Effect of organic manures on growth and flowering of tuberose (*Polianthes tuberosa*) cv. Phule Rajani

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SUCHISMITA PATTNAIK

03 FLS/14

DEPARTMENT OF FLORICULTURE AND LANDSCAPING
COLLEGE OF AGRICULTURE
ORISSA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY, BHUBANESWAR-751003
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ORISSA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY
DEPARTMENT OF FLORICULTURE AND LANDSCAPING
COLLEGE OF AGRICULTURE
BHUBANESWAR, ODISHA-751003

Dr. S. K. Palai
Floriculturist
O.I.C. AICRP on Floriculture

Bhubaneswar
Date: 15.7.16

CERTIFICATE - I

This is to certify that the thesis entitled **"EFFECT OF ORGANIC MANURES ON GROWTH AND FLOWERING OF TUBEROSE (*Polianthes tuberosa*) Cv. PHULE RAJANI"** submitted in partial fulfillment of the requirements for the award of the degree of **MASTER OF SCIENCE IN AGRICULTURE (FLORICULTURE AND LANDSCAPING)** from the **ORISSA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY**, Bhubaneswar is a faithful record of *bonafide* research work carried out by **SUCHISMITA PATTNAIK, Adm. No. 03FLS/14** under my guidance and supervision. No part of the thesis has been submitted for the award of any other degree or diploma.

It is further certified that the assistance and help availed by her from various sources during the course of investigation has been duly acknowledged.

S K Palai 15/7/16

Chairman
Advisory committee

CERTIFICATE-II

This is to certify that the thesis entitled **"EFFECT OF ORGANIC MANURES ON GROWTH AND FLOWERING OF TUBEROSE (*Polianthes tuberosa*) Cv. PHULE RAJANI"** submitted by **SUCHISMITA PATTNAIK, Adm. No. 03FLS/14** to the Orissa University of Agriculture and Technology, Bhubaneswar in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE IN AGRICULTURE (FLORICULTURE AND LANDSCAPING)** has been approved by the students' advisory committee and external examiner.

Advisory committee

Chairman: **Dr. S. K. Palai**
Floriculturist, AICRP on floriculture
OUAT, BBSR

15/7/16

Members:

1. **Dr. S. Beura**
Head, Dept. of floriculture &
Landscaping, CA & Director BTCC,
OUAT, BBSR

15/7/2016

2. **Dr. N. Panda**
Asst. Prof. Dept. of Soil Science and
Agricultural Chemistry, CA,
OUAT, BBSR

15.7.16

External examiner:

15.07.16

(Name and designation)

Prof. Partha Sarathi Munsi
Former Dean, Institute of Agriculture
UGC - Emeritus Fellow
Visva - Bharati

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"We are what we repeatedly do.
Excellence, therefore, is not an act but a
habit."

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Suchismita Pattnaik

(SUCHISMITA PATTNAIK)
Adm. No. 03 FLS/14

Place : Bhubaneswar
Date : 05.07.16

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LIST OF ABBREVIATIONS

%	:	Per cent
/	:	Per
@	:	At the rate
^{0}C	:	Degree Celsius
AM	:	Ante meridiem
cc	:	Cubic centimetre
CD	:	Critical difference
cm	:	Centimetre
cv.	:	Cultivar
dS	:	Desi simond
e.g.	:	For example
et al.	:	And others
etc.	:	Etcetera
Fig.	:	Figure
g	:	Gram
Ha	:	Hectare
i.e.	:	That is
Kg	:	Kilogram
M	:	Meter
Max.	:	Maximum
Min.	:	Minimum
mm	:	Millimetre
NC	:	Neem cake
No. of	:	Number of
NS	:	Non-significant
OUAT	:	Orissa university of Agriculture and Technology
pH	:	Hydrogen ion concentration
PM	:	Post meridiem
q	:	Quintal
RDF	:	Recommended dose of fertilizer
RH	:	Relative Humidity
Rs.	:	Rupees
SE(m)±	:	Standard Error of Mean
Sq m	:	square meter
VC	:	Vermicompost
Viz.	:	Namely

ABSTRACT

An investigation was carried out to find out the EFFECT OF ORGANIC MANURES ON GROWTH AND FLOWERING OF TUBEROSE (*Polianthes tuberosa*) Cv. PHULE RAJANI. The experiment was carried out at Biotechnology-cum-Tissue Culture Centre, Orissa University of Agriculture and Technology, Bhubaneswar, Odisha during May 2015 to May 2016. The experiment was laid out in Randomized Block Design with ten treatments and three replications. Bulbs of tuberose cv. Phule Rajani were planted in a spacing of 30 cm × 30 cm, in plots of size 1.5m X 1.5m each i.e. twenty five bulbs were planted per plot. The trial was conducted with ten treatments *viz.* T_1 (control), T_2 (Vermicompost @ 2 kg/ m^2), T_3 (Mustard oil cake @ 500g/m^2), T_4 (Karanja oil cake @ 500g/m^2), T_5 (Neem oil cake @ 500g/ m^2), T_6 (Groundnut oil cake @ 500g/m^2), T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2), T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2), T_9 (Vermicompost @ 1Kg/m^2 + Neem oil cake @ 250g/m^2), T_{10} (Vermicompost @ 1Kg/m^2 + Groundnut oil cake @ 250g/m^2). Manures were applied in soil and mixed thoroughly in soil. The result of the study revealed that application of organic manures influenced the vegetative, floral and bulb parameters of the plant significantly. Among all the organic manures and their combinations studied, the treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) recorded the maximum for vegetative growth parameters, like plant height, plant spread, number of leaves per plant, number of bulbs per plant, leaf length, leaf breadth and leaf area; bulb parameters like bulb length, bulb weight, bulb circumference and yield of the bulb compared to other treatments. Floral characters like, spike length, rachis length and diameter of spike were maximum in T_3 (Mustard oil cake @ 500g/m^2) compared to other treatments. Early flowering was also observed in this treatment i.e. days taken from planting to development of flower was minimum in this treatment. The floral characters like, number of spike per plant, number of florets per spike, floret length, floret width, flower yield, bloom life, vase life and water uptake by flower spikes in the vase were recorded maximum in treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) compared to other treatments. It was observed that application of vermicompost in combination with karanja oil cake (Pongamia oil cake) significantly influenced flower production in tuberose cv. Phule Rajani.

CHAPTER-1

INTRODUCTION

INTRODUCTION

Tuberose (*Polianthes tuberosa* L.) family Asparagaceae, occupies a very special position among flowers because of its attractive, elegant and fragrant white flowers. The flowers remain fresh for pretty long period, stand long distance transport and fill a useful place in the flower market (Patil *et al.,* 1999). Besides demand for cut flower tuberose also has great economic potential in essential oil industry (Alan *et al.*, 2007). The long spikes of tuberose are used for vase decoration, bouquet preparation and the florets for making artistic garlands, ornaments and button holes. The flowers emit a delightful fragrance and are the source of tuberose oil. The natural flower oil of tuberose is one of the most expensive raw material of perfume industry.

The common names as well as botanical name of the flower indicate its characteristics. The name *Polianthes* was given to the tuberose by Linnaeus in 1738. The generic name *Polianthes* is probably derived from the Greek word polios means white or shining and anthos means a flower, in allusion to the blooms of the common tuberose and the species name *tuberosa* has given as the plant being tuberous in nature. Therefore the common name tuberose derived from *tuberosa*, which actually is tuber-ose, not tube-rose. Tuberose is a fragrant night-blooming flower as can be witnessed from the various colloquial names used to describe it wherever it grows around the world.

Tuberose is half hardy, perennial, bulbous plant which grows 18-24 inches in height. It has long, bright green leaves clustered at the base of the plant and smaller, clasping leaves along the stem. The flowers grow on elongated spikes, produce clusters of fragrant waxy white flowers that bloom successively from the bottom towards the top of the spike. Each spike easily contains more than 30-60 flower buds based on the cultivar. Flowers have funnel shaped perianth, six stamens, numerous ovules. The fruit is a capsule. The flowers emit a strong scent that gets stronger during night time. The flowers are primarily night blooming, but bloom under the hot sun too.

Tuberoses are easy to grow and can be easily propagated through bulbs, and division of clumps whereas maximum commercial propagation is through bulbs. Bulbs are made of leaf bases and the stem remains concealed within scales. Roots are adventitious and shallow.

Tuberose is a native of Mexico from where it spread to different parts of the world during 16th Century. Tuberose cultivars are mainly three types - single, semi double and double. Single flowered cultivars are more fragrant and extensively used for essential oil extraction as the concrete percent has been observed to be more (0.08 to 0.11%) compared to double flowered cultivars. These are used as both loose and cut flowers. Its floral buds are greenish white where the colour turns to pure white by the time of flower opening.

The number of cultivars available in tuberose are relatively less as compared to other crops. Some of the popular single varieties, released by different research institutes and agricultural universities are Calcutta Single, Mexican Single, Phule Rajani, Rajath Rekha, Hyderabad single, Pune Single, Shringar, Prajwal etc., are being cultivated commercially.

For commercial flower production, the important objectives are increased flower production, quality of flowers and perfection in the form of plants. The quality of cut flowers is greatly influenced by climatic, geographical and nutritional factors. Tuberose requires high nutrient for proper growth and development and to achieve the escalating target of good quality tuberose production proper fertilization is the prime need. On the other hand, continuous use of inorganic fertilizers in crop field not only deteriorates the soil health but also reduces the soil microbial activities, soil organic content and may cause environmental imbalance (Alan *et al.*, 2007). In contrast, the use of green manures and other organic matter can improve soil structure, improve nutrient exchange and maintain soil health and that is why interests have been raising in organic farming (Mitra, 2010).

Organic farming system in India is not new and is being followed from ancient times. It is a method of farming system which primarily aims at cultivating the land and raising crops in such a way, as to keep the soil alive and in good health by use of organic wastes (crop, animal, farm wastes and aquatic wastes) and other biological materials along with beneficial microbes (bio-fertilizers) to release nutrients to crops for increased sustainable production in an eco-friendly, pollution free environment. Manures include bulky organic manures (Farmyard manure, compost, vermi-compost and green manure) and concentrated organic manures (oilcakes, blood meal, fish manure etc.). Manures with low nutrient content per unit quantity have longer residual effect besides improving soil physical properties compared to fertilizer with high nutrient content.

Organic manures, especially Oil cakes like neem cake, jatropa cake, mustard oil cake, castor cake etc. contain nematicidal properties. Also the application of organic manures can reduce the loss from nematodes by giving luxurious growth which can increase tolerance of the crop against nematode and also other pests. The use of organic manures may open a new vista to sustain or to reclaim the soil health without declining the crop yield if applied in proper doses. It is therefore, considered necessary to standardize the effective utilization of organic inputs for obtaining increased productivity, good quality spikes and excellent keeping quality of tuberose, on which very little work has so far been conducted.

Therefore, the present investigation entitled **"EFFECT OF ORGANIC MANURES ON GROWTH AND FLOWERING OF TUBEROSE (*Polianthes tuberosa*) Cv. PHULE RAJANI"** was set up with following objectives-

(i) To find out the effect of organic manures on vegetative growth of tuberose.

(ii) To study the effect of organic manures on flower yield of tuberose.

(iii) To study the effect of organic manures on bulb yield of tuberose.

(iv) To find out the most effective treatment for maximum flower yield and bulb production.

CHAPTER-2

REVIEW OF LITERATURES

REVIEW OF LITERATURE

Nutrition is very important aspect in crop management to get good yield and also quality product. The indiscriminate and continuous use of chemical fertilizers has lead to an imbalance of nutrients in soil which has adversely affected the soil health, affecting the yield and quality of the product. In contrast to that, the use of green manures and other organic matter can improve soil structure, improve nutrient exchange and maintain soil health and that is why interests have been raising in organic farming. Although very negligible work has been done to investigate the effect of organic manures on tuberose, the work of scientists on effect of organic manures on other flower crops has been reviewed and presented below:

2.1 Effect of organic manures on vegetative growth

2.1.1 Growth parameters

Atiyeh *et al.* (2000) stated that the relatively low concentration of vermicompost could promote plant growth in marigold.

The significant increase in plant height and leaf number in gladiolus in the plots treated with vermicompost @ 10 tonnes per hectare and 80% recommended NPK (100:60:60 kg per ha) was reported by Gangadharan and Gopinath, 2000.

Kusuma (2001) reported that the goldenrod plants supplied with vermicompost (10 tonnes per hectare) and 100% recommended NPK (100:50:50 kg per ha) produced highest plant height and maximum number of leaves.

Kukde *et al.* (2006) reported that bulb treatment of tuberose cv. Single, with Azotobacter and PSB at 2.5 g kg^{-1} and application of vermicompost @ 10 t per ha, gave maximum vegetative growth.

Parmar (2006) noted that the treatment 500g vermicompost per plant significantly increased plant height (133.78 cm), plant spread (68.33 cm), number of branches (9.69), number of shoots per plant (19.67), length of shoot (80.00 cm) in rose cv. Gladiator.

Chaitra and Patil (2007) observed significant increase in plant height, number of leaves, and number of branches, total dry matter production with the application of vermicompost @ 2.5 t per ha with 50% RDF in China aster .

Warade *et al.* (2007) observed that the vegetative growth of dahlia with respect to plant height, number of leaves per plant and plant spread were superior in the plots treated with 500 g vermicompost with 25 g PSB per plot.

Shankar *et al.* (2010) concluded that the application of vermicompost recorded maximum number of leaves and plant height, early basal floret opening, maximum spike length, number of florets per spike, diameter of basal floret, number of spikes per pant, number of spikes per hectare and weight of floret per spike.

Kabir *et al.* (2011) reported that plant height, number of leaves per plant, leaf length, breadth and number of side shoots per plant in tuberose cv. Single were more in plants applied with organic fertilizers along with half dose of chemical fertilizers than absolute use of chemical fertilizers.

Sandeep *et al.* (2011) revealed that the potting mixture comprising of vermicompost + coarse sand + soil (2:2:1) was found effective in enhancing the plant growth parameters *viz.*, plant height, plant spread, number of leaves per plant, number of branches per plant, stem diameter, leaf length and leaf width in cosmos.

Verma *et al.* (2011) stated that the treatment receiving *Azospirillum*, Phosphate solubilising bacteria, vermicompost and 50% recommended NPK recorded the highest plant height, number of branches, plant spread and dry matter accumulation.

Tripathi *et al.* (2012) reported that tuberose cv. Single treated with 75% recommended dose of NPK + 500 q FYM per ha + 250 q vermicompost per ha produced highest number of shoot per clump (18.95) and number of leaves per shoot (19.44).

