“STUDIES ON THE EFFECT OF DIFFERENT COMBINATIONS OF MEDIA AND BIO FERTILIZERS ON GROWTH, FLOWERING AND CUT FLOWER YIELD OF GERBERA (*Gerbera jamesonii* L.) cv. NATASHA UNDER PROTECTED CONDITIONS”

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B.Sc. (Hons) Hort.

MASTER OF SCIENCE IN HORTICULTURE

(FLORICULTURE AND LANDSCAPE ARCHITECTURE)

DEPARTMENT OF FLORICULTURE AND LANDSCAPE ARCHITECTURE

COLLEGE OF HORTICULTURE, MOJERLA, WANAPARTHY– 509 382

SRI KONDA LAXMAN TELANGANA STATE HORTICULTURAL UNIVERSITY

JANUARY, 2019

“STUDIES ON THE EFFECT OF DIFFERENT COMBINATIONS OF MEDIA AND BIO FERTILIZERS ON GROWTH, FLOWERING AND CUT FLOWER YIELD OF GERBERA (*Gerbera jamesonii* L.) cv. NATASHA UNDER PROTECTED CONDITIONS”

By

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B.Sc. (Hons.) Horticulture

THESIS SUBMITTED TO SRI KONDA LAXMAN TELANGANA STATE HORTICULTURAL UNIVERSITY
IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE AWARD OF THE DEGREE OF

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CERTIFICATE

Ms. NIMMALA SWARUPA has satisfactorily prosecuted the course of research and that the thesis entitled **"STUDIES ON THE EFFECT OF DIFFERENT COMBINATIONS OF MEDIA AND BIO FERTILIZERS ON GROWTH, FLOWERING AND CUT FLOWER YIELD OF GERBERA (*Gerbera jamesonii* L.) cv. NATASHA UNDER PROTECTED CONDITIONS"** submitted, is the result of original research work and is of sufficiently high standard to warrant its presentation to the examination.

I certify that neither the thesis nor its part there of has been previously submitted by her for a degree of any University.

Date : **(Dr. D. LAKSHMI NARAYANA)**

Place: Mojerla **Chairman**

CERTIFICATE

This is to certify that the thesis entitled **"STUDIES ON THE EFFECT OF DIFFERENT COMBINATIONS OF MEDIA AND BIO FERTILIZERS ON GROWTH, FLOWERING AND CUT FLOWER YIELD OF GERBERA (*Gerbera jamesonii* L.) cv. NATASHA UNDER PROTECTED CONDITIONS"** submitted in partial fulfilment of the requirements for the degree of Master of Science in Horticulture (Floriculture and Landscape Architecture) of Sri Konda Laxman Telangana State Horticultural University, Rajendranagar, is a record of the bonafide research work carried out by **Ms. NIMMALA SWARUPA** under our guidance and supervision.

No part of the thesis has been submitted by the student for any other degree or diploma. The published part and all assistance received during the course of the investigations have been duly acknowledged by the author of the thesis.

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LIST OF SYMBOLS AND ABBREVIATIONS

et al.	:	(*et albeit*) and elsewhere
etc.	:	and so on; and other people / things
i.e.	:	(*Id est.*) that is
viz.,	:	Namely
@	:	at the rate of
Fig.	:	Figure
cm	:	Centimeter
cm^2	:	Square centimeter
t	:	Tonne
t ha^{-1}	:	Tonnes per hectare
Wt.	:	Weight
g	:	Gram
kg	:	Kilogram
kg/ ha	:	Kilogram per hectare
g/l	:	Gram per liter
Lph	:	Liters per hour
v/v	:	Volume per volume
ha	:	Hectare
/	:	Per
%	:	Per cent
<	:	Less than
cv.	:	Cultivar
C. D	:	Critical difference
SE (m) ±	:	Standard error of mean
VAM	:	Vesicular Arbuscular Mycorrhiza

PSB	:	Phosphate Solubilizing Bacteria
N, P, K	:	Nitrogen, Phosphorous, Potassium
Mn	:	Manganese
FYM	:	Farm yard manure
NC	:	Neam cake
RDF	:	Recommended doses of fertilizer
COC	:	Copper oxy chloride
DAP	:	Days after planting
Chl. (a)	:	Chlorophyll (a)
Chl. (a + b)	:	Chlorophyll (a + b)
E-W	:	East – West
N-S	:	North-South
PG	:	Post graduation

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(Ms. NIMMALA SWARUPA)

DECLARATION

I, **Ms. NIMMALA SWARUPA** hereby declare that the thesis entitled **"STUDIES ON THE EFFECT OF DIFFERENT COMBINATIONS OF MEDIA AND BIO FERTILIZERS ON GROWTH, FLOWERING AND CUT FLOWER YIELD OF GERBERA (*Gerbera jamesonii* L.) cv. NATASHA UNDER PROTECTED CONDITIONS"** submitted to Sri Konda Laxman Telangana State Horticultural University**,** Rajendranagar, for the Degree of Master of Science in Horticulture (**FLORICULTURE AND LANDSCAPE ARCHITECTURE**) is the result of original research work done by me. I declare that no material contained in the thesis has been published earlier in any manner.

Place: Mojerla

Date :

Name : NIMMALA SWARUPA

I.D.No: MHM/16-08

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ABSTRACT

The present investigation entitled “Studies on the effect of different combinations of media and bio fertilizers on growth, flowering and cut flower yield of gerbera (*gerbera jamsonii* L.) cv. Natasha under protected conditions” was carried out during the year 2017 – 18 at College of Horticulture, Mojerla.

The results revealed that, among the different combinations of media, M_3 combination of media (Red soil + Coco peat + Vermicompost (1:1:1)) registered maximum plant height at first flower appearance (21.15 cm) and flower harvesting stage (23.67 cm), wider plant spread at first flower appearance East - West direction (49.70 cm) and North - South direction (52.40 cm), higher plant spread at flower harvesting stage East - West direction (51.41 cm) and North – South direction (55.56 cm), more number of leaves per plant (35.37 cm) and broader leaf area at final harvest (116.28 cm^2) over combination of medias.

The B_2 bio fertilizer, Vesicular Arbuscular mycorrhiza (VAM) recorded significantly maximum plant height at first flower appearance (16.76 cm) and flower harvesting stage (19.15 cm), wider plant spread at first flower appearance East - West direction (41.13 cm) and North - South direction (43.87 cm), higher plant spread at flower harvesting stage East -West direction (42.88 cm) and

North – South direction (46.87 cm), more number of leaves per plant (28.28 cm) and broader leaf area at final harvest (78.05 cm^2) than B_1 bio fertilizer, Phosphate Solubilizing Bacteria (PSB).

The interaction between different combinations media and bio fertilizers had significant influence on plant height, plant spread, number of leaves per plant and leaf area at final harvest. M_3 combination media (Red soil + Coco peat + Vermicompost (1:1:1)) and B_2 bio fertilizer, Vesicular Arbuscular mycorrhiza (VAM) registered significantly maximum plant height at first flower appearance (22.27 cm) and at flower harvesting stage (24.97 cm), wider plant spread at first flower appearance East - West direction (51.92 cm) and North - South direction (54.94 cm), higher plant spread at flower harvesting stage East - West direction (53.98 cm) and North – South direction (57.94 cm) more number of leaves per plant (37.29 cm) and broader leaf area at final harvest (120.45 cm^2).

Among the different combinations media, M_3 combination of media (Red soil + Coco peat + Vermicompost (1:1:1)) recorded less number of days taken to first flower bud appearance (39.56 days) and first flower opening (54.11 days), maximum number of flowers per plant (6.59) and highest diameter of the flower, flower stalk and disc flower (11.42, 0.72 and 5.46 cm respectively). The same combination of media registered significantly longer flower stalk (58.42 cm), more number of ray florets per flower (62.56), maximum fresh weight and dry weight of the flower (30.42 and 10.50 g respectively)

The B_2 bio fertilizer, Vesicular Arbuscular mycorrhiza (VAM) recorded significantly best values in terms of flower parameters viz., least number of days taken to first flower bud appearance (50.53 days) and first flower opening (68.54 days), more number of flowers per plant (5.52) and highest diameter of the flower (9.38 cm), flower stalk (0.62 mm) and disc flower (4.11 cm), longer flower stalk (54.90 cm), more number of ray florets per flower (53.87), maximum fresh weight (26.90 g) and dry weight of the flower (8.44 g) than B_1 bio fertilizer Phosphate Solubilizing Bacteria (PSB).

Significant interaction effect was observed between different combinations of media and bio fertilizers on flower parameters. M_3 combination of media (Red soil + Coco peat + Vermicompost (1:1:1)) with B_2 bio fertilizer,

Vesicular Arbuscular mycorrhiza (VAM) registered significantly less number of days taken to first flower bud appearance (37.42 days) and first flower opening (51.52 days), more number of flowers per plant (6.70) and maximum diameter of the flower (11.82 cm), flower stalk (0.74 mm) and disc flower (5.58 cm), longer flower stalk (59.77 cm), more number of ray florets per flower (64.94), maximum fresh weight and dry weight of the flower (31.77 and 10.82 g respectively).

Among the different combination media, M_3 combination of media (Red soil + Coco peat + Vermicompost (1:1:1)) recorded more number of roots per plant (58.37), maximum length of the primary root (51.37 cm), higher fresh weight of the plant (197.61 g) and more root to shoot ratio (0.93 %).

The data on longevity of the flower on plant indicated that, among the different combinations media, M_3 combination media (Red soil + Coco peat + Vermicompost (1:1:1)) recorded significantly maximum longevity of the flower on plant (18.52 days). Between the bio fertilizers, B_2 bio fertilizer, Vesicular Arbuscular mycorrhiza (VAM) recorded the highest longevity of the flower on plant (16.63 days).

Chapter I

INTRODUCTION

Gerbera is one of the herbaceous dwarf perennial plant, grows in clump with solitary flower heads on long slender stalks. It belongs to the family asteraceae and is native to South Africa. It is popularly known as barberton, Transvaal and African (daisy). Gerbera is a popular cut flower grown throughout the world and its flowers are available in a wide range of colors including yellow, red, orange, cream, white, pink, brick red, scarlet, salmon peach, maroon and various other intermediate shades.

Gerbera is an elegant flower of immense value as they are very attractive in garden with their star like flowers and borns terminally on slender long stems. It is very much suitable for making bouquets and flower arrangements since a leafless feature. Moreover it forms a effective colourful borders or beds. Gerbera is an ideal flower widely used as a cut flower besides for beds, pots, borders and rock gardens.

Gerbera is grown commercially in the Telangana state under naturally ventilated polyhouses. The total area under polyhouse cultivation in Telangana is about 1500 acres and more than 90 per cent of area is under Gerbera cultivation.

Different factors affect the growth and development of gerbera plants. Among them, potting media is one of the most important factor which plays a key role in quality production of the flowers. A potting media must serves four functions viz., providing of moisture, supply of nutrients, permits gas exchange to the roots and support to the plants.

A potting media's physical and chemical properties determines the nutritional status to sustain better plant growth. Composition of media supports the production of good quality flowers with more number and greater sizes. Soil alone as a growing media does not fulfill all requirements for better growth and development of any crop. Gerbera grows well in substrates such as coco peat, sawdust, vermicompost, FYM, rice husk *etc*. Soil is not considered as a good option as growing media. The use of coco peat as a potting medium is a common

practice for more than a decade. Cocopeat was gaining acceptance as a growing medium, because of its excellent aeration, durability, lightness and good water holding characteristics. The presence of organic compounds in coco peat can stimulate root growth and offer some natural resistance to plant diseases.

