Effect of Organic Manures and Biofertilizers on Vegetative and Floral Characters of China aster (*Callistephus chinensis* (L.) Nees.) cv. Kamini

Thesis

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By

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Dedicated To My

Loving

Grandmother

Saraswati

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Place: Bharsar

Date: *Akash Rana*

CERTIFICATE

This is to certify that the thesis entitled "**Effect of Organic Manures and Biofertilizers on Vegetative and Floral Characters of China aster cv. Kamini**" submitted in partial fulfillment of the requirements for the degree of **Master of Science (Horticulture)** with major in **Floriculture and Landscape Architecture** of the College of Horticulture, VCSG Uttarakhand University of Horticulture & Forestry, Bharsar, is a record *of bona fide* research carried out by **Mr. Akash Rana, ID. No. 15233,** under my supervision and no part of the thesis has been submitted for any other degree or diploma.

Prof. B. P. Nautiyal
Chairman
Advisory Committee

CERTIFICATE

We, the undersigned, members of Advisory Committee of **Mr. Akash Rana, I.D. No 15233,** a candidate for the degree of **Master of Science (Horticulture)** with major in **Floriculture and Landscape Architecture** agree that the thesis entitled **"Effect of Organic Manures and Biofertilizers on Vegetative and Floral Characters of China aster (*Callistephus chinensis* (L.) Nees.) cv. Kamini"** may be submitted in partial fulfilment of the requirements for the degree.

Prof. B.P. Nautiyal
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Abbreviations

%	=	Per Cent
*	=	Significant
@	=	At the rate of
Azoto	=	*Azotobacter*
cd	=	Critical Difference
cm	=	Centimetre
cm^2	=	Square Centimetre
cv.	=	Cultivar
df	=	Degree of Freedom
dm^2	=	Square decimetre
E-W	=	East to West
FYM	=	Farmyard manure
g	=	Gram
gm	=	General Mean
ha	=	Hectare
K	=	Potassium
Kg	=	Kilogram
L	=	Litre
m	=	Meter
m^2	=	Square Meter
Max.	=	Maximum
Min.	=	Minimum
Ms	=	Mean Square

N	=	Nitrogen
NC	=	Neem Cake
N-S	=	North to South
P	=	Phosphorus
ppm	=	Parts Per Million
PSB	=	Phosphorus Solubilizing Bacteria
RDF	=	Recommended Dose of Fertilizers
RDN	=	Recommended Dose of Nitrogen
RH	=	Relative Humidity
Se m	=	Standard Error Mean
Temp.	=	Temperature
v/v	=	Volume by Volume
VAM	=	*Vesicular Arbuscular Mycorrhiza*
° C	=	Degree Centigrade
mm	=	Millimetre

Chapter 1

INTRODUCTION

China aster (*Callistephus chinensis* (L.) Nees.) is one of the important commercial flower crops of our country. It belongs to the family Asteraceae. It is native to China and has spread to Europe and other tropical countries during 1731 A.D. (Desai, 1967). The generic name *Callistephus* was derived from two Greek words '*Kalistos*' means most beautiful and '*Stephus*' means a crown, referring to the large and colourful flower heads. It was first named by Linnaeus as *Aster chinensis,* and afterwards Nees subsequently changed this name to *Callistephus chinensis*. It is a half hardy annual, plants are erect, it has branches having hispid hair, leaves are arranged alternately on branches and it has solitary type of flowers. The aster blooms contain two kinds of florets: ray florets and disc florets (Bose *et al.*, 2003).

Among annuals, it ranks next to chrysanthemum and marigold. It is susceptible to more water logging conditions. Hence, well drained red loamy soils are preferred. Soil with heavy calcium content are not suitable for its cultivation, it grows well in soils having pH range of 6.8 -7.5. It needs limited rainfall of 500 – 700 mm followed by frequent but light irrigation. It requires 10 - 12° C day temperature to develop large size flowers whereas, the flower colour is well developed in the temperature range of 20 – 30° C during day and 15 – 17° C during night with relative humidity of 50 – 60 %. Higher temperature has an adverse effect on plants. The stems becomes too much elongated and be of poor quality, thus an optimum range of temperature is very important to get quality flowers in China aster. It needs bright sunlight for a longer period for its growth and flowering (Bhattacharjee, 2006).

There are wide range of colours availability in China aster that are pink, blue, purple, white due to which it has gained a noble position in the cut flower market. Along with this it also has a magnificent vase life which is a reason for its high demand. At present its cultivation is becoming popular around the cities for its extensive use as cut flower, loose flower, for making bouquets, buttonholes and garlands. In ornamental gardening, it is used as a bedding plant, edging pot plant and herbaceous border in addition to this it is also sold as a popular pot plant in major commercial nurseries. In India, it is being grown on a large scale in Karnataka, Tamil Nadu, Andhra Pradesh, Maharashtra and West Bengal. The flowers are often used for flower arrangements, religious offerings and as cut flower for interior decorations. It is also suitable for inter-cropping in coconut gardens and for mixing with leafy vegetables. As China aster is a short duration crop and requires less labour utilisation it is being grown by small and marginal farmers all around the country to gain high benefit as it can be grown in various agro climatic zones and do not requires much plant protection.

The increased production of quality as well as quantity of flowers is the main objective to be reckoned in commercial flower production. However, quality of flowers is primarily a varietal trait but it is greatly influenced by climatic, geographical and nutritional factors. Among them nutrition plays a very crucial role. For generating higher income farmers are using excessive amount of chemical fertilizers since the time of green revolution. One can get higher yield with the use of chemical fertilizers but they are not environment friendly and are responsible for soil, water and air pollution, although they also spread cancer causing agents (Mishra *et al*., 2012). The indiscriminate and imbalanced use of fertilizers in agriculture is the main reason behind depletion of productivity and loss of soil fertility (Swaminathan, 1996). Water soluble chemical fertilizers when applied to soil, a good portion of the added nutrients does not become available to the crop plants and lost either to the atmosphere up to the hydrosphere due to non-stimulation of the activities of heterotrophic soil organisms but facilitate that of the autotrophic nitrifying organisms, thereby hindering the immobilization of nutrients. Excessive use of chemical fertilizers causes the alteration of the appropriate soil structure, degradation of soil fertility, low yield and has adverse effects on both flora and fauna. Pandey and Kumar (2002) reported that chemical fertilizers are no longer hero for attaining the sustainability of soil which can be attained through the use of organic manures. Due to various shortcomings of chemical fertilizers farmers are focusing towards other alternate plant nutritional sources i.e., organic manures along with biofertilizers.

Organic matter helps to maintain a good soil structure, increases water holding capacity and nutrient supply rate. Ultimately, it improves soil fertility and productivity (Gaur *et al.,* 2002). Organic manures are natural source of plant nutrients needed to complete life processes like growth, development and reproduction of plants as well as these also enhance soil health status by favouring different physical and chemical properties. Contrary to chemical fertilizers, manures are easily available and cost-effective for farmers. They are complete essential nutrient sources (macro and micro nutrients) as compared to fertilizers

(Sharma, 2005). Prakash *et al*., 2014 stated that organic manure is well suited to achieve both production and conservation goals.

Among the different organic manures, Farmyard manure and Vermicompost are more preferred by the farmers as they are easily available as well as easy to prepare. Farmyard manure contains about approximately 5 - 6 kg nitrogen, 1.2 - 2.0 kg phosphorus and 5 - 6 kg potash per tonne. The quantity of FYM depends upon the way animals are feed and how the waste materials are being collected and stored. For preparing of better quality of FYM generally heap method is used. The areas where rainfall occurs less than 1000 mm, one can use pit method to prepare it. Gupta *et al.*, 1983 reported that application of farmyard manure increase crop production as well as population of micro flora in soil. Similarly, vermicompost is rich in macro (N, P, K) and micro nutrients (Fe, Bo, Zn, Mo) vital plant promoting substances, humus forming microorganisms and nitrogen fixers (Bano *et al*., 1987). It also contains biochemical substances that promote plant growth and fight plant diseases. The use of vermicompost not only increases the rate of water intake into soil but also improves the soil's ability to hold water. It is also very beneficial for enhancing colour, smell, taste, flavour and for keeping good quality of flowers. The quality of vermicompost depends on three factors i.e., earthworm, water and organic waste. Earthworms convert waste materials into valuable compost. Some of the earthworm species that are non-burrowing and consume organic debirs are *Eisenia foetida, Eudrilus eugeniae, Feretima elongata, Perionyx excavates*.

Along with organic manures biofertilizers are of great importance as these are microbial inoculants that helps to decompose complex organic matter and fix solubilize unavailable form of nutrients to available form at normal soil physical conditions. These are selected strains of beneficial soil microorganism that are cultured in a laboratory and are packed in a suitable container. There are various biofertilizers that are available in market like nitrogen fixing e.g. *Rhizobium*, *Bradyrhizobium*, *Azospirillum* and *Azotobacter*, phosphorous solubilising bacteria e.g. *Bacillus*, *Pseudomonas* and *Aspergillus*. Biofertilizers produces hormones and anti metabolites which promotes root growth along with this they also helps in decomposition of organic matter and mineralization in soil. When these are added to soil they increase the availability of nutrients and improve the yield by 10 – 25% without adversely affecting the soil and environment (Muraleedharan *et al*., 2010). Nitrogen is the most important macro nutrient that is required by the plants to complete their life cycle, its availability to plants can be gained by the use of *Azotobacter* as it helps in fixing atmospheric nitrogen in the soil and make it available to plants. It contains nitrogenise in it which is the most important enzyme that is involved in nitrogen fixation. Another second most important macro nutrient is phosphorous, it has crucial role in plant metabolism such as cell division, photosynthesis, breakdown of sugar, transfer of genetic characteristics from one generation to another and regulation of metabolic pathways most of the soils are deficient in soluble form of phosphorous which can be corrected by the use phosphate solubilizing bacteria. Biofertilizers are gaining momentum recently due to the increasing emphasis on maintenance of soil health, minimize environmental pollution and cut down on the use of chemicals in agriculture (Muraleedharan *et al*., 2010). These are also cost effective and renewable source of plant nutrients (Boraste *et al.*, 2009). They reduce per unit consumption of inorganic fertilizers along with increase the quality and quantity of flowers (Syamal *et al.*, 2006).

Use of organic manures and biofertilizers are environmentally safe and viable alternative of chemical fertilizers and it also increases microbial biomass in the soil (Selvamani *et al.,* 2011). Their combine use has an advantage of converting unusual surplus or waste in to useful products. The quantum of chemical fertilizers can be reduced by exploring the possibilities of using organic manures and biofertilizers in production of crop. Escalating prices of chemical fertilizers and poor purchasing power of marginal and small farmers, it is imperative to develop strategies for using organic manures and biofertilizers to their maximum potential with proper technology to meet the shortage of chemical fertilizers and improving soil fertility.

Therefore, keeping the above points in view, a comprehensive study on the effect of organic manures and biofertilizers on vegetative and floral characters of China aster were conducted with following objectives:

- To study the effect of organic manures and biofertilizers on vegetative and floral characters of plants.

Chapter 2

REVIEW OF LITERATURE

China aster is an important flowering crop of our country. It is cultivated on commercial basis of its market preference due to wide spectrum of forms attractive colours and comparatively longer vase life. The escalating business of flowers has led to uncontrolled and indiscriminate use of chemical fertilizers, insecticides, fungicides and growth promoters. Imbalanced use of these chemicals has adverse effect on the soil structure, environment, flora and fauna. Therefore, organic farming is the only solution of this problem (Rawat, 2002). In recent times, organic manures and biofertilizers have emerged as a supplement to mineral fertilizers as they are good source of plant minerals and are completely environment friendly. Misra and Kapoor (1992) also advocated use of organic manure for sustainable agriculture. Organic manures improve physical properties of soil by increasing humus content in the soil and consequently increasing its water holding capacity. Biofertilizers improve crop growth and quality of crops by fixation of solubilized unavailable form of nutrients to available form.

The component of present investigation concerning the effect of organic manures and biofertilizers on vegetative and floral characters for flower crops has been studied by few workers. It will be useful to review these works in China aster as well as in related ornamental flower crops and supplement the view to strengthen the concept developed from present study. Thus, after screening wide spectrum of literature available on this line, some of the most relevant ones are being presented for vegetative and floral characters under the following heads:

2.1 Effect of organic manures and biofertilizers on vegetative characters

Rathode *et al.* (2002) investigated the effect of integrated nutrient management on growth attributes of gaillardia. They found that application of 75 per cent recommended dose of fertilizer + *Azospirillum* + PSB resulted in maximum plant height (45.80 cm), stem girth (1.50 cm), number of branches (41.00) and number of leaves per plant (218.67).

Kumar *et al*. (2003) studied the effect of biofertilizers on vegetative growth parameters of China aster. They found that the application of 3/4th of the recommended dose of N and P in combination with full K + VAM + Phosphobacteria produced maximum plant height (59.80 cm), number of branches per plant (18.53), leaves per plant (277.00) and leaf area (3531.75 cm^2).

Methew and Singh (2003) conducted a study on effect of biofertilizers on growth parameters of African marigold. They observed that combined application of PSB + *Azotobacter* + *Azospirillum* as seedling dip method gave maximum plant height (85.62 cm) and number of branches per plant (15.65).

Rathi *et al.* (2005) studied the influence of biofertilizers on growth parameters of African marigold (*Tagetes erecta* L.). They reported that the application of *Azotobacter* + Phosphate solubilising bacteria + 3/4th Nitrogen produced maximum number of branches per plant (17.47), leaf area (13.88 cm^2), plant spread N-S (37.47 cm) and E-W (31.47 cm).

Nandre *et al.* (2005) investigated the effect of *Azotobacter* on growth and yield of China aster under reduced nitrogen doses. They reported that soil application of *Azotobacter* as and 75% recommended dose of nitrogen (112.5 kg/ha) with 50 kg/ha (P_2O_5 and K_2O each) produced increase plant height (58.72 cm) and number of branches per plant (26.45).

Anburanni and Kavitha (2006) studied the effect of integrated nutrient management on vegetative parameters in mullai (*Jasminum auriculatum*). They found that the application of FYM + 125% NPK (150:300:300 g/plant) + *Azospirillum* + Phosphobacteria (@ 2 kg/ha each) gave highest plant height (167.67 cm), length of primary shoot (157.02 cm), number of secondary shoots (9.99), leaf area per plant (82.31 cm^2) and plant spread (2.27 cm).

Chaitra (2006) studied the effect of integrated nutrient management on growth, yield and quality of China aster (*Callistephus chinensis* (L.) Nees.) They found that application of *Azospirillum* + PSB + Vermicompost + 50 per cent recommended NPK produced maximum plant height (60.88 cm), number of leaves (103.81), leaf area (23.16 dm^2), number of primary and secondary branches per plant (22.23 and 25.08, respectively) and stem girth (1.84 cm).

Kumar *et al.* (2006) conducted an experiment to find out effect of biofertilizers on vegetative parameters of marigold cv. Pusa Narangi Gainda. They reported that when PSB applied through seed treatment in combination with FYM produced increase plant height (44.3 cm) and plant spread (18.5 cm).

Mogal *et al.* (2006) conducted a field experiment to study the effect of organic manures and biofertilizers under reduced doses of nitrogen on vegetative growth parameters of China aster. They found that maximum plant height (58.72 cm), plant spread (38.47 cm), fresh weight of shoot and roots per plant at harvest (294.07 g) and dry weight of shoots and roots per plant at harvest (87.45 g) were obtained in the treatment containing Farmyard manure (FYM) (20 t/ha) + *Azotobacter* (3 kg / ha) + PSB (3 kg/ ha) + 100 % Nitrogen.

Syamal *et al.* (2006) investigated the effect of biofertilizers, *Azotobacter* and Phosphobacteria, each @ 1.00 and 1.50 kg/ha respectively on growth parameters of marigold (*Tagetes erecta* L.) cv. Rusty Red. They found that maximum plant height (61.77 cm) recorded with *Azotobacter* @ 1.50 kg/ha. However, maximum fresh and dry weights of leaves were recorded with *Azotobacter* @ 1.0 kg/ha (13.54 and 2.55 g, respectively) followed by @ 1.50 kg/ha (12.76 and 2.34 g, respectively).

Bhalla *et al*. (2007) carried out an experiment to find the effect of organic manures and biofertilizers on vegetative parameters of standard carnation (*Dianthus caryophyllus* L.). They reported that carnation cultivar Raggio-de-Sole grown in Sand + Soil + Vermicompost (1:1:1) (v/v) + Inorganic fertilizers + Biofertilizers @ (2 g/plant *Azospirillum* and phosphate solubilising bacteria each) produced maximum plant height (73.20 cm).

Gotmare *et al*. (2007) conducted an experiment on influence of integrated nutrient management on vegetative growth parameters of marigold (*Tagetes erecta* L.). They reported that maximum plant height (119.60 cm), number of primary branches per plant (13.26), length of primary branches (36.50 cm), stem diameter (2.47 cm), fresh weight of shoots and roots (232.66 g and 94.33 g; respectively) were obtained from the plants receiving treatment containing 70% RDF + *Azospirillum* (@ 5 kg/ha) + PSB (@ 5 kg/ha).

Jhon *et al*. (2007) investigated the response of organic manure and inorganic fertilizers on growth parameters in tulip (*Tulipa gesneriana* Linn.). They found that maximum plant height (36.15 cm), stem thickness (6.83 mm), number of leaves per plant (3.63) and wrapper leaf area (133.16 cm^2) were obtained in the plants receiving organic manure 60 t/ha.

Kumar and Singh (2007) studied the effect of Vermicompost and VAM inoculation on vegetative growth in China aster (*Callistephus chinensis* (L). Nees). They found that application of Vermicompost @ 10 t/ha resulted in significantly taller plants (43.70 cm), highest number of leaves and branches per plant (165.47 and 8.43, respectively) and plant spread (49.74 cm).

Srivastava and Govil (2007) found that corms of gladiolus cv. American Beauty treated with *Azotobacter* (100 g/L) produced minimum days taken to vegetative bud emergence (7.95 days) and maximum plant height (36.97 cm).

