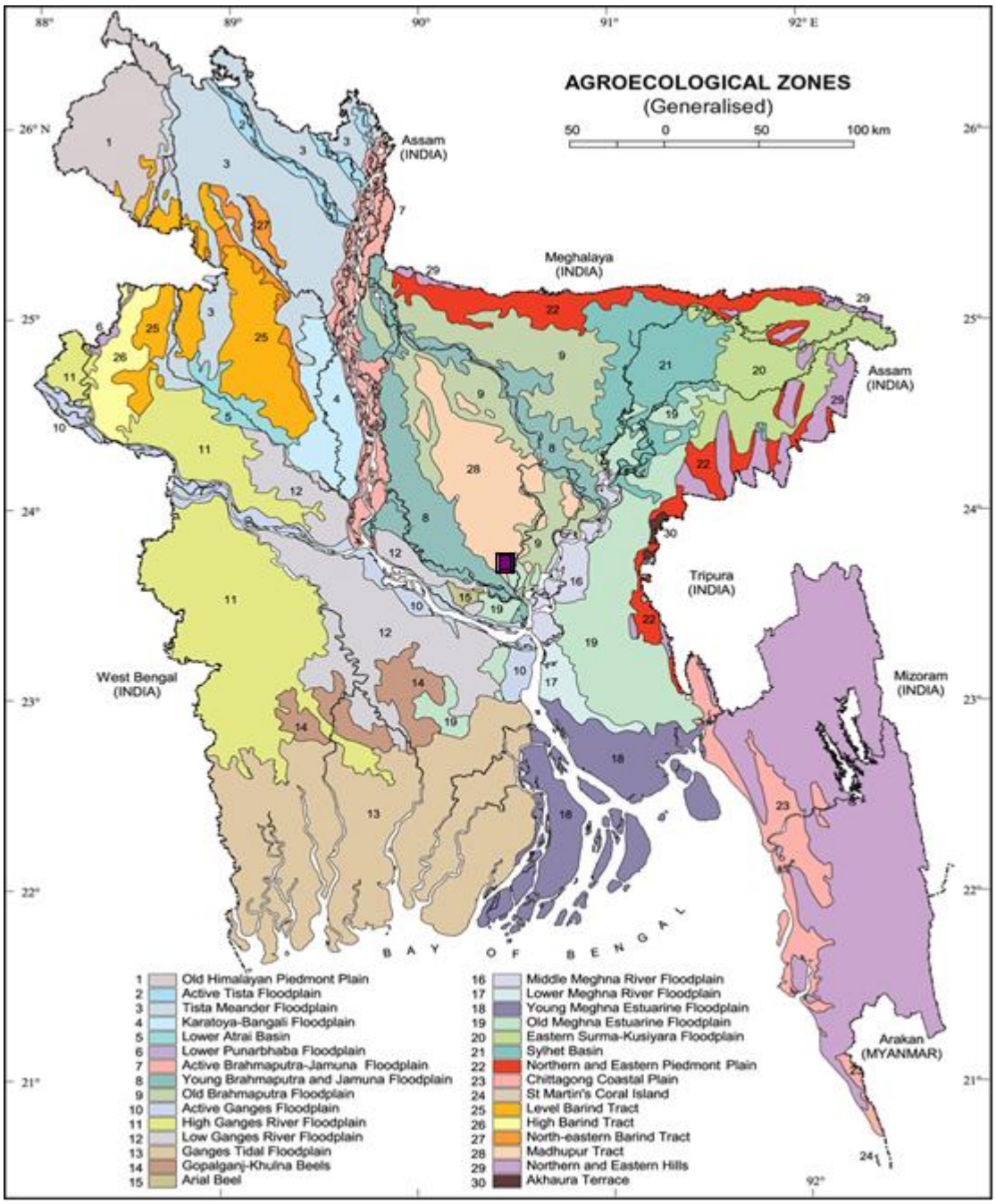
APPENDICES

APPENDICES

Appendix I. Map showing the experimental site under the study



The Experimental site under study

Appendix II. Monthly average temperature, relative humidity and total rainfall and sunshine of the experimental site during the period from February, 2020 to July, 2020