Vermicompost is an excellent soil conditioning agent and it's incorporation to soil improves texture, structure, permeability, water holding capacity and proliferation of micro-organisms which enhanced better plant growth, root growth and flower yield. Vermicompost contains 1.9, 2.0 and 0.8 per cent of N, P, K respectively. It also act as chelating agent and regulates the availability of metabolic micronutrients like iron and zinc to the plants and increases the plant growth and yield by providing nutrients in the available form.

Bio fertilizers are a mixture of microorganisms viz., bacteria, fungi and algae which are capable in mobilizing nutrient elements through biological process. These can be supplement to chemical fertilizers as they contribute plant nutrients through nitrogen fixation, phosphate solubilisation, maintenance of soil reaction, improvement of soil fertility and are capable of decomposing of organic matter. In commercial scale bio fertilizers are available in the form of rhizobium, azatobacter, azosphirillum, azolla and VAM.

Vesicular Arbuscular Mycorrhiza (VAM) is a fungi, can form a symbiosis with host plant. It stimulates growth and development of plants, increases absorption of plant immobile elements, reduces disease incidence. The role of Phosphorus Solubilizing Bacteria (PSB) as a bio fertilizer is unique in making the fixed soil-phosphorous unavailable form to available form. PSB produces plant growth regulating substances which promote root growth (Greaves and webley, 1969). The inoculation of PSB caused a further improvement in soil phosphorous, due to the solubilization of fixed or added phosphorous (Gaur, 1992). However, a meager work was done in Telangana to exploit the potential benefits of different combinations of media and bio fertilizers on Gerbera.

Keeping these points in view the present work was designed to study the effect of different combinations of media and bio fertilizers on growth, flowering and cut flower yield of gerbera (*Gerbera jamesonii L.*) under protected conditions.

Objectives:

1. To study the effect of different combinations of media on growth, flowering and cut flower yield of gerbera cv. Natasha under protected conditions.

2. To study the influence of bio fertilizers on growth, flowering and cut flower yield of gerbera cv. Natasha under protected conditions.

3. To study the effect of media combinations and bio fertilizers on growth, flowering and cut flower yield of gerbera cv. Natasha under protected conditions.

Chapter II

REVIEW OF LITERATURE

An endeavor is made to review the earlier work on different combinations of media and bio fertilizers on growth, flowering and cut flower yield of gerbera as well as other flower crops grown under protected conditions is reviewed in this chapter under the following heads.

1. Effect of different combinations of media on growth, flowering and cut flower yield.
2. Influence of bio fertilizers on growth, flowering and cut flower yield.

2.1 Effect of different combinations of media on growth, flowering and cut flower yield

2.1.1 Effect of cocopeat on growth, flowering and cut flower yield

Rexilius (1990) suggested that cocopeat was good as a media substrate because of its better water holding capacity and nutritional value. Chung *et al.* (1999) investigated the effect of 16 substrates on seedling growth of Gerbera cultivar 'Beauty'. They found that the substrate composed of cocopeat, peat, perlite and vermiculite (30:20:30:20 %) was most effective for seedling growth among the different medias tested.

Allera *et al.* (2000) studied the flower production of rose with different media combinations and reported that coconut fibre enriched media induced higher yield and best quality flowers with respect to stem length and stem weight. According to Noguera *et al.* (2000) cocopeat was best growing medium because of its high porosity (95%), nutritive value and slightly acidic nature.

Barreto maria shaila (2000) conducted an experiment on effect of different substrate media on growth, flower quality and vaselife of gerbera under polyhouse conditions and observed that vegetative growth was best in cocopeat alone substrate and flower quality was found to be superior in pots having the combination of peat and vermicompost (1:1).They also found that the highest

flower yield with remarkable vase life was obtained in cocopeat combined with either compost or vermicompost (1:1).

Jawaharlal *et al.* (2001) reported that when the anthurium plants grown in cocopeat as well as in combination of leaf mould registered more number of branches per plant and also took minimum number of days taken to produce first flower.

Maloupa *et al.* (2001) found that rose cultivar 'Bianca' showed better yield when grown in mixture of perlite : cocopeat, while cultivar 'First Red' gave better quality when grown in cocopeat alone medias.

Dutt *et al.* (2002) cited that when chrysanthemum plants grown in cocopeat + soilrite resulted in maximum number of leaves, shoot girth, number of shoots, final shoot length and number of flower as compared with other potting medias.

Aswath and Pillai (2004) conducted an experiment on effect of growing media containing cocopeat and normal media (sand + soil + FYM, 2:1:1) in different ratios on gerbera. They observed that medium containing 100 per cent cocopeat (v/v), resulted in high stalk length, stalk thickness, flower diameter and low dry matter production.

Bhatia *et al.* (2004) investigated the effect of growing media and fertilizers on growth and flowering of carnation cv. Sunrise under protected condition. They found that media enriched with soil + FYM + cocopeat (2:1:1) registered best values in all growth parameters viz., plant height, stem length, and number of shoots per plant.

Gupta *et al.* (2004) observed that when cocopeat used in combination with sawdust and sand (1:1:1, v/v), increased flower diameter, flower stalk length, flower weight and number of flowers per plant in gerbera.

Rani *et al.* (2005) tested four cultivars of lilium viz. *Brunello, Novacento, Romano* and *Elite* in two media i.e. natural soil + cocopeat and natural soil alone and reported that among the cultivars Elite was found to produce more number of leaves, longest bud and bulb size, followed by cv. Novacento when grown in mixture of soil + cocopeat.

Gupta *et al.* (2006) cited that in alstroemeria, the growing media of cocopeat + peat (1:1) produced maximum number of storage roots, fibrous roots and the heaviest rhizome clusters.

Jadwiga Treder (2008) studied the effect of cocopeat and fertilization on the growth and flowering of oriental lily 'Star gazer'. He opined that when lilies grown in cocopeat, flowered earlier and had better quality expressed as higher fresh and dry weight of flowers and leaves, longer flower buds, better root system and lower bulb depletion between planting and flowering as compared to those grown in the control substrate. Moreover the number of bulb roots and total root length were 34 per cent and 118 per cent higher in cocopeat than in control medium respectively.

Urooj-ul-nissa bergi (2011) carried out an experiment on effect of various substrates on growth, flowering and tuber Production of dahlia (*Dahlia variabilis* Desf.) cv. 'Pink Attraction' and reported that medium consisted with cocopeat + FYM (1:1) recorded maximum plant height (54.72 cm), number of leaves (102.93), primary branches (8.30), stem diameter (10.68 mm), plant spread (3364.45 cm^2), earliness in flowering (82.0 days), maximum flower diameter (12.6 cm), length of flower stalk (9.5 cm), number of flowers per plant (18.5), fresh weight of flower (20.8 g), duration of flowering (13.5 days) and flower yield (253.8 g/plant).

Padhiyar *et al.* (2017) investigated the influence of different potting media on growth and flowering of pot chrysanthemum var. Ajina Purple. They found that potting media of cocopeat + vermicompost + bio compost (2:1:1 v/v) exhibited maximum plant height (30.87 cm), number of branches per plant

(16.40), fresh weight of plant (342.80 g), dry weight of plant (170.87 g), flower diameter (37.42 mm), duration of flowering (126.33 days) and number of flowers (66.61).

Chavada *et al*. (2017) studied the effect of potting media on growth, flower yield and quality of rose (*Rosa hybrida* L.) cv. Top Secret under protected conditions. They reported that growth parameters viz., plant height (60.46 cm), leaf area (36.98 cm^2), number of leaves per flowering stalk (20.23) and stalk length of cut flower (36.23 cm) were recorded significantly maximum under potting media supplied with soil + cocopeat + leaf mould (1:1:1). They also observed that flowering parameters viz., number of days taken to bud initiation (13.23 days) and bud opening (12.72 days) were also recorded significantly minimum with the potting media proportion of soil + cocopeat + leaf mould treatment. Similarly, maximum flower diameter (8.23 cm), length of petal (3.76 cm), width of petal (3.85 cm) and number of flowers per plant (19.48) were recorded in soil + cocopeat and leaf mould treatment. The quality parameters viz., vase life of flower (8.18 days), fresh weight of cut flower (11.69 g) and dry weight of cut flower (3.27 g) were also recorded maximum in soil + cocopeat and leaf mould treatment.

2.1.2 Effect of vermicompost on growth, flowering and cut flower yield

Kale *et al.* (1987) in salvia and ornamental plants reported that increased leaf area index and flowering was observed due to vermicompost application.

Kulkarni *et al.* (1996) conducted an experiment on effect of vermicompost and in situ vermicomposting on growth and yield of china aster cv. Ostrich plume mixed and revealed that 75 per cent recommended dose of fertilizers and vermicompost at 2.5 to 5 tonnes per hectare gave higher values with respect to number of leaves per plant and flower yield.

Sreenivas and Narayanagowda (1999) found that application of vermicompost and FYM along with recommended NPK increased plant height, number of leaves, number of branches per plant and flower yield in china aster.

Studies conducted by Gangadharan and Gopinath (2000) on effect of organic and inorganic fertilizers on growth, flowering and quality of gladiolus cv. White prosperity and reported that significance increase in the plant height (72.88 cm), number of leaves (5.13), leaf area (1166.30 cm^2), leaf area index (2.90), fresh weight of whole plant (110.80 g), number of days taken to emergence of spike (73.42 days), length of spike (99.09 cm), width of spike (0.99 cm), length of rachis (48.28 cm), number of florets per spike (16.26), diameter of corm (5.91 cm), fresh weight of corm (55.60 g) and fresh weight of cormels (2.35 g) were obtained when the plot was treated with the combination of vermicompost @ 10 t per hectare + 80 per cent recommended NPK dosage.

Mashaldi (2000) investigated the effect of organic and inorganic fertilizers on growth, yield and postharvest life of marigold (*Tagetus erecta* L.) cv. Double orange and found that when the plants applied with vermicompost (15 tonnes per hectare) + 100 per cent recommended NPK produced maximum number of flowers per plant with greater flower diameter and flower yield than plants without vermicompost and fertilizer application.

Kusuma (2001) reported that golden rod plants supplied with vermicompost (10 tonnes per hectare) and 100 per cent recommended NPK (100:50:50 kg/ha) produced maximum plant height, number of leaves and flower yield.

Ajitkumar (2002) in marigold cited that maximum plant height, number of branches per plant, number of leaves per plant, flower diameter, number of flowers per plant and flower yield per hectare were obtained by the application of vermicompost 10 t per hectare + recommended NPK.

Gayathri (2003) observed that when limonium supplied with 75 per cent NP and 100 per cent K, combined with vermicompost, Azotobacter and PSB resulted higher plant spread.

Gayithri *et al.* (2004) in statice found that the application of 75 per cent recommended dose of N and P and 100 per cent K + Vermicompost + Azotobacter and PSB recorded significantly maximum values in respect of spike emergence, initiation of flowers, flower harvesting, spike length and number of branches per spike.

Haripriya *et al.* (2004) revealed that application of 100 per cent RDF + 200 g vermicompost per plant, resulted in maximum flower yield, number of flowers, fresh weight of flower and number of petals per flower in rose.

Munikrishnappa *et al.* (2004) cited that application of 50 per cent of recommended dose of fertilizer (RDF) along with vermicompost @ 5.0 t per hectare had improved the flower characters viz., length of the spike, length of the rachis, diameter of the florets, number of florets per spike and flower yield in tuberose.

Chauhan *et al* (2005) reported that number of flower buds per plant, individual flower weight and flower yield per square meter were maximum with the application of vermicompost at 1000 grams per square meter in marigold.