Chandra *et al.* (2009) findings suggested that 75 % of recommended dose of Phosphoric fertilizer + VAM (250 spores/pot) + Phosphate Solubilizing Fungi (20 ml of inoculums) increased the plant girth (99.10 cm), number of branches per plant (22.00) and plant height (24.20 cm) in chrysanthemum cv. Chizuka.

Preetham (2009) studied the response of organics on gladiolus (*Gladiolus hybrida* L.) cv. White Prosperity and found that highest plant height (57.26 cm) and number of leaves (6.80) was obtained under combination of Vermicompost (0.4 kg/m^2) + VAM (2 gm/plant).

Panchal *et al.* (2010) studied the effect of biofertilizers and nitrogenous fertilizer on growth parameters of annual white chrysanthemum (*Chrysanthemum coronarium* L.) under middle Gujarat agro climatic conditions. They found that application of 175 Kg N/ha + *Azospirillum* + *Azotobacter* produced significantly maximum plant height (96.23 cm), number of branches per plant (50.59), plant spread (79.08 cm in North - South direction and 78.79 cm in East - West direction).

Kabir *et al*. (2011) conducted a field experiment in tuberose cv. Single during the period from April, 2009 to March, 2010 to investigate the effect of organic fertilizers along with half chemical fertilizers. The experiment consisted of four different sources of fertilizers *viz.*, (i) recommended chemical fertilizers @ 400, 300, 300 and 100 kg/ha of urea, TSP, MP and Gypsum, respectively; (ii) Vermicompost @ 5 t/ha along with half of chemical fertilizers; (iii) poultry litter @ 20 t/ha along with half of chemical fertilizers and (iv) Cow dung @ 20 t/ha along with half of Chemical fertilizers. They found that plant height (95.6 cm), leaf number/plant (11.1), leaf length (45.9 cm) and number of side shoots/plant (4.82) were highest in plants treated with organic fertilizers along with half chemical fertilizers.

Verma *et al.* (2011) conducted an experiment to find out the effect of integrated nutrient management on growth parameters of chrysanthemum *(Chrysanthemum morifolium* Ramat.*)* cv. Raja. They observed that the treatment receiving *Azospirillum* + Phosphate Solubilising Bacteria (PSB) + Vermicompost + 50 per cent recommended NPK recorded the highest plant height (14.59 cm), number of primary branches (20.08), secondary branches (23.13), plant spread (33.20 cm), and dry matter accumulation (42.55 g/plant).

Airadevi and Mathad (2012) conducted a field experiment to find out the effect of integrated nutrient management on vegetative parameters of garland chrysanthemum. They observed that treatments containing *Azospirillum* + PSB + 50% Vermicompost + 50% Recommended doses of NPK recorded maximum plant height (87.00 cm), number of branches/ plant (39.61), plant spread (35.77 cm) and total dry matter production (22.77 g/plant).

Kumar *et al*. (2012) conducted a study on effect of biofertilizer and micronutrient on growth and flowering of tuberose (*Polianthes tuberosa* L.). They observed that combined application of PSB and boron (@ 200 g/l and 0.6%, respectively) gave the better results in respect of number of leaves per clump (63.37) and plant height (63.37 cm).

Singh *et al.* (2013) studied the effect of integrated nutrient management on growth and flowering of gladiolus (*Gladiolus grandiflorus* L.) cv. White Prosperity. They found that the treatment consisting [75% RDF, (NPK 225:150:150 kg/ha) + Vermicompost (2 Ton/ha) + PSB (2.5kg/ha) + *Azotobacter* (2.5kg/ha) gave the maximum plant height (56.93 cm), number of leaves per plant (13.20), length of longest leaf per plant (39.60 cm) and number of sprouts per plant (2.30).

Ravindra *et al*. (2013) observed that application of *Azospirillum* (@ 2 kg/acre) + PSB (@ 2 kg/acre) + Vermicompost (@ 2 t/acre) + 50% (RDF) produced maximum plant height (60.90 cm), number of leaves per plant (103.27) and number of branches per plant (25.39) in China aster.

Bohra and Kumar (2014) conducted an experiment to find out the effect of organic manures and bio-inoculants on vegetative and floral attributes of chrysanthemum. They reported that maximum plant height (30.17 cm), number of primary and secondary branches (3.78 and 19.78, respectively), plant spread (28.53 cm) and number of leaves per plant (184.33) were recorded from the plants treated with VAM (20 g/plant) + Vermicompost (300 g/m^2).

Kameswari *et al*. (2014) conducted an experiment on effect of different potting media mixtures on growth and flowering of chrysanthemum (*Dendranthema grandiflorum* T.) cv. Punjab Anuradha. They reported that maximum plant height (43.0 cm), plant spread (23.53 cm), and number of branches per plant (9.38) were found from the plants grown in the media containing Cocopeat + Sand + FYM + Vermicompost.

Mukesh (2014) carried out an investigation to find out the effect of different sources of nutrients on growth parameters in gladiolus (*Gladiolus hybridus hort*.) cv. Peater Pears. They found that application of 75% RDF (135:60:60 Kg/ha) + 25% Vermicompost + *Azospirillum* (2.0 g/plant) + PSB (2.0 g/plant) recorded minimum number of days taken to corm sprouting (13.47 days), maximum plant height (65.64 cm), number of leaves per plant (2.95) and length of the longest leaf per plant (33.17cm).

In an experiment, Pradeep *et al.* (2014) reported that application of organic and bio-fertilizers (Vermicompost, VAM and Humic acid) significantly influenced the different growth parameters *i.e.* maximum plant height (73.66 cm and 104.84 cm at 30 and 45 days after planting, respectively) and number of leaves at six leaf stage (5.60) in gladiolus (*Gladiolus grandiflorus* L.).

Prakash *et al.* (2014) conducted an experiment on the effect of tree spacing and organic manures on various growth parameters of (*Calendula officinalis* L.). The observed that the maximum plant height (51.06 cm) was observed in the plants applied with Vermicompost (1.50 kg).

Srivastava *et al*. (2014) investigated the effect of organic manures and biofertilizers on vegetative attributes in tuberose (*Polianthes tuberosa*) var. Shringar. They reported that maximum plant height (45.10 cm) and number of leaves/plant (86.25) were obtained with the use of Vermicompost (@ 2kg/m^2).

Bhatt *et al*. (2016) reported that maximum plant height (167.40 cm), number of branches per plant (43.20), plant spread (N-S) (102.60 cm) and dry matter content of plant (68.40%) was noted significantly in plants treated with *Azotobacter* + PSB + $3/4^{th}$ dose of N + full dose of P_2O_5 in marigold cv. Pusa Narangi Gainda.

Khanna (2016) investigated the effect of organic manures and PSB on vegetative and floral attributes of China aster (*Callistephus chinensis* (L.) Nees.) cv. Kamini. They found that application of Forest Litter (@ 15ton/ha) + FYM (@ 15ton/ha) + PSB (@ 50ml/15 L of water) recorded maximum plant height (43.09 cm), number of primary branches per plant (12.60), plant spread (20.06 cm) and leaf area (54.63 cm^2).

Kumar (2016) studied the response of chrysanthemum (*Dendranthema grandiflorum* Ramat.) cv. Dolly White to different sources and combinations of organic manure under the mid hill regions of Uttarakhand. They found that the treatment consisting Vermicompost (2 kg/ m^2) + Goat manure (2.5 kg/ m^2) has shown maximum plant height (95.46 cm), number of primary branches per plant (5.93) and number of secondary branches per plant (24.00).

2.2 Effect of organic manures and biofertilizers on floral characters

Barman *et al.* (2003) investigated the efficacy of Phosphate Solubilizing and Phytohormone producing bacteria on growth and yield of tuberose in acid soils of Tripura. They observed that application of farmyard manure along with recommended dose of fertilizer produced maximum spike length (91.25 cm), number of flowers per spike (30.66) and number of flowers/m^2 (47.99).

Ahmed *et al*. (2004) studied the effect of biofertilizers on floral attributes of gladiolus. They found the corms treated with *Azospirillum* recorded maximum number of florets per spike (13.12) and spike length (74.04 cm).

Mogal *et al*. (2006) studied the effect of organic manures and biofertilizers with reduced doses of nitrogen on vase life of China aster. They found that maximum vase life (11.95 days) was observed in flowers harvested from the treatment consisting of FYM (20 t/ha) + *Azotobacter* (3 kg/ha) + PSB (3 kg/ha) + 100% N.

Srivastava and Govil (2007) carried out an experiment to find out the effect of biofertilizers on floral attributes of gladiolus cv. American Beauty. They found that minimum days taken to spike emergence (80.95 days), opening of lowermost floret (9.78 days) and maximum diameter of the lowermost floret (19.17 cm) were found in the treatment containing PSB (100 g/L).

Thane *et al.* (2007) conducted an experiment on effect of integrated nutrient management on flower quality, yield and vase life of gerbera (*Gerbera jamesonii* H. Bolus.) grown under shade net conditions. They observed that the application of 70 per cent recommended dose of fertilizers + *Azotobacter* + PSB resulted in the highest flower stalk length (52.96 cm), flower stalks diameter (0.70 cm), flower diameter (9.20 cm), number of flowers per plant and per m^2 area (7.22 and 70.03, respectively).

Chaudhary (2009) investigated the influence of various biofertilizers on flowering and bulb production in tuberose (*Polianthes tuberosa* L.). They observed that minimum days taken to spike emergence (84.0 days) and basal floret opening (101.0 days) were obtained from the plants grown in the plot receiving *Azotobacter* (20 g/l) + PSB (20 g/l) + VAM (10 g/bulb). They also found that maximum spike length (89.00 cm), number of florets per spike (49.2), average root length (11.5 cm) and number of bulbs produced per plant (19.13) were recorded from the same treatment.

Pathak and Kumar (2009) reported that minimum days taken to spike emergence (82.46), maximum spike length (89.66 cm), rachis length (46.30 cm), number of florets per spike (14.40), diameter of first floret (10.99 cm) and vase life (9.83 days) were recorded from the plant treated with (VAM + Vermicompost + Vermiwash) treatment in gladiolus (*Gladiolus hybrida*) cv. White Prosperity.

Gudade *et al.* (2010) investigated the response of sunflower to integrated nutrient management. They observed that the diameter of disc (13.50 cm), number of filled seeds per disc (504.25), number of unfilled seeds per disc (73.00), 100 seed weight (5.00 g) and seed yield (13.65 q/ha) were superior in the plants receiving 2.5 t/ha Vermicompost + 75 percent Recommended dose of Nitrogen + *Azotobacter* seed inoculation.

Shankar *et al.* (2010) conducted an experiment to study the effect of organic manures and biofertilizers on flowering and bulb production in tuberose. They found that the application of Vermicompost and PSB (@ 1 kg/m^2 and 2 g/bulb, respectively) resulted in highest spike length (77.70 cm and 77.86 cm, respectively), number of spikes per plant (1.49 and 1.49, respectively), clump weight (283.58 g and 295.90 g, respectively) and longevity of spikes (15.69 days and 15.80 days, respectively).

Rajhansa *et al*. (2010) conducted a research on the effect of integrated nitrogen management in yield and flower quality of gladiolus (*Gladiolus grandiflorous* L.) cv. Candyman. They reported that application of 50% N (Urea) + 50% N (FYM) + P and K (each @ 20g/m^2) recorded maximum number of flowers per spike (14.53).

Kumar *et al.* (2011) found that maximum floret diameter (9.57 cm), number of florets per spike (19.67) and shortest period for spike emergence (71.75 days) were recorded when the plants inoculated with VAM + 25 % N by urea + 75 % N by Vermicompost and other inorganic fertilizers like Single Super Phosphate, Murate of Potash in gladiolus (*Gladiolus floribundus* L.) cv. White Prosperity.

Hadwani (2012) conducted an experiment to find out the effect of organic manures and biofertilizers on flowering parameters of tuberose. They found that the maximum spike length (78.00 cm), number of florets per spike (44.07), number of spikes per plant (4.26), number of spikes per plot (127.67) and number of spikes per hectare (4.73 lacks) were recorded with an application of ½ RDF + Neem Cake (@ 1 t/ha) + PSB (@ 1 g/m^2) + *Azotobacter* (@ 1 g/m^2). Similarly, longest vase life (12.33 days) and *in situ* longevity of spike (20.80 days) were also recorded in same treatment.

Kumar *et al*. (2012) conducted an experiment on the effect of biofertilizer and micronutrient on flowering parameters of tuberose (*Polianthes tuberosa* L.) cv. Pearl Double. They found that combined application of PSB and boron (@ 200 g/l and 0.6%, respectively) gave the better results in respect to minimum days for appearance of initial spike (80.15), number of days for opening of first floret (100.33), maximum number of florets per spike (41.11), floret length (6.50 cm), rachis length (28.37 cm), spike length (90.22 cm) and number of days for opening of last floret (130.37 days).

Chaudhary *et al*. (2013) conducted a study on the effect of integrated nutrient management on flowering characters of gladiolus. They reported that days to first floret opening (73.33) and number of days for 50% plant to sprout (94.66) were earliest under treatment 75% RDF + FYM (10 t/ha) + Vermicompost (10 t/ha).

Kumar *et al.* (2013) reported that biofertilizers and organic manures in combination (AMF + Vermicompost + Vermiwash) recorded minimum number of days taken to spike emergence (81.73 days), spike length (90.68 cm), rachis length (47.07 cm), number of florets per spike (15.08) and vase life (10.02 days) in gladiolus cv. White Prosperity.

According to Kumari *et al.* (2013) among different treatments tried, application of 75 % RDF + Vermicompost (3 t/ ha) + VAM (10 kg/ ha) + *Azospirillum* (10 kg/ha) + *Trichoderma harzianum* (5 kg/ha) registered least time for spike emergence (52.31 days, 48.49 days), number of days taken for first flower bud opening (58.74, 54.56), maximum number of florets/ spike (12.00, 13.67), spike length (100.26 cm, 129.79 cm) and spike girth (1.07 cm, 1.10 cm) in Kharif and Rabi seasons, respectively in gladiolus cv. American Beauty.

Mayuri *et al*. (2013) found that application of ½ RDF + Neem Cake (@ 1 t/ha) + PSB (@ 1 g/m^2) + *Azotobacter* (@ 1 g/m^2) recorded maximum spike length (78.00 cm), number of florets per spike (44.07), longest vase life (12.33 days), *in situ* longevity of spike (20.80 days), number of spikes per plant (4.26), number of spikes per net plot (127.67) and number of spikes per hectare (4.73 lacks) in tuberose (*Polianthes tuberosa* L.) cv. Double.

Moghadam and Shoor (2013) studied the effect of Vermicompost and two bacterial biofertilizers on quality parameters of petunia. They reported that the plants receiving *Azospirillum sp.* + Phosphate solubilizing Bacteria + Vermicompost + NPK (25% of recommended dose) produced improved flower quality as well as increase the flower yield per plant (86.82 g).

Ravindra *et al*. (2013) investigated the effect of integrated nutrient management on yield and vase life of China aster (*Callistephus chinensis* (L.) Nees.) for coastal Karnataka. They reported that combined application of *Azospirillum* (@ 2 kg/acre) + PSB (@ 2 kg/acre) + Vermicompost (@ 2 t/acre) + 50% (RDF) recorded minimum number of days to opening first flower (78.33), maximum number of flower per plant (49.73), flower yield (4.69 t/acre), flower diameter (5.93 cm), fresh weight of flower (6.03 g) and duration of flowering days (45.13).

Singh *et al.* (2013) studied the effect of integrated nutrient management on growth and flowering in gladiolus (*Gladiolus grandiflorus* L.) cv. White Prosperity. They observed that application of 75% RDF (NPK 225:150:150 kg/ha) + Vermicompost (2 t/ha) + PSB (2.5kg/ha) + *Azotobacter* (2.5kg/ha) recorded minimum days required for visibility of first spike (81.50 days), days required for opening of the first flower (91.10 days) , maximum number of spikes per plant (2.30), flower diameter (12.13 cm), spike diameter (1.07 cm), vase life (20.80 days) and longevity of spike (24.20 days).

Bohra and Kumar (2014) conducted a field experiment to find out the effect of organic manures and bioinoculant on floral attributes of chrysanthemum cv. Little Darling. They found that application of the VAM (20 g/plant) + Vermicompost (300 g/m^2) produced minimum days taken to bud initiation (55.78 days), days to first flowering (73.33 days), maximum flowering duration (28.33 days), flower longevity (16.33 days), number of flowers per plant (70.56), flower stalk length (7.80 cm) and flower weight (1.67 g).

Naik and Dalawai (2014) conducted an experiment on integrated nutrient management studies in carnation (*Dianthus caryophyllus* L.) cv. Soto under protected condition. They observed that combined application of *Azospirillum* + PSB + Vermicompost + FYM @ 75% RDF recorded the minimum days taken flower bud initiation (114.88), days taken for flower bud development (20.37), days taken for flower bud opening (20.37), maximum number of flowers per plant (12.98), stalk length (93.76 cm), stalk girth (0.45 cm), flower bud diameter (1.53 cm), flower diameter (6.95 cm) and vase life (12.52 days).

Mukesh (2014) carried out an investigation to study the effect of integrated nutrient management on flowering parameters of gladiolus (*Gladiolus hybridus* H.) cv. Peater Pears and found that application of 50% RDF + 50% Vermicompost + *Azospirillum* (2.0 g/plant) + PSB (2.0 g/plant) recorded earlier spike emergence while minimum days required for opening of first flower on spike and maximum longevity of spike.

Sisodia and Singh (2015) investigated the effect of organic manures and *Trichoderma* on flowering and yield attributes in gladiolus. They found that application of Farmyard manure significantly increased the spike length (60.61 cm), number of florets per spike (12.00) and duration of flowering (17.45 days). They also found that treatment combinations of FYM + Vermicompost was also found superior in enhancing shelf life of first and third floret (5.66 days and 5.89 days respectively).