Application of 75% N + 75% P + 100% K + VC @ 1.25 t per ha + castor cake @ 0.875 t per ha + Azotobacter @ 2 Kg per ha + PSB @ 22 Kg per ha in chrysanthemum cv. IIHR-6 recorded the maximum plant height, plant spread (NS, EW), number of branches and number of suckers. (Neelima *et al.*,2013).

Srivastava *et al.* (2014) reported that tuberose cv. Shringar recorded maximum plant height and number of leaves per plant with the use of 2 kg vermicompost per sq.m.

Meena *et al.* (2015) reported that in tuberose cv. Phule Rajani the maximum plant height (82.90 cm) was obtained by the application of neem cake 12 q per ha + vermicompost 20 q per ha + *Azotobacter* @ 2 g per plant + PSB @ 2 g per plant + 60% recommended dose of NPK through inorganic fertilizers.

Habib *et al.* (2016) reported that maximum plant height, growth, number of leaves per plant were obtained with the application of 10 ton vermicompost along with 50 percent recommended dose of fertilizer (RDF).

Suseela *et al.* (2016) reported that in tuberose cv. Suvasini maximum number of florets per spike was recorded by application of RDF 50% in combination with poultry manure 25% and neem cake 25%.

2.1.2 Bulb parameters

Kabir *et al.* (2011) revealed that bulb length and bulb diameter in tuberose cv. Single were greater in organic fertilizers along with half chemical fertilizers than absolute use of chemical fertilizers.

2.2 Effect of organic manures on Flowering characters

Chopde *et al.* (2007) found that flower quality and yield-contributing characters, *i.e.* length and diameter of spike, length of rachis, number of florets per spike, number of spikes per plant and yield of florets per hectare, were significantly increased with the application of vermicompost (2 t per ha) + *Azotobacter* + PSB (2.5 g per m^2).

Shankar *et al.* (2010) reported that tuberose cultivar Single when treated with vermicompost and PSB @ 1 kg/m^2 and 2 g/bulb respectively, produced highest spike length (77.70 and 77.86 cm, respectively) and maximum number of spikes per plant (1.49 and 1.49, respectively).

Sandeep *et al.* (2011) revealed that the potting mixture ratios treatment of vermicompost + coarse sand + soil (2:2:1) was found effective in enhancing the flowering parameters *viz.*, days to first bud initiation, bud diameter and bud length in cosmos.

Tripathi *et al.* (2012) observed that maximum spike yield (205030.71 spikes/ha) was obtained with the application of 75% recommended dose of NPK + 500q ha^{-1} FYM + 250q ha^{-1} Vermicompost in tuberose cv. Single.

Srivastava *et al.* (2014) reported that tuberose cv. Shrinagar recorded maximum rachis length with the use of 2 kg vermicompost per m^2.

Habib *et al.* (2015) found that spike length and rachis length were maximum with the application of 10 t vermicompost along with 50 percent recommended dose of fertilizer (RDF) in tuberose.

Rao *et al.* (2015) reported that tuberose cv. Hyderabad Double when treated with 75% RDF in integration with farm yard manure, vermicompost, Azospirillum and phosphate solubilising bacteria has significantly yielded maximum number of spikes per plant (2.33) with increased spike length, rachis length, number of florets per spike.

2.3 Quality parameters

Padaganur *et al.* (2005) reported that tuberose plants which received vermicompost either alone or in combination with ½ RDF were early to initiate flowering.

Parmar (2006) noted that treatment of vermicompost @ 500 g per plant significantly increased vase life (18.61 days) in rose cv. Gladiator.

Waheeduzzama *et al.* (2006) revealed that the treatment combination of vermicompost + 50% recommended dose of fertilizer recorded highest value for inflorescence longevity, number of days for exhibiting gloss loss and vase life in anthurium.

Srivastava *et al.* (2007) studied to determine the effect of *Azotobacter* and organic manures on the post harvest quality of tuberose (*Polianthes tuberosa*) cv. Double and found that vase life and water uptake were maximum in treatment combination of 5 t FYM/ha+3 t vermicompost/ha+*Azotobacter* .

Warade *et al.* (2007) observed that the growth of dahlia in respect of earliness of flowering were superior in the plants receiving 500 g vermicompost with 25 g PSB per plot.

Shankar *et al.* (2010) observed that tuberose cultivar Single when grown with vermicompost and PSB @ 1 kg/m^2 and 2 g/bulb, respectively, produced spikes with maximum longevity (15.69 and 15.80 days, respectively).

Application of the treatment 75% N + 75% P + 100% K + VC @ 1.25 t per ha + castor cake @ 0.875 t per ha + Azotobacter @ 2 Kg per ha + PSB @ 22 Kg per ha in chrysanthemum cv. IIHR-6 recorded the maximum shelf life of loose flower and vase life of cut flower, early flower bud initiation, first flower opening, longest flowering duration. (Neelima *et al.*, 2013)

Meena *et al.* (2015) observed that maximum flower duration (31.63 days) and spike durability in field (7.83 days) were obtained with the application of neem cake 12 q per ha + vermicompost 20 q per ha + *Azotobacter* @ 2 g per plant + PSB @ 2 g per plant + 60% recommended dose of NPK through inorganic fertilizers in tuberose cv. Phule Rajani.

Suseela *et al.* (2016) reported that in tuberose cv. Suvasini higher vase life was obtained with the application of 50% RDF in combination with 25% poultry manure along with 25% neem cake.

2.4 Effect of organic manures on Yield parameters

2.4.1 Flower yield

The significant increase in number of florets per spike in gladiolus in the plots treated with a combination of vermicompost @ 10 tonnes per hectare + 80% recommended NPK (100:60:60 kg per ha) was reported by Gangadharan and Gopinath (2000).

Plants applied with vermicompost (15 tonnes per hectare) + 100% recommended NPK in marigold produced maximum number of flowers per plant with greater flower diameter and flower yield as compared to the plants without vermicompost and fertilizer application (Mashaldi, 2000).

Kusuma (2001) reported that the goldenrod plants supplied with vermicompost (10 tonnes per hectare) and 100% recommended NPK (100:50:50 kg per ha) recorded maximum flower yield.

Chauhan *et al.* 2005 reported that maximum number of flower buds per plant, individual flower weight and flower yield per m^2 were recorded with application of vermicompost at 1000 g per m^2 in marigold.

Padaganur *et al.* (2005) found that higher flower spike yield was obtained with the application of 3 kg vermicompost per sq m along with 50 per cent RDF in tuberose.

Shashikanth *et al.* (2005) noticed that the application of vermicompost @ 5.0 t per ha along RDF had increased flower yield (13.9 t per ha) in marigold.

Parmar (2006) noted that the treatment of 500 g vermicompost per plant significantly increased diameter of flower (8.63 cm), number of petals per flower (76.50), fresh weight of flower (76.50 g), dry weight of flower (9.27 g), number of flowers per plant (98.39), number of flowers per ha (4,55,245.97) in rose cv. Gladiator.

Warade *et al.* (2007) observed that the growth of dahlia in respect of yield of flowers were superior in the plants receiving 500 g vermicompost with 25 g PSB per plot.

Sandeep *et al.* (2011) revealed that the potting mixture ratios treatment of vermicompost + coarse sand + soil (2:2:1) was found effective in enhancing the flowering parameters *viz.*, number of flowers per plant, flower diameter and stalk length in cosmos.

Verma *et al.* (2011) stated that the treatment receiving *Azospirillum*, Phosphate solubilising bacteria, vermicompost and 50% recommended NPK recorded the highest number of flowers per plant and flower yield in chrysanthemum.

Hadwani *et al.* (2013) reported that application of ½ RDF + Neem cake @ 1 t per ha + PSB @ 1 g per m^2+ *Azotobacter* @ 1 g per m^2 in tuberose recorded the maximum length of spike (78.00 cm), number of florets per spike (44.07), number of spikes per plant (4.26), number of spikes per net plot (127.67) and number of spikes per hectare (4.73 lacks).

Neelima *et al.* (2013) reported that the application of the treatment 75% N + 75% P + 100% K + VC @ 1.25 t per ha + castor cake @ 0.875 t per ha + Azotobacter @ 2 Kg per ha + PSB @ 22 Kg per ha recorded the maximum number of flower per plant, flower yield per ha and stalk length in chrysanthemum cv. IIHR-6.

Srivastava *et al.* (2014) reported that in tuberose cv. Shrinagar maximum yield of spikes per m^2 was observed with the use of 2 kg vermicompost per m^2.

Habib *et al.* (2015) reported that maximum yield of spikes per hectare were obtained with the application of 10 ton vermicompost along with 50 percent recommended dose of fertilizer (RDF).

Meena *et al.* (2015) reported that in tuberose cv. Phule Rajani the maximum spike length (58.43 cm), floret per spike (30.96), floret diameter (4.10 cm), spike per plant (2.98), ten floret weight (16.25), spike weight (53.26 g), spike per ha (3,31,111), were observed by the application of neem cake 12 q per ha + vermicompost 20 q per ha + *Azotobacter* @ 2 g per plant + PSB @ 2 g per plant + 60% recommended dose of NPK through inorganic fertilizers.

Shirsat *et al.* (2015) found that the highest number of flowers, spikes per plot and per ha were recorded maximum with the application of 50 % N through vermicompost + 50% N through urea + P and K (RDF).

2.4.2 Bulb yield

Shankar *et al.* (2010) observed that in tuberose cultivar Single when grown with vermicompost and PSB @ 1 kg/m^2 and 2 g/bulb, respectively, produced maximum weight of bulbs per plant, i.e. clump weight (283.58 and 295.90 g, respectively).

Kabir *et al.* (2011) reported that bulb production plant^{-1} in tuberose cv. Single were greater in organic fertilizers along with half chemical fertilizers than absolute use of chemical fertilizers.

Tripathi *et al.* (2012) reported that tuberose cv. Single treated with 75 % RDF + 500q FYM + 250q vermicompost/ha recorded the maximum number of bulbs/clump (7.70 and 7.767) maximum weight of bulb/clump (131.87 and 132.63g) highest bulb yield (52.60 and 53.10 tonnes/ ha).

Rao *et al.* (2014) reported that tuberose cv. Hyderabad Double when treated with 75% RDF in integration with farm yard manure, vermicompost, Azospirillum and phosphate solubilising bacteria has significantly yielded maximum number of bulbs per plant (32.60) and B: C ratio.

Meena *et al.* (2015) reported that in tuberose cv. Phule Rajani the maximum bulbs per plant (3.98), bulb per ha (4,42,222), gross return (Rs. 8,61,777 per ha), net return rupees (Rs. 6,20,000 per ha) and benefit per cost ratio (2.56) with highest trends were observed by the application of neem cake 12 q per ha + vermicompost 20 q per ha + *Azotobacter* @ 2 g per plant + PSB @ 2 g per plant + 60% recommended dose of NPK through inorganic fertilizers.

CHAPTER-3

MATERIALS & METHODS

MATERIALS AND METHODS

The field experiment was conducted during May 2015 to May 2016 at BTCC, Orissa University of Agriculture and Technology, Bhubaneswar, Odisha. Bhubaneswar is situated at 60 km away from the Bay of Bengal at an altitude of 25.5m above the mean sea level. Geographically it is located at 20°25′North latitude and 85°52′East latitude.

The experiment was conducted to study the effect of organic manures on growth and flowering of Tuberose (*Polianthes tuberosa* L.) cv. Phule Rajani. The observations on plant growth, flowering and bulb parameters were recorded.

3.1 Climate

Bhubaneswar comes under East and South Eastern Coastal Plain Zone and it experiences a hot and humid climate. The mean annual precipitation is 1505 mm, out of which 1293 mm is received within June to September and the rest 229 mm is received within October to May. The average maximum temperature ranges from 35°C to 40°C during May and June while the minimum temperature ranges from 13°C to 15°C during December and January. The relative humidity varies between 50% in summer and 90% in rainy season. The details of the weather conditions such as temperature, relative humidity under field conditions during the period of investigation have been presented in Appendix – I, as per the meteorological data recorded at the university observatory (field condition) situated near the experimental site.

3.2 Soil characteristics of the experimental site:

The soil of the experimental site is sandy loam in texture. The pH of the experimental site is alkaline and electrical conductivity is 0.28dS/m. The available N, P and K status of soil is high where as organic matter content is low. The physico – chemical properties of the soil of the experimental site is given in Appendix – II.

3.3 Weather Conditions during the Experimental Period

The experimental site is located in subtropical humid climate. The mean annual rainfall is 77.6 mm, average maximum temperature ranges from 37°C to 40°C during May and June while the minimum temperature ranges from 15°C to 17°C during December and January. The relative humidity varies between 55% in summer and 80% in rainy season.

3.4 Materials used

3.4.1 Manures:

As source of nutrients only organic manures were used to meet the nutritional needs of the crop. Among different organic manures, vermicompost, neem oil cake, mustard oil cake, karanja oil cake (Pongamia oil cake) and ground nut oil cake were used in different quantities and also in different combinations.

3.4.1.1 Vermicompost:

Vermicompost is a bulky organic manure. Bulky organic manures contain small percentage of nutrients and they are applied in large quantities. Farmyard manure (FYM), compost, vermicompost and green-manure are the most important and widely used bulky organic manures. Vermicompost is an organic manure produced as the vermicast by earth worm feeding on biological waste material; plant residues. This compost is an odourless, clean, organic material containing adequate quantities of N, P, K and several micronutrients essential for plant growth. It is eco-friendly, non-toxic, consumes low energy input for composting and is a recycled biological product.

3.4.1.2 Oil cakes:

Concentrated organic manures have higher nutrient content than bulky organic manure. The important concentrated organic manures are oilcakes, blood meal, fish manure etc. These are, therefore, relatively slow acting, but they supply available nitrogen for a longer period. After oil is extracted from oilseeds, the remaining solid portion is dried as cake which can, be used as manure. The oil cakes are of two types:

1. Edible oil cakes which can be safely fed to livestock; e.g.: Groundnut cake, Coconut cake etc.

2. Non edible oil cakes which are not fit for feeding livestock; e.g.: Castor cake, Neem cake, Mahua cake, Karanja oil cake (Pongamia oil cake) etc.

Both edible and non-edible oil cakes can be used as manures. However, edible oil cakes are fed to cattle and non-edible oil cakes are used as manures especially for horticultural crops. Nutrients present in oil cakes, after mineralization, are made available to crops 7 to 10 days after application. Oilcakes need to be well powdered before application for even distribution and quicker decomposition. Oil cakes can also act against some pests and pathogens.