Godse *et al.* (2006) studied the effect of organic manures and bio fertilizers with reduced doses of inorganic fertilizers on growth, yield and quality of gladiolus. They reported that plants received with the vermicompost @ 8 t per hectare + Azotobacter and PSB each of 25 kg per hectare each + 80 per cent RDF significantly increased plant height and number of leaves as compared to RDF and other treatments.

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Chaitra and Patil (2007) observed that significantly increased plant height, number of leaves per plant, number of branches per plant, total dry matter

production and flower yield in China aster cv. Kamini were obtained with the application of vermicompost @ 2.5 t per hectare with 50 per cent RDF.

Rajesh Bhalla *et al*. (2007) reported that maximum plant height (73.20 cm) was recorded in carnation cultivar Raggio - de – Sole, when grown in media enriched with sand + soil + vermicompost (1:1:1) + inorganic fertilizers + bio fertilizers.

Warade *et al.* (2007) found that the growth of dahlia in respect of height, number of leaves per plant, spread of plant, earliness of flowering and flower yield were superior when received the vermicompost @ 500 g along with PSB 25 g per plot.

Gharat *et al*. (2008) cited that when china aster plants treated with recommended dose of fertilizers + vermicompost produced higher flower yield (75.30 q/ha).

Sharma *et al.* (2008) conducted an experiment on response of gladiolus to integrated plant nutrient management. They reported that minimum number of days taken to sprouting, maximum plant height and number of leaves per plant were recorded when plants received recommended dose of NPK along with vermicompost and dual inoculation of Azotobacter and PSB.

Patel *et al*. (2011) observed that application of 160 kg N per ha and 10 t per hectare vermicompost, minimized number of days taken to 50 per cent flowering (64.25 days), maximum number of flowers (58.38), flower diameter (7.60 cm), flower yield (8793.60 kg/ha) and keeping quality (9.28 days) of african marigold cv. Sierra yellow.

Shadanpour *et al.* (2011) reported that in marigold the largest stem diameter, flower size, shoot fresh and dry weight were obtained when plants treated with mixture of 60 per cent v/v vermicompost with 30 per cent v/v sand plus 10 per cent v/v soil.

Kumar *et al.* (2013) studied the effect of integrated nutrient management on growth, flowering and yield parameters of marigold (*Tagetes erecta* L.) cv. Pusa Basanti Gainda. They revealed that the treatment T_7 (80% R.D. of NPK (96 kg N, 80 kg P and 80 kg K/ha) + vermicompost (128 q/ha) + *Azotobacter* (5.28 kg/ha)) showed better response to flowering and yield attributes.

Moghadam and Shoor (2013) investigated the effect of vermicompost and two bio fertilizer applications on growth, yield and quality of petunia *(Petunia hybrid)* and reported that when treatment received the Azospirillum + Phosphate Solubilizing Bacterium + Vermicompost + NPK (25% of recommended dose) recorded the highest plant height, number of branches, plant spread, leaf area index and dry matter accumulation.

Rahbari *et al*. (2013) evaluated the effect of vermicompost rates (10%, 20%, 30% and 40%) on growth of pot marigold transplants. They found that maximum shoot fresh weight and dry weight, root fresh weight and dry weight were recorded on 40 per cent vermicompost rate.

Thumar *et al.* (2013) noticed that in marigold 70 per cent RDF + 2 t per hectare vermicompost + Azotobacter + Azospirillium + PSB significantly gave higher yield parameters *viz.*, flower yield per plant and hectare.

Ali Salehi Sardoei *et al.* (2014)) conducted an experiment on effect of vermicompost on growth and flowering of African Marigold (*Tagetes erecta*). They reported that vermicompost had significant ($P<0.05$) positive effect on leaf growth, flower number and shoot fresh and dry weights as compared to both control and amended media. Moreover the highest content of Chl. (a), total Chl. a+b, Carotenoids and total pigments were noticed in 60 per cent vermicompost application.

Chauhan *et al.* (2014) studied the effect of different media on growth, flowering and cut flower yield of gerbera (*Gerbera jamesonii* Bolus) cv.

Alcochete under protected conditions. They reported that the media amended with normal soil + rice husk + coco peat + castor cake + vermicompost (1:1:1:1:1) performed better for maximum plant height and plant spread at first flower appearance and pick flowering stage as well as more number of leaves and suckers per plant.

Renuka Gupta *et al* (2014) conducted an experiment on influence of vermicompost application in potting media on growth and flowering of marigold crop and observed that vermicompost application had significant positive effects on growth and flowering of seedlings including plant biomass, plant height, number of buds and flowers.

Premkumar *et al* (2016) investigated the response of chrysanthemum cultivar Dolly white to different sources and combinations of organic manure under the mid hill regions of Uttarakhand. They found that the treatment supplied with vermicompost (2 t/ ha) and goat manure (25 t/ ha) significantly recorded maximum vegetative growth, flowering and number of flowers per plant.

2.2 Influence of bio fertilizers on growth, flowering and cut flower yield

2.2.1 Effect of Phosphate solubilizing bacteria (PSB) on growth, flowering and cut flower yield

Gupta (1997) in marigold observed that maximum plant height, number of leaves per plant, stem diameter and leaf area were recorded when the treatment applied with Azotobacter and PSB through soil application.

Studies conducted by Hemavathi (1997) on effect of organic manures and bio fertilizers on growth and productivity of chrysanthemum cv. Local yellow and reported that higher flower yield per plant was recorded in the treatment of PSB + 75 per cent recommended NPK.

Chandrikapure (1998) cited that in marigold maximum plant height, stem diameter, number of leaves and branches were recorded in the treatment supplied with bioinoculants like Azotobacter and PSB with 100 per cent N.

Deshmukh (1998) found that all growth characters of gaillardia viz., plant height, stem diameter, number of leaves, branches and leaf area were maximum in treatment inoculated with Azotobacter and PSB in combination with 75 per cent and 100 per cent recommended dose of nitrogen.

Kaloti (1998) evaluated that in China aster maximum plant height, number of branches, number of leaves, main stem diameter and leaf area per plant were recorded in the treatment of Azotobacter + PSB with 75 and 100 per cent recommended dose of nitrogen.

Chandrikapure *et al.* (1999) found that local variety of african marigold produced significantly greater plant height in the treatment of 100 per cent N + Azotobacter + Phosphate Solubilizing Bacteria and higher flower yield per ha in the treatment of Azotobacter + PSB + 75 per cent N.

Gupta *et al*. (1999) studied the effect of graded levels of nitrogen and bio inoculants on growth and yield of marigold (*Tagetes erecta*) and reported that growth and flower yields were maximum in the treatment of Azotobacter + Phosphorus Solubilizing Bacteria (applied to soil or seedling) in combination with 75 or 100 per cent nitrogen application.

Studies conducted by Swami Nathan *et al*. (1999) in tuberose cv. Mexican single and reported that combined application of NPK with *Azospirillum* and Phosphobacteria resulted in higher spike yield, spike length, number of florets per spike and best floret quality.

Pandhre (2003) cited that in tuberose, maximum number of florets per spike, length of spike, size of florets were recorded by the application of Azotobacter + PSB+ 75 per cent NP + 100 per cent recommended dose of K/ha.

Prabhat Kumar *et al.* (2003) stated that application of bio fertilizers like PSB + VAM proved to be most effective in increasing the plant height, number of leaves, leaf area and number of branches in china aster.

Rathod *et al.* (2003) reported that maximum flower diameter, early flowering, highest number of flowers per plant and flowers yield per hectare were recorded in gaillardia with the application of 100 per cent recommended dose of NPK along with Azotobacter in combination with PSB.

Gayathri *et al.* (2004) observed that in statice, minimum number of days taken to spike emergence, initiation of flowers, flower harvesting and maximum spike length and number of branches per spike were recorded in the treatment of 75 per cent recommended dose of N and P + 100 per cent K + Vermicompost + Azotobacter + PSB.

Gupta *et al.* (2004) in carnation, reported that application of bio fertilizers like VAM, Azospirillum and PSB registered higher plant height, minimum number of days taken to first flowering, maximum flower size and best vase life.

Padmadevi *et al.* (2004) investigated the effect of bio fertilizers on floral characters of anthurium and found that the treatment supplied with Azospirillum, Phosphobacteria and Vesicular Arbuscular Mycorrhiza (VAM), along with full dose of inorganic nutrients recorded the highest stalk length.

Dubey and Misra (2006) observed that the dual inoculation of gladiolus corm with *Azotobacter* + PSB was found best among all the bio fertilizer treatments for early corm sprouting, more number of leaves per plant, maximum leaf area and higher plant height.

Godse *et al.* (2006) studied the effect of organic manures and bio ferfilizers with reduced doses of inorganic fertilizers on growth, yield and quality of gladiolus. They revealed that plants applied with vermicompost 8 t per hectare

+ Azotobacter and PSB @ 25 kg per hectare each + 80 per cent RDF significantly recorded maximum values in terms of growth, yield and quality attributes viz., plant height, number of leaves, number of spikes per hectare, length of spike and number of florets per spike.

Kukde *et al.* (2006) conducted an experiment on effect of organic manures and bio fertilizers on growth, flowering and yield of tuberose cv. Single and observed that when tuberose bulb treated with Azotobacter and PSB at 2.5 g per kg bulb gave maximum vegetative growth, early opening of first pair of florets, and higher flower yield

Mogal *et al.* (2006) carried out an experiment on effect of manures and bio fertilizers under reduced doses of nitrogen on growth, yield and quality of China aster. They reported that flower yield and quality was most superior in the plants supplied with vermicompost, Azotobacter, PSB and 100 per cent N.

Chaudhary (2007) evaluated the effect of nitrogen, phosphorus and bio fertilizers on plant growth and bulb production in tuberose. He opined that application of bio fertilizers in combination with N at the rate of 100 Kg per hectare and P at the rate of 50 Kg per hectare proved to be equally effective to N at the rate of 200 Kg per hectare and P at the rate of 100 Kg per hectare in increasing the plant height, number of leaves per plant and number of bulb per plant.

Chaitra and Patil (2007) in china aster cv. Kamini observed that significant increase in plant height, number of leaves, number of branches, total dry matter production and flower yield were obtained with the application of PSB and 50 per cent RDF.

Deshmukh *et al.* (2008) studied the effect of bio inoculants with graded doses of NPK on growth, yield, flower quality and production in gaillardia. They reported that significantly maximum vegetative growth parameters viz., plant height, plant spread and diameter of main stem were recorded in the treatment of

75 per cent NPK + seedling inoculation with *Azotobacter* + PSB (500 g each per 5 litre of water).

Sharma *et al.* (2008) stated that minimum number of days taken to sprouting, maximum spike length and number of florets per spike, quality corms and cormels were obtained when gladiolus plants were received recommended dose of NPK along with vermicompost and dual inoculation of Azotobacter and PSB.

Singh *et al.* (2008) investigated the effect of bio-fertilizers and graded doses of nitrogen on growth and flower yield of calendula (*Calendula officinalis* L.) and found that application of Azotobacter + Phosphate Solubilizing Bacteria (PSB) + 75 per cent N per hectare was found better with respect to plant growth, advanced flowering and prolonged duration of flowering.

Kumar *et al*. (2009) carried out a study on effect of integrated nutrient management on growth, flowering behaviour and yield of marigold (*Tagetes erecta* L.). They reported that combined application of *Azotobacter* and PSB with FYM and 50 per cent recommended dose of nitrogen and phosphorus significantly improved growth, flowering behavior and yield.

Sharma *et al.* (2009) studied the effect of nutrient management on growth, flowering and seed production of China aster under protected conditions. They found that the integrated use of the recommended doses of NPK with vermicompost and triple inoculation with *Azotobacter* + PSB + VAM gave maximum growth, yield, quality and seed yield.