Khanna (2016) studied the effect of organic manures and PSB on vegetative and floral attributes of China aster (*Callistephus chinensis* (L.) Nees.) cv. Kamini. They found that treatment consisting Forest Litter (@ 15ton/ha) + FYM (@ 15 ton/ha) + PSB (@ 50 ml/15 L of water) has shown maximum stalk length (33.46 cm), flower diameter (6.36 cm) and vase life (9.66 days).

Kumar (2016) conducted an experiment on response of chrysanthemum (*Dendranthema grandiflorum* Ramat.) cv. Dolly White to different sources and combinations of organic manure under the mid hill regions of Uttarakhand. They observed that days taken to first bud initiation (81.63 ± 2.78), days taken to first opening of flower (97.26 ± 3.57) and days taken to 100% flowering (126.79 ± 6.82) was minimum in the treatment consisting of Vermicompost (2 kg/ m^2) + Goat manure (2.5 kg/ m^2).

Chapter 3

MATERIALS AND METHODS

The present study on the "Effect of organic manures and biofertilizers on vegetative and floral characters of China aster (*Callistephus chinensis* (L.) Nees.) cv. Kamini" was conducted from April to August 2016. The experiment was based on the evaluation of vegetative and floral characters of China aster. The details of experimental materials used and methods adopted during the course of investigation are described below:

3.1 Experimental Site

The investigation was conducted at the Floriculture and Landscaping block, College of Horticulture, Veer Chandra Singh Garhwali, Uttarakhand University of Horticulture and Forestry, Bharsar, District Pauri Garhwal (Uttarakhand) in 2016. Bharsar is situated at the high hills of Himalayas at 29^0 20'-29^0 75' N Latitude and 78^0 10'-78^0 80' E Longitude. The altitude of the place is 1900 meter above the mean sea level.

3.2 Prevailing Climatic Conditions

In general, the climate of the Bharsar represents the mild summer, higher precipitation and colder or severe cold prolonged winter. The climate factors *i.e.* precipitation, temperature, relative humidity and wind, in association with elevation (valleys or mountain range from temperate zone), proximity to Great Himalaya, slope aspects, drainage, vegetation etc. are responsible for the micro-climate of this area. Major output of precipitation is in the form of rain fall, besides occasional occurrence of dew, hailstorm, fog, frost, snow fall etc. The South-East monsoon commences towards the end of June while the North-East monsoon causes occasional winter showers during November-February. During winter, snow fall is common in this region. During summer months, Bharsar has hot climate prevailing for few hours in a day, the maximum temperature during May-June is recorded between 23.5°C-28.9°C however nights are cool. December and January are the coldest months; the minimum temperature reaches to 1°C to -4°C. Relative humidity is normally highest during rainy season (July -

August), often recorded near to saturation point (92-97%) and it gradually decreases towards winters.

3.3 Soil Conditions

The soils at Bharsar come under inceptisols. The soil of experimental plot was sandy loam with adequate drainage and optimum water holding capacity. Before laying out the experiment, random soil samples were collected from the furrow slice (0-15 cm depth) of different spots and composite sample was prepared for determination of various soil characteristics.

3.3 Nutrient Status of Experimental Area

Particulars	Value obtained	Method Employed
1. Soil pH	5.5	Digital pH Meter (Jackson, 1973)
2. Organic carbon (%)	1.13	Rapid Titration Method (Walkley and Black, 1934)
3. Available N (kg/ha)	206.13	Alkaline Potassium permanganate method (Subbiah and Asija,1956)
4. Available P (kg/ha)	32.42	Olsen Method (Olsen *et al*.,1954)
5. Available K (kg/ha)	243.81	Normal Neutral ammonium Extract potassium Method (Perur *et al*., 1973)

3.4 Experimental Planting Material

The experimental material used for the present investigation comprised of seeds China aster cv. Kamini were obtained from the germplasm purchased from IIHR, Bangalore.

3.4.1. Description of cultivar

Kamini is a popular cultivar of China aster developed through pedigree method of breeding. It is a cross between AST6 X AST36. Its flower colour is deep pink more attractive than cv. Local Pink (Bhattacharjee, 2006).

3.5 Growing media components

Various growing media used were Farmyard manure, Vermicompost, *Azotobacter* & PSB.

3.5.1 Farmyard Manure

Farmyard manure was procured from the department itself. It was decomposed mixture of dung & urine along with leaf litter & left over material from roughage or fodder fed to cattle. It contained N (0.5 %), P (0.25 %), K (0.5 %) Singh. (2014).

3.5.2 Vermicompost

Vermicompost was purchased locally. It was decomposed mixture of waste vegetables, fruits and other organic material produced with the help of earthworms. It contained N (3 %), P (1 %) and K (1.5 %) Singh. (2014).

3.5.3 Biofertilizers

Two biofertlizers namely were used as a source of biofertilizers *Azotobacter* and Phosphate Solubilizing bacteria (PSB). *Azotobacter* is one of the most important non-symbiotic nitrogen fixing micro-organisms. It is the commercial product of Pantnagar bio lab. Phosphate solubilizing bacteria is the commercial product obtained from market that is marketed by Karnataka agro chemicals.

3.6 Mode of Application of Inputs

Farm Yard Manure (FYM) and Vermicompost were applied as per treatment allocation to the plots uniformly and incorporated into the soil before transplanting of seedlings. Biofertilizers i.e. *Azotobacter* (30 ml/15L) & PSB (50ml/15L) were applied by seedlings dipping method. Roots of the seedlings were dipped in these solutions for 30 minutes as per the treatments and treated seedlings were transplanted in the field.

3.7 Experimental Design and Layout Plan

The experiment consisted of sixteen treatments with three replications. The experiment was plotted according to Randomized Complete Block Design (Gomez and Gomez, 1984).

The detail of the experimental design and layout plan is as follow:

Name of Crop	:	China aster
Cultivar	:	Kamini
Experimental design	:	Randomized Complete Block Design
Number of replications	:	Three
Total experimental area	:	61.50 m^2
Plot size	:	100 cm x 100 cm
Number of plants per plot	:	Nine
Spacing between plants	:	30 cm x 30 cm
Growing conditions	:	Open field

The treatment details are as Follows:

T_1 : Control

T_2 : Farmyard manure @ (36 ton/ ha)

T_3 : Vermicompost @ (12 ton/ ha)

T_4 : Phosphate Solubilizing Bacteria @ (50 ml /15L of water)

T_5 : *Azotobacter* @ (30ml/15L of water)

T_6 : Farmyard manure @ 18 ton/ ha (50%) + Vermicompost @ 06 ton/ ha (50%)

T_7 : Farmyard manure @ 28.8 ton/ ha (80%) + Phosphate Solubilizing Bacteria @ (50ml /15L of water)

T_8 : Farmyard manure @ 30.6ton/ ha (85%) + *Azotobacter* @ (30ml/15L of water)

T_9 : Vermicompost @ 9.6ton/ ha (80%) + Phosphate Solubilizing Bacteria @ (50ml/15 L of water)

T_{10} : Vermicompost @ 10.2ton/ ha (85%) + *Azotobacter* @ (30ml/15L of water)

T_{11} : Phosphate Solubilizing Bacteria @ (50ml/ 15 L of water) + Azotobacter @ (30ml/ 15L of water)

T_{12} : Farmyard manure @ 18 ton/ ha (50%) + Vermicompost @ 06 ton/ ha (50%) + Phosphate Solubilizing Bacteria @ (50 ml /15L of water)

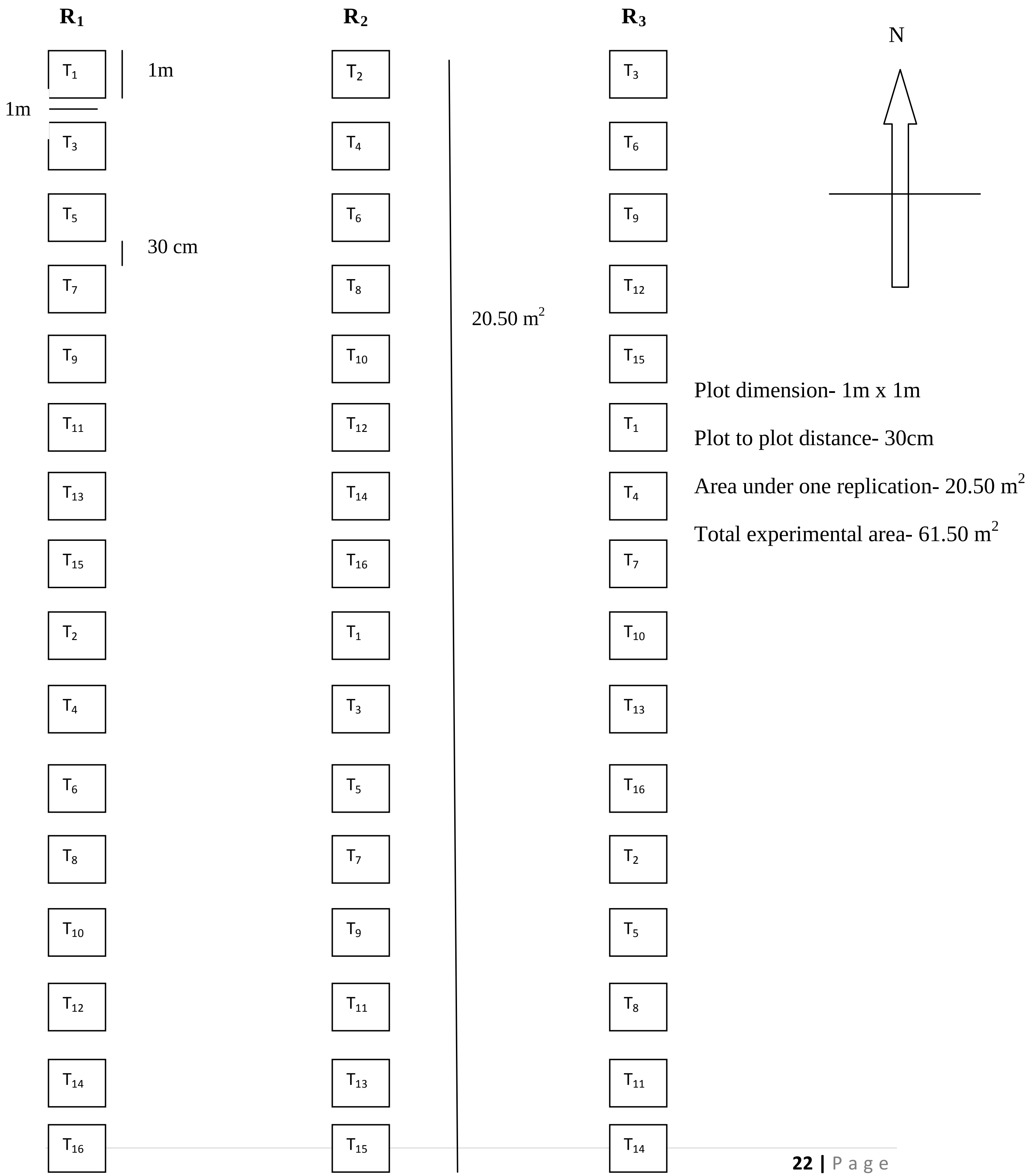
T_{13} : Vermicompost @ 9.6ton/ ha (80%) + Phosphate Solubilizing Bacteria @ (50 ml /15L of water) + *Azotobacter* @ (30ml/15L of water)

T_{14} : Farmyard manure @ 28.8 ton/ ha (80%) + Phosphate Solubilizing Bacteria @ (50ml /15L of water) + *Azotobacter* @ (30ml/15L of water)

T_{15} : Farmyard manure @ 18 ton/ha (50%) + Vermicompost @ 06 ton/ha (50%) + *Azotobacter* @ (30ml/15L of water)

T_{16} : Farmyard manure @18 ton/ ha (50%) + Vermicompost @ 06 ton/ ha (50%) + Phosphate Solubilizing Bacteria @ (50 ml /15L of water) + *Azotobacter* @ (30ml/15L of water)

Layout of Experimental Field



3.8 Preparation of nursery beds and sowing of seeds

The seeds of China aster cv. Kamini were sown on raised beds in the second week of April, 2016. The size of nursery beds was 1.0 m x 1.0 m x 0.15 m. Seeds were sown in lines at a spacing of 5- 6 cm and at a depth of 0.5 cm After sowing seeds were covered with well sieved mixture of FYM and soil. Watering was done twice a day. Thinning and weeding operations were done at regular interval. Seedlings were ready to transplanting after one month.

3.9 Preparation of Experimental Site and Planting

The land was brought to a fine tilth by two deep ploughings with a power tiller. Before leveling of experimental field, all weeds and leftover crop residues were removed. A spacing of 30 cm between two sub-plots was provided for irrigation channels and working space. The transplanting of healthy and uniform sized seedlings was done in raised beds of size (1 m x 1 m) on first week of May, 2016. The seedlings were planted at a spacing of 30 cm x 30 cm from plant to plant and row to row to accommodate nine plants per bed. The experiment was laid out with sixteen treatments replicated thrice in Randomized Complete Block Design. The plants were watered immediately after planting and at daily intervals during growing period. Hoeing was done after transplanting as and when needed to get rid of weeds and to aerate the soil. Standard cultural practices were followed uniformly for all the experimental plots.

3.10 Preparation of Vase Life Studies

The flowers were harvested with the help of sharp secateurs during morning hours in fully opened flower stage. Immediately after harvesting, flower stems were kept in a bucket containing water and brought to the laboratory. Each flower stem was given a slanting cut at the base to increase the absorption area. Immediately the flower stems were placed in 200 ml vase (conical flask) containing tap water.

Plate 1: Raised seedlings of Chin aster cv. Kamini

Plate 2: View of experimental site

3.11 Observations Recorded

The observations were recorded on five selected plants per treatment in each replication and average value was calculated. The following observations on growth and flowering characters were recorded:

3.11.1 Vegetative Characters

3.11.1.1 Plant height (cm)

Plant height was recorded at the time of peak flowering from the base of the plant, *i.e.*, just above the soil level up to the base of apical flower on the tallest shoot with the help of meter scale. Mean plant height was calculated and expressed in centimeters.

3.11.1.2 Number of primary branches per plant

Total numbers of branches attached from main stem per plants were counted at the time of peak flowering and expressed as average number of primary branches per plant.

3.11.1.3 Plant spread (cm)

Plant spread was recorded at the time of peak flowering with scale from North – South and East-West directions and their mean was calculated and expressed in centimeters.

3.11.1.4 Number of leaves per plant

From each of the randomly selected plants, in an individual treatment the number of leaves per plant were counted at the time of peak flowering. Mean value was recorded as number of leaves per plant.

3.11.1.5 Leaf area (cm^2)

Leaf area was recorded with the help of leaf area meter and their mean values were expressed in square centimeters.

3.11.2 Floral Characters

3.11.2.1 Days taken to first flower bud initiation

Numbers of days required for bud initiation were counted from transplanting up to the stage till first flower bud on a plant becomes visible.

3.11.2.2 Days taken to first flowering

Numbers of days required for flower initiation were counted from transplanting up to the stage when flower bud on the plant was fully open.

3.11.2.3 Duration of flowering (days)

Duration of flowering was recorded from peak flowering when 60-70% flowers were fully open up to the stage till it remained in presentable form.

3.11.2.4 Number of flowers per plant

Numbers of flowers per plant were counted when all buds on a plant were fully open.

3.11.2.5 Number of flowers per bed

The numbers of flowers per bed were counted and reported on mean basis.

3.11.2.6 Stalk length of flower (cm)

Length of stalk was measured from the base of stem to the base of apical flower with the help of a scale and expressed in centimeters.

3.11.2.7 Flower Diameter (cm)

Flower diameter was measured at the time of peak flowering as average of the distance apices of petal in East or West direction between apices of petal in North to South direction and expressed in centimeters.

3.11.2.8 Average weight of flower (g)

Weight of single flower picked in morning hours was taken with the help of an electronic balance averaged and expressed in gram.

3.11.2.9 Vase life (days)

The day when 50 per cent of florets were wilted was taken as terminal day of vase life with respect to a particular treatment. The number of days were counted from the day of placing the flower stalk in the vase to the terminal day and expressed as vase life in days.

3.11.2.10 Shelf life (days)

Five randomly selected flowers from each treatment were kept in tray under ambient room temperature condition. The numbers of days were counted from the day of placing the flowers to till the 50 per cent of ray florets were wilted.

3.11.3 Economics

The economics regarding the cultivation of crop was calculated separately for all the treatment combinations on per hectare basis.

3.11.3.1 Cost of cultivation

Cost of cultivation (Rs. per ha) for each treatment combination was calculated separately taking into consideration of all cultural practices followed in the cultivation.

3.11.3.2 Gross return

The gross return (Rs. per ha) for each treatment combination was calculated taking into consideration the yield and market price of produce.

3.11.3.3 Net return

The net return (Rs. per ha) was calculated for each treatment combination separately by using the following expression: Net return (Rs. per ha) = Gross return (Rs. per ha) – Cost of cultivation (Rs. per ha)

3.11.3.4 Cost Benefit ratio

The cost benefit ratio for each treatment combination was calculated separately using the following expression

C: B ratio = $\frac{\text{Cost of cultivation (Rs. Per ha)}}{\text{Net return (Rs. Per ha)}}$

3.12 Statistical Analysis

The data were statistically analyzed by using Randomized Complete Block Design. The significance of difference among treatment means were tested by F-test. Wherever, the F-test was found to be significant, critical difference (CD) at 5 per cent level of significance was calculated. The results obtained are presented in the forms of tables and are given at appropriate place for result interpretation.

Analysis of variance

The table for analysis of variance (ANOVA) was set as explained by Gomez and Gomez (1984).