3.4.1.3 Neem oil cake:

The neem cake is the main by-product of neem oil. It contains 1.07-1.30 percent sulphur. This is one of the most useful manures to crop as it adds organic matter and also acts as a nitrification inhibitor. It is very efficient in the management of insects and other pests. The cake contains salanin, nimbin, azadirachtin and azadiradione as the major components. The azadirachtin repels the insects, inhibit feeding and affect their hormonal balance. It also protects the crop from the attack of nematodes, soil grubs and white ants. The latest research indicates that more than 200 insect species could be controlled efficiently with application of neem cake. The neem cake contains 13% crude protein, 26-50% carbohydrate, 8-26% crude fibre, 5-18% ash and 1-17% acid insoluble ash.

3.4.1.4 Groundnut oil cake:

Ground nut cake is edible oil cake which is obtained from the seeds of groundnut after extraction of oil. It is rich in nutrients especially nitrogen and adds organic matter also. It also has pesticidal properties and it can help the plant in biotic stress.

3.4.1.5 Mustard oil cake:

Mustard oil cakes are the by-products of mustard oil seed crop. Mustard cake, more correctly known as mustard oil cake, is cheap and easy to break down and apply to the soil as a conditioner. In addition to reducing viruses and nematodes, mustard oil cake increases plant survival rate and yields.

3.4.1.6 Karanja oil cake:

The Karanja oil cake (Pongamia oil cake) manure are very good to use as organic fertilizers as they are a rich source of NPK and Karanjin, which improves soil fertility. The pressed cake when applied to the soil, also has pesticidal property, particularly against nematodes, and others similar pest. As a natural fertilizer, it can be mixed with neem cake pellets to give a better result.

Table-1: Average nutrient content of organic manures used for the experiment

Name of the manure	Manure type	Nutrient content (%)		
		N	P_2O_5	K_2O
Mustard oil cake	Concentrated manure-non edible oil-cake	6.1	1.8	1.5
Karanja oil cake (Pongamia oil cake)	Concentrated manure-non edible oil-cake	3.9	0.9	1.2
Neem oil cake	Concentrated manure-non edible oil-cake	5.4	1	1.4
Ground nut oil cake	Concentrated manure- edible oil-cake	7.3	1.5	1.3
Vermi-compost	Bulky organic manure	1.5-2.5	0.9-1.7	1.5-2.4

3.4.2 Plant material

Variety: Phule Rajani

Tuberose cv. Phule Rajani was chosen for this experiment. This cultivar was developed at Mahatma Phule Krishi Vidyapeeth, Pune in 2004. This variety bears greenish white colour buds, which is a special attribute. It flowers in 88 days and yield 8 spikes per bulb. The spikes measure 85cm long and have 48 flowers per spike. The flowers are 7.5 cm long which are larger as compared local single cultivars. The flower spikes exhibit 7 days vase life under ambient conditions. Phule Rajani is recommended both for loose and cut flower purpose.

3.5 Treatment details:

The experiment was laid out with ten treatments *viz.*, vermicompost, mustard oil cake, karanja oil cake (pongamia oil cake), neem oil cake and groundnut oil cake alone and in combination at different concentrations. In control, no nutrients were applied. The detailed information regarding different treatments are as follows:

Table-2: Details of treatments used

Sl. No.	Treatment	Symbol
1	Control (no organic manure)	T_1
2	Vermicompost @ 2 Kg/ m^2	T_2
3	Mustard oil cake @ 500 g/m^2	T_3
4	Karanja oil cake @ 500 g/m^2	T_4
5	Neem oil cake @ 500 g/m^2	T_5
6	Ground nut oil cake @ 500 g/m^2	T_6
7	Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250 g/m^2	T_7
8	Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250 g/m^2	T_8
9	Vermicompost @ 1Kg/m^2 + Neem oil cake @ 250 g/m^2	T_9
10	Vermicompost @ 1Kg/m^2 + Ground nut oil cake @ 250 g/m^2	T_{10}

3.6 Experimental details:

Name of the crop : Tuberose (*Polianthes tuberosa* L.)

Variety : Phule Rajani

No. of Treatments : 10

No. of Replications : 3

3.6.1 Experimental design and layout:

Design : Randomised Block Design

Size of individual plot : 1.5m x 1.5m

Spacing : 30 cm x 30 cm

Number of plants/plot : 25

Total number of plot : 30

Total population : 750

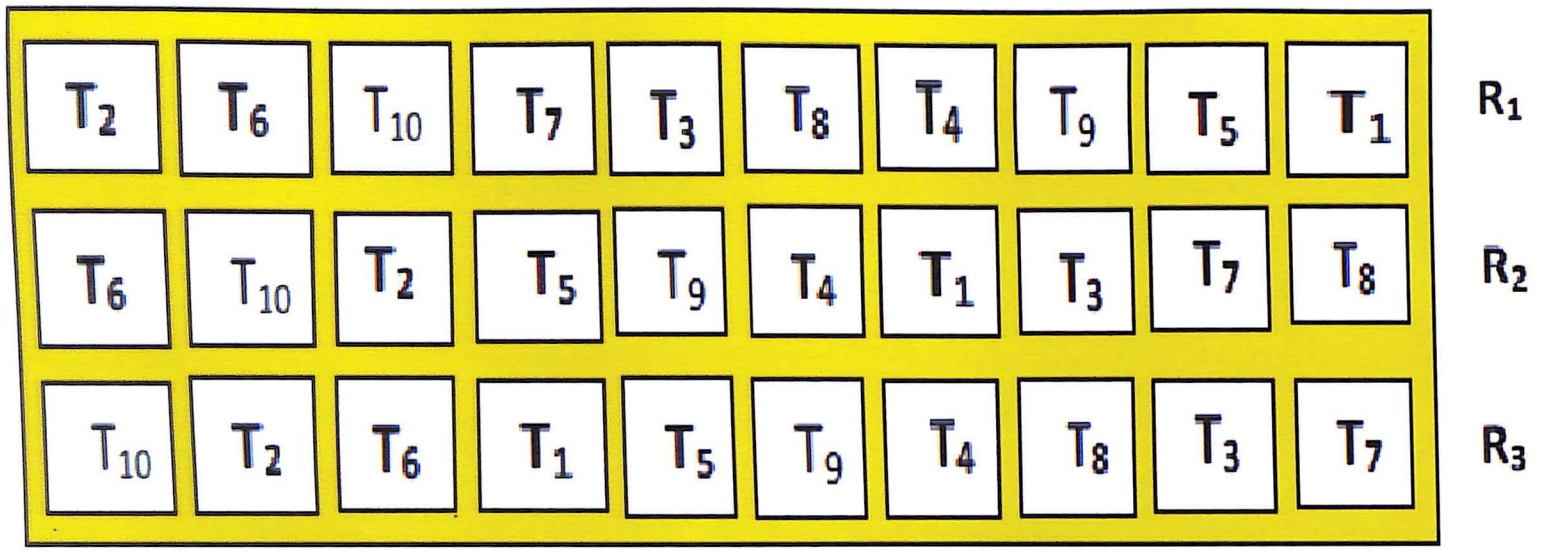
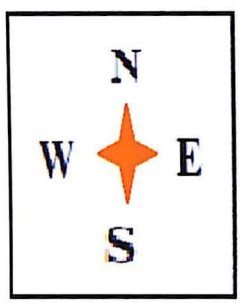


Figure-1: Plan of Layout of the Experimental plots



T_1 (Control)

T_2 (Vermicompost @ 2 kg/ m^2)

T_3 (Mustard oil cake @ 500g/m^2)

T_4 (Karanja oil cake @ 500g/m^2)

T_5 (Neem oil cake @ 500g/ m^2)

T_6 (Groundnut oil cake @ 500g/m^2)

T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2)

T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2)

T_9 (Vermicompost @ 1Kg/m^2 + Neem oil cake @ 250g/m^2)

T_{10} (Vermicompost @ 1Kg/m^2 + Groundnut oil cake @ 250g/m^2)

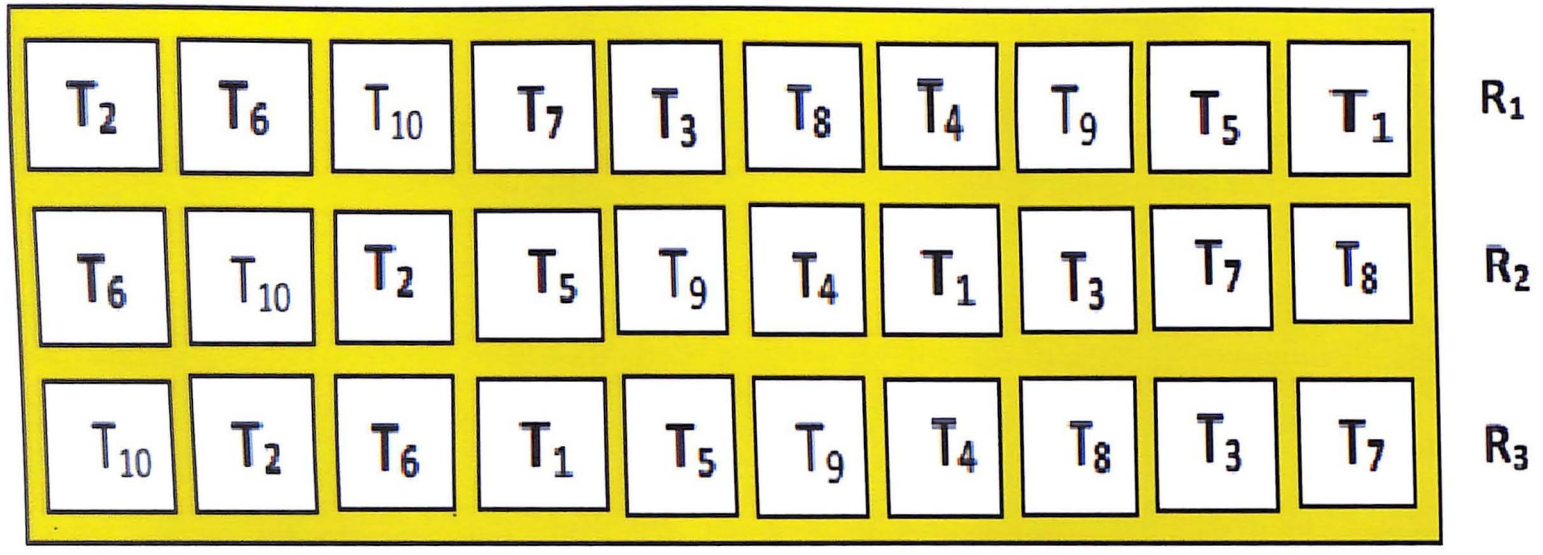
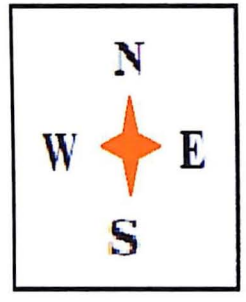


Figure-1: Plan of Layout of the Experimental plots



T_1 (Control)

T_2 (Vermicompost @ 2 kg/ m^2)

T_3 (Mustard oil cake @ 500g/m^2)

T_4 (Karanja oil cake @ 500g/m^2)

T_5 (Neem oil cake @ 500g/ m^2)

T_6 (Groundnut oil cake @ 500g/m^2)

T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2)

T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2)

T_9 (Vermicompost @ 1Kg/m^2 + Neem oil cake @ 250g/m^2)

T_{10} (Vermicompost @ 1Kg/m^2 + Groundnut oil cake @ 250g/m^2)



Fig 2. An overview of the experimental plot

3.7 Cultivation techniques

3.7.1 Land preparation, layout and planting

Prior to the commencement of the experiment, the entire site was ploughed thoroughly with power tiller several times followed by harrowing and was exposed to sun for a period of 1 month. The whole field was then divided into 30 plots in three rows of 10 each. In between the rows and columns a space of 1m was provided for ease of inter-cultural operations and recording of data. A light irrigation was given prior to planting. Medium sized healthy, disease and pest free bulbs were planted in the experimental plot.

3.7.2 Application of manures

Manures were applied and mixed in the soil thoroughly. The amount and type of manure applied were as per the treatment.

3.7.3 Irrigation

Throughout the growing season optimum soil moisture was maintained by giving irrigation at regular intervals according to need. In general, irrigation has given at 5-7 days interval in winter months, whereas during summer season it was at 2-3 days interval. Irrigation was done through drip lines.

3.7.4 Weeding

Weeding was done at regular interval and the total area was kept weed free during the period of experiment. Mostly, weeds were removed by hand with the help of implements like hand hoe, weeding pin, etc.

3.7.5 Plant protection

Plant protection chemicals were applied as and when any disease/pest is observed. No prophylactic plant protection measures were adopted by applying chemicals.

3.7.6 Harvesting of spike

Tuberose flowers all the year round. Peak flowering time is from the month of July onwards. Spikes were harvested at bud-burst stage when basal pair of florets have just opened. Harvesting was done manually in the morning time by giving clean slant cut at the base of the spike using sharp knife. Around 5cm basal portion of spike was left above the ground to allow the growth of bulb. Immediately after harvest the cut portion of the spike was immersed in a bucket containing water. Unwanted leaves on the spike were removed to minimize the transpiration loss.

3.7.7 Uprooting of bulb

Bulbs reach maturity at the cessation of flowering when the leaves become yellow. Irrigation was withheld when crop reached this stage and soil was allowed to dry. Harvesting of bulb was done by uprooting individual clumps manually by digging the soil. Then the bulbs were cleaned by removing the leaf portions and adhering soil.

3.7.8 Separation, curing, grading and storage of bulb

After lifting and cleaning, individual bulbs/offsets from each clump were separated out by hand. The bulbs were then graded into mother bulb, large (16g), medium (6g -16g) and small (6g) bulbs based on their size/weight cleaned and graded bulbs were spread on the floor and exposed to sun to dry or cure. The bulbs were stirred everyday to prevent fungal attack and rotting. After curing bulbs were stored in protected shady place with good aeration.

3.8 Observations recorded

The data were recorded on various parameters of growth, development, flowering and flower quality. Three plants were selected at random and tagged in each treatment and replication. The mean value of the observed data are presented.

3.8.1 Vegetative parameters

3.8.1.1 Plant height (cm)

Height of plant was measured in centimeter by using meter scale. All the leaves of the plant were brought together and the maximum height of the leaves was considered as the top end point to measure height. Collar region of the plant was taken as the basal end point. In this case the leaves which are too long from average were excluded. Plant height of three different plants, in a treatment, were measured and the mean was calculated.