Mittal *et al*. (2010) conducted an experiment on effect of integrated nutrient management on growth and yield of African marigold (*Tagetes erecta* L.) cv. 'Local' under middle gujarat agro-climatic conditions. They observed that application of 70 per cent RDF + 3 t/ha vermicompost + *Azotobacter* + *Azospirillum* + PSB produced significantly maximum plant height, number of branches per plant, plant spread in N-S and E-W directions.

Pandey *et al.* (2010) reported that application of 75 per cent recommended dose of fertilizer and vermicompost coupled with dual inoculation of Azotobacter and VAM produced significantly tall plants, higher number of lateral shoots, greater plant spread, early bud formation and flowering.

Kumar *et al.* (2012) in tuberose observed that combined application of PSB inoculation and higher doses of boron (PSB @ 200 g/l + Boron @ 0.6%) recorded better values in terms of flower and yield attributes.

Hadwani *et al.* (2013) cited that application of FYM @ 30 tons per hectare + PSB @ 2 gram per square meter + Azotobacter @ 2 gram per square meter recorded maximum spike length, number of florets per spike, number of spike per plant and longest vase life in the treatment of 50 per cent RDF + NC @ 1 tonn per hectare + PSB @ 1g/m^2 + Azotobacter @ 1 g/m^2 in tuberose.

Moghadam and Shoor (2013) studied the effect of vermicompost and two bio-fertilizer applications on growth, yield and quality of petunia *(Petunia hybrid).*They reported that treatment supplied with Azospirillum + Phosphate solubilizing bacterium + Vermicompost + NPK (25 per cent of recommended dose) recorded maximum plant height, number of branches, plant spread, leaf area index and dry matter accumulation.

Thumar *et al.* (2013) noticed that 70 per cent RDF + 2 t per hectare vermicompost + Azotobacter + Azospirillium + PSB significantly gave higher yield *viz.*, flower yield per plant and hectare in marigold.

2.2.2 Effect of VAM on growth, flowering and cut flower yield

Johnson *et al.* (1982) studied the effect of Vesicular Arbuscular Mycorrhizal association on chrysanthemum and reported that there was a significant increase in the plant height by the VAM association.

Bagyaraj and Powell (1985) found that VAM inoculation and organic fertilizer application increased the plant height in marigold. Davies (1986) observed that *Rosa multiflora* inoculated with VAM fungi gave better plant height than uninoculated plants.

Comprubi *et al.* (1987) reported that chrysanthemum inoculated with *Glomus* spp. showed 7-10 days early flowering. Balasubramaniam (1989) cited that when french marigold seedlings inoculated with VAM increased foliar P levels.

Wen (1991) conducted an experiment on effect of temperature and *Glomus* spp. on growth and cut flower quality of micorpropagated *Gerbera jamesonii* and reported that gerbera colonized by *G. etunicatus*, flowered 16 days earlier than uninoculated plant.

Wang *et al.* (1993) concluded that VAM inoculated gerbera plants produced larger, longer and more flowers than noninoculated gerbera. Bonita *et al.* (1994) observed that inoculation of gerbera and zinnia plants with *G. intraradix* significantly increased the stalk length.

Naik *et al.* (1995) investigated the field response of China aster to the inoculation of VAM fungi at different phosphorus levels and found that 75 per cent of the recommended P along with *Glomus* spp. showed higher plant height.

Amal Aboul Nasir (1996) carried out an experiment on effect of VAM on *Tagetes erecta* and *Zinnia elegans* and observed that better plant height was noticed when both of them were inoculated with *Glomus* spp. Justin Mohan (1998) revealed that inoculation of *Azospirillum* alone or in combination with VAM fungi resulted in increased flower yield in marigold.

Rajadurai *et al*. (2000) conducted an experiment on effect of *Azospirillum* and VAM on growth characters of African marigold (*Tagetes erecta* L.) and reported that application of NPK at 45: 45: 37.5 mg/kg along with combined

inoculation of *Azospirillum* and VAM exhibited increased growth with respect to plant height, number of leaves and laterals per plant.

Prabhat Kumar *et al.* (2003) stated that application of bio fertilizers like PSB + VAM proved to be most effective in increasing the plant height, number of leaves, leaf area and number of branches in china aster.

Soroa *et al.* (2003) investigated the effect of bio fertilizers on gerbera and found that treatment with *G.fasciculatum* recorded significant improvement in flower initiation (50 days earlier) as compared with control.

Venkatesha *et al.* (2003) observed that days for spike emergence, days for 50 per cent flowering, number of spike per hectare, cormels per hectare, florets per spike, rachis length and vase life were significantly improved with the application of Azospirillum and Vesicular Arbuscular Mycorrhiza (VAM) combined with different rates of N and P in gladiolus cv. White prosperity.

Gupta *et al.* (2004) in carnation, reported that the application of bio fertilizers like VAM, Azospirillum and PSB had registered maximum plant height, minimum number of days taken to first flowering, maximum flower size and better vase life.

Padmadevi *et al.* (2004) studied the effect of bio fertilizers on floral characters of anthurium and found that the treatment supplied with *Azospirillum*, phosphobacteria and Vesicular Arbuscular Mycorrhiza (VAM) along with full dose of inorganic nutrients recorded the highest stalk length.

Studies conducted by Shasidhara *et al.* (2005) on growth, flowering, yield, quality and economics of calendula (*Calendula officinalis* Linn.) as influenced by nutrients and bio-inoculants. They found that higher levels of N (100 kg/ha) and VAM (5 grams per plant) significantly improved the growth parameters like leaf width and number of branches per plant.

Vijay Kumar and Abnit Singh, (2007) cited that when plant treated with vermicompost and VAM inoculation (10 ton/ha and 3 to 5 g/ plant respectively) improved the growth and yield attributes in China aster cv. Shashank.

Kumar *et al.* (2008) recorded best values on growth and flowering attributes of marigold at higher levels of NPK (200: 100: 80 kg/ha), VAM (2 g/plant) and *Azospirillum* (3 ppm).

Pushkar *et al*. (2008) conducted an experiment on effect of chemical and bio fertilizers on growth and yield of african marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gainda. They reported that application of chemical fertilizer (200 kg N/ha, 80 kg P/ha, 80 kg K/ha) and bio fertilizer (VAM 10 kg/ha) recorded the maximum values in terms of plant height, diameter of main stem, spread of plant along the row, spread of plant across the row, number of primary branches per plant, fresh weight of plant canopy, dry matter content of main stem (%) dry matter content of primary branches (%) and number of primary branches per plant.

Sharma *et al.* (2009) investigated the effect of nutrient management on growth, flowering and seed production of China aster under protected conditions. They observed that the integrated use of the recommended doses of NPK with vermicompost and triple inoculation with Azotobacter + PSB + VAM gave maximum growth and yield.

Pushkar and Rathore (2008) studied the effect of chemical and bio fertilizers on growth and yield of African marigold (*Tagetes erecta* L.) cv. Pusa Narangi gainda. They reported that application of chemical fertilizer (200 kg N, 80 kg P, 80 kg K) and bio fertilizer (VAM 10 kg per hectare) recorded best values in growth and yield attributes.

Keisam *et al.* (2014) studied the effect of organic nutrients on growth, flowering and yield of *Gladiolus grandiflorus L.* They found that application of organic fertilizers [Vermicompost @ 2.5 t per hectare + VAM + humic acid @

0.2 per cent (FS)] registered maximum values in terms of growth characters viz., plant height (73.66 cm and 104.84 cm) at 30 and 45 DAP respectively, number of leaves (5.60), leaf length (50.03 cm), leaf width (8.62 cm) and minimum days taken for sixth leaf stage (37.10 days) and flowering parameters like minimum days taken for first spike emergence (44.10 days), days taken for first flower to open (51.35 days) and maximum spike length (110.60 cm), rachis length (44.20 cm), number of florets per spike (11.40), flower weight (4.99 g) and the number of marketable spikes per plot (50.45).

The results of the above studies confirm that different combinations of media and bio fertilizers influences the growth, flowering and cut flower yield of flower crops. However the use of suitable combination of media and bio fertilizers based on crop and variety is to be well understood to get desirable results.

Chapter III

MATERIAL AND METHODS

The present investigation entitled, “Studies on the effect of different combinations of media and bio fertilizers on growth, flowering and cut flower yield of gerbera (*Gerbera jamsonii* L.) cv. Natasha under protected conditions.” was carried out during the Rabi season of the year 2017-18 at College of Horticulture, Mojerla, Sri Konda Laxman Telangana State Horticultural University. The details of the location, the material used and the techniques adopted during the period of experimentation are presented in this chapter in the following heading and sub headings.

3.1 GEOGRAPHICAL AND WEATHER CONDITIONS OF THE EXPERIMENTAL SITE

The experiment was laid out in naturally ventilated polyhouse and the site is situated at an altitude of 542.3 m above mean sea level on 78° 29' East longitude and 17° 19' North latitude. The climate is semi-arid. Data on weather parameters during the course of investigation recorded at the Meteorological Research Station attached to the Krishi Vignan Kendra, Madanapuram, Kothakota Mandal is presented in Appendix I.

3.2 MATERIALS

3.2.1 Earthen pots

The dimensions of 20 cm height and 30 cm diameter were used for the experimentation.

3.2.2. PLANTING MATERIAL

Five week old tissue cultured plants of gerbera cv. Natasha were used as planting material and were procured from Florence flora, Bangalore.

3.2.3 DESCRIPTION OF THE GERBERA CULTIVAR NATASHA

It is a variety of private sector from Florence flora. Plants have a characteristic feature of stem length of around 65 cm, having red colour flowers

with green colour center position. Moreover it's flower diameter is nearly 12 cm and productivity is very high.

3.3 CULTURAL PRACTICES

The cultural practices were followed as per the recommendations. Moreover raised beds of were drenched with Bavistin @ 2 g / l as a preventive measure to control certain pests incidence.

3.3.1 LAYOUT OF THE EXPERIMENT

The experiment was laid out in a Factorial Randomized Block Design (FRBD) with ten treatments consisting of different media combinations and bio fertilizers replicated thrice. Each treatment had five pots and each pot having only one plant (Plate 1).

3.3.2 POT FILLING

Fungicide viz., Bavistin @ 2g/l treated pots were initially filled with some stones, then filled with well mixed potting media as per the treatments of the experiment.

3.3.3 BIO-FERTILIZER APPLICATION

Bio-fertilizers of PSB@ 4g/plant and VAM@ 3g/plant were provided as per treatment specifications.

3.3.4 BASAL NUTRIENT APPLICATION

N, P, and K @ 4g, 2g, and 4g respectively were applied to each pot in the form of urea, single super phosphate and muriate of potash. Urea was applied in two splits, the first dose as basal application and the other dose at 40 days after planting. The entire dose of single super phosphate and muriate of potash were applied as basal dose.

3.3.5 LAYING OF DRIP LINE OR LATERAL

Drip line or lateral consists of 16 mm diameter provided with 50 cm emitting distance with a discharge capacity of 4 lph was used to conduct the experiment.

3.3.6 PLANTING

Uniformly grown tissue cultured plants having 4-5 leaves were planted at a center of the pot. The crown portion must be placed 2 cm above from the potting media without disturbing the root ball. Before planting plants were treated with Bavistin @ 2g/l as a prophylactic measure.

3.4 INTERCULTURAL OPERATIONS

Standard inter cultural practices were followed during the entire crop period for all the experimental pots.

3.4.1 IRRIGATION

The pots were irrigated with a rose can immediately after planting. Subsequent irrigations were provided through drip irrigation system which was operated every day to keep the soil moisture at the field capacity level.