Month	Air temperature (°C)		Relative humidity (%)	Rainfall (mm)
	Maximum	Minimum		
February, 2020	28.10	18.83	45.18	19
March, 2020	32.18	22.56	65.53	25
April, 2020	33.74	23.87	67.23	85
May, 2020	33.20	24.20	73.0	291
June, 2020	33.40	26.80	79.0	259
July, 2020	31.40	25.80	81.50	542

Source: Bangladesh Meteorological Department (Climate and Weather Division), Agargoan, Dhaka– 1212

Appendix III. Morphological, physical and chemical characteristics of initial soil (0-15 cm depth) of the experimental site

A. Morphological characteristics of the experimental field

Morphological features	**Characteristics**
Location	Horticulture Farm, SAU, Dhaka
AEZ	Modhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained
Cropping pattern	Not Applicable

Source: Soil Resource Development Institute (SRDI), Khamarbari, Dhaka

B. Physical composition of the soil

Particle size	constitution
Sand	40%
Silt	40%
Clay	20%
Texture	Sandy loamy

Source: Soil Resource Development Institute (SRDI), Khamarbari, Dhaka

C. Chemical composition of the soil

Soil characters	Value
Organic matter	1.44 %
Potassium	0.15 meq/100 g soil
Calcium	3.60 meq/100 g soil
Magnesium	1.00 meq/100 g soil
Total nitrogen	0.072
Phosphorus	22.08 µg/g soil
Sulphur	25.98 µg/g soil
Boron	0.48 µg/g soil
Copper	3.54 µg/g soil
Iron	262.6 µg/g soil
Manganese	164 µg/g soil
Zinc	3.32 µg/g soil

Source: Soil Resource Development Institute (SRDI), Khamarbari, Dhaka

Appendix IV. Influence of organic amendments and bio-control agent on plant height of gerbera

Treatments	Plant height (cm)			
	15 DAT	30 DAT	45 DAT	60 DAT
T_1	10.73 a	20.15 b	29.85 b	38.82 b
T_2	9.97 b	19.06 c	29.31 bc	37.67 c
T_3	10.89 a	21.77 a	30.92 a	39.94 a
T_4	9.56 bc	17.91 d	28.78 c	37.22 c
T_5	8.95 c	18.15 d	26.78 d	36.18 d
$LSD_{0.05}$	0.7404	0.3071	1.0495	0.6628
CV%	3.92	4.84	2.91	2.93

[In a column means having similar letter(s) is/ are statistically identical and those having dissimilar letter(s) differ significantly as per as 0.05 (%) level of probability; Here, T_1= Farmyard manure (3 t/ha) + ¼ RDF, T_2= Vermicompost (3 t/ha) + ¼ RDF, T_3= Trichocompost (3 t /ha) + ¼ RDF, T_4= Tricholeachate (3000 L/ha) + ¼ RDF and T_5= Control (Recommended doses of fertilizers: N_{150} P_{30} K_{100} S_{20} B_1 Zn_1 kg/ha)]

Appendix V. Influence of organic amendments and bio-control agent on plant spread of gerbera

Treatments	Plant spread (cm)			
	15 DAT	30 DAT	45 DAT	60 DAT
T_1	13.34 bc	17.67 b	22.06 b	27.47 c
T_2	13.94 b	17.89 ab	22.61b	28.40 b
T_3	14.67 a	18.28 a	23.89 a	29.50 a
T_4	13.11 c	16.94 c	21.55 b	26.94 d
T_5	12.11 d	16.65 c	20.12 c	26.08 e
$LSD_{0.05}$	0.67	0.5673	1.27	0.5020
CV%	2.78	3.72	3.92	4.96

[In a column means having similar letter(s) is/ are statistically identical and those having dissimilar letter(s) differ significantly as per as 0.05 (%) level of probability; Here, T_1= Farmyard manure (3 t/ha) + ¼ RDF, T_2= Vermicompost (3 t/ha) + ¼ RDF, T_3= Trichocompost (3 t /ha) + ¼ RDF, T_4= Tricholeachate (3000 L/ha) + ¼ RDF and T_5= Control (Recommended doses of fertilizers: N_{150} P_{30} K_{100} S_{20} B_1 Zn_1 kg/ha)]

Appendix VI. Influence of organic amendments and bio-control agent on flower characteristics of gerbera