3.8.1.2 Plant spread (cm)

The plant spread of the tagged plants were recorded as the horizontal distance between one end of the canopy to the other end with the help of a meter scale. It is recorded in centimeter. Mean of those three plants was taken as average plant spread of a particular plot. Plant spread of three different plants, in a treatment, were measured and the mean was calculated.

3.8.1.3 Number of leaves/Plant

Matured leaves from tagged plants were counted and recorded at monthly intervals. Immature leaves were excluded from the count. Number of leaves in three different plants, in a treatment were counted and the mean was calculated.

3.8.1.4 Number of bulblets/Plant

The number of bulblets per plant or clump was counted by uprooting one plant, at random, from each treatment. The bulblets were washed thoroughly to remove adhering soil particles. They were graded into three different categories *viz.* small, medium and large. The diameter (cm), length (cm) and weight (g) of individual bulblets were recorded separately in different categories and the mean data were presented.

3.8.1.5 Leaf length (cm)

Length of three randomly selected matured leaves from each tagged plant was measured by meter scale and recorded in centimeter at monthly intervals. Length was measured from the base of the leaf to tip. Care has been taken not to select the leaves which are too long or too short from the average height of the plant. Length of three leaves each, from three different plants, in a treatment, were measured and the mean was calculated.

3.8.1.6 Leaf breadth (cm)

Breadth of three matured leaves which were selected for the length from each tagged plant was measured visualizing the widest part around the centre by meter scale and recorded in centimeter at monthly intervals. Width of three leaves each, from three different plants, in a treatment, were measured and the mean was calculated.

3.8.1.7 Leaf Area (sq cm)

Leaf area of 3rd and 4th leaf was measured from each tagged plant by using Leaf Area Meter and plate of 250cm^2 size. The leaf area was expressed in square centimeter. Leaf area of two leaves each, from three different plants, in a treatment, were measured and the mean was calculated.

3.8.2 Floral parameters

3.8.2.1 Days taken for opening of first flower from planting

This observation was recorded by counting the number of days from the date of planting to the first flower opening, in each treatment, in the tagged plants.

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3.8.2.2 Spike length (cm)

Length of the spike was measured, when the spike was at exact stage to harvest, with the help of meter scale and unit used was centimeter. Length was taken from the point of spike emergence to the top most floret on spike. Three spikes from each plot were taken and their average length was recorded.

3.8.2.3 Rachis length (cm)

This is the flowering zone of the spike which was measured as the distance between lowermost floret to the uppermost floret and recorded in centimeter. Length of rachis was taken when the spike is at its harvesting stage. Three spikes from each plot were taken and their average length was recorded.

3.8.2.4 Number of spikes per plant

Total number of spikes harvested from the tagged plants were counted in each treatment. The average number of spikes per plant was calculated and presented.

3.8.2.5 Diameter of spike (cm)

Diameter of the spike was measured in centimeter with the help of a slide caliper. The measurements were taken in the middle portion of the spike. Three spikes from each plot were taken and their average diameter was recorded.

3.8.2.6 Number of florets per spike

The total number of florets present in a spike were counted and recorded. Number of florets present in three spikes, in each treatment and replication, were counted and the mean was calculated.

3.8.2.7 Floret length (cm)

The length of the individual floret including the petal spread was measured in centimeter using a slide calipers. Length of three florets from each spike was measured and the mean was calculated.

3.8.2.8 Floret width (cm)

The width of the floret from the randomly tagged three plants was measured, in each treatment and replication, with the help of a scale and was recorded in centimeters. Average width of three florets from each treatment and replication was measured and the mean was calculated.

3.8.2.9 Weight of twenty (20) florets

Randomly selected 20 florets were weighed by using electrical balance and the observations were recorded in grams.

3.8.2.10 Bloom life (days)

Bloom life of a spike indicates the time period from opening of first floret to the last floret of a particular spike in field condition. The bloom life of three spikes, in each treatment and replication, were counted and the mean was calculated.

3.8.2.11 Vase life (days)

For vase life observation, spikes were harvested early in the morning, when the basal pair of florets, on spike, have just opened. Spikes were cut with a sharp knife and the cut ends were immediately placed in a bucket containing clean water and brought to the laboratory. All spikes were cut to an equal length of 75cm and were kept in conical flask filled with 250ml of distilled water.

Vase life of spikes was measured by counting the days from the day when spike was kept in vase till its last floret opened. Three spikes from each treatment and replication were taken and the mean was calculated.

3.8.2.12 Water uptake by cut spike in vase (ml)

When spikes were kept for vase life in flask, the mouth of the flasks were sealed with non-absorbent parafilm to avoid water loss through evaporation. After the end of vase life, the quantity of water remaining in the flask was measured by using measuring cylinder. The amount of water absorbed by each spike was calculated by subtracting the quantity of water remaining in the flask from initial volume (250ml).

3.8.2.13 Flower yield

The flower yield was calculated and recorded as gram. The per plot yield was projected to per square meter.

3.8.3 Bulb parameters

3.8.3.1 Bulb length (cm)

Length of bulb was measured in centimeter by slide caliper and it was taken along the longitudinal axis of the bulb from basal disc to tip. Observations were recorded for the mother bulb and selected individual bulbs from each grade. Length of three bulbs, in each grade, were measured and the mean was calculated.

3.8.3.1 Bulb weight (g)

Weighing of bulb has done by using electrical balance. Weight of the whole clump, mother bulb and bulbs of different grades, in each treatment, were recorded separately. Weight of three bulbs, in each grade, were measured and the mean was calculated.

3.8.3.2 Circumference of the bulb (cm)

Circumference of the bulb of different grades, from each treatment and replication was measured by a thread and the same was again measured by a scale and recorded in centimeters. Circumference of three bulbs, in each grade, were measured and the mean circumference was calculated.

3.8.3.3 Bulb yield

Total clump weight of three samples from each plot was measured in grams. Then the mean is multiplied to the number of plants per plot to get bulb yield per plot. The per plot yield was projected to per square meter.

3.9 Statistical analysis

Randomized block design was used for the experiment and analyzed according to Fisher's analysis of variance technique. Level of significance employed in 'F' test was P=0.05. Critical differences were calculated for comparisons wherever 'F' tests were significant.

CHAPTER-4

RESULTS

CHAPTER-4

RESULTS

RESULTS

4.1 Plant height

It is evident from the data presented in the Table 3 that the plant height varied significantly among different treatments of organic manures. Plant height was increased significantly by application of all organic manures over control.

Among the different sole applications of organic manures, treatment T_4 (Karanja oil cake @ 500g/m^2) (51.41cm) showed highest plant height followed by treatment T_3 (Mustard oil cake @ 500g/m^2) (45.58 cm) which were statistically at par.

Among different combinations of mustard oil cake, karanja oil cake, neem oil cake and groundnut oil cake with vermicompost were used, the maximum plant height was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) (54.54 cm) followed by treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) (51.68 cm) and the treatment was statistically at par.

Among all the treatments i.e. application of organic manures either alone or in combinations, the combination in T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) exhibited highest plant height (54.54 cm) and the minimum plant height (40.23 cm) was observed in T_1 (Control) followed by T_9 (Vermicompost @ 1Kg/m^2 + Neem oil cake @ 250g/m^2) (43.51cm).

4.2 Plant spread (N-S)

The data presented in Table 3 revealed that the plant spread varied significantly among different treatments of organic manures. Plant spread (N-S) was significantly increased by application of all organic manures over control.

Among the different sole applications of organic manures, treatment T_3 (Mustard oil cake @ 500g/m^2) (42.63 cm) showed highest plant spread (N-S) followed by treatment T_4 (Karanja oil cake @ 500g/m^2) (40.98 cm) which were at par.

When different combinations of mustard oil cake, karanja oil cake, neem oil cake and groundnut oil cake with vermicompost were tried, the maximum plant spread (N-S) (44.84 cm) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) followed by treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) (44.16 cm) which was statistically at par.

Table 3. Effect of organic manures on plant height and plant spread (north-south and east-west) of tuberose (*Polianthes tuberosa* L.) cv. Phule Rajani

Treatments		Plant height (cm)*	Plant spread (N-S) (cm)*	Plant spread (E-W) (cm)*
T_1	Control (no organic manure)	40.23	33.42	30.03
T_2	Vermicompost @ 2 kg/ m^2	45.27	34.00	36.22
T_3	Mustard oil cake @ 500g/m^2	45.58	42.63	40.64
T_4	Karanja oil cake @ 500g/m^2	51.41	40.98	37.22
T_5	Neem oil cake @ 500g/m^2	43.63	34.62	35.47
T_6	Ground nut oil cake @ 500g/m^2	45.04	37.63	34.92
T_7	Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2	54.54	44.84	43.63
T_8	Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2	51.68	44.16	41.33
T_9	Vermicompost @ 1Kg/m^2 + Neem oil cake @ 250g/m^2	43.51	39.07	35.36
T_{10}	Vermicompost @ 1Kg/m^2 + Ground nut oil cake @ 250g/m^2	45.41	36.02	35.51
C.D. at 5%		6.193	2.388	2.755
SE(m) ±		2.949	1.137	1.311

*** Significant at 5%**

When the sole application and combinations of organic manures were compared, the combination of T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) showed highest plant spread (N-S) (44.84 cm) and the minimum plant spread (33.42 cm) was observed in T_1 (Control).

4.3 Plant spread (E-W)

The data presented in Table 3 revealed that the plant spread (E-W) varied significantly among different treatments of organic manures. Plant spread was significantly increased by application of all organic manures over control.

Among the different sole applications of organic manures, treatment T_3 (Mustard oil cake @ 500g/m^2) (40.64 cm) showed highest plant spread (E-W) followed by treatment T_4 (Karanja oil cake @ 500g/m^2) (37.22 cm).

When different combinations of mustard oil cake, karanja oil cake, neem oil cake and groundnut oil cake with vermicompost were used, the maximum plant spread (E-W) (43.63 cm) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) followed by treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) (41.33 cm) and the treatments were statistically at par.

When the sole application and combinations of organic manures were compared, the combination of T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) showed highest plant spread (E-W) (43.63 cm) and the minimum plant spread (30.03 cm) was observed in T_1 (Control).

4.4 Number of leaves/plant

The data presented in Table 4 revealed that the number of leaves varied significantly among different treatments of organic manures. Number of leaves was significantly increased by application of all organic manures over control.

Among the different sole applications of organic manures, treatment T_3 (Mustard oil cake @ 500g/m^2) (50.11) showed highest number of leaves followed by treatment T_4 (Karanja oil cake @ 500g/m^2) (48.66) and the treatments was statistically at par.

When different combinations of mustard oil cake, karanja oil cake, neem oil cake and groundnut oil cake with vermicompost were used, the maximum number of leaves (64.22) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) followed by treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) (53.11).

When the sole application and combinations of organic manures were compared, the combination of T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) showed maximum number of leaves (64.22) and the minimum number of leaves (47.22) was observed in T_1 (Control) followed by T_6 (Groundnut oil cake @ 500g/m^2) (47.66).

4.5 Leaf length (cm)

The data presented in Table 4 revealed that the leaf length varied significantly among different treatments of organic manures. Leaf length was significantly increased by application of all organic manures over control.

Among the different sole applications of organic manures, treatment T_3 (Mustard oil cake @ 500g/m^2) (47.74 cm) showed highest leaf length followed by treatment T_4 (Karanja oil cake @ 500g/m^2) (47.43 cm) and the treatments were statistically at par.

When different combinations of mustard oil cake, karanja oil cake, neem oil cake and groundnut oil cake with vermicompost were used, highest leaf length (48.67 cm) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) followed by treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) (45.20 cm) and the treatments were statistically at par.

When the sole application and combinations of organic manures were compared, the combination of T_7 (Vermicompost @ 1Kg/m^2 +Mustard oil cake @ 250g/m^2) showed highest leaf length (48.67 cm) and the minimum leaf length (39.32) was observed in T_1 (Control) followed by T_6 (Ground nut oil cake @ 500g/m^2) (41.78 cm).

4.6 Leaf width (cm)

The data presented in Table 4 revealed that the leaf breadth varied significantly among different treatments of organic manures. Leaf breadth was significantly increased by application of all organic manures over control.

Among the different sole applications of organic manures, treatment T_3 (Mustard oil cake@ 500g/ m^2) (1.52 cm) showed highest leaf breadth followed by treatment T_4 (Karanja oil cake @ 500g/m^2) (1.32 cm).

When different combinations of mustard oil cake, karanja oil cake, neem oil cake and groundnut oil cake with vermicompost were used, highest leaf breadth (1.66cm) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake

Table 4. Effect of organic manures on number of leaves/plant, leaf length, leaf width and leaf area of tuberose (*Polianthes tuberosa* L.) cv. Phule Rajani

Treatments		Number of leaves/plant*	Leaf length (cm)*	Leaf width (cm)*	Leaf area (sq cm)*
T_1	Control (no organic manure)	47.22	39.32	1.16	46.62
T_2	Vermicompost @ 2 kg/ m^2	48.55	46.84	1.24	52.76
T_3	Mustard oil cake @ 500g/m^2	50.11	47.74	1.52	69.28
T_4	Karanja oil cake @ 500g/m^2	48.66	47.43	1.32	64.21
T_5	Neem oil cake @ 500g/m^2	47.77	45.35	1.16	54.56
T_6	Ground nut oil cake @ 500g/m^2	47.66	41.78	1.20	57.56
T_7	Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2	64.22	48.67	1.66	80.16
T_8	Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2	53.11	45.20	1.54	71.75
T_9	Vermicompost @ 1Kg/m^2 + Neem oil cake @ 250g/m^2	48.55	43.59	1.21	52.83
T_{10}	Vermicompost @ 1Kg/m^2 + Ground nut oil cake @ 250g/m^2	52.44	44.27	1.37	62.57
C.D. at 5%		1.700	3.679	0.137	2.213
SE(m) ±		0.809	1.751	0.065	1.053

*** Significant at 5%**

@ 250g/m^2) followed by treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) (1.54 cm) and the treatment was statistically at par.

When the sole application and combinations of organic manures were compared, the combination of T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) showed highest leaf breadth (1.66 cm) and the minimum leaf breadth (1.16 cm) was observed in T_1 (Control) and T_5 (Neem oil cake @ 500g/m^2) followed by T_6 (Groundnut oil cake @ 500g/m^2) (1.20 cm).