3.4.2 WEEDING AND HOEING

Hand weeding was done as and when weeds were noticed. Hoeing operations were carried out at monthly intervals.

3.4.3 FERTILIZER APPLICATION

It was applied 3-4 weeks after planting, when the plants were well established and it's weekly schedule as follows.

3.4.4 WEEKLY SCHEDULE OF FERTILIZER/PESTICIDE

Day	Fertilizer/Pesticide	Dosage per litre of water
Monday	19:19:19	2g
Tuesday	13:0:45	3g
Wednesday	COC/Alite/SAP	2g
Thursday	19:19:19	2g
Friday	Insecticide + Neem oil	2ml + 5 ml
Saturday	Rexolin	2g

3.4.5 PLANT PROTECTION MEASURES

Prophylactic plant protection measures were taken to control pest and disease incidence at regular intervals.

3.5 HARVESTING

Flowers were harvested when the outer rows of ray florets were completely elongated and one or two rows of disc florets were fully developed and perpendicular to the flower stalks, by sideward pull of the flower stalk at the base and the heel of the base was removed by giving a slant cut using a sharp knife and kept immediately in the chlorinated water.

3.6 TECHNICAL PROGRAMME OF WORK

3.6.1Experimental details:

Crop	:	Gerbera (*Gerbera jamesonii* L.)
Variety	:	Natasha
Season	:	Rabi, 2017-2018.
Design	:	Factorial Randomized block Design (FRBD)
Number of factors	:	02
Number of Treatments	:	10
Number of replications	:	03
Number of pots per treatment	:	05
Number of plants per pot	:	01
Nature of pot	:	Clay
Size of pot	:	20 cm height with 30 cm diameter.
Location of work	:	Poly house, PG Research Block

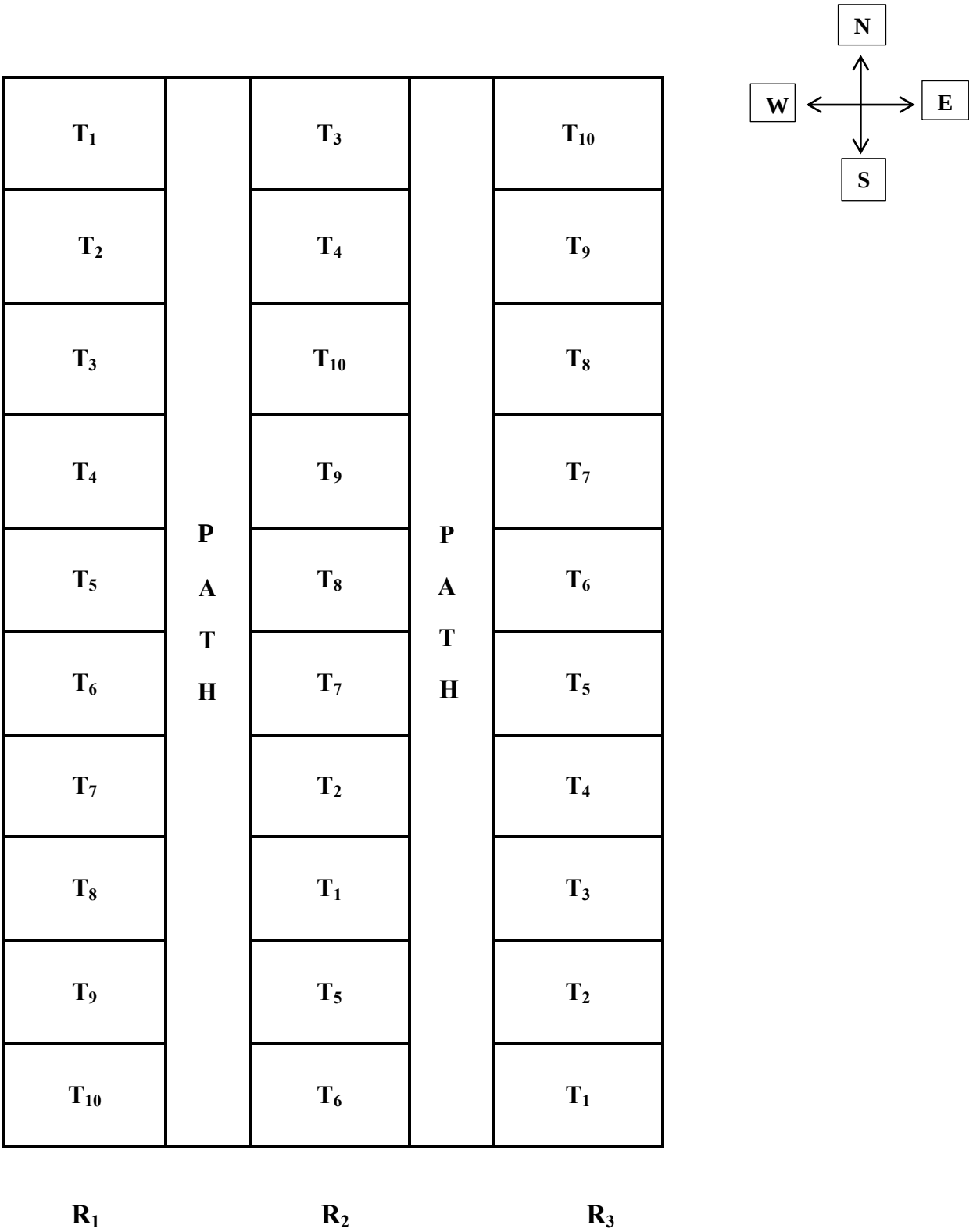

Fig.3.1 Plan and Layout view of the experimental site

Factor 1: Media (M)

M_1 - Red soil + Coco peat (1:1)

M_2 - Red soil + Vermicompost (1: 1)

M_3 - Red soil + Coco peat + Vermicompost (1:1:1)

M_4 - Red soil + Coco peat + Vermicompost (2:1:1)

M_5 - Control (Red soil only)

Factor 2: Bio fertilizers (B)

B_1 - PSB (Phosphate Solubilizing Bacteria)

B_2 - VAM (Vesicular - Arbuscular - Mycorrhiza)

3.6.2 TREATMENT DETAILS

T_1:	M_1B_1	T_6:	M_3B_2
T_2:	M_1B_2	T_7:	M_4B_1
T_3:	M_2B_1	T_8:	M_4B_2
T_4:	M_2B_2	T_9:	M_5B_1
T_5:	M_3B_1	T_{10}:	M_5B_2

3.7 DETAILS OF OBSERVATIONS RECORDED

Average values of the five pot plants, under each treatment were calculated for the following characters.

3.7.1 GROWTH PARAMETERS

3.7.1.1 Plant height at first flower appearance (cm)

It was measured from the base of the plant to the top of the plant at first flower appearance and mean value expressed in centimeters (cm).

3.7.1.2 Plant height at flower harvesting stage (cm)

It was measured from the base of the plant to the top of the plant at flower harvesting stage and mean figure expressed in centimeters (cm).

3.7.1.3 Plant spread at first flower appearance East-West direction (cm)

It was measured by using the measuring scale in East-West direction at first flower appearance and average value expressed in centimeters (cm).

3.7.1.4 Plant spread at first flower appearance North-South direction (cm)

This parameter was measured by using the measuring scale in a North-South direction at first flower appearance and mean figure expressed in centimeters (cm).

3.7.1.5 Plant spread at flower harvesting stage East-West direction (cm)

It was measured by using the measuring scale, placed in a East-West direction at flower harvesting stage average value expressed in centimeters (cm).

3.7.1.6 Plant spread at flower harvesting stage North-South direction (cm)

It was measured with the help of measuring scale, placed in a North-South direction at flower harvesting stage mean figure expressed in centimeters (cm).

3.7.1.7 Number of leaves per plant

Total number of leaves produced per plant in each treatment was counted and average value expressed in number.

3.7.1.8 Leaf area at final harvest (cm^2)

It was calculated with the help of an electronic leaf area meter model and mean figure expressed in square centimeter (cm^2).

3.7.2 FLOWER PARAMETERS :-

3.7.2.1 Number of days taken to first flower bud appearance (days)

Number of days taken for the appearance of first flower bud after planting was recorded and mean figure expressed in days.

3.7.2.2 Number of days taken to first flower opening

Number of days taken for complete opening of the flower from the emergence of flower bud was counted and averages were expressed in days.

3.7.2.3 Number of flowers per plant

The number of flowers per plant was counted and the average value was expressed in number.

3.7.2.4 Flower diameter (cm)

The diameter of the completely opened flower was measured by using measuring scale and expressed in centimeters (cm).

3.7.2.5 Flower stalk diameter (cm)

The diameter of flower stalk was measured particularly at middle point by using vernier calipers and mean figure expressed in centimeters (cm).

3.7.2.6 Length of flower stalk (cm)

It was measured from the point just below the flower head up to the point of origin of stalk and the averages were worked out and expressed in centimeters (cm).

3.7.2.7 Number of ray florets per flower

The number of ray florets per flower were counted at the harvesting stage and averages expressed in number.

3.7.2.8 Disc flower diameter (cm)

It was recorded by using the measuring scale and mean figure expressed in centimeter (cm).

3.7.2.9 Fresh weight of the flower (g)

It was recorded by using an electronic balance and average value expressed in grams (g).

3.7.2.10 Dry weight of the flower (g)

It was recorded by using an electronic balance and mean figure expressed in grams (g).

3.8 ROOT PARAMETERS

3.8.1 Number of roots per plant

The numbers of roots per plant was counted and mean figure expressed in number.

3.8.2 Length of the primary root (cm)

It was calculated by using the measuring scale and average values expressed in centimeters (cm).

3.8.3 Fresh weight of the plant (g)

It was recorded by using an electronic balance and averages worked out and expressed in grams (g).

3.8.4 Root to shoot ratio (%)

The root to shoot ratio was recorded on fresh weight basis i.e. by cutting the plant in two parts, the aerial part i.e. shoot and the sub aerial part i.e. root and

then by weighing each part separately on the digital weighing balance and mean figure expressed in percentage (%).

3.9 QUALITY PARAMETERS

3.9.1 Longevity of the flower on plant (Days)

Number of days taken for flower anthesis to petal drying or abscission was counted and averages expressed in days.

3.10 STATISTICAL ANALYSIS

The data was subjected to statistical scrutiny by the method of analysis of variance outlined by Panse and Sukhatma (1985). Statistical significance was tested with 'F' value at 5% level of probability and whenever the F value was found significant critical difference was worked out at five per cent level of probability.

Chapter IV

RESULTS AND DISCUSSION

The present investigation **"Studies on the effect of different combinations of media and bio fertilizers on growth, flowering and cut flower yield of gerbera (*Gerbera jamsonii* L.) cv. Natasha under protected conditions "** was carried out during the rabi season of the year 2017-18 at College of Horticulture, Mojerla, Sri Konda Laxman Telangana State Horticultural University. The data of the growth, flower, root and quality parameters were statistically analyzed and the results obtained are discussed in this chapter in the following paragraphs.

4.1 Growth parameters.

4.2 Flower parameters.

4.3 Root parameters.

4.4 Quality parameters.

4.1 Growth parameters

The data on growth parameters *viz*., plant height, plant spread, number of leaves per plant and leaf area are presented in the table 4.1.1 to 4.1.8 and depicted in the figure 4.1.1 to 4.1.3

4.1.1 Plant height at first flower appearance (cm)

The data pertaining to plant height at first flower appearance as influenced by different combinations of media and bio fertilizers is presented in the table 4.1.1 and fig.4.1.1

Significant difference in plant height at first flower appearance was observed due to different combinations of media treatments. Among the treatments, M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) recorded significantly the highest plant height at first flower appearance (21.15 cm), whereas M_5 combination of media - control (red soil only) recorded significantly lowest value (12.39 cm).