Treatments	Flower stalk length (cm)	Number of ray florets per flower	Number of flowers per plot
T_1	54.11 b	46.67 b	71.40 b
T_2	54.56 b	45.33 c	67.98 b
T_3	57.11a	48.00 a	76.20 a
T_4	53.11 c	42.67 d	62.16 c
T_5	51.22 d	44.33 c	56.64 d
$LSD_{0.05}$	0.8420	1.1401	1.6124
CV%	2.83	2.33	2.49

[In a column means having similar letter(s) is/ are statistically identical and those having dissimilar letter(s) differ significantly as per as 0.05 (%) level of probability; Here, T_1= Farmyard manure (3 t/ha) + ¼ RDF, T_2= Vermicompost (3 t/ha) + ¼ RDF, T_3= Trichocompost (3 t /ha) + ¼ RDF, T_4= Tricholeachate (3000 L/ha) + ¼ RDF and T_5= Control (Recommended doses of fertilizers: N_{150} P_{30} K_{100} S_{20} B_1 Zn_1 kg/ha)]

Appendix VII. Analysis of variance of the data of plant height of gerbera as influenced by organic manure and bio-control agent

Source of variation	Degree of freedom	Mean sum of square			
		Plant height (cm)			
		15 DAT	30 DAT	45 DAT	60 DAT
Replication	2	0.05334	0.03101	0.22430	0.11030
Treatment	4	1.96500*	7.55882*	7.04212*	6.34918*
Error	8	0.15464	0.02660	0.31069	0.12391

*significance at 5% level of probability
**significance at 1% level of probability
NS-non significant

Appendix VIII. Analysis of variance of the data of number of leaves per plant of gerbera as influenced by organic manure and bio-control agent

Source of variation	Degree of freedom	Mean sum of square			
		Number of leaves per plant			
		15 DAT	30 DAT	45 DAT	60 DAT
Replication	2	0.26667	0.18067	0.11667	0.20000
Treatment	4	0.77500*	1.59421*	2.38933*	3.93502*
Error	8	0.72500	0.08067	0.12333	0.11667

*significance at 5% level of probability
**significance at 1% level of probability
NS-non significant

Appendix IX. Analysis of variance of the data of plant spread of gerbera as influenced by organic manure and bio-control agent

Source of variation	Degree of freedom	Mean sum of square			
		Plant spread			
		15 DAT	30 DAT	45 DAT	60 DAT
Replication	2	0.09074	0.18746	0.14074	0.02007
Treatment	4	0.60000*	1.36834*	2.86491*	5.23851*
Error	8	1.65556	0.09078	0.04352	0.07110

*significance at 5% level of probability
**significance at 1% level of probability
NS-non significant

Appendix X. Analysis of variance of the data on different plant characters of gerbera as influenced by organic manure and bio-control agent

Source of variation	Degree of freedom	Mean sum of square				
		Leaf length	Leaf breadth	Number of sucker		Diameter of flower bud
				90 DAT	180 DAT	
Replication	2	0.25046	0.01274	0.06214	0.24609	0.00271
Treatment	4	1.32189*	1.03537*	0.71592*	1.18229*	0.01877*
Error	8	0.21133	0.09950	0.07446	0.05660	0.00178

*significance at 5% level of probability
**significance at 1% level of probability
NS-non significant

Appendix XI. Analysis of variance of the data on different flower characters of gerbera as influenced by organic manure and bio-control agent

Source of variation	Degree of freedom	Mean sum of square				
		Flower diameter	Flower stalk length	Flower stalk diameter	Number of flowers per plant	Number of flowers per plot
Replication	2	0.00267	0.200	0.0626	0.11296	4.06667
Treatment	4	0.24126*	13.886*	0.1512*	0.25926*	9.33333*
Error	8	0.23926	0.200	0.048	0.02037	0.73333

*significance at 5% level of probability
**significance at 1% level of probability
NS-non significant

Appendix XII. Analysis of variance of the data on different flower characters of gerbera as influenced by organic manure and bio-control agent

Source of variation	Degree of freedom	Mean sum of square					
		Number of ray florets per flower	Days to flower bud initiation	Days to flower bud open	Days to full bloom	Shelf life	Vase life
Replication	2	0.200	1.024	0.266	2.400	0.20	0.411
Treatment	4	12.745*	26.500*	5.895*	1.933*	5.26*	4.734*
Error	8	0.366	0.200	0.350	3.233	0.36	0.197

*significance at 5% level of probability
**significance at 1% level of probability
NS-non significant