4.7 Leaf area (sq cm)

The data presented in Table 4 revealed that the leaf area varied significantly among different treatments of organic manures. Leaf area was significantly increased by application of all organic manures over control.

Among the different sole applications of organic manures, treatment T_3 (Mustard oil cake @ 500g/ m^2) (69.28 sq cm) showed highest leaf area followed by treatment T_4 (Karanja oil cake @ 500g/m^2) (64.21 sq cm).

When different combinations of mustard oil cake, karanja oil cake, neem oil cake and groundnut oil cake with vermicompost were used, highest leaf area (80.16 sq cm) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) followed by treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) (71.75 sq cm).

When the sole application and combinations of organic manures were compared, the combination of T_7 (Vermicompost @ 1Kg/m^2 +Mustard oil cake @ 250g/m^2) showed highest leaf area (80.16 sq cm) and the minimum leaf area (46.62 sq cm) was observed in T_1 (Control) followed by T_2 (Vermicompost @ 2Kg/m^2) (52.76 sq cm).

4.8 Days taken for opening of first flower from planting

The data presented in the Table 5 indicated that the days taken for opening of first flower from planting varied significantly among different treatments of organic manures. Days taken for opening of first flower from planting was significantly decreased by application of all organic manures over control.

Among the different sole applications of organic manures, treatment T_3 (Mustard oil cake @ 500g/m^2) (149.88 days) showed minimum days taken for the opening of first flower from planting followed by treatment T_4 (Karanaja oil cake @ 500g/m^2) (151.33 days).

Table 5. Effect of organic manures on days taken for opening of first flower from planting, spike length, spike diameter and rachis length of tuberose (*Polianthes tuberosa* L.) cv. Phule Rajani

Treatments		Days taken for opening of first flower from planting*	Spike length (cm)*	Spike diameter (cm)*	Rachis length (cm)*
T_1	Control (no organic manure)	177.33	87.62	0.32	20.05
T_2	Vermicompost @ 2 kg/ m^2	165.33	92.36	0.41	22.62
T_3	Mustard oil cake @ 500g/m^2	149.88	97.36	0.52	26.52
T_4	Karanja oil cake @ 500g/m^2	151.33	92.55	0.44	23.56
T_5	Neem oil cake @ 500g/m^2	161.77	90.82	0.48	21.03
T_6	Ground nut oil cake @ 500g/m^2	168.77	95.16	0.47	21.22
T_7	Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2	150.33	94.11	0.44	22.58
T_8	Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2	158.55	91.48	0.49	25.74
T_9	Vermicompost @ 1Kg/m^2 + Neem oil cake @ 250g/m^2	172.33	91.96	0.42	22.22
T_{10}	Vermicompost @ 1Kg/m^2 + Ground nut oil cake @ 250g/m^2	162.88	92.75	0.44	23.25
C.D. at 5%		2.859	3.427	0.078	2.746
SE(m) ±		1.361	1.631	0.037	1.307

*** Significant at 5%**

When different combinations of mustard oil cake, karanja oil cake, neem oil cake and groundnut oil cake with vermicompost were used, minimum days taken for the early open of first flower from planting (150.33 days) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) followed by treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) (158.55 days).

When the sole application and combinations of organic manures were compared, treatment T_3 (Mustard oil cake @ 500g/m^2) showed minimum days for the early open of first flower from planting (149.88 days) and the maximum days (177.33 days) for the opening of first flower was observed inT_1 (control) followed by T_9 (Vermicompost @ 1Kg/m^2 + Neem oil cake @ 250g/m^2) (172.33 days).

4.9 Spike length (cm)

The data presented in Table 5 revealed that the spike length varied significantly among different treatments of organic manures. Spike length was significantly increased by application of all organic manures over control.

Among the different sole applications of organic manures, treatment T_3 (Mustard oil cake @ 500g/m^2) (97.36 cm) exhibited longest spike followed by treatment T_6 (Groundnut oil cake @ 500g/m^2) (95.16 cm) and the treatments were statistically at par.

When different combinations of mustard oil cake, karanja oil cake, neem oil cake and groundnut oil cake with vermicompost were used, the treatments were at par with each other.

When the sole application and combinations of organic manures were compared, treatment T_3 (Mustard oil cake @ 500g/m^2) showed highest spike length (97.36cm) and the minimum spike length (87.62 cm) was observed in T_1 (Control) followed T_5 (Neem oil cake @ 500g/m^2) (90.82 cm).

4.10 Diameter of spike (cm)

The data presented in Table 5 revealed that the diameter of spike varied significantly among different treatments of organic manures. Diameter of spike was significantly increased by application of all organic manures over control.

Among the different sole applications of organic manures, treatment T_3 (Mustard oil cake @ 500g/m^2) (0.52 cm) showed highest diameter of spike followed by treatment T_5 (Neem oil cake @ 500g/m^2) (0.48 cm) and the treatments were statistically at par.

When different combinations of mustard oil cake, karanja oil cake, neem oil cake and groundnut oil cake with vermicompost were used, highest diameter of spike (0.49 cm) was recorded in treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) followed by treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) (0.44 cm) and T_{10} (Vermicompost @ 1Kg/m^2 + Ground nut oil cake @ 250g/m^2@ 250g/m^2) (0.44 cm)and the treatments were statistically at par.

When the sole application and combinations of organic manures were compared, treatment T_3 (Mustard oil cake @ 500g/m^2) showed highest diameter of spike (0.52 cm) and the minimum diameter of spike (0.32 cm) was observed in T_1 (Control) followed T_2 (Vermicompost @ 2 kg/ m^2) (0.43 cm).

4.11 Rachis length (cm)

The data presented in Table 5 revealed that the rachis length varied significantly among different treatments of organic manures. Rachis length was significantly increased by application of all organic manures over control.

Among the different sole applications of organic manures, treatment T_3 (Mustard oil cake @ 500g/m^2) (26.52 cm) showed highest rachis length followed by treatment T_4 (Karanja oil cake @ 500g/m^2) (23.56 cm).

When different combinations of mustard oil cake, karanja oil cake, neem oil cake and groundnut oil cake with vermicompost were used, highest rachis length (25.74 cm) was recorded in treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) followed by treatment T_{10} (Vermicompost @ 1Kg/m^2 + Groundnut oil cake @ 250g/m^2) (23.25 cm)and the treatments was statistically at par.

When the sole application and combinations of organic manures were compared, treatment T_3 (Mustard oil cake @ 500g/m^2) showed highest rachis length (26.52 cm) and the minimum rachis length (20.05 cm) was observed in T_1 (control) followed byT_5 (Neem oil cake @ 500g/m^2) (21.03 cm).

4.12 Number of spike/plant

The data presented in Table 6 revealed that the number of spike/plant varied significantly among different treatments of organic manures. Number of spike/plant was significantly increased by application of all organic manures over control.

Among the different sole applications of organic manures, treatment T_4 Karanja oil cake @ 500g/m^2) (5.55) showed highest number of spike/plant followed by treatment T_3 (Mustard oil cake @ 500g/m^2) (4.66) and the treatments was statistically at par.

When different combinations of mustard oil cake, karanja oil cake, neem oil cake and groundnut oil cake with vermicompost were used, highest number of spike/plant (5.77) was recorded in treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) followed by treatment T_{10} (Vermicompost @ 1Kg/m^2+ Groundnut oil cake @ 250g/m^2) (5.11) and the treatments was statistically at par.

When the sole application and combinations of organic manures were compared, treatmentT_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) showed highest number of spike/plant (5.77) and the minimum number of spike/plant (4.00) was observed in T_1 (Control).

4.13 Number of florets/spike

The data presented in Table 6 revealed that the number of florets/spike varied significantly among different treatments of organic manures. Number of florets/spike was significantly increased by application of all organic manures over control.

Among the different sole applications of organic manures, treatment T_4 (Karanja oil cake @ 500g/m^2) (47.77) showed highest number of florets/spike followed by treatment T_3 (Mustard oil cake @ 500g/m^2) (46.22) and the treatments were statistically at par.

When different combinations of mustard oil cake, karanja oil cake, neem oil cake and groundnut oil cake with vermicompost were used, highest number of florets/spike (50.88) was recorded in treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) followed by treatment T_{10} (Vermicompost @ 1Kg/m^2 + Groundnut oil cake @ 250g/m^2) (43.22).

When the sole application and combinations of organic manures were compared, treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) showed highest number of florets/spike (50.88) and the minimum number of florets/spike (36.22) was observed in T_1 (Control) followed by T_6 (Groundnut oil cake @ 500g/m^2) (38.88).

4.14 Floret length (cm)

The data presented in Table 6 revealed that the floret length varied significantly among different treatments of organic manures. Floret length was significantly increased by application of all organic manures over control.

Among the different sole applications of organic manures, treatment T_4 (Karanja oil cake @ 500g/m^2) (5.78 cm) showed highest floret length followed by

Table 6. Effect of organic manures on number of spikes/plant, number of florets/spike, floret length and floret width of tuberose (*Polianthes tuberosa* L.) cv. Phule Rajani

Treatments		Number of spikes/plant*	Number of florets/spike*	Floret length (cm)*	Floret width (cm)*
T_1	Control (no organic manure)	4.00	36.22	4.85	2.82
T_2	Vermicompost @ 2 kg/ m^2	4.22	39.33	5.77	2.94
T_3	Mustard oil cake @ 500g/m^2	4.66	46.22	5.33	3.45
T_4	Karanja oil cake @ 500g/m^2	5.55	47.77	5.78	3.55
T_5	Neem oil cake @ 500g/m^2	4.44	43.00	5.27	3.18
T_6	Ground nut oil cake @ 500g/m^2	4.22	38.88	5.20	2.90
T_7	Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2	4.77	41.77	5.71	3.13
T_8	Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2	5.77	50.88	5.81	3.70
T_9	Vermicompost @ 1Kg/m^2 + Neem oil cake @ 250g/m^2	4.22	42.66	5.52	3.08
T_{10}	Vermicompost @ 1Kg/m^2 + Ground nut oil cake @ 250g/m^2	5.11	43.22	5.53	3.26
C.D. at 5%		0.995	2.347	0.228	0.245
SE(m) ±		0.473	1.117	0.108	0.116

*** Significant at 5%**

treatment T_2 (Vermicompost @ 2 kg/m^2) (5.77 cm) and the treatments were statistically at par.

When different combinations of mustard oil cake, karanja oil cake, neem oil cake and groundnut oil cake with vermicompost were used, highest floret length (5.81cm) was recorded in treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) followed by treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) (5.71 cm) and the treatments were statistically at par.

When the sole application and combinations of organic manures were compared, treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) showed highest floret length (5.81 cm) and the minimum floret length (4.85 cm) was observed in T_1 (Control), followed byT_6 (Groundnut oil cake @ 500g/m^2) (5.20 cm).

4.15 Floret width (cm)

The data presented in Table 6 revealed that the floret width varied significantly among different treatments of organic manures. Floret width was significantly increased by application of all organic manures over control.

Among the different sole applications of organic manures, treatment T_4 (Karanja oil cake @ 500g/m^2) (3.55 cm) showed highest floret width followed by treatment T_3 (Mustard oil cake @ 500g/m^2) (3.45 cm) and the treatments were statistically at par.

When different combinations of mustard oil cake, karanja oil cake, neem oil cake and groundnut oil cake with vermicompost were used, highest floret width (3.70 cm) was recorded in treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) followed by treatment T_{10} (Vermicompost @ 1Kg/m^2 + Groundnut oil cake @ 250g/m^2) (3.26 cm).

When the sole application and combinations of organic manures were compared, treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) showed highest floret width (3.70 cm) and the minimum floret width (2.82 cm) was observed in T_1 (Control) followed T_6 (Groundnut oil cake @ 500g/m^2) (2.90 cm).

4.16 Bloom life (days)

The data presented in Table 7 revealed that the bloom life varied significantly among different treatments of organic manures. Bloom life was significantly increased by application of all organic manures over control.

Among the different sole applications of organic manures, treatment T_3 (Mustard oil cake @ 500g/m^2) (21.66 days) showed maximum bloom life followed by

treatment T_5 (Neem oil cake @ 500g/ m^2) (21.55 days) and the treatments were statistically at par.

When different combinations of mustard oil cake, karanja oil cake, neem oil cake and groundnut oil cake with vermicompost were used, maximum bloom life (22.22 days) was recorded in treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) followed by treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) (20.88 days) and the treatments were statistically at par.

When the sole application and combinations of organic manures were compared, treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) showed maximum bloom life (22.22 days) and the minimum bloom life (17.11 days) was observed in T_1 (Control) followed by T_9 (Vermicompost @ 1Kg/m^2 + Neem oil cake @ 250g/m^2) (17.66 days).

4.17 Vase life (days)

The data presented in Table 7 revealed that the vase life varied significantly among different treatments of organic manures. Vase life was significantly increased by application of all organic manures over control.

Among the different sole applications of organic manures, treatment T_2 (Vermicompost @ 2 Kg/m^2) (13.44 days) showed maximum vase life followed by treatment T_5 (Neem oil cake @ 500g/m^2) (12.88 days) and the treatments were statistically at par.

When different combinations of mustard oil cake, karanja oil cake, neem oil cake and groundnut oil cake with vermicompost were used, maximum vase life (15.77 days) was recorded in treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) followed by treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) (13.55 days)and the treatments were statistically at par.

When the sole application and combinations of organic manures were compared, treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) showed maximum vase life (15.77 days) and the minimum vase life (9.55 days) was observed in T_1 (Control) followed by T_3 (Mustard oil cake @ 500g/m^2) (10.77 days) and T_9 (Vermicompost @ 1Kg/m^2 + Neem oil cake @ 250g/m^2) (10.77 days).

Table 7. Effect of organic manures on bloom life, vase life and water uptake in vase of tuberose (*Polianthes tuberosa* L.) cv. Phule Rajani

Treatments		Bloom life (days)*	Vase life (days)*	Water uptake in vase (ml)*
T_1	Control (no organic manure)	17.11	9.55	36.22
T_2	Vermicompost @ 2 kg/ m^2	20.00	13.44	46.11
T_3	Mustard oil cake @ 500g/m^2	21.66	10.77	39.33
T_4	Karanja oil cake @ 500g/m^2	20.33	12.55	41.22
T_5	Neem oil cake @ 500g/m^2	21.55	12.88	42.55
T_6	Ground nut oil cake @ 500g/m^2	19.22	9.77	37.66
T_7	Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2	20.88	13.55	46.88
T_8	Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2	22.22	15.77	51.33
T_9	Vermicompost @ 1Kg/m^2 + Neem oil cake @ 250g/m^2	17.66	10.77	39.44
T_{10}	Vermicompost @ 1Kg/m^2 + Ground nut oil cake @ 250g/m^2	20.55	11.88	40.55
C.D. at 5%		1.660	2.268	1.721
SE(m) ±		0.790	1.08	0.819

*** significant at 5%**



Fig 3. Vase life studies in Tuberose cv. Phule Rajani

4.18 Water uptake by cut spike in vase (ml)

The details in Table 7 indicated that the Water uptake by cut spike in vase varied significantly among different treatments of organic manures. Water uptake by cut spike in vase was significantly increased by application of organic manures over control.