Bio fertilizers also showed significant difference on plant height at first flower appearance. Significantly higher plant height was recorded in B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) (16.76 cm), than B_1 bio fertilizer (PSB) Phosphate Solubilizing Bacteria (15.52 cm).

The interaction between different combinations of media and bio fertilizers was found to be significant. The M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) with B_2 bio fertilizer (VAM) (Vesicular Arbuscula Mycorrhiza) recorded significantly the higher value (22.27 cm), whereas it was significantly lower in M_5 combination of media - control (Red soil only) with B_1 bio fertilizer (PSB) (Phosphate Solubilizing Bacteria) (12.03 cm).

The highest plant height at first flower appearance was recorded in M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) was due to good aeration and better water retentive capabilities of cocopeat resulted in faster growth. These results are in accordance with the findings of Maria shaila, (2000) in gerbera.

The similar results were also reported by Elizabeth George (2012) in gerbera who reported that media enriched with vermicompost might have increased the plant height as it was a rich source of readily available macronutrients and chelated form of micronutrients like Fe and Zn.

The maximum plant height at first flower appearance was registered in B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) might be due to association with plant roots, resulted in nutrients availability for diffusion of phosphate ion and increased the surface area for absorption of nutrients such as N, K, Mn and Zn. The present findings are comparable with that of Praveen Kumar (2007) in gerbera.

4.1.2 Plant height at flower harvesting stage (cm)

Table 4.1.2 represent that all the different combinations of media differed significantly on plant height at flower harvesting stage. Among the different combinations of media, M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) recorded significantly maximum plant height at flower harvesting stage (23.67 cm), while it was minimum in M_5 combination of media - control (red soil only) (14.72 cm).

There was significant difference observed between bio fertilizers with respect to plant height at flower harvesting stage. B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) recorded significantly maximum plant height at flower harvesting stage (19.15 cm), over B_1 bio fertilizer (PSB) (Phosphate Solubilizing Bacteria) (17.85 cm).

Significant interaction effect was observed between different combinations of media and bio fertilizers on this parameter. Significantly the highest value was recorded in M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) with B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) (24.97 cm) and it was significantly lower in M_5 combination of media - control (Red soil only) with B_1 bio fertilizer (PSB) (Phosphate Solubilizing Bacteria) (14.39 cm).

The data on plant height at flower harvesting stage indicated that M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) recorded higher value which might be due to more availability of nutrients, favoured stem elongation, ultimately resulted in increased cell division at sub apical meristem. Similar results were also reported by Chauhan *et al*. (2014), Praveen Kumar (2007) and Barreto Maria shaila (2000) in gerbera.

4.1.3 Plant spread at first flower appearance East – West direction (cm)

The plant spread at first flower appearance East-West direction (cm) as effected by different combinations of media and bio fertilizers is presented in the table 4.1.3 and depicted in the fig.4.1.2

All combinations of media had significant influence on this parameter. Among the different combinations of media, M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) recorded significantly higher value (49.70 cm), while M_5 combination of media - control (Red soil only) registered significantly lower value (30.44 cm) (Plate 2)

Likewise, Plant spread at first flower appearance East-West direction also exerted significant difference due to bio fertilizers. Significantly higher value was recorded in B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) (41.13 cm), than B_1- bio fertilizer (PSB) (Phosphate Solubilizing Bacteria) (38.41cm).

The effect of different combinations of media and bio fertilizers was found to be significant on this parameter. The M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) with B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) recorded significantly higher value (51.92 cm), whereas it was significantly lower in M_5 combination of media - control (Red soil only) with B_1 bio fertilizer (PSB) (Phosphate Solubilizing Bacteria) (29.51cm).

The data on plant spread at first flower appearance East-West direction indicated that M_3 combination of media - Red soil + Coco peat + Vermicompost

(1:1:1)) recorded best value which was due to higher plant height of this treatment as compared to others. Moreover it might be due to better moisture retention capacity, availability of sufficient nutrients and good aeration. The findings are in accordance with the results of Jawaharlal *et al.* (2001) in Anthurium who stated that coco peat applied alone or in combination with FYM resulted in wider plant spread. These findings are in line with the reports of Chauhan *et al*. (2014) and Praveen Kumar (2007) in gerbera.

4.1.4 Plant spread at first flower appearance North – South direction (cm)

The data enunciated on Plant spread at first flower appearance North - South direction as influenced by different combinations media and bio fertilizers is tabulated in the table 4.1.4

From the data it is clear that there were significant difference observed among the treatments on this parameter. Significantly maximum value was recorded in M_3 combination media - Red soil + Coco peat + Vermicompost (1:1:1) (52.40 cm), while it was minimum in M_5 combination media - control (Red soil only) (32.94 cm).

Bio fertilizers also showed significant difference on this parameter. Significantly higher value was recorded in B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) (43.87 cm) over B_1 bio fertilizer (PSB) (Phosphate Solubilizing Bacteria) (40.93 cm).

The interaction between different combinations of media and bio fertilizers was found to be significant. The M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) with B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) recorded significantly maximum value (54.94 cm), whereas significantly minimum in M_5 combination of media - control (Red soil only) with B_1 bio fertilizer (PSB) (Phosphate Solubilizing Bacteria) (31.85 cm).

The highest plant spread at first flower appearance North-South direction was registered in the M_3 combination of media - Red soil + Coco peat + vermicompost (1:1:1) might be due to longer plant height of this treatment rather than others. Moreover it was due to the availability of macro and micronutrients, led to wider plant spread. The same findings were noted by Pawar *et al.* (2002) in Anthurium, Chauhan *et al*. (2014) and Praveen Kumar (2007) in gerbera.

4.1.5 Plant spread at flower harvesting stage East - West direction (cm)

The data pertaining to plant spread at flower harvesting stage East - West direction as effected by different combinations of media and bio fertilizers is presented in the table 4.1.5

Significant difference was observed due to different combinations of media on this parameter. Among the treatments, M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) recorded significantly higher value (51.41 cm), while it was significantly minimum in M_5 combination media - control (red soil only) (31.94 cm).

There was significant difference observed due to bio fertilizers on this parameter. The B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) recorded significantly maximum value (42.88 cm) than B_1 bio fertilizer (PSB) (Phosphate Solubilizing Bacteria) (39.93 cm).

Effect of different combinations of media and bio fertilizers was found to be significant on this parameter. The M_3 combination of media - Red soil + Cocopeat + Vermicompost (1:1:1) with B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) recorded significantly higher value (53.98 cm), whereas it was significantly lower in M_5 combination of media - control (Red soil only) with B_1 bio fertilizer (PSB) (Phosphate Solubilizing Bacteria) (30.85 cm).

The maximum plant spread at flower harvesting stage East-West direction was registered in M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) which might be due to the same treatment recorded maximum value of plant spread at first flower appearance East-West direction. Our results are comparable with that of Pawar *et al.* (2002) in Anthurium, Praveen Kumar, (2007) and Chauhan *et al*. (2014) in gerbera.

4.1.6 Plant spread at first flower harvesting stage North - South direction (cm)

The results related to plant spread at flower harvesting stage North - South direction as influenced by different combinations of media and bio fertilizers is presented in the table 4.1.6.

Table 4.1.6 represent that, all the different combinations of media differed significantly on this parameter. Significantly the highest value was recorded in M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) (55.56

cm). Significantly the lowest value was recorded in M_5 combination media - control (Red soil only) (35.94 cm).

The two bio fertilizers exerted significant difference on this parameter. The B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) recorded significantly the highest value (46.87 cm) over B_1 bio fertilizer (PSB) (Phosphate Solubilizing Bacteria) (43.99 cm).

The interaction between different combinations of media and bio fertilizers was found to be significant. The M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) with B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) recorded significantly the highest value (57.94 cm), while it was significantly lowest in M_5 combination of media - control (Red soil only) with B_1 bio fertilizer (PSB) (Phosphate Solubilizing Bacteria) (34.85 cm).

The data enunciated on plant spread at flower harvesting stage North-South direction revealed that M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) recorded higher value which might be due to the same treatment recorded maximum value of plant spread at first flower appearance North-South direction rather than other treatments. The similar results were also reported by Pawar *et al.* (2002) in Anthurium, Chauhan *et al*. (2014) and Praveen Kumar (2007) in gerbera.

4.1.7 Number of leaves per plant

Effect of different combinations of media and bio fertilizers on number of leaves per plant is illustrated in the table 4.1.7 and depicted in the figure 4.1.3

There was significant difference observed due to different combinations of media on number of leaves per plant. Among the different combinations of media, M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) recorded significantly more number of leaves per plant (35.37), whereas M_5 combination of media - control (Red soil only) recorded significantly less value (19.17).

Bio fertilizers also showed significant difference on number of leaves per plant. Significantly the highest value was recorded in B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) (28.28) over B_1 bio fertilizer (PSB) (Phosphate Solubilizing Bacteria) (26.02).

Significant interaction effect was observed between different combinations of media and bio fertilizers. The M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) with B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) recorded significantly the highest value (37.29), while it was significantly lowest in M_5 combination of media - control (Red soil only) with B_1 bio fertilizer (PSB) (Phosphate Solubilizing Bacteria) (18.13).

It was observed that more number of leaves per plant was registered in M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) which was due to the same treatment recorded luxurious vegetative growth and maximum plant spread rather than other treatments.

The maximum number of leaves per plant was recorded in B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) might be due to the availability of more nutrients, led to more leaf number. The results are in conformity with the findings of Chauhan *et al.* (2014), Praveen Kumar, (2007) and Elizabeth George (2012) in gerbera.

4.1.8 Leaf area at final harvest (cm^2)

The data recorded on leaf area at final harvest as influenced by the different combinations of media and bio fertilizers is presented in the table 4.1.8.

All the combinations of media had significant influence on leaf area at final harvest. Among the different combinations of media, M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) recorded significantly maximum leaf area at final harvest (116.28 cm^2). Significantly minimum value was recorded in M_5 combination of media - control (Red soil only) (39.10 cm^2).

There was significance difference observed between bio fertilizers with respect to leaf area at final harvest. The B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) recorded significantly maximum value (78.05 cm^2) than B_1 bio fertilizer (PSB) (Phosphate Solubilizing Bacteria) (67.22 cm^2).

Leaf area at final harvest differed significantly due to different combinations of media and bio fertilizers. The M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) with B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) recorded significantly maximum value (120.45 cm^2), while it was significantly minimum in M_5 combination of media - control (Red soil only) with B_1 bio fertilizer (PSB) (Phosphate Solubilizing Bacteria) (35.08 cm^2).

The data pertaining to leaf area at final harvest (cm^2) was recorded to be maximum in M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1). Which was due to the same treatment recorded maximum values in plant spread parameter in both directions rather than other treatments. These findings are in consonance with the reports of Sindhu and Guptha (1993) in tea rose and they found that nitrogen being a constituent of chlorophyll might have increased the leaf area.

The present findings are comparable with that of Subhankar Saha *et al*. (2018) in gerbera

4.2 Flower parameters

The data on flower parameters *viz.*, number of days taken to first flower bud appearance, number of days taken to first flower opening, number of flowers per plant, flower diameter, flower stalk diameter, length of the flower stalk, number of ray florets per flower, disc flower diameter, fresh weight of the flower and dry weight of the flower are presented in the table 4.2.1 to 4.2.10 and illustrated in the figure 4.2.1 to 4.2.6

4.2.1 Number of days taken to first flower bud appearance (days)

The data pertaining to number of days taken to first flower bud appearance as influenced by different combinations of media and bio fertilizers is presented in the table 4.2.1 and depicted in the figure 4.2.1

Significant difference was observed due to different combinations of media on this parameter. Among the different combinations of media, M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) recorded significantly less number of days taken to first flower bud appearance (39.56 days) (Plate 3), whereas M_5 combination of media - control (Red soil only) recorded significantly more number of days taken to first flower bud appearance (64.66 days).