Source of variation	**Degree of freedom**	**Sum of squares**	**Mean sum of squares**	**F calculated value**
Replication(r)	(r-1)	Sr	Sr/r-1 = Mr	Mr/Me
Treatment (t)	(t-1)	St	St/t-1 = Mt	Mt / Me
Error (E)	(r-1) (t-1)	Se	Se/(r-1)(t-1) = Me	

Where,

R	Number of replications
T	Number of treatments
Sr	Sum of square due to replications

St	Sum of square due to treatments
Se	Sum of square due to error
Mr	Mean sum of square due to replication
Mt	Mean sum of square due to treatment
Me	Mean sum of square due to error

The calculated 'f' value was compared with the tabulated F value. If F-test was found significant, then standard error and critical difference were calculated as under:

SE m$\pm$ = $\sqrt{(Me/r)}$

SE d$\pm$ = $\sqrt{(2Me/r)}$

C.D. (5%) = SE d x t 0.05 error d.f.

Where,

SE m$\pm$ = Standard error of mean

SE d$\pm$ = Standard error of difference

C.D. $_{(5\%)}$ = Critical difference at 5% level of significance

Chapter 4
RESULTS

The experimental findings of the present investigation entitled Effect of organic manures and biofertilizers on vegetative and floral characters of China aster (*Callistephus chinensis* (L.) Nees.) cv. Kamini is presented in this chapter under the following subheads with the help of tables. The analysis of variance of different parameters under study have been given in appendix 1.

4.1 Vegetative Characters

4.1.1 Plant height (cm)

On the perusal of data tabulated in Table 4.1 it is evident that plant height varied with respect to different treatments used. Data showed that maximum plant height (76.73 ± 0.35 cm) was observed from the plants grown in the plots applied with treatment containing FYM + PSB + *Azotobacter* (T_{14}) followed by T_{15} (75.46 ± 0.28 cm) and T_{16} (73.73 ± 0.32 cm). However, the minimum plant height (62.60 ± 0.31 cm) was observed from the plants grown in control plots (T_1). The data also showed that treatment containing T_2 and T_3 showed statistically at par results with respect to plant height (63.86 ± 0.14 cm and 64.20 ± 0.09 cm respectively). Similarly, treatment containing T_5 (66.66 ± 0.08) and T_7 (66.40 ± 0.25 cm) were also statistically at par with each other in terms of plant height.

4.1.2 Number of primary branches per plant

The data pertaining to the effect of organic manures and biofertilizers on the number of primary branches of China aster cultivar Kamini are depicted in Table 4.1. It is evident from the perusal of data that organic manures and biofertilizers significantly increased the number of primary branches per plant. Maximum number of primary branches per plant (13.63 ± 0.08) was observed from the plants grown in the plots applied with treatment containing FYM + Vermicompost + PSB + *Azotobacter* (T_{16}) followed by T_{14} (12.66 ± 0.14) and T_{13} (12.30 ± 0.11). However, minimum number of primary branches per plants (5.26 ± 0.08) was observed from the plants grown in control (T_1). The plants grown in the plots applied with treatments containing T_4 (6.66 ± 0.08) were statistically at par with T_5 (6.70 ± 0.05). Data also showed that all the treatments and their combinations were significantly superior over control.

4.1.3 Plant spread (cm)

Plant spread determines the size of the plants in different directions. A well spread plant will look pleasing and artistic as well as produces good number of showy flowers. Perusal of data pertaining to the effect of organic manures and biofertilizers on plant spread of China aster cultivar Kamini is depicted in Table 4.1. Data revealed that the maximum plant spread (21.63 ± 0.12 cm) was observed from the plants grown in the plots applied with treatment containing FYM + Vermicompost + PSB + *Azotobacter* (T_{16}) followed by $T_{14,}$ T_{13} and T_9 (21.30 ± 0.05 cm, 20.23 ± 0.06 cm and 20.60 ± 0.11 respectively) and the minimum plant spread (13.30 ± 0.45 cm) was observed from the plants grown in the control plots (T_1). Data also showed that all the treatments were found significantly superior over control.

4.1.4 Number of leaves per plant

Data pertaining to number of leaves per plant is presented in Table 4.1, Among different treatments applied, the highest number of leaves per plant (162.20 ± 0.20) was observed from plants grown in the plots receiving treatment combination FYM + Vermicompost + PSB + *Azotobacter* (T_{16}) which was found at par with the plants grown in plots treated with FYM + PSB + *Azotobacter* (T14) and Vermicompost + PSB + *Azotobacter* (T13) (161.70 ± 0.08 and 159.76 ± 0.20 respectively). The minimum number of leaves per plant (147.53 ± 0.23) was observed from the plants grown in control which was found statistically at par with T_2 (149.60 ± 0.17). Data also revealed that the plots applied with the treatment T_3 (150.26 ± 0.07) and T_4 (151.63 ± 0.04) were found statistically at par with each other. Similarly treatments T_5 (152.30 ± 0.25), T_6 (153.33 ± 0.28), T_7 (154.50 ± 0.11) and T_8 (153.53 ± 0.23) were also found statistically at par with each other.

4.1.5 Leaf area (cm^2)

Data pertaining to leaf area is presented in Table 4.1, Among different treatments applied, the maximum leaf area (53.73 ± 1.62) was observed from plants grown in the plots receiving treatment combination Vermicompost + PSB + *Azotobacter* (T_{13}) which was found at par with the treatments T_9, T_{10}, T_5, T_6, T_{12}, T_{15}, T_{14} and T_{16} (48.06 ± 1.51, 48.33 ± 1.66, 48.60 ± 2.19, 49.90 ± 2.33, 50.00 ± 1.51, 51.33 ± 3.36, 52.26 ± 3.13, 52.80 ± 4.14 respectively). The minimum leaf area (37.60 ± 1.25) was observed from the plants grown in control which was statistically at par with treatments T_7, T_2, T_3, T_4, T_{11} and T_8 (41.46 ± 5.70, 43.20 ± 7.74, 44.23 ± 3.33, 44.50 ± 2.00, 47.13 ± 1.32 and 47.43 ± 3.36 respectively).

4.2 Floral Characters

4.2.1 Days taken to first flower bud initiation

An exploratory experiment with sixteen treatments was conducted to see their effect on number of days taken to first flower bud initiation. It is evident from the Table 4.2 that all the applied treatments significantly improved the number of days taken to bud initiation. The plants grown in the plots applied with treatment containing Farmyard manure @18 ton/ ha (50%) + Vermicompost @ 06 ton/ ha (50%) + Phosphate Solubilizing Bacteria @ (50 ml /15L of water) + *Azotobacter* @ (30 ml/15L of water) (T_{16}) took minimum (58.43 ± 0.24) days to bud initiation followed by T_{13} (60.26 ± 0.08 days) and T_{14} (60.80 ± 0.05 days), whereas, maximum (76.50 ± 0.20) days taken to first flower bud initiation was observed from the plants grown in control plots (T_1) which was found statistically at par with T_2 (76.10 ± 0.26 days). It is clear from the data all the treatments were found to significantly improve the number of days taken to first flower bud initiation over control except T_2.

4.2.2 Days taken to first flowering

As far as number of days taken to first flowering is concerned, it varied significantly with respect to different treatments used and data is represented in the Table 4.2. Data revealed that flowering was delayed in control which took (93.03 ± 0.28 days) for flowering, whereas the plants grown in the plots applied with treatment containing Farmyard manure @18 ton/ ha (50%) + Vermicompost @ 06 ton/ ha (50%) + Phosphate Solubilizing

Bacteria @ (50 ml /15L of water) + *Azotobacter* @ (30 ml/15L of water) i.e. T_{16} recorded the minimum (74.43 ± 0.09 days) days taken to first flowering among the various treatments applied. The plants grown in the treatment T_{13} containing Vermicompost @ 9.6 ton/ ha (80%) + Phosphate Solubilizing Bacteria @ (50 ml /15L of water) + *Azotobacter* @ (30 ml/15L of water) and Farmyard manure @ 28.8 ton/ ha (80%) + Phosphate Solubilizing Bacteria @ (50ml /15L of water) + *Azotobacter* @ (30ml/15L of water) T_{14} showed statistically at par results with respect to number of days taken to first flowering (76.33 ± 0.14 days and 76.73 ± 0.07 days, respectively). Data also revealed that plants grown in the plots applied with different treatments had significantly improved the number of days taken to flowering as compared to control (T_1).

4.2.3 Duration of flowering (Days)

The data pertaining to the effect of organic manures and biofertilizers on duration of flowering (days) of China aster cultivar Kamini are given in Table 4.2. Duration of flowering recorded from peak flowering up to the stage till plants remain presentable, it was found maximum (20.80 ± 0.05 days) from the plants grown in the plots applied with treatment T_{16} containing Farmyard manure @18 ton/ ha (50%) + Vermicompost @ 06 ton/ ha (50%) + Phosphate Solubilizing Bacteria @ (50 ml /15L of water) + *Azotobacter* @ (30ml/15L of water) (T_{16}) which was found statistically at par with the plants grown in the plots applied with Farmyard manure @ 28.8 ton/ ha (80%) + Phosphate Solubilizing Bacteria @ (50ml /15L of water) + *Azotobacter* @ (30ml/15L of water) (T_{14}) (20.36 ± 0.14 days). However, minimum duration of flowering (14.46 ± 0.78 days) was observed from the plants grown in the plots applied with treatment (T_2) which was found statistically at par with control (14.73 ± 0.06 days)

4.2.4 Number of flowers per plant

Data recorded on number of flowers per plant are depicted in Table 4.2. Data revealed that the maximum number of flowers per plant (36.60 ± 0.25) was observed from the plants grown in the plots applied with Farmyard manure @18 ton/ ha (50%) + Vermicompost @ 06 ton/ ha (50%) + Phosphate Solubilizing Bacteria @ (50 ml /15L of water) + *Azotobacter* @ (30ml/15L of water) (T_{16}). However, minimum number of flowers per plant (22.76 ± 1.24) was noticed from the plants grown in control (T_1) which was found statistically at par with the plots applied with treatment T_2 (23.36 ± 0.21). The other treatments that shows statistically at par results with each other were T_4 (27.26 ± 0.08) with T_5 (26.46 ± 0.12), T_{11} (33.76 ± 0.08) with T_{12} (34.23 ± 0.08), T_{13} (35.70 ± 0.05) with T_{14} (35.30 ± 0.05) and T_{12} (34.23 ± 0.08) with T_{15} (34.80 ± 0.05). However except T_2 all other treatments showed significant increase in number of flowers per plant as compared to control.

4.2.5 Number of flowers per bed

On the perusal of data tabulated in Table 4.2, it is evident that the highest number of flowers per bed (360.30 ± 5.62) was observed from the plants grown in the plots applied with treatment containing Farmyard manure @18 ton/ ha (50%) + Vermicompost @ 06 ton/ ha (50%) + Phosphate Solubilizing Bacteria @ (50 ml /15L of water) + *Azotobacter* @ (30ml/15L of water) (T_{16}). However, minimum number of flowers per bed (204.90 ± 11.17) was observed from the plants grown in control (T_1) which was statistically at par with the plots applied with Farmyard manure @ (36 ton/ ha) (210.30 ± 1.96). Data also revealed that plants grown in the plots applied with treatments T_6 and T_9 showed statistically at par results in respect to number of flowers per bed (267.00 ± 0.79 and 273.43 ± 0.66 respectively).The other treatments that showed statistically at par results with each other are T_{11} (303.90 ± 0.79) with T_{12} (308.10 ± 0.79) and T_{14} (312.40 ± 2.71) with T_{15} (310.10 ± 1.73). However, data showed that all the treatments were found to be significantly superior over control (T_1) except T_2.

4.2.6 Stalk length of flower (cm)

On perusal of data presented on Table 4.3 data revealed that maximum stalk length of the flower (34.43 ± 0.20 cm) was observed from plants grown in the plots applied with Vermicompost @ 9.6ton/ ha (80%) + Phosphate Solubilizing Bacteria @ (50 ml /15L of water) + *Azotobacter* @ (30ml/15L of water) (T_{13}) which was found statistically at par with

T_{16} (34.23 ± 0.08) and minimum stalk length (24.83 ± 2.11 cm) was recorded from the plants grown in control (T_1). However, the plants grown in the plots applied with treatment containing Farmyard manure @ (36 ton/ ha) (T_2) showed statistically at par results in terms of stalk length (25.63 ± 0.12 cm) with control (T_1). Data also showed that plants grown in plots applied with treatment T_{15} (33.26 ± 0.12 cm) and T_{14} (33.70 ± 0.11 cm) were statistically at par in terms of stalk length

4.2.7 Flower Diameter (cm)

Data recorded in Table 4.3 summarizes the effect of different treatments on diameter of flower. It is evident from data that the organic manures and biofertilizers treatments significantly increased the diameter of flower. Data revealed that maximum flower diameter (7.73 ± 0.08 cm) was recorded from the plants grown in the plots applied with treatment containing Vermicompost @ 9.6ton/ ha (80%) + Phosphate Solubilizing Bacteria @ (50 ml /15L of water) + *Azotobacter* @ (30 ml/15L of water) (T_{13}) followed by T_{16} (7.20 ± 0.05 cm) and T_{14} (6.80 ± 0.05 cm), whereas, minimum diameter of flower (3.26 ± 0.08 cm) was observed from control plot. However treatments T_4 (4.03 ± 0.03 cm) with T_5 (4.20 ± 0.05 cm), T_6 (4.50 ± 0.05 cm) with T_7 (4.66 ± 0.08 cm) and T_8 (5.63 ± 0.03 cm) with T_{10} (5.73 ± 0.08 cm) were found statistically at par with each other. Data also revealed that plants grown in the plots applied with different treatments had significantly improved the flower diameter as compared to control.

4.2.8 Average weight of flower (g)

The data pertaining to the effect of organic manures and biofertilizers on average flower weight of China aster cultivar Kamini are given in Table 4.3 the maximum average weight of flower (3.38 ± 0.23 g) was found from the flowers harvested from the plots receiving Vermicompost @ 9.6ton/ ha (80%) + Phosphate Solubilizing Bacteria @ (50 ml /15L of water) + *Azotobacter* @ (30 ml/15L of water) (T_{13}) which was found statistically at par result with the plots applied with treatment containing Farmyard manure @18 ton/ ha (50%) + Vermicompost @ 06 ton/ ha (50%) + Phosphate Solubilizing Bacteria @ (50 ml /15L of water) + *Azotobacter* @ (30 ml/15L of water) T_{16} (3.37 ± 0.10 g) and Farmyard manure @ 28.8 ton/ ha (80%) + Phosphate Solubilizing Bacteria @ (50ml /15L of water) + *Azotobacter*

@ (30 ml/15L of water) i.e., T_{14} (3.16 ± 0.16 g). Whereas minimum average weight of flowers (0.90 ± 0.05 g) was obtained from the flowers harvested from the control which was found statistically at par result with the plots applied with treatment containing FYM @ (36 ton/ ha) T_2 (1.45± 0.05 g) and Vermicompost @ (06 ton/ ha) i.e., T_3 (1.50 ± 0.16 g). The other treatments that showed statistically at par results were T_4 (1.76 ± 0.12 g), T_5 (1.80 ± 0.15 g), T_6 (1.98 ± 0.28 g), T_7 (2.00 ± 0.32 g), T_9 (2.06 ± 0.43 g), T_8 (2.10 ± 0.70 g), T_{10} (2.23 ± 0.12 g) and T_{11} (2.33 ± 0.16 g)

4.2.9 Vase life (days)

Vase life is the period for which flowers remain in presentable form in vase without losing its grade and quality. An exploratory experiment with different organic manures and biofertilizers alone or in combination was conducted to see their effect on the vase life. It is evident from Table 4.3 maximum vase life (9.73 ± 1.84 days) was found from flowers harvested from the plants grown in plots treated with Farmyard manure @18 ton/ ha (50%) + Vermicompost @ 06 ton/ ha (50%) + Phosphate Solubilizing Bacteria @ (50 ml /15L of water) + *Azotobacter* @ (30ml/15L of water) (T_{16}) which was found statistically at par with T_{13} (9.56 ± 0.60 days), T_{15} (9.20 ± 1.02 days), T_{12} (8.86 ± 0.31 days), T_{14} (8.73 ± 0.44 days), T_{11} (8.40 ± 1.06 days), T_{10} (8.03 ± 1.44 days), T_9 (7.93 ± 0.12 days) and T_8 (7.86 ± 0.08 days), whereas minimum vase life was seen in flowers harvested from control (5.13 ± 0.33) which was at par with T_2 (5.20 ± 0.05 days), T_3 (5.53 ± 1.18 days), T_4 (5.80 ± 1.44 days) , T_6 (5.93 ± 0.41 days), T_5 (6.13 ± 2.08) and T_7 (6.76 ± 0.08 days).

4.2.10 Shelf life (days)

The data on shelf life of loose flowers are presented in Table 4.3. The flowers harvested from the plants grown in plots treated with Vermicompost @ 9.6ton/ ha (80%) + Phosphate Solubilizing Bacteria @ (50 ml /15L of water) + *Azotobacter* @ (30ml/15L of water) (T_{13}) recorded maximum shelf life (4.90 ± 0.77 days) which was found statistically at par with T_{16} (4.73 ± 0.63 days), T_{15} (4.36 ± 0.61 days), T_{14} (4.13 ± 0.48 days), T_{12} (4.03 ± 0.41 days), T_{11} (3.96 ± 0.52 days) , T_{10} (3.93 ± 0.42 days) and T_9 (3.86 ± 0.18 days), while, the minimum shelf life of (2.23 ± 0.08 days) was recorded in control (T_1) plots which was found statistically at par with T_2 (2.40 ± 0.05 days), T_3 (2.76 ± 0.08 days), T_4 (2.86 ± 0.08 days), T_5 (3.03 ± 0.03 days) and T_6 (3.20 ± 0.05 days).