Among the different sole applications of organic manures, treatment T_2 (Vermicompost @ 2 kg/m^2) showed highest water uptake by cut spike in vase of (46.1ml) followed by treatment T_5 (Neem oil cake @ 500g/m^2) (42.5 ml).

When different combinations of mustard oil cake, karanja oil cake, neem oil cake and groundnut oil cake with vermicompost were used, the maximum water uptake by cut spike in vase was recorded highest in treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) (51.3 ml) followed by treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) (46.8 ml).

When the sole application and combinations of organic manures were compared,the sole application of T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) showed highest water uptake by cut spike in vase (51.3 ml) and the minimum of (36.2 ml)was observed in control (T_1) followed by T_6 (Groundnut oil cake @ 500g/m^2) (37.6 ml).

4.19 Number of bulbs/plant

The data presented in Table 8 revealed that the number of bulbs/plant varied significantly among different treatments of organic manures. Number of bulbs/plant was significantly increased by application of all organic manures over control.

Among the different sole applications of organic manures, treatment T_4 (Karanja oil cake @ 500g/m^2) (15.77) showed highest number of bulbs/plant followed by treatment T_3 (Mustard oil cake @ 500g/m^2) (13.55) and the treatments were statistically at par.

When different combinations of mustard oil cake, karanja oil cake, neem oil cake and groundnut oil cake with vermicompost were used, the maximum number of bulbs/plant (16.33) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) followed by treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) (15.33) which was statistically at par.

When the sole application and combinations of organic manures were compared, the combination of T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @

Table 8. Effect of organic manures on number of bulbs/plant, total bulb weight of bulb of tuberose (*Polianthes tuberosa* L.) cv. Phule Rajani

Treatments		Number of bulbs/plant*	Total bulb weight (g)*
T_1	Control (no organic manure)	10.44	83.90
T_2	Vermicompost @ 2 kg/ m^2	11.11	111.93
T_3	Mustard oil cake @ 500g/m^2	13.55	225.93
T_4	Karanja oil cake @ 500g/m^2	15.77	159.30
T_5	Neem oil cake @ 500g/m^2	13.11	101.96
T_6	Ground nut oil cake @ 500g/m^2	11.11	117.26
T_7	Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2	16.33	304.76
T_8	Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2	15.33	167.76
T_9	Vermicompost @ 1Kg/m^2 + Neem oil cake @ 250g/m^2	12.88	140.13
T_{10}	Vermicompost @ 1Kg/m^2 + Ground nut oil cake @ 250g/m^2	12.77	137.03
C.D. at 5%		2.428	2.816
SE(m) ±		1.156	1.340

***Significant at 5%**

250g/m^2) showed maximum number of bulbs/plant (16.33) and the minimum number of bulbs/plant (10.44) was observed in T_1 (Control) followed by T_2 (Vermicompost @ 2 kg/ m^2) (11.11) and T_6 (Groundnut oil cake @ 500g/m^2) (11.11).

4.20 Total bulb weight (g)

The data presented in Table 8 revealed that the total bulb weight varied significantly among different treatments of organic manures. Total bulb weight was significantly increased by application of all organic manures over control.

Among the different sole applications of organic manures, treatment T_3 (Mustard oil cake @ 500g/m^2) (225.93 g) showed highest total bulb weight followed by treatment T_4 (Karanja oil cake @ 500g/m^2) (159.30 g).

When different combinations of mustard oil cake, karanja oil cake, neem oil cake and groundnut oil cake with vermicompost were used, total bulb weight (304.76 g) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) followed by treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) (167.76 g).

Among all treatment combinations, treatment T_7 (Vermicompost @ 1Kg/m^2 +Mustard oil cake @ 250g/m^2) showed highest total bulb weight (304.76 g) and the minimum total bulb weight (83.90 g) was observed in T_1 (Control) followed by T_5 (Neem oil cake @ 500g/ m^2) (111.93 g).

4.21 Individual weights of bulbs (g)

The given Table 9 reveals that the treatments showed significant effect on the average individual weight of bulbs.

4.21.1 Small bulb

Among the different sole applications of organic manures, treatment T_3 (Mustard oil cake @ 500g/m^2) (16.70 g) showed highest average weight in small bulb grade followed by treatment T_4 (Karanja oil cake @ 500g/m^2) (13.46 g).

When different combinations of mustard oil cake, karanja oil cake, neem oil cake and groundnut oil cake with vermicompost were used, highest average weight in small bulb grade (17.90 g) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) followed by treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) (15.06 g).

Among all treatment combinations of organic manures, treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) showed highest average

Table 9. Effect of organic manures on average individual weight of bulb of tuberose (*Polianthes tuberosa* L.) cv. Phule Rajani

Treatments		Individual bulb weight (g)*		
		Small	Medium	Large
T_1	Control (no organic manure)	10.50	16.76	29.50
T_2	Vermicompost @ 2 kg/ m^2	11.56	18.33	42.46
T_3	Mustard oil cake @ 500g/m^2	16.70	27.10	58.40
T_4	Karanja oil cake @ 500g/m^2	13.46	22.30	58.06
T_5	Neem oil cake @ 500g/m^2	11.20	17.40	33.66
T_6	Ground nut oil cake @ 500g/m^2	11.51	17.70	50.66
T_7	Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2	17.90	29.96	61.06
T_8	Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2	15.06	24.10	58.10
T_9	Vermicompost @ 1Kg/m^2 + Neem oil cake @ 250g/m^2	12.56	21.43	57.40
T_{10}	Vermicompost @ 1Kg/m^2 + Ground nut oil cake @ 250g/m^2	11.53	19.00	51.83
C.D. at 5%		1.405	1.905	1.806
SE(m) ±		0.669	0.907	0.86

*** Significant at 5%**

weight in small bulb category (17.90 g) and the minimum bulb weight (10.50 g) was observed in T_1 (Control) followed by T_5 (Neem oil cake @ 500g/ m^2) (11.20 g).

4.21.2 Medium bulb

Among the different sole applications of organic manures, treatment T_3 (Mustard oil cake @ 500g/m^2) (27.10 g) showed highest average weight of medium bulb followed by treatment T_4 (Karanja oil cake @ 500g/m^2) (22.30 g).

When different combinations of mustard oil cake, karanja oil cake, neem oil cake and groundnut oil cake with vermicompost were used, highest average weight in medium bulb grade (29.96 g) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) followed by treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) (24.10 g).

Among all treatment combinations of organic manures, treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) showed highest average weight of bulb (29.96 g) and the minimum bulb weight (16.76 g) was observed in T_1 (Control) followed by T_5 (Neem oil cake @ 500g/ m^2) (17.40 g) in the medium bulb grade.

4.21.3 Large bulb

Among the different sole applications of organic manures, treatment T_3 (Mustard oil cake @ 500g/m^2) (58.40 g) showed highest average weight of bulb in large bulb grade followed by treatment T_4 (Karanja oil cake @ 500g/m^2) (58.06 g) which was at par.

When different combinations of mustard oil cake, karanja oil cake, neem oil cake and groundnut oil cake with vermicompost were used, highest average weight of bulb (61.06 g) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) followed by treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) (58.10 g) in large bulb grade.

When the sole application and combinations of organic manures were compared, treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) showed maximum average bulb weight (61.06 g) and the minimum bulb weight (29.50 g) was observed in T_1 (Control) followed by T_5 (Neem oil cake @ 500g/ m^2) (33.66 g) in large bulb grade.



Fig 4. **Tuberose bulb influenced by application of organic manures**

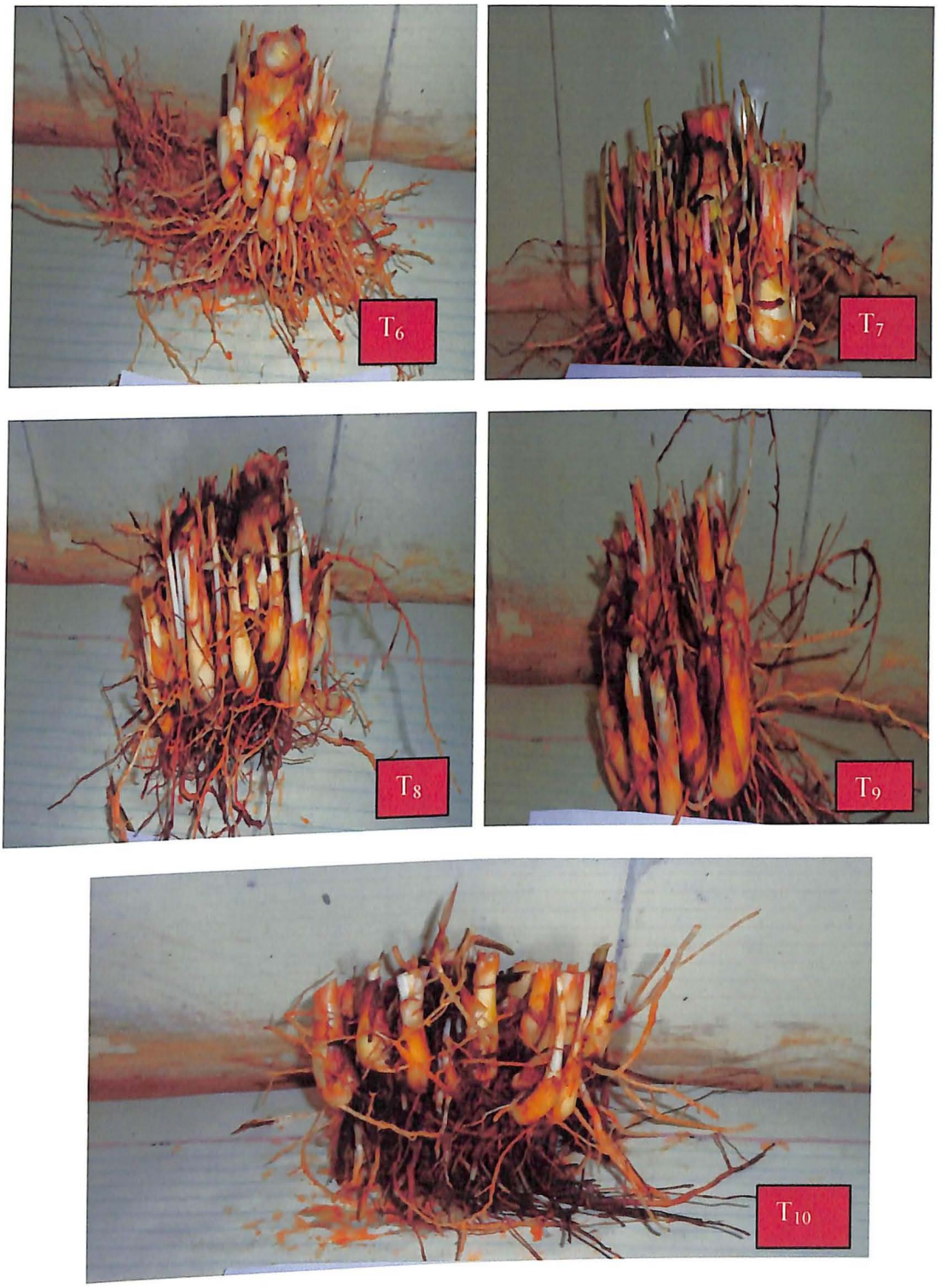


Fig 5. Tuberose bulb influenced by application of organic manures

4.22 Average bulb circumference (cm)

The data given in Table 10 revealed that the different treatments of organic manures showed significant effect on average circumference of bulbs.

4.22.1 Small bulb

Among the different sole applications of organic manures, treatment T_3 (Mustard oil cake @ 500g/m^2) (5.58 cm) showed highest average circumference in small bulb category followed by treatment T_6 (Groundnut oil cake @ 500g/m^2) (5.44 cm) which is statistically at par.

When different combinations of mustard oil cake, karanja oil cake, neem oil cake and groundnut oil cake with vermicompost were used, highest average circumference in small bulb category (5.59 cm) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 +Mustard oil cake @ 250g/m^2) followed by treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) (5.54 cm) which was statistically at par.

When the sole application and combinations of organic manures were compared, treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) showed highest average circumference in small bulb grade (5.59 cm) and the minimum small bulb circumference (3.45 cm) was observed in T_1 (Control) followed by T_5 (Neem oil cake @ 500g/ m^2) (4.29 cm).

4.22.2 Medium bulb

Among the different sole applications of organic manures, treatment T_3 (Mustard oil cake @ 500g/m^2) (7.74 cm) showed highest average circumference in medium bulb grade followed by treatment T_4 (Karanja oil cake @ 500g/m^2) (6.69 cm).

When different combinations of mustard oil cake, karanja oil cake, neem oil cake and groundnut oil cake with vermicompost were used, highest average circumference in medium bulb category (7.83 cm) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) followed by treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) (7.64 cm).

Among all treatment combinations, treatment T_7 (Vermicompost @ 1Kg/m^2 +Mustard oil cake @ 250g/m^2) showed highest average circumference in medium bulb (7.83 cm) and the minimum medium bulb circumference (5.29 cm) was observed in T_1 (Control) followed by T_5 (Neem oil cake @ 500g/ m^2) (5.44 cm).

