“Effect of different biofertilizers and organic manures on growth and yield of onion (*Allium cepa* L.)”

THESIS

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Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya

In partial fulfilment of the requirements for the degree of

MASTER OF SCIENCE (Ag.)

In

HORTICULTURE

(Vegetable Science)

By

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2022

CERTIFICATE – I

This is to certify that the thesis entitled ***"Effect of different biofertilizers and organic manures on growth and yield of onion (Allium cepa L.)"*** *submitted in partial fulfillment of the requirement for the degree of* **MASTER OF SCIENCE IN AGRICULTURE HORTICULTURE (Vegetable Science)** of Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior *is a record of the bonafide research work carried out by* **Miss PRIYANKA KASHYAP** *under my guidance and supervision. The subject of the thesis has been approved by the student's Advisory Committee and the Director of Instruction.*

No part of the thesis has been submitted for any other degree or diploma or has been published. All the assistance and help received during the course of this investigation has been acknowledged by the scholar.

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This is to certify that the thesis entitled ***"Effect of different biofertilizers and organic manures on growth and yield of onion (Allium cepa L.)"*** *submitted by* **Miss PRIYANKA KASHYAP** *to the* Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior *in partial fulfilment of the requirements for the degree of* **MASTER OF SCIENCE IN AGRICULTURE HORTICULTURE (Vegetable Science)** *has been accepted after evaluation by the External Examiner and approved by the Student's Advisory Committee after an oral examination on the same.*

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Date : ……

Place : ……..

(Priyanka Kashyap)

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Symbol / Abbreviation	Meaning
,	Comma
>	Greater then
<	Less then
x	Multiple
;	Semi colon
&	And
@	At the rate of
^{o}C	Degree Celsius
C.D.	Critical Difference
Cm	Centimeter
C.V.	Coefficient of Variation
DAT	Days after Transplanting
DAS	Day after Sowing
D.F.	Degree of Freedom
et al.	And others
etc	and the rest
Fig.	Figure (s)
g	Gram
ha	Hectare
HI	Harvest Index
i.e.	That is
R.V.S.K.V.V.	Rajmata Vijayaraje Scindia Krishi Vishwa Vidhyalaya
Kg	Kilogram (s)
M	Meter (s)
Mrl	Meter row length
No.	Number (s)
NS	Non significant
RH	Relative humidity
Rs.	Rupees
S.Em.±	Standard error of mean
S.S.	Sum of Square
Viz.	Namely
√	Square root
%	Percent
±	Plus or Minus

Chapter - I

INTRODUCTION

Onion *(Allium cepa* L.*)* is a bulbous, biennial herb belonging to the family Alliaceae and genus *Allium*. It is believed to be originated from Central Asia comprising Iran, Afghanistan, Pakistan, Tajikistan and Uzbekistan. This is consumed all over the world throughout the year. It is one of the most important commercial vegetable and crop grown in India and being exported to other countries. Onion is known as 'Queen of kitchen'. It is an indispensable item in every kitchen used as salad, culinary purpose for flavouring as spices in pickles, sauce and vegetable. Generally onion is cultivated in Rabi as late season. But due to lack of proper storage condition and losses due to spoilage in the monsoon season the prices goes up.

Production of onion during Kharif is required to fill up the gap of demand and supply. It was cultivated in more than 175 countries, in nearly 3 million ha, producing more than 50 million tonnes. India is the second largest producer after China. India producing 26916 Thousand MT and area 1654 thousand hectare (Anonymous 2020). In India, onion grown in Gujarat, Madhya Pradesh, Orissa, Rajasthan, Tamilnadu, Bihar and Maharashtra, out of them Maharashtra cover maximum area and production of onion in India. Maharashtra is largest producer of onion in the country. The onion production depends mainly on area cultural practices like nutrition, irrigation and plant protection measure beside the congenial climatic factors.