4.3 Effect of organic manures and biofertilizers on cost of cultivation of China aster cv. Kamini

Data depicted in Table 4.4 summarizes the effect of organic manures and biofertilizers on cost of cultivation of China aster. It is evident from data that the organic manures and biofertilizers treatments significantly increased cost benefit ratio. Plots which were treated with Farmyard manure @18 ton/ ha (50%) + Vermicompost @ 06 ton/ ha (50%) + Phosphate Solubilizing Bacteria @ (50 ml /15L of water) + *Azotobacter* @ (30ml/15L of water) (T_{16}) showed maximum estimated yield per hectare (12142.11 kg/ha) and minimum yield was obtained in (T_1) control (1844.10 kg/ha). Data also showed that highest gross returns, net return and cost benefit ratio (364263.30 Rs/ha, 188998.30 Rs/ha and 1:1.07 respectively) was recorded in T_{16}. However minimum gross returns, net returns (55323 Rs/ha and -49142 Rs/ha) were recorded in (T_1) control and minimum cost benefit ratio was recorded from treatment T_2 (1: -0.48) followed by control (1: -0.47).

Plate 3: View of experimental plot at peak flowering stage

Plate 4: Effect of organic manures and biofertilizers on flower diameter of China aster cv. Kamini

Table 4.1: Effect of organic manures and biofertilizers on plant height (cm), number of primary branches, plant spread (cm), number of leaves per plant and leaf area (cm^2) of China aster cv. Kamini

Treatments		Plant height (cm) ± S.E(m)	No. of primary branches per plant ± S.E(m)	Plant spread (cm) ± S.E(m)	No. of leaves per plant ± S.E(m)	Leaf area (cm^2) ± S.E(m)
T_1	Control	62.60 ± 0.31	5.26 ± 0.08	13.30 ± 0.45	147.53 ± 0.23	37.60 ± 1.25
T_2	FYM	63.86* ± 0.14	5.83* ± 0.06	13.76* ± 0.08	149.60 ± 0.17	43.20 ± 7.74
T_3	Vermicompost	64.20* ± 0.09	6.23* ± 0.08	14.76* ± 0.08	150.26* ± 0.07	44.23 ± 3.33
T_4	PSB	64.90* ± 0.23	6.66* ± 0.08	15.53* ± 0.08	151.63* ± 0.04	44.50 ± 2.00
T_5	*Azotobacter*	66.66* ± 0.08	6.70* ± 0.05	16.30* ± 0.11	152.30* ± 0.25	48.60* ± 2.19
T_6	FYM + Vermicompost	67.66* ± 0.12	7.80* ± 0.05	16.66* ± 0.08	153.33* ± 0.28	49.90* ± 2.33
T_7	FYM + PSB	66.40* ± 0.25	7.33* ± 0.14	17.26* ± 0.12	154.50* ± 0.11	41.46 ± 5.70
T_8	FYM + *Azotobacter*	68.43* ± 0.41	8.40* ± 0.15	18.26* ± 0.12	153.53* ± 0.23	47.43 ± 3.36
T_9	Vermicompost + PSB	74.44* ± 0.23	9.26* ± 0.12	20.60* ± 0.11	155.50* ± 0.15	48.06* ±1.51
T_{10}	Vermicompost + *Azotobacter*	69.96* ± 0.29	9.60* ± 0.17	17.76* ± 0.08	157.40* ± 0.15	48.33* ± 1.66
T_{11}	PSB + *Azotobacter*	71.60* ± 0.15	10.80* ± 0.05	18.60* ± 0.17	156.56* ± 0.17	47.13 ± 1.32
T_{12}	FYM + Vermicompost + PSB	70.80* ± 0.05	10.20* ± 0.15	19.70* ± 0.15	158.33* ± 0.14	50.00* ± 1.51
T_{13}	Vermicompost + PSB + *Azotobacter*	72.73* ± 0.18	12.30* ± 0.11	20.23* ± 0.06	159.76* ± 0.20	53.73* ± 1.62
T_{14}	FYM + PSB + *Azotobacter*	76.73* ± 0.35	12.66* ± 0.14	21.30* ± 0.05	161.70* ± 0.08	52.26* ± 3.13
T_{15}	FYM + Vermicompost + *Azotobacter*	75.46* ± 0.28	11.53* ± 0.08	19.33* ± 0.14	158.70* ± 0.04	51.33* ± 3.36
T_{16}	FYM + Vermicompost + PSB + *Azotobacter*	73.73* ± 0.32	13.63* ± 0.08	21.63* ± 0.12	162.20* ± 0.20	52.80* ± 4.14
S.E(d)		0.34	0.15	0.42	1.24	4.88
$C.D_{(0.05)}$		0.69	0.31	0.20	2.55	9.97

*Significant at 5% level of significance with control

Table 4.2: Effect of organic manures and biofertilizers on number of days taken to bud initiation, number of days taken to flowering, duration of flowering (days), number of flowers per plant and number of flowers per bed of China aster cv. Kamini

Treatments		Days taken to first flower bud initiation ± S.E(m)	Days taken to first flowering ± S.E(m)	Duration of flowering (days) ± S.E(m)	Number of flowers per plant ± S.E(m)	Number of flowers per bed ± S.E(m)
T_1	Control	76.50 ± 0.20	93.03 ± 0.28	14.73 ± 0.06	22.76 ± 1.24	204.90± 11.17
T_2	FYM	76.10* ± 0.26	92.56 ± 0.14	14.46± 0.78	23.36 ± 0.21	210.30 ± 1.96
T_3	Vermicompost	74.66* ± 0.12	90.43* ± 0.20	15.66* ± 0.08	25.53* ± 0.21	229.80* ± 1.96
T_4	PSB	72.76* ± 0.08	88.43* ± 0.14	16.76* ± 0.08	27.26* ± 0.08	245.40* ± 0.79
T_5	*Azotobacter*	73.40* ± 0.11	89.56* ± 0.23	16.16* ± 0.08	26.46* ± 0.12	255.90* ± 0.79
T_6	FYM + Vermicompost	71.63* ± 0.08	87.40* ± 0.15	17.16* ± 0.08	28.43* ± 0.08	267.00* ± 0.79
T_7	FYM + PSB	70.83* ± 0.06	86.73* ± 0.11	17.73* ± 0.06	29.66* ± 0.08	286.50* ± 0.60
T_8	FYM + *Azotobacter*	69.46* ± 0.08	85.43* ± 0.20	18.43* ± 0.08	31.83* ± 0.06	274.50* ± 0.52
T_9	Vermicompost + PSB	70.26* ± 0.09	86.30* ± 0.11	18.06* ± 0.03	30.50* ± 0.05	273.43* ± 0.66
T_{10}	Vermicompost + *Azotobacter*	68.76* ± 0.24	84.60* ± 0.25	18.80* ± 0.05	32.46* ± 0.23	292.20* ± 2.10
T_{11}	PSB + *Azotobacter*	66.46* ± 0.08	82.53* ± 0.14	19.23* ± 0.08	33.76* ± 0.08	303.90* ± 0.79
T_{12}	FYM + Vermicompost + PSB	64.73* ± 0.11	80.26* ± 0.09	19.50* ± 0.11	34.23* ± 0.08	308.10* ± 0.79
T_{13}	Vermicompost + PSB + *Azotobacter*	60.26* ± 0.08	76.33* ± 0.14	20.20* ± 0.05	35.70* ± 0.05	313.20* ± 0.52
T_{14}	FYM + PSB + *Azotobacter*	60.80* ± 0.05	76.73* ± 0.07	20.36* ± 0.14	35.30* ± 0.05	312.40* ± 2.71
T_{15}	FYM + Vermicompost + *Azotobacter*	62.90* ± 0.11	78.46* ± 0.08	19.80* ± 0.05	34.30* ± 0.00	310.10* ± 1.73
T_{16}	FYM + Vermicompost + PSB + *Azotobacter*	58.43* ± 0.24	74.43* ± 0.09	20.80* ± 0.05	39.10* ± 1.10	360.30* ± 5.62
S.E(d)		0.19	0.24	0.28	0.60	4.81
$C.D_{(0.05)}$		0.40	0.49	0.58	1.23	9.88

Significant at 5% level of significance with control

Table 4.3: Effect of organic manures and biofertilizers on stalk length of flower (cm), flower diameter (cm), average weight of flower (g), vase life (days) and shelf life (days) of China aster cv. Kamini

Treatments		Stalk length of flower (cm) ± S.E(m)	Flower diameter (cm) ± S.E(m)	Average weight of flower (g) ± S.E(m)	Vase life (days) ± S.E(m)	Shelf life (days) ± S.E(m)
T_1	Control	24.83± 2.11	3.26 ± 0.08	0.90 ± 0.05	5.13 ± 0.33	2.23 ± 0.08
T_2	FYM	25.63 ± 0.12	3.63* ± 0.03	1.45 ± 0.24	5.20 ± 0.05	2.40 ± 0.05
T_3	Vermicompost	26.73* ± 0.16	3.86* ± 0.03	1.50 ± 0.28	5.53 ± 1.18	2.76 ± 0.08
T_4	PSB	27.63* ± 0.08	4.03* ± 0.03	1.76* ± 0.12	5.80 ± 1.44	2.86 ± 0.08
T_5	*Azotobacter*	28.30* ± 0.15	4.20* ± 0.05	1.80* ± 0.15	6.13 ± 2.08	3.03 ± 0.03
T_6	FYM + Vermicompost	29.26* ± 0.08	4.50* ± 0.05	1.98* ± 0.28	5.93 ± 0.41	3.20 ± 0.05
T_7	FYM + PSB	29.70* ± 0.10	4.66* ± 0.08	2.00* ± 0.32	6.76 ± 0.08	3.63* ± 0.23
T_8	FYM + *Azotobacter*	31.03* ± 0.03	5.63* ± 0.03	2.10* ± 0.70	7.86 ± 0.08	3.43* ± 0.29
T_9	Vermicompost + PSB	30.40* ± 0.17	5.23* ± 0.08	2.06* ± 0.43	7.93 ± 0.12	3.86* ± 0.18
T_{10}	Vermicompost + *Azotobacter*	31.66* ± 0.08	5.73* ± 0.08	2.23* ± 0.12	8.03* ± 1.44	3.93* ± 0.42
T_{11}	PSB + *Azotobacter*	32.13* ± 0.08	6.03* ± 0.03	2.33* ± 0.16	8.40* ± 1.06	3.96* ± 0.52
T_{12}	FYM + Vermicompost + PSB	32.63* ± 0.12	6.53* ± 0.08	2.86* ± 0.41	8.86* ± 0.31	4.03* ± 0.41
T_{13}	Vermicompost + PSB + *Azotobacter*	34.43* ± 0.20	7.73* ± 0.08	3.38* ± 0.23	9.56* ± 0.60	4.90* ± 0.77
T_{14}	FYM + PSB + *Azotobacter*	33.70* ± 0.11	6.80* ± 0.05	3.16* ± 0.16	8.73* ± 0.44	4.13* ± 0.48
T_{15}	FYM + Vermicompost + *Azotobacter*	33.26* ± 0.12	6.26* ± 0.12	3.06* ± 0.31	9.20* ± 1.02	4.36* ± 0.61
T_{16}	FYM + Vermicompost + PSB + *Azotobacter*	34.23* ± 0.08	7.20* ± 0.05	3.37* ± 0.10	9.73* ± 1.84	4.73* ± 0.63
S.E(d)		0.75	0.09	0.41	1.37	0.53
$C.D_{(0.05)}$		1.55	0.19	0.85	2.82	1.10

*Significant at 5% level of significance with control

Table 4.4: Effect of organic manures and biofertilizers on cost of cultivation of China aster cv. Kamini

Treatments		Estimated yield Kg/ha	Cost of Cultivation (Rs/ ha)	Gross Return (Rs/ha)	Net Return (Rs/ha)	Cost : Benefit ratio
T_1	Control	1844.10	104465.00	55323.00	-49142.00	1: -0.47
T_2	FYM	3049.35	176465.00	91480.50	-84984.50	1: -0.48
T_3	Vermicompost	3447.00	164465.00	103410.00	-61055.00	1: -0.37
T_4	PSB	4319.04	107475.00	129571.20	22106.20	1:0.20
T_5	*Azotobacter*	4606.20	106265.00	138186.00	31921.00	1:0.30
T_6	FYM + Vermicompost	5286.60	170465.00	158598.00	-11867.00	1: -0.06
T_7	FYM + PSB	5730.00	163625.00	171900.00	8275.00	1:0.05
T_8	FYM + *Azotobacter*	5764.50	166385.00	172935.00	6550.00	1:0.03
T_9	Vermicompost + PSB	5632.65	152765.00	168979.50	16214.50	1:1
T_{10}	Vermicompost + *Azotobacter*	6516.06	156365.00	195481.80	39116.80	1:0.25
T_{11}	PSB + *Azotobacter*	7080.87	109265.00	212426.10	103161.10	1:0.94
T_{12}	FYM + Vermicompost + PSB	8811.66	173465.00	264349.80	90884.80	1:0.52
T_{13}	Vermicompost + PSB + *Azotobacter*	10586.16	154565.00	317584.80	163019.80	1:1.05
T_{14}	FYM + PSB + *Azotobacter*	9871.84	165425.00	296155.20	130730.20	1:0.79
T_{15}	FYM + Vermicompost + *Azotobacter*	9489.06	172265.00	284671.80	112406.80	1:0.65
T_{16}	FYM + Vermicompost + PSB + *Azotobacter*	12142.11	175265.00	364263.30	188998.30	1:1.07

Chapter 5
DISCUSSION

All plants require more or less the same minerals or nutrients to complete their life cycles, yet, an optimum and balanced level of nutrients is necessary for optimum growth and higher production of quality flowers in ornamental crops. Now a day's use of chemical fertilizers in excess quantity is increasing with a rapid pace to get higher yield but excess use of these chemical fertilizers is not only adversely affecting soil health and environment but they are also responsible for reduction in crop productivity. Therefore, a trend of cultivation of flowers with the use of organic manures and biofertilizers is increasing at a precipitant rate, as they are not only beneficial for soil health and environment but they also provide optimum level of nutrients to plants for completing their life cycle and to increase productivity. The findings presented in experimental results gave a detail account of the vegetative and floral attributes, as influenced by organic manures and biofertilizers. In this chapter, an attempt has been made to discuss the experimental findings to offer possible explanation for the effect of different treatments with regard to different attributes studied in light of work done by other scientists.

5.1 Effect of organic manures and biofertilizers on vegetative growth of China aster cv. Kamini

The plant height was influenced significantly by different levels of nutrients. The maximum plant height (76.73 ± 0.35 cm) was recorded by the application of Farmyard manure @ 28.8 ton/ ha (80%) + Phosphate Solubilizing Bacteria @ (50ml /15L of water) + *Azotobacter* @ (30ml/15L of water) than all other treatments tried. The least plant height (62.60 ± 0.31cm) was recorded in the control. FYM supplies all major nutrients (N, P, K, Ca, S) necessary for plant growth, as well as micronutrients (Fe, Mn, Cu and Zn) Kumar *et al.* (2011). The increase in plant height might be due to the increase availability of nitrogen and phosphorus by using T_{14} treatment as nitrogen is a constituent of protein which is essential for the formation of protoplasm thus improving cell division, cell enlargement and ultimately increases the plant height. The improvement in plant height can also be attributed due to essential role of PSB and *Azotobacter* in solubilization of insoluble P and N through production of organic acid. The adequate supply of P and N seems to have promoted root growth and that leads to vigorous vegetative growth of plants. Similar results were also observed by Mogal *et al.* (2006) in China aster and Kumar *et al*. (2006) in marigold. The decrease in the plant height may be due to unavailability of sufficient nutrients at critical stages to plant for its luxuriant growth. Similar findings were reported by Johnson *et al.* (1982) in chrysanthemum.

The branches are the body structure of the plant and these were significantly influenced by the varying sources of the treatments tried. The significantly higher number of primary branches (13.63 ± 0.08) was recorded in the plants applied with Farmyard manure @18 ton/ ha (50%) + Vermicompost @ 06 ton/ ha (50%) + Phosphate Solubilizing Bacteria @ (50 ml /15L of water) + *Azotobacter* @ (30ml/15L of water). This could be attributed to the use of FYM and Vermicompost as they might have acts as a source of macro (N, P and K) and micronutrients (Zn, Fe, Cu, and Mn), enzymes and growth hormones in the early crop growth phase, which in turn encouraged early vigorous growth Kumar *et al.* (2011). Simultaneously, PSB and *Azotobacter* had helped in converting these nutrients to readily absorbable form thus increasing absorption area of nutrient and water. Thereby it might have favoured for stimulation and production of auxiliary buds resulting in formation of more number of branches. The above results are also corroborated with the findings of Ravindra *et al*. (2013) in gallardia and kameswari *et al*. (2013) in chrysanthemum.

Plant spread determines the size of the plants in different directions. A well spread plant will look pleasing and artistic as well as produces good number of showy flowers. Maximum (21.63 ± 0.12 cm) plant spread was observed when plants were supplied with Farmyard manure @18 ton/ ha (50%) + Vermicompost @ 06 ton/ ha (50%) + Phosphate Solubilizing Bacteria @ (50 ml /15L of water) + *Azotobacter* @ (30ml/15L of water) and minimum (13.30 ± 0.45 cm) plant spread was recorded in control. It might be due to production of more number of leaves in T_{16} treatment. Production of leaves leads to photosynthesis and translocation of photosynthates to other parts of plants thereby, resulting in better plant spread. FYM and Vermicompost improve physical, chemical and biological properties of soil. Improvement in soil structure due to FYM and Vermicompost had leads to better soil environment providing superior roots and ultimately exhibiting better vegetative growth (Prasad and Sinha, 2000). Increase in plant spread can also be due to the better mobilization and supply of available nitrogen and phosphorous that can be attributed to phosphate solubilizing microorganisms and *Azotobacter*. These findings are in corroboration with the work of Airadevi and Mathad (2012) in chrysanthemum and Mogal *et al.* (2006) in China aster.