Bio fertilizers also showed significant difference on this parameter. Significantly less number of days taken to first flower bud appearance was recorded in B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) (50.53 days) over B_1 bio fertilizer (PSB) (Phosphate Solubilizing Bacteria)) (53.91 days).

The interaction between different combinations of media and bio fertilizers was found to be significant. The M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) with B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) recorded significantly less number of days taken to first flower bud appearance (37.42 days), while it was significantly more in M_5 combination of media - control (Red soil only) with B_1 bio fertilizer (PSB) (Phosphate Solubilizing Bacteria) (66.44 days).

Minimum number of days taken to first flower bud appearance was recorded in M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) might be due to good vegetative growth converted in to early reproductive phase. Similar results were reported by Chauhan *et.al* (2014) in gerbera and they found that media enriched with higher organic matter, led to early first flower bud appearance. Moreover Barreto maria shaila (2000) in gerbera reported that sufficient number of leaves per plant produced the healthy buds and flowers at early stage.

The present investigation was in consistent with other reports of Praveen Kumar (2007) in gerbera.

The B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) recorded the least number of days taken to first flower bud appearance was due to up take of good amount of phosphorous, resulted in early flower bud appearance.

4.2.2 Number of days taken to first flower opening

Effect of different combinations of media and bio fertilizers on number of days taken to first flower opening is presented in the table 4.2.2 and fig.4.2.2

Table 4.2.2 represent that all the different combinations of media differed significantly on this parameter. Among the treatments, M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) recorded significantly less number of days taken to first flower opening (54.11 days), while it was significantly more in M_5 combination of media - control (Red soil only) (87.15 days).

There was significant difference observed between bio fertilizers with respect to number of days taken to first flower opening. The B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) recorded significantly less number

of days taken to first flower opening (68.54 days) than B_1 bio fertilizer (PSB) (Phosphate Solubilizing Bacteria)) (72.90 days).

Significant interaction effect was observed between different combinations of media and bio fertilizers on this parameter. Significantly minimum number of days taken to first flower opening was recorded in M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) with B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) (51.52 days). Significantly maximum number of days taken to first flower appearance was recorded in M_5 combination of media - control (Red soil only) with B_1 bio fertilizer (PSB) (Phosphate Solubilizing Bacteria) (89.43 days).

Minimum number of days taken to first flower opening was registered in M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) was due to the same treatment recorded early appearance of first flower bud appearance rather than others. These findings are in line with the reports of Chauhan *et al*. (2014) and Praveen Kumar (2007) in gerbera.

4.2.3 Number of flowers per plant

The data on number of flowers per plant as influenced by different combinations of media and bio fertilizers is presented in the table 4.2.3.

All the different combinations of media showed significant differences with respect to number of flowers per plant. Significantly higher number of flowers per plant was recorded in M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) (6.59), whereas it was significantly lower in M_5 combination of media - control (Red soil only) (3.99).

Likewise bio fertilizers also exerted significant difference on this parameter. Significantly higher number of flowers per plant was recorded in the B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) (5.52) over B_1 bio fertilizer (PSB) (Phosphate Solubilizing Bacteria) (5.19).

The effect of different combinations of media and bio fertilizers was found to be significant on this parameter. The M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) with B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) recorded significantly the highest value (6.70), while it was significantly lowest in M_5 combination of media - control (Red soil only) with B_1 bio fertilizer (PSB) (Phosphate Solubilizing Bacteria) (3.76).

The data enunciated on number of flowers per plant revealed that the M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) recorded maximum value which might be due to vigorous vegetative growth, wider plant spread and more number of leaves per plant, resulted in increased carbohydrate reserve material along with the proper uptake of all available nutrients led to more number of flowers per plant. Similar results were also reported by Chauhan *et al*. (2014) in gerbera and they found that better vegetative growth positively influenced the flower production.

4.2.4 Flower diameter (cm)

The data related to flower diameter (cm) as effected by different combinations of media and bio fertilizers is presented in the table 4.2.4 and depicted in the fig.4.2.3

From the data it is clear that there was significant difference observed among the different combinations of media with respect to flower diameter (cm). Significantly maximum value was recorded in M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) (11.42 cm), whereas it was minimum in M_5 combination of media - control (Red soil only) (7.07 cm) (Plate 4)

The two Bio fertilizers exerted significant difference on flower diameter. Significantly the highest flower diameter was recorded in the B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) (9.38 cm) over the B_1 bio fertilizer (PSB) (Phosphate Solubilizing Bacteria)) (8.82 cm).

The interaction between different combinations of media and bio fertilizers was found to be significant. The M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) with B_2 bio fertilizer VAM (Vesicular Arbuscular Mycorrhiza) recorded significantly the highest flower diameter (11.82 cm), while it was significantly lowest in M_5 combination of media - control (Red soil only) with B_1 bio fertilizer PSB (Phosphate Solubilizing Bacteria) (6.72 cm).

Maximum flower diameter was recorded in the M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) which might be due to luxuriant vegetative growth resulted in more green biomass of plant led to more availability of primary and secondary metabolites, favoured higher source to sink

ratio represented the more diameter of flower. The results are in conformity with the findings of Chauhan *et al.* (2014) in gerbera.

4.2.5 Flower stalk diameter (cm)

Effect of different combinations of media and bio fertilizers on flower stalk diameter is presented in the table 4.2.5.

Significant difference in flower stalk diameter was observed due to different combinations of media. Among the different combinations of media, M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) recorded significantly maximum flower stalk diameter (0.72 cm), whereas M_5 combination of media - control (Red soil only) recorded significantly minimum value (0.50 cm).

Bio fertilizers also showed significant difference on this parameter. Between the bio fertilizers the B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) registered significantly maximum flower stalk diameter (0.62 cm) than B_1 bio fertilizer (PSB) (Phosphate Solubilizing Bacteria) (0.60 cm).

Significant interaction effect was observed between different combinations of media and bio fertilizers. The M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) with B_2 bio fertilizer VAM (Vesicular Arbuscular Mycorrhiza) recorded significantly maximum flower stalk diameter (0.74 cm), while it was significantly minimum in M_5 combination of media - control (Red soil only) with B_1 bio fertilizer PSB (Phosphate solubilizing bacteria) (0.49 cm).

The highest flower stalk diameter was recorded in M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) which was due to the same treatment registered maximum flower diameter rather than other treatments. The results are in accordance with that of Chauhan *et al.* (2014) and Praveen Kumar (2007) in gerbera.

4.2.6 Flower stalk length (cm)

The data on length of the flower stalk as influenced by the different combinations of media and bio fertilizers is presented in the table 4.2.6 and depicted in the figure 4.2.4

All different combinations of media had significant influence on length of the flower stalk. Among the treatments, M_3 combination of media - Red soil +

Coco peat + Vermicompost (1:1:1) recorded significantly the highest flower stalk length (58.42 cm), while M_5 combination of media - control (Red soil only) registered significantly lowest value (49.57 cm) (Plate 5)

Likewise, bio fertilizers also exerted significant difference on this parameter. Significantly maximum flower stalk length was recorded in B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) (54.90 cm) over B_1 bio fertilizer (PSB) (Phosphate Solubilizing Bacteria)) (53.50 cm).

Flower stalk length differed significantly due to treatments and bio fertilizers. The M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) with B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) recorded significantly the highest flower stalk length (59.77 cm), while it was significantly lowest in M_5 combination of media - control (Red soil only) with B_1 bio fertilizer (PSB) (Phosphate Solubilizing Bacteria) (48.49 cm).

The data recorded on flower stalk length indicated that maximum value was registered in M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) was due to the same treatment recorded maximum flower and flower stalk diameter rather than other treatments. The present investigation was in consistent with other reports of Chauhan *et al*. (2014) and Praveen Kumar (2007) in gerbera.

4.2.7 Number of ray florets per flower

Number of ray florets per flower as effected by different combinations of media and bio fertilizers is presented in the table 4.2.7.

It was evident from the table that all the different media combination treatments differed significantly with respect to number of ray florets per flower. Significantly maximum value was registered in M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) (62.56), whereas it was significantly minimum in M_5 combination of media - control (Red soil only) (42.78).

The two bio fertilizers showed significant difference on number of ray florets per flower. Significantly maximum value was recorded in B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) (53.87) than B_1 bio fertilizer (PSB) (Phosphate Solubilizing Bacteria)) (50.93).

Significant interaction effect was observed between different combinations of media and bio fertilizers on this parameter. Significantly the

highest value was recorded in M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1)) with B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) (64.94), while it was significantly lowest in M_5 combination of media - control (Red soil only) with B_1 bio fertilizer PSB (Phosphate Solubilizing Bacteria) (41.51).

The data enunciated on number of ray florets per flower revealed that M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) registered maximum value which was due to the same treatment recorded maximum flower diameter, flower stalk diameter and flower stalk length as compared to rest of the treatments. These findings are in line with the reports of Chauhan *et al.* (2014) and Praveen Kumar (2007) in gerbera.

4.2.8 Disc flower diameter (cm)

Effect of different combinations of media and bio fertilizers on disc flower diameter is illustrated in the table 4.2.8 and the figure 4.2.5

Table 4.2.8 represent that all the different combinations of media treatments differed significantly on disc flower diameter. Among the treatments, M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) recorded significantly maximum disc flower diameter (5.46 cm), while M_5 combination of media - control (Red soil only) recorded significantly minimum value (2.49 cm).

There was significant difference observed due to bio fertilizers on this parameter. Significantly maximum disc flower diameter was recorded in B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza)) (4.11cm) over B_1 bio fertilizer (PSB) (Phosphate Solubilizing Bacteria)) (3.79 cm).

The interaction between different combinations of media and bio fertilizers was found to be significant. The M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) with B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) recorded significantly maximum disc flower diameter (5.58 cm), while it was significantly minimum in M_5 combination of media - control (Red soil only) with B_1 bio fertilizer (PSB) (Phosphate Solubilizing Bacteria) (2.18 cm).

Maximum disc flower diameter was recorded in M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) might be due to the same

treatment recorded maximum flower diameter, flower stalk diameter and flower stalk length as compared to rest of the treatments. The present investigation was in consistent with other reports of Chauhan *et al.* (2014), Barreto Maria shaila (2000) and Praveen Kumar (2007) in gerbera.

4.2.9 Fresh weight of the flower (g)

The data recorded on fresh weight of the flower as influenced by different combinations of media and bio fertilizers is presented in the table 4.2.9 and illustrated in the fig.4.2.6

All the different combinations of media treatments had significant influence on fresh weight of the flower. Among the treatments, M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) registered significantly maximum fresh weight of the flower (30.42 g), whereas it was significantly minimum in M_5 combination of media - control (Red soil only) (21.57 g).

The two bio fertilizers also showed significant difference with respect to fresh weight of the flower. The B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) recorded significantly maximum fresh weight of the flower (26.90 g) than B_1 bio fertilizer (PSB) (Phosphate Solubilizing Bacteria) (25.52 g).

Significant interaction effect was observed between different combinations of media and bio fertilizers. The M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) with B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) recorded significantly maximum fresh weight of the flower (31.77 g), while it was significantly minimum in M_5 combination of media - control (Red soil only) with B_1 bio fertilizer (PSB) (Phosphate Solubilizing Bacteria) (20.49 g).