Table 10. Effect of organic manures on circumference of bulb of tuberose (*Polianthes tuberosa* L.) cv. Phule Rajani

Treatments		Average bulb circumference (cm)*			
		Small	Medium	Large	Mother
T_1	Control (no organic manure)	3.45	5.29	8.32	10.22
T_2	Vermicompost @ 2 kg/ m^2	4.50	5.54	8.53	10.67
T_3	Mustard oil cake @ 500g/m^2	5.58	7.74	9.73	13.18
T_4	Karanja oil cake @ 500g/m^2	4.91	6.69	9.43	12.76
T_5	Neem oil cake @ 500g/m^2	4.29	5.44	8.44	10.36
T_6	Ground nut oil cake @ 500g/m^2	5.44	5.75	8.89	11.09
T_7	Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2	5.59	7.83	9.88	14.02
T_8	Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2	5.54	7.64	9.53	12.87
T_9	Vermicompost @ 1Kg/m^2 + Neem oil cake @ 250g/m^2	5.02	6.28	9.11	11.82
T_{10}	Vermicompost @ 1Kg/m^2 + Ground nut oil cake @ 250g/m^2	5.01	6.17	8.90	11.19
C.D. at 5%		0.451	0.412	0.548	0.288
SE(m) ±		0.214	0.196	0.260	0.137

*** Significant at 5%**

4.22.3 Large bulb

Among the different sole applications of organic manures, treatment T_3 (Mustard oil cake @ 500g/m^2) (9.73 cm) showed highest average circumference in large bulb grade followed by treatment T_4 (Karanja oil cake @ 500g/m^2) (9.43 cm) which was statistically at par.

When different combinations of mustard oil cake, karanja oil cake, neem oil cake and groundnut oil cake with vermicompost were used, highest average circumference in large bulb grade (9.88 cm) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) followed by treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) (9.53 cm) which was statistically at par.

When the sole application and combinations of organic manures were compared, treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) showed highest average bulb circumference in large bulb grade (9.88 cm) and the minimum large bulb circumference (8.32 cm) was observed in T_1 (Control) followed by T_5 (Neem oil cake @ 500g/ m^2) (8.44 cm).

4.22.4 Mother bulb

Among the different sole applications of organic manures, treatment T_3 (Mustard oil cake @ 500g/m^2) (13.18 cm) showed highest average circumference of mother bulb followed by treatment T_4 (Karanja oil cake @ 500g/m^2) (12.76 cm).

When different combinations of mustard oil cake, karanja oil cake, neem oil cake and groundnut oil cake with vermicompost were used, highest average circumference of mother bulb (14.02 cm) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) followed by treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) (12.87 cm).

When the sole application and combinations of organic manures were compared, treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) showed highest average circumference of mother bulb (14.02 cm) and the minimum mother bulb circumference (10.22 cm) was observed in T_1 (Control) followed by T_5 (Neem oil cake @ 500g/ m^2) (10.36 cm).

4.23 Average bulb length (cm)

The data given in Table 11 revealed that the different treatments of organic manures showed significant effect on average length of bulbs.

4.23.1 Small bulbs

Among the different sole applications of organic manures, treatment T_3 (Mustard oil cake @ 500g/m^2) (3.56 cm) exhibited highest bulbs length in small grade followed by treatment T_4 (Karanja oil cake @ 500g/m^2) (3.33 cm).

Among different combinations of mustard oil cake, karanja oil cake, neem oil cake and groundnut oil cake with vermicompost, longest bulb, in small grade was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 +Mustard oil cake @ 250g/m^2) (3.66 cm) followed by treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) (3.53 cm) which was statistically at par.

Among the sole application and combinations of organic manures, treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) recorded longest bulb (3.66 cm) and the smallest (2.36 cm) was observed in T_1 (Control) followed by T_5 (Neem oil cake @ 500g/ m^2) (2.60 cm) in small bulb grade.

4.23.2 Medium bulb

Among the different sole applications of organic manures, treatment T_3 (Mustard oil cake @ 500g/m^2) (3.90 cm) showed highest average length in medium bulb grade followed by treatment T_4 (Karanja oil cake @ 500g/m^2) (3.50 cm).

Among different combinations of mustard oil cake, karanja oil cake, neem oil cake and groundnut oil cake with vermicompost, highest average length in medium bulb grade (3.96 cm) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) followed by treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) (3.83 cm) which was statistically at par.

Among the sole application and combinations of organic manures, treatment T_7 (Vermicompost @ 1Kg/m^2 +Mustard oil cake @ 250g/m^2) showed highest average bulb length in medium grade (3.96 cm) and the minimum bulb length in this grade (2.53 cm) was observed in T_1 (Control) followed by T_5 (Neem oil cake @ 500g/ m^2) (2.70 cm).

Table 11. Effect of organic manures on length of bulbs of tuberose (*Polianthes tuberosa* L.) cv. Phule Rajani

Treatments		Average bulb length (cm)*			
		Small	Medium	Large	Mother
T_1	Control (no organic manure)	2.36	2.53	2.76	3.40
T_2	Vermicompost @ 2 kg/ m^2	2.96	3.03	3.36	3.50
T_3	Mustard oil cake @ 500g/m^2	3.56	3.90	4.10	4.50
T_4	Karanja oil cake @ 500g/m^2	3.33	3.50	3.90	4.36
T_5	Neem oil cake @ 500g/m^2	2.60	2.70	3.10	3.41
T_6	Ground nut oil cake @ 500g/m^2	3.10	3.20	3.36	3.60
T_7	Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2	3.66	3.96	4.23	5.10
T_8	Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2	3.53	3.83	4.06	4.36
T_9	Vermicompost @ 1Kg/m^2 + Neem oil cake @ 250g/m^2	3.10	3.46	3.83	4.10
T_{10}	Vermicompost @ 1Kg/m^2 + Ground nut oil cake @ 250g/m^2	3.10	3.46	3.70	4.03
C.D. at 5%		0.145	0.165	0.177	0.184
SE(m) ±		0.069	0.078	0.084	0.087

*** Significant at 5%**

4.23.3 Large bulb

Among the different sole applications of organic manures, treatment T_3 (Mustard oil cake @ 500g/m^2) (4.10 cm) showed highest average length in large bulb category followed by treatment T_4 (Karanja oil cake @ 500g/m^2) (3.90 cm).

Among different combinations of mustard oil cake, karanja oil cake, neem oil cake and groundnut oil cake with vermicompost, highest average length in large bulb category (4.23 cm) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) followed by treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) (4.06 cm) which was statistically at par.

Among the sole application and combinations of organic manures, treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) showed highest average length in large bulb category (4.23 cm) and the minimum bulb length (2.76 cm) was observed in T_1 (Control) followed by T_5 (Neem oil cake @ 500g/ m^2) (3.10 cm).

4.23.4 Mother bulb

Among the different sole applications of organic manures, treatment T_3 (Mustard oil cake @ 500g/m^2) (4.50 cm) showed highest average length of mother bulb followed by treatment T_4 (Karanja oil cake @ 500g/m^2) (4.36 cm) which was statistically at par.

Among different combinations of mustard oil cake, karanja oil cake, neem oil cake and groundnut oil cake with vermicompost, highest average length of mother bulb (5.10 cm) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) followed by treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) (4.36 cm).

When the sole application and combinations of organic manures were compared, treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) showed highest average length of mother bulb (5.10 cm) and the minimum mother bulb length (3.40 cm) was observed in T_1 (Control) followed by T_5 (Neem oil cake @ 500g/ m^2) (3.41 cm).

4.24 Floret weight

The data presented in the table 12 revealed that the effect of different treatments of organic manures on individual floret weight was non-significant.

Table 12. Effect of organic manures on floret weight, flower yield and bulb yield of tuberose (*Polianthes tuberosa* L.) cv. Phule Rajani

Treatments		Avg. Floret weight (g)	Flower yield/ (g/m^2)*	Bulb yield/ (g/m^2)*
T_1	Control (no organic manure)	0.84	1352.71	134.43
T_2	Vermicompost @ 2 kg/ m^2	0.86	1586.08	234.02
T_3	Mustard oil cake @ 500g/m^2	0.87	2076.73	401.91
T_4	Karanja oil cake @ 500g/m^2	0.86	2534.09	212.47
T_5	Neem oil cake @ 500g/m^2	0.86	1825.17	189.57
T_6	Ground nut oil cake @ 500g/m^2	0.85	1468.96	145.15
T_7	Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2	0.83	1838.32	434.67
T_8	Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2	0.85	2773.38	234.63
T_9	Vermicompost @ 1Kg/m^2 + Neem oil cake @ 250g/m^2	0.84	1593.04	202.07
T_{10}	Vermicompost @ 1Kg/m^2 + Ground nut oil cake @ 250g/m^2	0.84	2086.07	156.59
C.D. at 5%		NS	8.521	1.032
SE(m) ±			4.057	0.491

*** Significant at 5%**

4.25 Flower yield

The data presented in Table 12 revealed that the flower yield varied significantly among different treatments of organic manures. Flower yield was significantly increased by application of all organic manures over control.

Among the different sole applications of organic manures, treatment T_4 (Karanja oil cake @ 500g/m^2) showed maximum flower yield (2534.09 g/m^2) followed by treatment T_3 (Mustard oil cake @ 500g/ m^2) (2076.73 g/m^2).

When different combinations of mustard oil cake, karanja oil cake, neem oil cake and groundnut oil cake with vermicompost were used, maximum flower yield (2773.38 g/m^2) was recorded in treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) followed by treatment T_{10} (Vermicompost @ 1Kg/m^2 + Ground nut oil cake @ 250g/m^2) (2086.07 g/m^2).

When the sole application and combinations of organic manures were compared, treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) showed maximum flower yield (2773.38 g/m^2) and the minimum flower yield (1352.71 g/m^2) was observed in T_1 (Control) followed by T_6 (Ground nut oil cake @ 500g/ m^2) (1468.96 g/m^2).

4.26 Bulb yield

The data presented in Table 12 revealed that the bulb yield varied significantly among different treatments of organic manures. Bulb yield was significantly increased by application of all organic manures over control.

Among the different sole applications of organic manures, treatment T_3 (Mustard oil cake @ 500g/m^2) showed maximum bulb yield (401.91 g/m^2) followed by treatment T_2 (Vermicompost @ 2Kg/m^2) (234.02 g/m^2).

When different combinations of mustard oil cake, karanja oil cake, neem oil cake and groundnut oil cake with vermicompost were used, maximum bulb yield (434.67 g/m^2) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) followed by treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) (234.63 g/m^2).

When the sole application and combinations of organic manures were compared, treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) showed maximum bulb yield (434.67 g/m^2) and the minimum bulb yield (134.43 g/m^2) was observed in T_1 (Control) followed by T_6 (Ground nut oil cake @ 500g/ m^2) (145.15 g/m^2).

CHAPTER-5

DISCUSSION

CHAPTER-5

DISCUSSION

DISCUSSION

Tuberose occupies a very special position among flowers because of its attractive, elegant and fragrant white flowers. The flowers remain fresh for pretty long period, stand long distance transport and fill a useful place in the flower market (Patil *et al.*, 1999). Besides demand for cut flower tuberose also has great economic potential in essential oil industry (Alan *et al.*, 2007). The long spikes of tuberose are used for vase decoration, bouquet preparation and the florets for making artistic garlands, ornaments and button holes. The flowers emit a delightful fragrance and are the source of tuberose oil. The natural flower oil of tuberose is one of the most expensive raw material of perfume industry.

The use of organic manures may open a new vista to sustain or to reclaim the soil health without declining the crop yield if applied in proper doses. It is therefore considered necessary to standardize the effective utilization of organic inputs for obtaining increased productivity, good quality spikes and excellent keeping quality of tuberose, on which very little work has been conducted so far.

Hence, it was felt necessary to conduct a trial on 'Effect of organic manures on growth and flowering of tuberose (*Polianthes tuberosa* L.) cv. Phule Rajani' which has been discussed in this chapter.

The experiment was laid out with ten treatments *viz.*, vermicompost, mustard oil cake, karanja oil cake, neem oil cake and groundnut oil cake alone or in combination of half level of vermicompost with half level of other treatments. One among 10 treatments is left for control, without any nutrient source.

5.1 Effect of organic manures on vegetative growth of tuberose (*Polianthes tuberose* L.) cv. Phule Rajani

Among the treatments, T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) showed highest plant height (54.54 cm) followed by treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) (51.68 cm) and the treatment was statistically at par. Similar findings were reported by Ajit Kumar (2002) with respect to application of vermicompost and recommended dose of NPK in China aster and marigold; Chaitra and Patil (2007) in China aster. Sunitha *et. al.*(2007) also noticed significantly higher plant height with application of vermicompost and 50% RDF in African marigold and Shankar *et al.*(2010); Kabir *et. al.* (2011) and Munikrishnappa *et. al.*(2011) in tuberose.

Maximum plant spread (N-S) (44.84 cm) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 +Mustard oil cake @ 250g/m^2) followed by treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) (44.16 cm) which was statistically at par; Maximum plant spread (E-W)(43.63 cm) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) followed by treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) (41.33 cm)and the treatments was statistically at par.

Significantly maximum number of leaves (64.22) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) followed by treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) (53.11). The results were related to the findings of Shankar *et al.*(2010); Kabir *et al.* (2011 and Munikrishnappa *et al.*,(2011) in tuberose and Tripathy *et al.* (2012) who reported the more number of leaves with the application of vermicompost in tuberose.

Maximum number of bulbs per plant (16.33) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) followed by treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) (15.33) which was statistically at par. Highest leaf length (48.67 cm) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) followed by treatment T_4 (Karanja oil cake @ 500g/m^2) (47.74 cm) and the treatments was statistically at par. The length of leaf without application of organic manure (control) is 39.32cm. The improvement in leaf length in tuberose with the application of organic manures was also reported by Shankar *et al.*, (2010); Kabir *et al.*(2011) and Munikrishnappa *et al.*, (2011) in tuberose.

Highest leaf breadth (1.66 cm) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) followed by treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) (1.54 cm) and the treatment was statistically at par. The breadth/width of leaf without application of organic manure (control) is 1.16cm. The improvement in leaf breadth with the application of vermicompost was also reported by Shankar *et al.*, (2010); Kabir *et al.*(2011) and Munikrishnappa *et al.*, (2011) in tuberose.

Significantly highest leaf area (80.16 sq cm) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) followed by treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) (69.28 sq cm), whereas in lowest leaf area (46.62 sq.cm) was observed without application of organic manures.

The given results revealed that organic manures showed significant effect on growth of the plant. Among all the organic manures and their combinations T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) showed better results compared to other treatments. This improvement in vegetative parameters like plant height, plant spread, number of leaves per plant, number of bulbs per plant, leaf length, leaf breadth and leaf area might be due to application of vermicompost to the soil, which significantly increased in soil enzyme activity such as urease, phosphomonoesterase, phosphodisterase and anysulphatase (Albiach *et al.*, 2000) and also, stimulated plant growth promoting bacteria (Gupta and Prashad, 1991). It not only provided nitrogen, phosphorus and potash, but also a good source of micro nutrient. These above contents of vermicompost might have helped to make the availability of plant nutrients effectively to crop plant which made it possible for the plants to grow and put forth luxuriant growth (Padaganur *et al.*, 2005). Similar improvement in growth due to incorporation of vermicompost was also reported by (Patel, 1992). Similar findings were also reported by (Kulkarni, 1994) in China aster; Patil (1999) in tuberose; Bhalla *et. al.*(2006) in gladiolus; Renukaradya *et. al.* (2011) in carnation and Tripathi *et.al.* (2012) in tuberose.