Leaves are the photosynthetic part of plant, the yield of crop is directly correlated to the number of leaves. The significantly maximum number of leaves (162.20 ± 0.20) were recorded in the treatment T_{16} Farmyard manure @18 ton/ ha (50%) + Vermicompost @ 06 ton/ ha (50%) + Phosphate Solubilizing Bacteria @ (50 ml /15L of water) + *Azotobacter* @ (30ml/15L of water) and minimum (147.53 ± 0.23) number of leaves were observed in control. Integrated approach of nutrient supply through organic matters and biofertilizers like PSB and *Azotobacter* gave better chlorophyll content (Sharma and Thakur, 2002). The increase in number of leaves in T_{16} may be due to increased nitrogen availability which can be due to the use of FYM and Vermicompost along with *Azotobacter* that has helped in transforming the complex form of nitrogen into available form, as nitrogen is a constituent of protein, component of protoplast and increase chlorophyll content in leaves. All these factors contribute to cell multiplication, cell enlargement and differentiation which could have resulted in better photosynthesis and ultimately exhibited more number of leaves. The use of biofertilizers had also led to better availability of nitrogen and phosphorous that can also be a reason for better root proliferation, uptake of nutrients and water, thus causing more growth. These finding are in conformity with the findings of Kumar *et al.* (2003) in China aster and Bohra and kumar (2014) in chrysanthemum.

The application of organic manures and biofertilizers on vegetative growth resulted in marked increased in leaf area of plant. The treatment with (T_{13}) Vermicompost @ 9.6ton/ ha (80%) + Phosphate Solubilizing Bacteria @ (50 ml /15L of water) + *Azotobacter* @ (30ml/15L of water) registered significantly maximum leaf area (53.73 ± 1.62 cm2) and the minimum (37.60 ± 1.25 cm^2) was noticed in (T_1). This might be due to the increased availability of nitrogen and phosphorous which are important constituent of chlorophyll and protein thus causing more growth. Relatively presence of nitrogen and phosphorous in Vermicompost which is absorbed by plant roots promote the more growth in plants. Similar findings were reported by Chaitra (2006) in China aster, Kumar *et al.* (2003) in China aster and Anburanni and Kavitha (2006) in carnation.

5.2 Effect of organic manures and biofertilizers on floral characters of China aster cv. Kamini

The different treatments had a significant effect on the time taken (days) after transplanting for bud and flower initiation. Plants receiving Farmyard manure @18 ton/ ha (50%) + Vermicompost @ 06 ton/ ha (50%) + Phosphate Solubilizing Bacteria @ (50 ml /15L of water) + *Azotobacter* @ (30ml/15L of water) combination had taken significantly less number of days for bud initiation (58.43 ± 0.24 days), flowering (74.43 ± 0.09) and maximum duration of flowering (20.80 ± 0.05 days) in comparison to other treatment combinations. However, maximum days taken to bud initiation (76.50 ± 0.20 days), days to flowering (93.03 ± 0.28 days) and flowering duration (14.73 ± 0.06 days) were found in control. The earliness in flowering might be attributed to amplification of nutrients especially; nitrogen, phosphorus and potassium from Farmyard manure and Vermicompost which promoted the translocation of phytohormones to the shoots resulting in the early bud and flower initiation. Phosphobacterium and *Azotobacter* might have indirect role, which makes the nutrient readily available along with the presence of plant growth promoting substances which might have led to early flowering through better uptake of nutrients. Optimum availability of all the nutrients to the plants has helped to complete vegetative growth soon, resulting in early flowering and delay in flowering in control might be due to the higher level of nitrogen resulted in synthesis of more protein and protoplasm from carbohydrates and less amount of carbohydrates stored in vegetative parts which resulted delayed flowering. These finding are in conformity with the findings of Singh *et al.* (2013) in gladiolus, Ravindra *et al*. (2013) in China aster and Naik and Dalawai (2014) in carnation.

Numbers of flowers per plant (36.60 ± 0.25), number of flowers per bed (360.30 ± 5.62) were significantly higher in plants receiving different combination of Farmyard manure @18 ton/ ha (50%) + Vermicompost @ 06 ton/ ha (50%) + Phosphate Solubilizing Bacteria @ (50 ml /15L of water) + *Azotobacter* @ (30ml/15L of water). *Azotobacter* and Phosphate-Solubilizing Bacteria (PSB) species like *Pseudomonas striata, Bacillus polymyxa* and *Bacillus megaterium* are also reported to beneficial in increasing the phosphorus availability in soil and thereby increasing yield (Gupta, 2006).The increased in flower yield might be attributed to more number of leaves per plant as well as plant spread would have also resulted in production and accumulation of maximum photosynthates, resulting the production of more number of flowers. Similar finding have been reported by Ravindra *et al.* (2013) in China aster, Naik and Dalawai (2014) in carnation and Thane *et al.* (2007) in gerbera.

Stalk length (33.46 ± 0.75 cm) was recorded highest in treatment (T_{13}) Vermicompost @ 9.6ton/ ha (80%) + Phosphate Solubilizing Bacteria @ (50 ml /15L of water) + *Azotobacter* @ (30ml/15L of water) as compared to all other treatments. Increase in stalk length might be due to the better nutrients uptake and photosynthesis under this treatment. The increase in available nitrogen in soil might be due to fixation of atmospheric nitrogen by *Azotobacter*, whereas increase in available P might be due to production of organic acids by PSB. These acids act as a chelating agent and form stable complexes with Fe and Al, thereby releasing unavailable forms of P to the soil solution making it available for uptake by the plant Kumar *et al.* (2011). Thus, the presence of PSB, Vermicompost and *Azotobacter* might have attributed to sufficient supply of micro and macronutrients. These findings are matching with those of Hadwani (2012) in tuberose and Thane *et al.* (2007) in gerbera.

In China aster, the flower showing higher diameter are preferred in the market. The maximum diameter (7.73 ± 0.08 cm) and average weight of flower (3.38 ± 0.23 g) were observed in plants treated with Vermicompost @ 9.6ton/ ha (80%) + Phosphate Solubilizing Bacteria @ (50 ml /15L of water) + *Azotobacter* @ (30ml/15L of water) (T_{13}) and minimum flower diameter (3.26 ± 0.08 cm) and average weight of flower (0.90 ± 0.05 g) were observed in control (T_1). The positive effect of manures added to soil may promote the activity of bacteria which enhances the availability of N, P, K and also improves the nutrients absorption capacity of plant roots (Bertand *et al.*, 2008). Increase in flower diameter and flower weight depends on the proper amount of potassium and nitrogen and if these nutrients found in large quantity then the large size flowers can be obtained. Phosphorus solubilizing bacteria and *Azotobacter* possess the ability to bring sparingly insoluble inorganic or organic phosphates and nitrates in to the soluble forms by secreting organic acids which lower soil pH, and in turn, bring about dissolution of immobile forms of soil phosphate and nitrate (Desai *et al.*, 2005; Kawankhe and Jane, 2002) which can also contribute to improving flower diameter. Similar results have been reported by Khanna (2016) in China aster and Ravindra *et al*. (2013) in China aster.

The maximum vase life (9.73 ± 1.84 days) was recorded in Farmyard manure @18 ton/ ha (50%) + Vermicompost @ 06 ton/ ha (50%) + Phosphate Solubilizing Bacteria @ (50 ml /15L of water) + *Azotobacter* @ (30ml/15L of water). It might be due to overall food nutrient status of flowers under this treatment. Application of organic manures and biofertilizers influences flower longevity due to the increased nutrient uptake by plants and greater development of water conducting tissue. It might also be due to the presence of ethylene inhibitors or due to the presence of cytokinins which delay senescence of flowers. Similar beneficial effects of biofertilizers and FYM on vase life and Average weight have been also reported in tuberose by Hadwani (2012) in tuberose, Mogal *et al*. (2006) in China aster and Singh *et al.* (2013) in gladiolus.

5.3 Effect of organic manures and biofertilizers on cost of cultivation of China aster cv. Kamini

The maximum C: B ratio (1:1.07) was obtained in plants grown under the plots treated with Farmyard manure @18 ton/ ha (50%) + Vermicompost @ 06 ton/ ha (50%) + Phosphate Solubilizing Bacteria @ (50 ml /15L of water) + *Azotobacter* @ (30ml/15L of water) (T_{16}) and minimum C: B ratio (1: -0.48) was recorded in (T_2) followed by control (1: -0.47). The C: B is directly depends upon increased in flower yield, it might be attributed to the more number of leaves per plant and plant spread that would have resulted in production and accumulation of maximum photosynthates, resulting the production of more number of flowers. Similar finding have been reported by Narasimha and Haripriya, 2001 in crossandra, Chandrikapure *et* *al.,* 1999 in marigold. The highest cost benefit ratio is might be due to combined application of organic manures and biofertilizers supplies macro and micro nutrients which is absorbed by plants root system it is leads to increment of flower yield per plant/bed/hectare and it show direct impact on cost benefit ratio of China aster plants similar results were also observed by Verma *et al.* (2011) in chrysanthemum and Khanna (2016) in China aster.

Chapter 6
SUMMARY AND CONCLUSION

The present investigation was carried out at Floriculture and Landscaping Block, College of Horticulture, Veer Chandra Singh Garhwali, Uttarakhand University of Horticulture and Forestry, Bharsar, Pauri Garhwal, Uttarakhand during April - August of 2016 to find out the effect of organic manures and biofertilizers on vegetative and floral characters of china aster to get better yield and quality flowers.

The salient findings of the investigation are mentioned below:

1. Among sixteen treatments, best plant height (76.73 ± 0.35 cm) was observed from the plants grown in plots applied with treatment containing Farmyard manure @ 28.8 ton/ ha (80%) + Phosphate Solubilizing Bacteria @ (50ml /15L of water) + *Azotobacter* @ (30ml/15L of water).

2. The plant spread (21.63 ± 0.12 cm) was observed maximum in the plants grown in plots applied with Farmyard manure @18 ton/ ha (50%) + Vermicompost @ 06 ton/ ha (50%) + Phosphate Solubilizing Bacteria @ (50 ml /15L of water) + *Azotobacter* @ (30ml/15L of water).

3. Plants grown in plots applied with treatment containing Farmyard manure @18 ton/ ha (50%) + Vermicompost @ 06 ton/ ha (50%) + Phosphate Solubilizing Bacteria @ (50 ml /15L of water) + *Azotobacter* @ (30ml/15L of water) exhibited maximum number of primary branches per plant and number of leaves (13.63 ± 0.08 and 162.20 ± 0.20, respectively). However, minimum number of primary branches per plant and number of leaves (5.26 ± 0.08 and 147.53 ± 0.23) was recorded from plants grown in control.

4. The maximum leaf area (53.73 ± 1.62 cm^2) was recorded from the plants grown in the plots applied with treatment containing Vermicompost @ 9.6 ton/ ha (80%) + Phosphate Solubilizing Bacteria @ (50ml /15L of water) + *Azotobacter* @ (30ml/15L

of water). (T_{13}) and minimum leaf area (37.60 ± 1.25 cm^2) was observed from the plants grown in control.

5. Various treatments exhibited variable number of days taken to bud initiation and it was noticed that treatment consisting of control took maximum time for initiation of buds (76.50 ± 0.20 days) while treatment comprising of Farmyard manure @18 ton/ ha (50%) + Vermicompost @ 06 ton/ ha (50%) + Phosphate Solubilizing Bacteria @ (50 ml /15L of water) + *Azotobacter* @ (30ml/15L of water) took least (58.43 ± 0.24 days) for bud initiation.

6. Days taken to early flowering were significantly influenced by different treatments. The plants grown in plots treatment containing Farmyard manure @18 ton/ ha (50%) + Vermicompost @ 06 ton/ ha (50%) + Phosphate Solubilizing Bacteria @ (50 ml /15L of water) + *Azotobacter* @ (30ml/15L of water) was recorded early flowering (74.43 ± 0.09) days and whereas maximum days taken to flowering (93.03 ± 0.28) was recorded in control.

7. While studying duration of flowering of China aster cv. Kamini, it was revealed that best results were observed in Farmyard manure @18 ton/ ha (50%) + Vermicompost @ 06 ton/ ha (50%) + Phosphate Solubilizing Bacteria @ (50 ml /15L of water) + *Azotobacter* @ (30ml/15L of water) (20.80 ± 0.05 days), among different treatments applied.

8. Average number of flowers per plant and flowers per bed was observed in maximum in plants grown in plots applied with treatment containing Farmyard manure @18 ton/ ha (50%) + Vermicompost @ 06 ton/ ha (50%) + Phosphate Solubilizing Bacteria @ (50 ml /15L of water) + *Azotobacter* @ (30ml/15L of water) recorded maximum number of flowers/plant (36.60 ± 0.25) and flowers/bed (360.30 ± 5.62).

9. Stalk length ranged from 24.83 ± 2.11 to 34.23 ± 0.08 cm in all the treatments and it was having highest value for the plants grown in plots applied with treatment containing Vermicompost @ 9.6 ton/ ha (80%) + Phosphate Solubilizing Bacteria @

(50ml /15L of water) + *Azotobacter* @ (30ml/15L of water) and lowest in plants grown in control plots.

10. The highest flower diameter and average weight of flower were found of the plants grown in plots applied with treatment containing Vermicompost @ 9.6 ton/ ha (80%) + Phosphate Solubilizing Bacteria @ (50ml /15L of water) + *Azotobacter* @ (30ml/15L of water) (7.73 ± 0.08 cm and 3.38 ± 0.23 g, respectively) and lowest (3.26 ± 0.08 cm and 0.90 ± 0.05 g, respectively) of plants grown in control plots.

11. Vase life was observed maximum (9.73 ± 1.84 days) of plants harvested from the plots applied with treatment containing Farmyard manure @18 ton/ ha (50%) + Vermicompost @ 06 ton/ ha (50%) + Phosphate Solubilizing Bacteria @ (50 ml /15L of water) + *Azotobacter* @ (30ml/15L of water).

12. Plants grown in plots treated with Farmyard manure @18 ton/ ha (50%) + Vermicompost @ 06 ton/ ha (50%) + Phosphate Solubilizing Bacteria @ (50 ml /15L of water) + *Azotobacter* @ (30ml/15L of water) were recorded highest C: B ratio (1:1.07) and lowest (1: -0.48) C: B ratio was recorded in T_2.

Conclusion

The results indicated that application of organic manures with use of biofertilizers had significantly improved the vegetative and flowering characters of China aster cv. Kamini as compared to control. Use of organic sources of nutrient not only increase the quality and yield attributing traits in plants but also improved the health and fertility status of soil. Among the different treatments applied best C : B ratio, vegetative and flowering parameters were found from the plants grown in the plots applied with FYM @18 ton/ ha (50%) + Vermicompost @ 06 ton/ ha (50%)+ PSB @ (50 ml /15L of water) + *Azotobacter* @ (30ml/15L of water) .Whereas, some of the flowering characters viz. Stalk length, Flower diameter and Shelf life were found best in the plots treated with Vermicompost @ 9.6ton/ ha (80%) + PSB@ (50 ml /15L of water) +*Azotobacter* @ (30ml/15L of water). Thus, it can be concluded that application of FYM @18 ton/ ha (50%) + Vermicompost @ 06 ton/ ha (50%) + PSB @ (50 ml /15L of water) + *Azotobacter* @ (30ml/15L of water) is effective in improving quality and quantity traits in China aster cv. Kamini.

Chapter 7
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Appendix 1

Calculation of cost of cultivation of China aster cv. Kamini

Table 1:

A.	**PARTICULARS (per hectare)**	(Rs.)
1.	Seed cost	45000
2.	Preparation of nursery beds and sowing of seeds 5 man days @ 200/man day	1000
3.	Intercultural practices in nursery beds 2 man day @ 200/ man day	400
4.	Irrigation of nursery beds 2 man days @ 200/man day 4 times	1600
5.	Preparation of field 2 ploughings @ 300/hr , 6hrs for one hectare +2 man	7200
6.	Layout & beds preparation 10 man days @ 200/ man day	2000
7.	Lifting of seedlings and their transplanting 12 man days @ 200/ man day	2400
8.	Total Irrigations in crop 12 irrigations 3 hrs/irrigation 14 man days @ 200/ man day	2800
9.	Weeding, hoeing and gap filling 15 man days @ 200/ man day 6 times	14400
10.	Neem spray 10 L @ Rs.110/250 ml +2 man	4800
11.	Harvesting, grading and packing, etc. 30 man days @ 200/ man day	6000
12.	Transportation	1500
	Total	**89100**
T_1.	Control	
B.	Other costs	1000
1.	Depreciation costs (instruments etc.)	1000
2.	Risk factor (5% of working capital)	4455
3.	Management Cost (10% of working capital)	8910
	Total cost	**104465**

- Yield of China aster is = 1844.1 Kg/ha
- Sale rate of China aster flowers @ 30 Rs/Kg
- Total sale rate of China aster flowers =55323 Rs.
- Total gross return = 55323
- Net return = gross return – total cost of cultivation
- 55323 – 104465 = -49142
- Cost: Benefit ratio $= \frac{\text{Cost of cultivation (Rs/ha)}}{\text{Net returns (Rs/ha)}}$ 104465/-49142 = 1: -0.47

Table 2:

A.	**PARTICULARS (per hectare)**	(Rs.)
1.	Seed cost	45000
2.	Preparation of nursery beds and sowing of seeds 5 man days @ 200/man day	1000
3.	Intercultural practices in nursery beds 2 man day @ 200/ man day	400
4.	Irrigation of nursery beds 2 man days @ 200/man day 4 times	1600
5.	Preparation of field 2 ploughings @ 300/hr , 6hrs for one hectare +2 man	7200
6.	Layout & beds preparation 10 man days @ 200/ man day	2000
7.	Lifting of seedlings and their transplanting 12 man days @ 200/ man day	2400
8.	Total Irrigations in crop 12 irrigations 3 hrs/irrigation 14 man days @ 200/ man day	2800
9.	Weeding, hoeing and gap filling 15 man days @ 200/ man day 6 times	14400
10.	Neem spray 10 L @ Rs.110/250 ml +2 man	4800
11.	Harvesting, grading and packing, etc. 30 man days @ 200/ man day	6000
12.	Transportation	1500
	Total	**89100**
T_2.	FYM @ 36 t/ha	72000
B.	Other costs	1000
1.	Depreciation costs (instruments etc.)	1000
2.	Risk factor (5% of working capital)	4455
3.	Management Cost (10% of working capital)	8910
	Total cost	**176465**