The highest fresh weight of the flower was registered in M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) which might be due to the same treatment recorded better flower parameters such as maximum flower diameter, flower stalk diameter, flower stalk length, number of ray florets per flower and disc flower diameter rather than other treatments. These findings are in line with the reports of Chauhan *et al*. (2014) in gerbera.

4.2.10 Dry weight of the flower (g)

The data pertaining to dry weight of the flower as influenced by different combinations of media and bio fertilizers is presented in the table 4.2.10

Significant difference in dry weight of the flower was observed due to different combinations of media. Among the treatments, M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) recorded significantly maximum dry weight of the flower (10.50 g), whereas M_5 combination of media - control (Red soil only) recorded significantly minimum dry weight of the flower (6.25 g).

Likewise, bio fertilizers also exerted significant difference on this parameter. Significantly maximum dry weight of the flower (g) was recorded in B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) (8.44 g) over B_1 bio fertilizer (PSB) (Phosphate Solubilizing Bacteria)) (8.08 g).

Dry weight of the flower differed significantly due to different combinations of media and bio fertilizers. The M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) with B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) recorded significantly maximum dry weight of the flower (10.82 g), while it was significantly minimum in M_5 combination of media - control (Red soil only) with B_1 bio fertilizer (PSB) (Phosphate Solubilizing Bacteria) (6.08 g).

The highest dry weight of the flower was recorded in M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) which was due to the same treatment registered maximum fresh weight of the flower as compared to other treatments. Similar results were also reported by Chauhan *et al*. (2014) in gerbera.

4.3 Root parameters

The data on root parameters *viz*., number of roots per plant, length of the primary root, fresh weight of the plant and root to shoot ratio are presented in the table 4.3.1 to 4.3.4 and depicted in the fig.4.3.1 to 4.3.2

4.3.1 Number of roots per plant

The data enunciated on number of roots per plant as affected by different combinations of media and bio fertilizers is presented in the table 4.3.1 and depicted in the fig.4.3.1

There was significant difference observed due to the different combinations of media treatment with respect to number of roots per plant.

Significantly maximum value was recorded in M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) (58.37), whereas M_5 combination of media - control (Red soil only) registered minimum value (41.67).

Bio fertilizers also showed significant difference on number of roots per plant. Significantly more number of roots per plant was recorded in B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) (50.95) than B_1 bio fertilizer (PSB) (Phosphate Solubilizing Bacteria)) (49.02).

The interaction between different combinations of media and bio fertilizers was found to be significant. The M_3 combination of Media - Red soil + Coco peat + Vermicompost (1:1:1) with B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) recorded significantly more number of roots per plant (60.29), while it was significantly less in M_5 combination of media - control (Red soil only) with B_1 bio fertilizer (PSB) (Phosphate Solubilizing Bacteria) (41.13).

More number of roots per plant was recorded in M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) which might be due to the luxurious vegetative growth of this treatment rather than others. Moreover it was due to the less compact nature media, permitted more space for root development. The results are in accordance with the findings of Barreto Maria shaila (2000) in gerbera.

4.3.2 Length of the primary root (cm)

The data recorded on length of the primary root as influenced by different combinations of media and bio fertilizers is presented in the table 4.3.2 and the figure 4.3.2

Significant difference in length of the primary root was observed due to different combinations of media. Among the treatments, M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) recorded significantly the highest length of the primary root (51.37 cm), whereas M_5 combination of media - control (Red soil only) recorded significantly lowest value (34.67 cm).

There was significant difference observed due to bio fertilizers on length of the primary root. Between the bio fertilizers, the B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) recorded significantly the highest length of the primary root (43.95 cm) over B_1 bio fertilizer (PSB) (Phosphate Solubilizing Bacteria) (42.02 cm).

Significant interaction effect was observed between different combinations of media and bio fertilizers. The M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1)) with B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) recorded significantly the highest length of the primary root (53.29 cm), while it was significantly lowest in M_5 combination of media - control (Red soil only) with B_1 bio fertilizer (PSB) (Phosphate Solubilizing Bacteria) (34.13 cm).

The highest length of the primary root was registered in M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) which was due to the less compact nature media, permitted more space for root development. The present findings are comparable with that of Barreto Maria shaila (2000) in gerbera.

4.3.3 Fresh weight of the plant (g)

The results related to fresh weight of the plant as effected by different combinations of media and bio fertilizers is presented in the table 4.3.3 and the figure 4.3.2

From the table it is clear that all different combinations of media treatments differed significantly on this parameter. Among the treatments, M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) recorded significantly maximum fresh weight of the plant (197.61 g), whereas it was significantly minimum in M_5 combination of media - control (red soil only) (119.44 g).

Likewise, bio fertilizers also exerted significant influence on fresh weight of the plant. The B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) registered significantly maximum value (158.78 g), than B_1 bio fertilizer (PSB) (Phosphate Solubilizing Bacteria) (147.55 g).

The interaction between different combinations of media and bio fertilizers was found to be significant. The M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) with B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) recorded significantly maximum value (202.78 g), while it was significantly minimum in M_5 combination of media - control (Red soil only) with B_1 bio fertilizer (PSB) (Phosphate Solubilizing Bacteria) (115.42 g).

The data enunciated on fresh weight of the plant revealed that M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) recorded maximum fresh weight of the plant which might be due to the same treatment registered better values in terms of growth, flower and root parameters as compared to rest of the treatments. The present investigation was in consistent with other reports of Barreto Maria shaila (2000) in gerbera.

4.3.4 Root to shoot ratio (%)

Effect of different media combinations and bio fertilizers on root to shoot ratio is illustrated in the table 4.3.4.

It is evident from the table that, all the different combinations of media treatments differed significantly with respect to root to shoot ratio. Significantly maximum root to shoot ratio was registered in M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) (0.93 %), whereas M_5 combination of media - control (Red soil only) recorded significantly the lowest value (0.68 %).

Bio fertilizers also showed significant difference on root to shoot ratio. Significantly the highest value was recorded in B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) (0.85 %) over B_1 bio fertilizer (PSB (Phosphate Solubilizing Bacteria)) (0.82 %).

Significant interaction effect was observed between different combinations of media and bio fertilizers on root to shoot ratio. Significantly the highest value was recorded in M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) with B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) (0.93 %), while it was significantly lowest in M_5 combination of media - control (Red soil only) with B_1 bio fertilizer PSB (Phosphate Solubilizing Bacteria) (0.68 %).

From the data it was clear that M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) registered maximum root to shoot ratio which was due to the same treatment recorded more root weight, resulted in more absorption of nutrition from the media led to more root to shoot ratio. These findings are in line with the reports of Barreto Maria shaila (2000) in gerbera.

4.4 Quality parameters

The data on quality parameters viz., longevity of the flower on plant is presented in the table 4.4.1 and the figure 4.4.1

4.4.1 Longevity of the flowers on plant (Days)

The data pertaining to longevity of the flower on plant as influenced by different combinations of media and bio fertilizers is presented in the table 4.4.1 and illustrated in the fig.4.4.1

All combinations of media treatments had significant influence on longevity of the flower on plant. Among the treatments, M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) recorded significantly maximum value (18.52 days), whereas M_5 combination of media recorded significantly minimum value (14.01days).

There was significant difference observed due to bio fertilizers on this parameter. Between the bio fertilizers, the B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza)) recorded best value (16.63 days) than B_1 bio fertilizer (PSB) (Phosphate Solubilizing Bacteria)) (16.18 days).

The interaction between different combinations of media and bio fertilizers was found to be significant. The M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) with B_2 bio fertilizer (VAM) (Vesicular Arbuscular Mycorrhiza) recorded significantly maximum value (18.63 days), while it was significantly minimum in M_5 combination of media - control (Red soil only) with B_1 bio fertilizer PSB (Phosphate Solubilizing Bacteria) (13.45 days).

Maximum longevity of the flower on plant was registered in M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) which might be due to the same treatment recorded maximum dry matter production and flower diameter rather than other treatments. The results are in conformity with the findings of Chauhan *et al*. (2014) in gerbera.

Chapter V

SUMMARY AND CONCLUSIONS

The present investigation entitled "Studies on the effect of different combinations of media and bio fertilizers on growth, flowering and cut flower yield of gerbera (*Gerbera jamsonii* L.) cv. Natasha under protected conditions " was carried out during the year 2017-2018 at College of Horticulture, Mojerla, Sri Konda Laxman Telangana State Horticultural University. The experiment was carried out with five combinations of media (M), M_1 - Red soil + Coco peat (1:1), M_2 - Red soil + Vermicompost (1: 1), M_3 - Red soil + Coco peat + Vermicompost (1:1:1), M_4 - Red soil + Coco peat + Vermicompost (2:1:1) and M_5 - Control (Red soil only) with two bio fertilizers (B), viz., B_1 - PSB (Phosphate Solubilizing Bacteria) and B_2 - VAM (Vesicular Arbuscular Mycorrhiza) in Factorial Randomized Block Design and replicated thrice. The salient features of the findings are summarized here under.

I. GROWTH PARAMETERS

- Among the different combinations of media, M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) recorded maximum plant height at first flower appearance and at flower harvesting stage, plant spread in both the directions at first flower appearance and at flower harvesting stage, number of leaves per plant and leaf area.
- Vesicular Arbuscular mycorrhiza (VAM) bio fertilizer recorded significantly maximum plant height, plant spread, number of leaves per plant and leaf area.
- In the interaction effect, M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) with B_2 bio fertilizer Vesicular Arbuscular Mycorrhiza (VAM) recorded best values in all growth parameters.

II. FLOWER PARAMETERS

- The M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) recorded the least number of days taken to first flower bud appearance and first flower opening than other treatments.

- Between the bio fertilizers, Vesicular Arbuscular Mycorrhiza (VAM) bio fertilizer recorded significantly more number of flowers per plant.
- Among the different combinations of media, M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) exhibited maximum diameter of the flower, flower stalk and disc flower.
- More number of ray florets per flower and maximum length of the flower stalk were recorded significantly in M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1).
- In the interaction effect, M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) with B_2 bio fertilizer Vesicular Arbuscular Mycorrhiza (VAM) recorded maximum fresh and dry weights of the flower.

III. ROOT PARAMETERS

- Among the different combinations media, M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) recorded more number of roots per plant.
- Maximum primary root length was recorded in M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1).
- The M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1)) recorded maximum fresh and dry weights of the flower.
- In the interaction effect, M_3 combination media - Red soil + Coco peat + Vermicompost (1:1:1) with B_2 bio fertilizer Vesicular Arbuscular Mycorrhiza (VAM) recorded maximum root to shoot ratio.

IV. QUALITY PARAMETERS

- Maximum longevity of the flower on plant was recorded in the M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) with B_2 bio fertilizer, Vesicular Arbuscular Mycorrhiza (VAM).

CONCLUSION:

It could be concluded from the present investigation that among the different combinations media, M_3 combination of media - Red soil + Coco peat + Vermicompost (1:1:1) and B_2 bio fertilizer, Vesicular Arbuscular Mycorrhiza (VAM) showed positive effect on growth, flowering, root and quality parameters over other combinations media and bio fertilizer.

FUTURE LINE OF WORK:

- Different combinations media and bio fertilizers along with plant growth regulators might be experimented for getting better results.
- Various combinations of media and bio fertilizers along with the different micronutrient concentrations at various intervals might be experimented.

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APPENDIX

Monthly meteorological data during crop growth period from November 2017 to February 2018.

Month	Temperature (˚C)		Rainfall (mm)	Relative humidity (%)	
	Maximum	Minimum		Maximum	Minimum
November	33.41	18.19	-	107.17	36.08
December	31.84	15.64	-	78.64	30.90
January	32.44	16.18	-	73.57	30.08
February	34.53	17.34	-	67.89	23.14