5.2 Effect of organic manures on flowering parameter of tuberose (*Polianthes tuberose* L.) cv. Phule Rajani

Among the ten treatments, T_3 (Mustard oil cake @ 500g/m^2) (149.88 days) showed significantly minimum days taken for the early opening of first flower from planting followed by treatment T_7 (Vermicompost + Mustard oil cake @ 250g/m^2) (150.33 days); Highest spike length was recorded in T_3 (Mustard oil cake @ 500g/m^2) (97.36 cm) followed by treatment T_6 (Groundnut oil cake @ 500g/m^2) (95.16 cm) and the treatment was statistically at par. Significantly highest rachis length was recorded in T_3 (Mustard oil cake @ 500g/m^2) (26.52 cm) followed by treatment T_8 (Vermicompost + Karanja oil cake @ 250g/m^2) (25.74 cm).

Highest number of spike per plant (5.77) was recorded in treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) followed by treatment T_4 (Groundnut oil cake @ 500g/m^2) (5.55) and the treatment was statistically at par; Highest diameter of spike was recorded in T_3 (Mustard oil cake @ 500g/m^2) (0.52 cm) followed by treatment T_8 (Vermicompost + Karanja oil cake @ 250g/m^2) (0.49 cm) and the treatment was statistically at par.

Significantly highest number of florets per spike (50.88) was recorded in treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) followed by treatment T_4 (Karanja oil cake @ 500g/m^2) (47.77). Similar improvement in number of florets per spike obtained by application of vermicompost with other organic manures were also reported by Padaganur *et al.* (2005); Kabir *et al.* (2011) and Munikrishnappa *et al.* (2011) in tuberose.

Highest floret length (5.81cm) was recorded in treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) followed by treatment T_4 (Karanja oil cake @ 500g/m^2) (5.78cm) and the treatment was statistically at par. Similar improvement in floret length obtained by application of vermicompost with other organic manures or fertilizers were reported by Padaganur *et al.* (2005); Kabir *et al.* (2011) and Shirsat *et al.* (2015) in tuberose. Significantly highest floret width (3.70 cm) was recorded in treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) followed by treatment T_4 (Karanja oil cake @ 500g/m^2) (3.55 cm).

Maximum bloom life (22.22 days) was recorded in treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) followed by treatment T_3 (Mustard oil cake @ 500g/m^2) (21.66 days) and the treatment was statistically at par. Bloom life in the field is more and this might be due to application of vermicompost (Padaganur *et al.*, 2005) in tuberose.

Maximum vase life (15.77 days) was recorded in treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) followed by treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) (13.55 days) and the treatment was statistically at par. Maximum water uptake by cut spike in vase was recorded highest in treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) (51.3 ml) followed by treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) (46.8 ml). More uptake of water by the cut spikes of treatments with Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2 while they were in vase which might be because of low microbial clogging. (Chopde *et al.*, 2007; Srivastava *et al.*, 2007; Shankar et al., 2010; Ravi *et al.*, 2014 and Shirsat *et al.*, 2015). Netra *et al.*, 1999 and Chaitra and Patil (2007) also reported the increase in vase life and water uptake by application of vermicompost in China aster.

Vermicopost which is a nutritive fertilizer increased the level of macro and micro nutrients in soil and improve the level of growth promoting substances. As a result their application stimulating the vegetative and reproductive growth of the

plant. The improvement in flowering parameters might be attributed to the greater leaf area and more number of leaves per plant as well as plant spread would have resulted in production and accumulation of maximum photosynthates, resulting in the production of more number of flowers with bigger size. The obtained results are in accordance with earlier findings of Asrey *et al.* (2002) in gladiolus; Bhalla *et al.* (2007) in carnation; Waheeduzzama *et. al.* (2007) in anthurium and Shankar *et al.* (2010) in tuberose.

5.3 Effect of organic manures on bulb parameter of tuberose (*Polianthes tuberose* L.) cv. Phule Rajani

Among the ten treatments highest average bulb length in small bulb grade (3.66 cm) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) followed by treatment T_3 (Mustard oil cake @ 500g/m^2) (3.56 cm) which was statistically at par. Highest average bulb length in medium bulb category (3.96 cm) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) followed by treatment T_3 (Mustard oil cake @ 500g/m^2) (3.90 cm) which was statistically at par. Highest average bulb length in large bulb grade (4.23 cm) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) followed by treatment T_3 (Mustard oil cake @ 500g/m^2) (4.10 cm) which was statistically at par. Highest average length of mother bulb (5.10 cm) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) followed by treatment T_3 (Mustard oil cake @ 500g/m^2) (4.5 cm).

Among all treatments, significantly highest total bulb weight (304.76 g) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) followed by treatment T_3 (Mustard oil cake @ 500g/m^2) (225.93 g). Significantly highest average bulb weight in small bulb grade (17.90 g) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) followed by treatment T_3 (Mustard oil cake @ 500g/m^2) (16.7 g). Significantly highest average bulb weight in medium bulb grade (29.96 g) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) followed by treatment T_3 (Mustard oil cake @ 500g/m^2) (27.10 g). Significantly highest average bulb weight in large bulb grade (61.06 g) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) followed by treatment T_3 (Mustard oil cake @ 500g/m^2) (58.40 g). Similar findings were also reported by Shankar *et al.*, (2010) in tuberose.

Highest average bulb circumference in small bulb grade (5.59 cm) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) followed by treatment T_3 (Mustard oil cake @ 500g/m^2) (5.58 cm) which was statistically at par. Significantly highest average circumference in medium bulb category (7.83 cm) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) followed by treatment T_3 (Mustard oil cake @ 500g/m^2) (7.74 cm). Highest average bulb circumference in large bulb grade (9.88 cm) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) followed by treatment T_3 (Mustard oil cake @ 500g/m^2) (9.83 cm) which was statistically at par. Significantly highest average circumference of mother bulb (14.02 cm) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) followed by treatment T_3 (Mustard oil cake @ 500g/m^2) (13.18 cm).

The higher bulb parameters in plants applied with organic manures than control might be due to production of more assimilate by greater number of leaves (Shankar *et al.*, 2010 and Kabir *et al.*, 2011) in tuberose.

Significant effect of vermicompost along with mustard oil cake on all the above mentioned characters is due to the fact that vermicompost provided better nutrition as it contains all the major nutrients besides micro-nutrients, it also has some beneficial micro-organisms which results into improved chemical, physical and biological properties of soil, with supply of organic carbon, improved nutrient and water use efficiency, water holding capacity and porosity of soil. The obtained results are in accordance with the earlier findings of Bhalla *et. al.* (2006) in gladiolus; Singh *et. al.* (2006) in rose; Bhalla *et. al.* (2007) in carnation and Sunitha *et. al.* (2007) in African marigold.

5.4 Effect of organic manures on yield parameter of tuberose (*Polianthes tuberose* L.) cv. Phule Rajani

Among the ten treatments, maximum flower yield (2773.38 g) was recorded in treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) followed by treatment T_{10} (Vermicompost @ 1Kg/m^2 + Ground nut oil cake @ 250g/m^2) (2086.07 g). Similar improvement in flower yield obtained by application of vermicompost with other organic manures were also reported by Padaganur *et al.* (2005); Chauhan *et al.* (2005) in marigold; Sandeep *et al.* (2011) in cosmos.

Among the ten treatments, maximum bulb yield (434.67) was recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) followed by

treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) (234.63). Similar improvement in bulb yield obtained by application of vermicompost with other organic manures were also reported by Tripathi *et al.* (2012); Rao *et al.* (2014) and Meena *et al.* (2015) in tuberose.

CHAPTER-6

SUMMARY & CONCLUSION

SUMMARY AND CONCLUSION

The experiment entitled "EFFECT OF ORGANIC MANURES ON GROWTH AND FLOWERING OF TUBEROSE (*Polianthes tuberosa*) Cv. PHULE RAJANI" was carried out at BTCC, Orissa University of Agriculture and Technology, Bhubaneswar, Odisha during the period May 2015 to May 2016. The trial was conducted with ten treatments *viz.*, vermicompost, mustard oil cake, karanja oil cake, neem oil cake and groundnut oil cake alone and in combination of half level of vermicompost with half level of other treatments. One among 10 treatments is left for control without any nutrient source. The experiment was laid out in Randomized Block Design with three replications. The observations were recorded under vegetative parameters, including plant height, plant spread, number of leaves per plant, number of clumps per plant, leaf length, breadth and leaf area; flower parameters, including days taken for opening of first flower from planting, spike length, rachis length, number of spikes per plant, diameter of spike, number of florets per spike, floret length, floret width, bloom life, vase life, water uptake by cut spike in vase, flower yield and bulb parameters, including bulb length, bulb weight, circumference of the bulb and yield of the bulb. The results were statistically analysed and presented.

The results of the experiment are summarized as follows:

The obtained results revealed that application of organic manures exhibited significant differences for vegetative and floral parameters of the plant. Among all the organic manures and their combinations tried, treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) recorded the maximum plant height (54.54 cm), plant spread (N-S) (44.84 cm), plant spread (E-W) (43.63 cm), number of leaves (64.22), number of clumps per plant (16.33), leaf length (48.67 cm), leaf breadth (1.66 cm) and leaf area (80.16 sq cm) compared to other treatments.

Among the all treatments, T_3 (Mustard oil cake @ 500g/m^2) recorded significantly minimum days taken for opening of first flower from planting (149.88 days), spike length (97.36 cm), rachis length (26.52 cm) and diameter of spike compared to other treatments.

Maximum number of spike per plant (3.77), number of florets per spike (50.88), floret length (5.81cm), floret width (3.70 cm), bloom life (22.22 days), vase life (15.77 days), water uptake by cut spike in vase (51.3 ml) and flower yield

(2773.38 g) were recorded in treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) compared to other treatments.

Highest average bulb length in small bulb grade (3.66 cm), medium bulb grade (3.96 cm), large bulb grade (4.23 cm) and mother bulb (5.10 cm); highest total bulb weight (304.76 g); weight of small bulb (17.90 g), weight of medium bulb (29.96 g) and weight of large bulb (61.06 g); highest average circumference of small bulb (5.59 cm), medium bulb (7.83 cm), large bulb (9.88 cm), mother bulb (14.02 cm) and yield of bulb (434.67g) were recorded in treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) compared to other treatments.

Based on the result of the present study it was concluded that application of organic manures obtained significant differences in vegetative, flower and bulb parameters of the plant. Among all the organic manures and their combinations treatment T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) recorded the maximum vegetative parameters and bulb parameters compared to other treatments. The treatment T_3 (Mustard oil cake @ 500g/m^2) recorded maximum value for some of the floral parameters, and for other floral parameters treatment T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) recorded maximum value, compared to other treatments.

It is therefore suggested that for getting better quality of spike and bulb under organic farming, treatment T_3 (Mustard oil cake @ 500g/m^2), T_7 (Vermicompost @ 1Kg/m^2 + Mustard oil cake @ 250g/m^2) and T_8 (Vermicompost @ 1Kg/m^2 + Karanja oil cake @ 250g/m^2) are recommended under Bhubaneswar condition in tuberose cv. Phule Rajani.

Based on the result of the present study it was concluded that the area of research has huge scope with regards to conserving the soil health which is becoming a burning problem due to increased use of chemical fertilizers. The use of organic manures with compatible combinations and at required rates can be promising in increasing yield and quality of flowers. The use of oil cakes can be more effective in infected soils and disease and pest prone areas which can decrease the cost of plant protection.

As many kinds of organic manures are available, further research can be continued to test their effect on growth and yield of tuberose. More research has to be done to standardize the dose and type of organic manures. Research can be done on other high yielding and promising varieties of tuberose. The capability of organic

manures in controlling pest and diseases and increasing plant tolerance to biotic and abiotic stress can be investigated. The effect of organic manures on essential oil content can be tested. Keeping the need and importance of organic farming in view, the attempts are to be made to create awareness among farmers as most of the growers are unaware about the benefits of organic manures.

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APPENDICES

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Appendix - I

Monthly average weather data of Bhubaneswar from May 2015 to May 2016

Month	Mean Evaporation (mm)	Rainfall (mm)	Rainy days	Mean Temperature		Relative humidity (%)	
				Max.	Min.	7:00 AM	2:00 PM
May	8.9	27.4	5	39.0	27.0	88	52
Jun	6.1	94.8	13	36.2	26.1	88	62
Jul	3.4	223.5	18	32.4	25.0	90	71
Aug	3.3	297.8	16	33.0	25.6	92	77
Sep	3.3	151.5	12	33.0	25.0	91	75
Oct	3.4	75.5	7	33.0	23.5	93	66
Nov	3.6	8.3	3	31.2	20.1	91	55
Dec	3.4	14.8	3	29.2	17.5	86	52
Jan	3.4	0.6	1	30.0	15.7	91	39
Feb	3.7	3.0	2	34.6	21.3	89	42
Mar	5.4	1.5	2	37.0	23.4	86	40
Apr	5.5	0.0	-	40.8	26.6	85.5	36.5
May	6.2	32.68	3	39.1	26.4	82.4	48.6

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Appendix - II

Physico – chemical properties of the soil

Particulars	Value	Methods used
Sand (%)	70	Robinson's Pipette Method (Piper, 1950)
Silt (%)	11	Robinson's Pipette Method (Piper, 1950)
Clay (%)	18	Robinson's Pipette Method (Piper, 1950)
Texture	Sandy loam	Jackson Method (1973)
B.D. (g/cc)	1.56	Jackson Method (1973)
P.D. (g/cc)	2.67	Jackson Method (1973)
Porosity (%)	42	Jackson Method (1973)
pH	8.04	pH meter method (Jackson, 1973)
EC (dS/m)	0.28	Conductometric (Jackson, 1973)
OC (g/kg)	4.2	Rapid titration Walkey and Black method (Jackson, 1973)
Available N (kg/ha)	191.7	Modified kjeldhal's technique (Jackson, 1973)
Available P (kg/ha)	7.3	Olsen method (Olsen *et al.*, 1954) and stated by Jackson, 1973
Available K (kg/ha)	127.6	Flame photometer (Muhr *et al.*, 1965) as stated by Jackson,1973