- Yield of China aster is = 3049.35 Kg/ha
- Sale rate of China aster flowers @ 30 Rs/Kg
- Total sale rate of China aster flowers = 91480.5 Rs.
- Total gross return = 91480.5
- Net return = gross return – total cost of cultivation
- 91480.5 - 176465 = -84984.5
- Cost: Benefit ratio = $\frac{\text{Cost of cultivation (Rs/ha)}}{\text{Net returns (Rs/ha)}}$ 176465/-84984.5 = 1: -0.48

Table 3:

A.	**PARTICULARS (per hectare)**	(Rs.)
1.	Seed cost	45000
2.	Preparation of nursery beds and sowing of seeds 5 man days @ 200/man day	1000
3.	Intercultural practices in nursery beds 2 man day @ 200/ man day	400
4.	Irrigation of nursery beds 2 man days @ 200/man day 4 times	1600
5.	Preparation of field 2 ploughings @ 300/hr , 6hrs for one hectare + 2 man	7200
6.	Layout & beds preparation 10 man days @ 200/ man day	2000
7.	Lifting of seedlings and their transplanting 12 man days @ 200/ man day	2400
8.	Total Irrigations in crop 12 irrigations 3 hrs/irrigation 14 man days @ 200/ man day	2800
9.	Weeding, hoeing and gap filling 15 man days @ 200/ man day 6 times	14400
10.	Neem spray 10 L @ Rs.110/250 ml +2 man	4800
11.	Harvesting, grading and packing, etc. 30 man days @ 200/ man day	6000
12.	Transportation	1500
	Total	**89100**
$T_{3.}$	Vermicompost @ 12t/ha	60000
B.	Other costs	1000
1.	Depreciation costs (instruments etc.)	1000
2.	Risk factor (5% of working capital)	4455
3.	Management Cost (10% of working capital)	8910
	Total cost	**164465**

- Yield of China aster is = 3447 Kg/ha
- Sale rate of China aster flowers @ 30 Rs/Kg
- Total sale rate of China aster flowers = 103410 Rs.
- Total gross return = 103410
- Net return = gross return – total cost of cultivation
- 103410 – 164465 = -61055
- Cost: Benefit ratio = $\frac{\text{Cost of cultivation (Rs/ha)}}{\text{Net returns (Rs/ha)}}$ 164465/-61055 = 1: -0.37

Table 4:

A.	**PARTICULARS (per hectare)**	(Rs.)
1.	Seed cost	45000
2.	Preparation of nursery beds and sowing of seeds 5 man days @ 200/man day	1000
3.	Intercultural practices in nursery beds 2 man day @ 200/ man day	400
4.	Irrigation of nursery beds 2 man days @ 200/man day 4 times	1600
5.	Preparation of field 2 ploughings @ 300/hr , 6hrs for one hectare + 2 man	7200
6.	Layout & beds preparation 10 man days @ 200/ man day	2000
7.	Lifting of seedlings and their transplanting 12 man days @ 200/ man day	2400
8.	Total Irrigations in crop 12 irrigations 3 hrs/irrigation 14 man days @ 200/ man day	2800
9.	Weeding, hoeing and gap filling 15 man days @ 200/ man day 6 times	14400
10.	Neem spray 10 L @ Rs.110/250 ml +2 man	4800
11.	Harvesting, grading and packing, etc. 30 man days @ 200/ man day	6000
12.	Transportation	1500
	Total	**89100**
T_4.	PSB @ 5 L/ha	3000
B.	Other costs	1000
1.	Depreciation costs (instruments etc.)	1000
2.	Risk factor (5% of working capital)	4455
3.	Management Cost (10% of working capital)	8910
	Total cost	**107465**

- Yield of China aster is = 4319.04 Kg/ha
- Sale rate of China aster flowers @ 30 Rs/Kg
- Total sale rate of China aster flowers = 129571.2 Rs.
- Total gross return = 129571.2
- Net return = gross return – total cost of cultivation
- 129571.2 – 107465 = 22106.2
- Cost: Benefit ratio $= \frac{\text{Cost of cultivation (Rs/ha)}}{\text{Net returns (Rs/ha)}}$ 107465/22106.2 = 1:0.20

Table 5:

A.	**PARTICULARS (per hectare)**	(Rs.)
1.	Seed cost	45000
2.	Preparation of nursery beds and sowing of seeds 5 man days @ 200/man day	1000
3.	Intercultural practices in nursery beds 2 man day @ 200/ man day	400
4.	Irrigation of nursery beds 2 man days @ 200/man day 4 times	1600
5.	Preparation of field 2 ploughings @ 300/hr , 6hrs for one hectare + 2 man	7200
6.	Layout & beds preparation 10 man days @ 200/ man day	2000
7.	Lifting of seedlings and their transplanting 12 man days @ 200/ man day	2400
8.	Total Irrigations in crop 12 irrigations 3 hrs/irrigation 14 man days @ 200/ man day	2800
9.	Weeding, hoeing and gap filling 15 man days @ 200/ man day 6 times	14400
10.	Neem spray 10 L @ Rs.110/250 ml +2 man	4800
11.	Harvesting, grading and packing, etc. 30 man days @ 200/ man day	6000
12.	Transportation	1500
	Total	**89100**
T_5.	*Azotobacter* @ 3 L/ha	1800
B.	Other costs	1000
1.	Depreciation costs (instruments etc.)	1000
2.	Risk factor (5% of working capital)	4455
3.	Management Cost (10% of working capital)	8910
	Total cost	**106265**

- Yield of China aster is = 4606.2 Kg/ha
- Sale rate of China aster flowers @ 30 Rs/Kg
- Total sale rate of China aster flowers = 138186 Rs.
- Total gross return = 138186 Rs
- Net return = gross return – total cost of cultivation
- 138186– 106265 = 31921
- Cost: Benefit ratio = $\frac{\text{Cost of cultivation (Rs/ha)}}{\text{Net returns (Rs/ha)}}$ 106265/31921 = 1:0.30

Table 6:

A.	**PARTICULARS (per hectare)**	(Rs.)
1.	Seed cost	45000
2.	Preparation of nursery beds and sowing of seeds 5 man days @ 200/man day	1000
3.	Intercultural practices in nursery beds 2 man day @ 200/ man day	400
4.	Irrigation of nursery beds 2 man days @ 200/man day 4 times	1600
5.	Preparation of field 2 ploughings @ 300/hr , 6hrs for one hectare + 2 man	7200
6.	Layout & beds preparation 10 man days @ 200/ man day	2000
7.	Lifting of seedlings and their transplanting 12 man days @ 200/ man day	2400
8.	Total Irrigations in crop 12 irrigations 3 hrs/irrigation 14 man days @ 200/ man day	2800
9.	Weeding, hoeing and gap filling 15 man days @ 200/ man day 6 times	14400
10.	Neem spray 10 L @ Rs.110/250 ml +2 man	4800
11.	Harvesting, grading and packing, etc. 30 man days @ 200/ man day	6000
12.	Transportation	1500
	Total	**89100**
$T_{6.}$	FYM@ 18 t/ha + Vermicompost@ 06t/ha	66000
B.	Other costs	1000
1.	Depreciation costs (instruments etc.)	1000
2.	Risk factor (5% of working capital)	4455
3.	Management Cost (10% of working capital)	8910
	Total cost	**170465**

- Yield of China aster is = 5286.6 Kg/ha
- Sale rate of China aster flowers @ 30 Rs/Kg
- Total sale rate of China aster flowers = 158598 Rs.
- Total gross return = 158598 Rs
- Net return = gross return – total cost of cultivation
- 158598 – 170465 = -11867
- Cost: Benefit ratio = $\frac{\text{Cost of cultivation (Rs/ha)}}{\text{Net returns (Rs/ha)}}$ 170465/-11867 = 1: -0.06

Table 7:

A.	**PARTICULARS (per hectare)**	(Rs.)
1.	Seed cost	45000
2.	Preparation of nursery beds and sowing of seeds 5 man days @ 200/man day	1000
3.	Intercultural practices in nursery beds 2 man day @ 200/ man day	400
4.	Irrigation of nursery beds 2 man days @ 200/man day 4 times	1600
5.	Preparation of field 2 ploughings @ 300/hr , 6hrs for one hectare + 2 man	7200
6.	Layout & beds preparation 10 man days @ 200/ man day	2000
7.	Lifting of seedlings and their transplanting 12 man days @ 200/ man day	2400
8.	Total Irrigations in crop 12 irrigations 3 hrs/irrigation 14 man days @ 200/ man day	2800
9.	Weeding, hoeing and gap filling 15 man days @ 200/ man day 6 times	14400
10.	Neem spray 10 L @ Rs.110/250 ml +2 man	4800
11.	Harvesting, grading and packing, etc. 30 man days @ 200/ man day	6000
12.	Transportation	1500
	Total	**89100**
T_7.	FYM@ 28.8 t/ha + PSB@ 5L/ha	59160
B.	Other costs	1000
1.	Depreciation costs (instruments etc.)	1000
2.	Risk factor (5% of working capital)	4455
3.	Management Cost (10% of working capital)	8910
	Total cost	**163625**

- Yield of China aster is = 5730 Kg/ha
- Sale rate of China aster flowers @ 30 Rs/Kg
- Total sale rate of China aster flowers = 171900 Rs.
- Total gross return = 171900 Rs
- Net return = gross return – total cost of cultivation
- 171900 – 163625 = 8275
- Cost: Benefit ratio = $\frac{\text{Cost of cultivation (Rs/ha)}}{\text{Net returns (Rs/ha)}}$ 163625/8275 = 1: 0.05

Table 8:

A.	**PARTICULARS (per hectare)**	(Rs.)
1.	Seed cost	45000
2.	Preparation of nursery beds and sowing of seeds 5 man days @ 200/man day	1000
3.	Intercultural practices in nursery beds 2 man day @ 200/ man day	400
4.	Irrigation of nursery beds 2 man days @ 200/man day 4 times	1600
5.	Preparation of field 2 ploughings @ 300/hr , 6hrs for one hectare + 2 man	7200
6.	Layout & beds preparation 10 man days @ 200/ man day	2000
7.	Lifting of seedlings and their transplanting 12 man days @ 200/ man day	2400
8.	Total Irrigations in crop 12 irrigations 3 hrs/irrigation 14 man days @ 200/ man day	2800
9.	Weeding, hoeing and gap filling 15 man days @ 200/ man day 6 times	14400
10.	Neem spray 10 L @ Rs.110/250 ml +2 man	4800
11.	Harvesting, grading and packing, etc. 30 man days @ 200/ man day	6000
12.	Transportation	1500
	Total	**89100**
T_8.	FYM@ 30.6 t/ha + Azotobacter@ 3L/ha	61920
B.	Other costs	1000
1.	Depreciation costs (instruments etc.)	1000
2.	Risk factor (5% of working capital)	4455
3.	Management Cost (10% of working capital)	8910
	Total cost	**166385**

- Yield of China aster is = 5764.5 Kg/ha
- Sale rate of China aster flowers @ 30 Rs/Kg
- Total sale rate of China aster flowers = 172935 Rs.
- Total gross return = 172935 Rs
- Net return = gross return – total cost of cultivation
- 172935 – 166385 = 6550
- Cost: Benefit ratio $= \frac{\text{Cost of cultivation (Rs/ha)}}{\text{Net returns (Rs/ha)}}$ 166385/6550 = 1:0.03

Table 9:

A.	**PARTICULARS (per hectare)**	(Rs.)
1.	Seed cost	45000
2.	Preparation of nursery beds and sowing of seeds 5 man days @ 200/man day	1000
3.	Intercultural practices in nursery beds 2 man day @ 200/ man day	400
4.	Irrigation of nursery beds 2 man days @ 200/man day 4 times	1600
5.	Preparation of field 2 ploughings @ 300/hr , 6hrs for one hectare + 2 man	7200
6.	Layout & beds preparation 10 man days @ 200/ man day	2000
7.	Lifting of seedlings and their transplanting 12 man days @ 200/ man day	2400
8.	Total Irrigations in crop 12 irrigations 3 hrs/irrigation 14 man days @ 200/ man day	2800
9.	Weeding, hoeing and gap filling 15 man days @ 200/ man day 6 times	14400
10.	Neem spray 10 L @ Rs.110/250 ml +2 man	4800
11.	Harvesting, grading and packing, etc. 30 man days @ 200/ man day	6000
12.	Transportation	1500
	Total	**89100**
T_9.	Vermicompost@ 9.6 t/ha + PSB@ 5L/ha	48300
B.	Other costs	1000
1.	Depreciation costs (instruments etc.)	1000
2.	Risk factor (5% of working capital)	4455
3.	Management Cost (10% of working capital)	8910
	Total cost	**152765**

- Yield of China aster is = 5632.65 Kg/ha
- Sale rate of China aster flowers @ 30 Rs/Kg
- Total sale rate of China aster flowers = 168979.5 Rs.
- Total gross return = 168979.5 Rs
- Net return = gross return – total cost of cultivation
- 168979.5 –152765 = 16214.5
- Cost: Benefit ratio $= \frac{\text{Cost of cultivation (Rs/ha)}}{\text{Net returns (Rs/ha)}}$ 152765/16214.5 = 1:1

Table 10:

A.	**PARTICULARS (per hectare)**	(Rs.)
1.	Seed cost	45000
2.	Preparation of nursery beds and sowing of seeds 5 man days @ 200/man day	1000
3.	Intercultural practices in nursery beds 2 man day @ 200/ man day	400
4.	Irrigation of nursery beds 2 man days @ 200/man day 4 times	1600
5.	Preparation of field 2 ploughings @ 300/hr , 6hrs for one hectare + 2 man	7200
6.	Layout & beds preparation 10 man days @ 200/ man day	2000
7.	Lifting of seedlings and their transplanting 12 man days @ 200/ man day	2400
8.	Total Irrigations in crop 12 irrigations 3 hrs/irrigation 14 man days @ 200/ man day	2800
9.	Weeding, hoeing and gap filling 15 man days @ 200/ man day 6 times	14400
10.	Neem spray 10 L @ Rs.110/250 ml +2 man	4800
11.	Harvesting, grading and packing, etc. 30 man days @ 200/ man day	6000
12.	Transportation	1500
	Total	**89100**
$T_{10.}$	Vermicompost@ 10.2 t/ha + *Azotobacter*@ 5L/ha	51900
B.	Other costs	1000
1.	Depreciation costs (instruments etc.)	1000
2.	Risk factor (5% of working capital)	4455
3.	Management Cost (10% of working capital)	8910
	Total cost	**156365**

- Yield of China aster is = 6516.06 Kg/ha
- Sale rate of China aster flowers @ 30 Rs/Kg
- Total sale rate of China aster flowers = 195481.8 Rs.
- Total gross return = 195481.8 Rs
- Net return = gross return – total cost of cultivation
- 195481.8 –156365 = 39116.8
- Cost: Benefit ratio $= \frac{\text{Cost of cultivation (Rs/ha)}}{\text{Net returns (Rs/ha)}}$ 156365/39116.8 = 1:0.25

Table 11:

A.	PARTICULARS (per hectare)	(Rs.)
1.	Seed cost	45000
2.	Preparation of nursery beds and sowing of seeds 5 man days @ 200/man day	1000
3.	Intercultural practices in nursery beds 2 man day @ 200/ man day	400
4.	Irrigation of nursery beds 2 man days @ 200/man day 4 times	1600
5.	Preparation of field 2 ploughings @ 300/hr , 6hrs for one hectare + 2 man	7200
6.	Layout & beds preparation 10 man days @ 200/ man day	2000
7.	Lifting of seedlings and their transplanting 12 man days @ 200/ man day	2400
8.	Total Irrigations in crop 12 irrigations 3 hrs/irrigation 14 man days @ 200/ man day	2800
9.	Weeding, hoeing and gap filling 15 man days @ 200/ man day 6 times	14400
10.	Neem spray 10 L @ Rs.110/250 ml +2 man	4800
11.	Harvesting, grading and packing, etc. 30 man days @ 200/ man day	6000
12.	Transportation	1500
	Total	**89100**
$T_{11.}$	PSB@ 5L/ha + *Azotobacter*@ 3L/ha	4800
B.	Other costs	1000
1.	Depreciation costs (instruments etc.)	1000
2.	Risk factor (5% of working capital)	4455
3.	Management Cost (10% of working capital)	8910
	Total cost	**109265**

- Yield of China aster is = 7080.87 Kg/ha
- Sale rate of China aster flowers @ 30 Rs/Kg
- Total sale rate of China aster flowers = 212426.1 Rs.
- Total gross return = 212426.1 Rs
- Net return = gross return – total cost of cultivation
- 212426.1 –109265 = 103161.1

Cost: Benefit ratio $= \frac{\text{Cost of cultivation (Rs/ha)}}{\text{Net returns (Rs/ha)}}$ 109265/103161.1 = 1:0.94

Table 12:

A.	PARTICULARS (per hectare)	(Rs.)
1.	Seed cost	45000
2.	Preparation of nursery beds and sowing of seeds 5 man days @ 200/man day	1000
3.	Intercultural practices in nursery beds 2 man day @ 200/ man day	400
4.	Irrigation of nursery beds 2 man days @ 200/man day 4 times	1600
5.	Preparation of field 2 ploughings @ 300/hr , 6hrs for one hectare + 2 man	7200
6.	Layout & beds preparation 10 man days @ 200/ man day	2000
7.	Lifting of seedlings and their transplanting 12 man days @ 200/ man day	2400
8.	Total Irrigations in crop 12 irrigations 3 hrs/irrigation 14 man days @ 200/ man day	2800
9.	Weeding, hoeing and gap filling 15 man days @ 200/ man day 6 times	14400
10.	Neem spray 10 L @ Rs.110/250 ml +2 man	4800
11.	Harvesting, grading and packing, etc. 30 man days @ 200/ man day	6000
12.	Transportation	1500
	Total	**89100**
$T_{12.}$	FYM@ 18t/ha + Vermicompost @06t/ha + PSB@ 5L/ha	69000
B.	Other costs	1000
1.	Depreciation costs (instruments etc.)	1000
2.	Risk factor (5% of working capital)	4455
3.	Management Cost (10% of working capital)	8910
	Total cost	**173465**

- Yield of China aster is = 8811.66 Kg/ha
- Sale rate of China aster flowers @ 30 Rs/Kg
- Total sale rate of China aster flowers = 264349.8 Rs.
- Total gross return = 264349.8 Rs
- Net return = gross return – total cost of cultivation
- 264349.8 –173465 = 90884.8

$$\text{Cost: Benefit ratio} = \frac{\text{Cost of cultivation (Rs/ha)}}{\text{Net returns (Rs/ha)}} \quad 173465/90884.8 = 1:0.52$$

Table 13:

A.	**PARTICULARS (per hectare)**	(Rs.)
1.	Seed cost	45000
2.	Preparation of nursery beds and sowing of seeds 5 man days @ 200/man day	1000
3.	Intercultural practices in nursery beds 2 man day @ 200/ man day	400
4.	Irrigation of nursery beds 2 man days @ 200/man day 4 times	1600
5.	Preparation of field 2 ploughings @ 300/hr , 6hrs for one hectare + 2 man	7200
6.	Layout & beds preparation 10 man days @ 200/ man day	2000
7.	Lifting of seedlings and their transplanting 12 man days @ 200/ man day	2400
8.	Total Irrigations in crop 12 irrigations 3 hrs/irrigation 14 man days @ 200/ man day	2800
9.	Weeding, hoeing and gap filling 15 man days @ 200/ man day 6 times	14400
10.	Neem spray 10 L @ Rs.110/250 ml +2 man	4800
11.	Harvesting, grading and packing, etc. 30 man days @ 200/ man day	6000
12.	Transportation	1500
	Total	**89100**
$T_{13.}$	Vermicompost@ 9.6t/ha + PSB@ 5L/ha + *Azotobacter*@ 3L/ha	50100
B.	Other costs	1000
1.	Depreciation costs (instruments etc.)	1000
2.	Risk factor (5% of working capital)	4455
3.	Management Cost (10% of working capital)	8910
	Total cost	**154565**

- Yield of China aster is = 10586.16 Kg/ha
- Sale rate of China aster flowers @ 30 Rs/Kg
- Total sale rate of China aster flowers = 317584.8 Rs.
- Total gross return = 317584.8 Rs
- Net return = gross return – total cost of cultivation
- 317584.8 – 154565 = 163019.8

Cost: Benefit ratio $= \frac{\text{Cost of cultivation (Rs/ha)}}{\text{Net returns (Rs/ha)}}$ 154565/163019.8 = 1:1.05

Table 14:

A.	**PARTICULARS (per hectare)**	(Rs.)
1.	Seed cost	45000
2.	Preparation of nursery beds and sowing of seeds 5 man days @ 200/man day	1000
3.	Intercultural practices in nursery beds 2 man day @ 200/ man day	400
4.	Irrigation of nursery beds 2 man days @ 200/man day 4 times	1600
5.	Preparation of field 2 ploughings @ 300/hr , 6hrs for one hectare + 2 man	7200
6.	Layout & beds preparation 10 man days @ 200/ man day	2000
7.	Lifting of seedlings and their transplanting 12 man days @ 200/ man day	2400
8.	Total Irrigations in crop 12 irrigations 3 hrs/irrigation 14 man days @ 200/ man day	2800
9.	Weeding, hoeing and gap filling 15 man days @ 200/ man day 6 times	14400
10.	Neem spray 10 L @ Rs.110/250 ml +2 man	4800
11.	Harvesting, grading and packing, etc. 30 man days @ 200/ man day	6000
12.	Transportation	1500
	Total	**89100**
$T_{14.}$	FYM@ 28.8t/ha + PSB@ 5L/ha + *Azotobacter*@ 3L/ha	60960
B.	Other costs	1000
1.	Depreciation costs (instruments etc.)	1000
2.	Risk factor (5% of working capital)	4455
3.	Management Cost (10% of working capital)	8910
	Total cost	**165425**

- Yield of China aster is = 9871.84 Kg/ha
- Sale rate of China aster flowers @ 30 Rs/Kg
- Total sale rate of China aster flowers = 296155.2 Rs.
- Total gross return = 296155.2 Rs
- Net return = gross return – total cost of cultivation
- 296155.2 – 165425 = 130730.2

Cost: Benefit ratio $= \frac{\text{Cost of cultivation (Rs/ha)}}{\text{Net returns (Rs/ha)}}$ 165425/130730.2 = 1:0.79

Table 15:

A.	**PARTICULARS (per hectare)**	(Rs.)
1.	Seed cost	45000
2.	Preparation of nursery beds and sowing of seeds 5 man days @ 200/man day	1000
3.	Intercultural practices in nursery beds 2 man day @ 200/ man day	400
4.	Irrigation of nursery beds 2 man days @ 200/man day 4 times	1600
5.	Preparation of field 2 ploughings @ 300/hr , 6hrs for one hectare + 2 man	7200
6.	Layout & beds preparation 10 man days @ 200/ man day	2000
7.	Lifting of seedlings and their transplanting 12 man days @ 200/ man day	2400
8.	Total Irrigations in crop 12 irrigations 3 hrs/irrigation 14 man days @ 200/ man day	2800
9.	Weeding, hoeing and gap filling 15 man days @ 200/ man day 6 times	14400
10.	Neem spray 10 L @ Rs.110/250 ml +2 man	4800
11.	Harvesting, grading and packing, etc. 30 man days @ 200/ man day	6000
12.	Transportation	1500
	Total	**89100**
$T_{15.}$	FYM@ 18t/ha + Vermicompost@ 06t/ha + *Azotobacter*@ 3L/ha	67800
B.	Other costs	1000
1.	Depreciation costs (instruments etc.)	1000
2.	Risk factor (5% of working capital)	4455
3.	Management Cost (10% of working capital)	8910
	Total cost	**172265**

- Yield of China aster is = 9489.06 Kg/ha
- Sale rate of China aster flowers @ 30 Rs/Kg
- Total sale rate of China aster flowers = 284671.8 Rs.
- Total gross return = 284671.8 Rs
- Net return = gross return – total cost of cultivation
- 284671.8 – 172265 = 112406.8

Cost: Benefit ratio = $\frac{\text{Cost of cultivation (Rs/ha)}}{\text{Net returns (Rs/ha)}}$ 172265/112406.8 = 1:0.65

Table 16:

A.	**PARTICULARS (per hectare)**	(Rs.)
1.	Seed cost	45000
2.	Preparation of nursery beds and sowing of seeds 5 man days @ 200/man day	1000
3.	Intercultural practices in nursery beds 2 man day @ 200/ man day	400
4.	Irrigation of nursery beds 2 man days @ 200/man day 4 times	1600
5.	Preparation of field 2 ploughings @ 300/hr , 6hrs for one hectare + 2 man	7200
6.	Layout & beds preparation 10 man days @ 200/ man day	2000
7.	Lifting of seedlings and their transplanting 12 man days @ 200/ man day	2400
8.	Total Irrigations in crop 12 irrigations 3 hrs/irrigation 14 man days @ 200/ man day	2800
9.	Weeding, hoeing and gap filling 15 man days @ 200/ man day 6 times	14400
10.	Neem spray 10 L @ Rs.110/250 ml +2 man	4800
11.	Harvesting, grading and packing, etc. 30 man days @ 200/ man day	6000
12.	Transportation	1500
	Total	**89100**
$T_{16.}$	FYM@ 18t/ha + Vermicompost@ 06t/ha + PSB@ 3L/ha + *Azotobacter*@ 3L/ha	70800
B.	Other costs	1000
1.	Depreciation costs (instruments etc.)	1000
2.	Risk factor (5% of working capital)	4455
3.	Management Cost (10% of working capital)	8910
	Total cost	**175265**

- Yield of China aster is = 12142.11 Kg/ha
- Sale rate of China aster flowers @ 30 Rs/Kg
- Total sale rate of China aster flowers = 364263.3 Rs.
- Total gross return = 364263.3 Rs
- Net return = gross return – total cost of cultivation
- 364263.3 – 175265 = 188998.3

Cost: Benefit ratio $= \dfrac{\text{Cost of cultivation (Rs/ha)}}{\text{Net returns (Rs/ha)}}$ 175265/188998.3 = 1:1.07

Appendix 2

Statistical analysis for different characters under study

Source of variation	Degree of freedom	Mean Sum of Squares				
		X1	**X2**	**X3**	**X4**	**X5**
Replication	2	0.17	0.08	0.23	5.21	6.18
Treatment	15	59.42	20.85	20.44	56.66	58.26
Error	30	0.17	0.03	0.06	2.33	35.76

Source of variation	Degree of freedom	Mean Sum of Squares				
		X6	**X7**	**X8**	**X9**	**X10**
Replication	**2**	0.15	0.11	0.32	0.72	27.86
Treatment	**15**	99.85	103.64	12.07	67.06	5206.44
Error	**30**	0.06	0.08	0.12	0.55	34.85

Source of variation	**Degree of freedom**	**Mean Sum of Squares**				
		X11	**X12**	**X13**	**X14**	**X15**
Replication	**2**	1.09	0.04	0.46	6.76	0.87
Treatment	**15**	28.20	5.58	1.61	7.88	1.88
Error	**30**	0.86	0.01	0.26	2.85	0.43

X1=Plant height (cm), X2= Number of primary branches per plant X3= Plant spread (cm), X4= Number of leaves per plant, X5= Leaf area (cm2), X6= Days taken to first bud initiation, X7= Days taken to first flowering, X8= Duration of flowering (days), X9= Number of flowers per plant, X10= Number of flowers per bed, X11= Stalk length of the flower (cm), X12= Flower diameter (cm), X13= Average weight of flower (g), X14= Vase life (days) and X15= Shelf life (days).

Appendix 3

Mean monthly meteorological data of VCSG Uttarakhand University of Horticulture and Forestry for the year 2016 (march to august)

Month	Maximum temperature(°c)	Minimum temperature (°c)	Rainfall (mm)
March	12.8	9.1	17.8
April	17.0	13.7	6.0
May	23.5	16.0	47.5
June	28.9	16.7	86.4
July	27.3	16.2	489.2
August	17.8	15.6	242.9

Abstract

Abstract

Name: Akash Rana
Year of Admission: 2015
Department: (F &LA)
Id Number: 15233
Degree: M.Sc. Horticulture
Major Field: Floriculture and Landscape Architecture
Minor Field: Soil Science

Title of Thesis: "Effect of Organic Manures and Biofertilizers on Vegetative and Floral Characters of China aster (*Callistephus chinensis* (L.) Nees.) cv. Kamini"

The present investigation was carried out at Floriculture and Landscaping Block, College of Horticulture, Veer Chandra Singh Garhwali, Uttarakhand University of Horticulture and Forestry, Bharsar, District Pauri Garhwal (Uttarakhand) from April to August 2016 to find out the effect of organic manures and biofertilizers on vegetative and floral characters of China aster cv. Kamini. Experiment includes sixteen treatments. Each treatment consists of nine plants which replicated thrice. Experimental design was Randomized Complete Block Design.

The results of investigation revealed that plants grown in plots applied with treatment containing FYM @ 28.8 ton/ ha + PSB @ (50ml /15L of water) + *Azotobacter* @ (30ml/15L of water) produced tallest plant height (76.73 ± 0.35 cm). Whereas maximum number of primary branches (13.63 ± 0.08), plant spread (21.63 ± 0.12 cm) and number of leaves per plant were (162.20 ± 0.20) recorded from the plants grown in plots applied with treatment consisting FYM @18 ton/ ha + Vermicompost @ 06 ton/ ha + PSB @ (50 ml /15L of water) + *Azotobacter* @ (30ml/15L of water). Flowering parameters viz., minimum days taken to bud initiation (58.43 ± 0.24) and flowering (74.43 ± 0.09), maximum duration of flowering (20.80 ± 0.05 days), number of flowers per plant (36.60 ± 0.25), number of flowers per bed (360.30 ± 5.62), vase life (9.73 ± 1.84 days), shelf life (4.73 ± 0.63 days) and maximum C:B (1:1.07) were recorded from the plants grown in plots treated with treatment consisting FYM @18 ton/ ha + Vermicompost @ 06 ton/ ha + PSB @ (50 ml /15L of water) + *Azotobacter* @ (30ml/15L of water).Whereas other flowering characters viz., stalk length (34.43 ± 0.20 cm), flower diameter (7.73 ± 0.08 cm) and average weight of flower (3.38 ± 0.23 g) were found maximum in pants grown in plots treated with treatment consisting Vermicompost @ 9.6ton/ ha + PSB@ (50 ml /15L of water) +*Azotobacter* @ (30ml/15L of water).

Thus the present investigation revealed that among all the treatments applied FYM @18 ton/ ha + Vermicompost @ 06 ton/ ha + PSB @ (50 ml /15L of water) + *Azotobacter* @ (30ml/15L of water) was found more effective in improving the vegetative and floral characters of China aster cv. Kamini.

Prof. B.P Nautiyal	Dr. Mamta Bohra	Mr. Akash Rana
Chairman	Advisor	Author

Abstract

सारांश

विद्यार्थी का नाम – आकाश राणा
उपाधि– स्नातकोत्तर औद्यानिकी (पु0 एंव भू–सौ0)
विभाग – पुष्पोत्पादन एवं भू–सौन्दर्यीकरण
सूक्ष्म विषय–मृदा विज्ञान

अभिज्ञान संख्या– 15233
प्रवेश का वर्ष–2015
मुख्य विषय– पुष्पोत्पादन

शोध का विषय – कार्बनिक खाद एवं जैव उर्वरक के स्त्रोतों का चाईना एस्टर की प्रजाति कामिनी के कायिकी एवं पुष्पों की विशेषताओं पर प्रभाव।

प्रस्तुत शोध कार्य कार्बनिक खाद एवं जैव उर्वरक के स्त्रोतों का चाईना एस्टर की प्रजाति कामिनी के कायिकी और पुष्पों की विशेषताओं पर प्रभाव जाँचने के लिए अप्रैल से अगस्त 2016 के दौरान औद्यानिकी महाविद्यालय, वीर चन्द्र सिंह गढ़वाली उत्तराखण्ड औद्यानिकी एवं वानिकी विश्वविद्यालय भरसार के पुष्पोत्पादन एवं भू–सौन्दर्यीकरण प्रखण्ड पर किया गया। यह शोध कार्य सोलह उपचारों में किया गया। प्रत्येक उपचार में नौ पौधें सम्मलित थे जो कि तीन पुनरावृत्तियों में रैन्डोमाइज्ड कम्पलीट ब्लाक डिजाईन मे लगाये गये थे।

जाँच के परिणामों से पता चला है कि पौधों की उच्चतम ऊँचाई (76.73 ± 0.35 सेमी.) गोबर की खाद @ 28.8 टन/हैक्टेयर + पी0एस0बी0 @ (50 मिली0/15ली0 पानी में) + अजोटोबैक्टर @ (50 मिली0/15ली0 पानी में) द्वारा उपचारित पौधों में पायी गयी। जबकि प्राथमिक शाखाओं की अधिकतम संख्या (13.63 ± 0.08), पौधों का फैलाव (21.63 ± 0.12 सेमी.), एवं प्रति पौधा पत्तियों की संख्या (162.20 ± 0.20) गोबर की खाद @ 18 टन/हैक्टेयर + केंचुए की खाद @ 06 टन/हैक्टेयर + पी0एस0बी0 @ (50 मिली0/15ली0 पानी में) + अजोटोबैक्टर @ (30 मिली0/15ली0 पानी में) द्वारा उपचारित पौधों में पायी गयी। इस शोध में पुष्पन (58.43 ± 0.24) तथा पुष्प खिलने के लिए (74.43 ± 0.09) न्यूनतम दिनों की संख्या, अधिकतम पुष्पन अवधि (20.80 ± 0.05), प्रति पौधा पुष्पों की संख्या (39.10 ± 0.25), प्रति इकाई पुष्पों की संख्या (360.30 ± 5.62), पात्र आयु (9.73 ± 1.84 दिन), शैल्फ लाइफ (4.73 ± 0.63 दिन) एव अधिक लाभ लागत अनुपात (1:1.07) गोबर की खाद @18 टन/हैक्टेयर + केंचुए की खाद @ टन/हैक्टेयर + पी0एस0बी0 @ (50मिली0/15ली0 पानी में) + अजोटोबैक्टर @ (30 मिली0/15ली0 पानी में) द्वारा उपचारित पौधों में पायी गयी। जबकि अन्य पुष्प मानक जैसे कि डंठल की लम्बाई (34.43 ± 0.20 सेमी.), पुष्प व्यास (7.73 ± 0.08 सेमी.) और औसत पुष्प वजन (3.38 ± 0.23 ग्राम) केंचुए की खाद @ 9.6 टन/हैक्टेयर + पी0एस0बी0 @ (50मिली0/15ली0 पानी में) + अजोटोबैक्टर @ (30मिली0/15ली0 पानी में) द्वारा उपचारित पौधों में पायी गयी।

अतः इस शोध के निष्कर्ष से यह प्राप्त किया गया है कि गोबर की खाद @18 टन/हैक्टेयर + केंचुए की खाद @ टन/हैक्टेयर + पी0एस0बी0 @ (50मिली0/15ली0 पानी में) + अजोटोबैक्टर @ (30 मिली0/15ली0 पानी में) का सम्मिश्रण चाइना एस्टर की प्रजाति कामिनी की व्यवसायिक खेती के लिए प्रयोग किया जा सकता है।

प्रो0 बी0पी0 नोटियाल	डॉ0 ममता बोहरा	आकाश राणा
चेयरमैन	सलाहकार	लेखक

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Vitae

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(Akash Rana)