About 38 kcal calories of energy are obtained from 100g onion. Nutritive value of onion (nutritive value per 100 g onion scales) , water (89 g), lipids (0.16 g), carbohydrate (8.6 g), fiber (1.8 g), potassium (157 mg), sulphur (70 mg), phosphorus (33gm), calcium (20gm), vitamin C (6.4 gm.), vitamin E (0.26 gm.), vitamin B6 (0.116gm.), folic acid (19mcg.), glutamic acid (0.118g), argentine (0.156g), lysine (0.055g) and leucine (0.041g) (Bose *et al*. 2000).

The pungency in the onion due to sulphur contains compound volatile known as *allyl-propyl-disulphide* ($C_6H_{12}S_2$) and the red colour is because of the pigment "anthocyanin" and yellow colour because of "quercetin". The

nutritive value of onion varies from variety to variety. Nutritionally, fresh onion contains about 86.6 per cent moisture, 11.6 per cent carbohydrates, 0.2 to 0.5 per cent calcium, 0.05 per cent phosphorus and traces of iron and ascorbic acid (Dev *et al*. 2004). It has got many medicinal values and is commonly used as diuretic and anti diabetic drugs. It is very useful against sun-strokes 'Loo' in summer. Value addition in onion is done by marketing dehydrated onions and onion flakes. Its extract is used in the prevention of atherosclerosis and coronary heart disease as it inhibits the aggregation of human blood platelets to form clots, which have the potential for arterial blockage. Its bulbs are diuretic and heart stimulant. Eating raw onion is beneficial in the treatment of cancer, tuberculosis and asthma. Its aroma and pungency is due to the volatile sulphur compound known as *Allyl propyl di-sulphide*.

Onion is a cool season crop but can be grown under a wide range of climatic conditions. The best performance can be obtained in a mild weather without the extremes of cold, heat and excessive rainfall. Low temperatures early in the season are desirable with higher temperatures after bulb formation. Long days are favourable to onion production as this enhances leaf development and formation which is directly related to bulb size. The optimum temperature for vegetative phase and bulb development is 13-24ºC and 16-25ºC respectively. It requires about 70% relative humidity for good growth.

The use of bio-fertilizers is the eco-friendly alternate sources to meet the nutrients requirement of crops. In recent years, bio-fertilizers have emerged as a promising component of integrated nutrients supply in agriculture. Bio-fertilizers include mainly the nitrogen fixing, phosphate solubilizing & plant growth promoting micro-organisms. The bio-fertilizers benefiting the crop production are *Azotobactor, Azospirillium*, blue green algae, *Azolla*, PSB, KSB, *mycorrhizae*. However the bio-fertilizers despite of their tremendous potential and benefits are unpredictable & inconsistent in their performance under field condition. The inoculation of *PSB bio-fertilizer* increases the yield of crops by 10 to 30 per cent. Use of *bio-fertilizers* not only supplement the nutrients but also improve the efficiency of applied nutrients (Bhati *et al.* 2018). Mineral fertilizers play an important role of onion plant

growth and productivity. Many investigators reported that the vegetative growth of onion plants and minerals uptake was increased with increasing the level of NPK- fertilizers. On the other hand, we can say that continuous usage of inorganic fertilizers affects soil structure. Hence, organic fertilizers can serve as alternative to mineral fertilizers as reported by for improving soil structure.

The application of organic manures like FYM and poultry manure alone and in combination with NPK have been reported to decrease the bulk density, improve the soil porosity and increase water holding capacity (Maheswarappa *et al.* 1999). Integrated nutrient supply approach for the crop by judicious mixture of organic manures along with the inorganic fertilizers has a number of agronomical and environmental efficiencies. This approach is not only the reliable way for obtaining fairly high productivity with substantial fertilizer economy but also ensures the concept of ecological soundness leading to sustainable agriculture (Swaminathan, 1987).

FYM is the commonly used organic manure not only provides plant nutrients but also improves the physical and chemical properties of soil. The combined usages of FYM with inorganic fertilizers is of special significance under intensive cropping system as both are complementary and supplementary to each other in sustaining crop yield and soil productivity. Likewise, poultry manure is also an important source of nutrients and has direct effect on plant growth. It contains about 1.20 per cent N, 2.15 per cent P_2O_5 and 1.20 per cent K_2O. It also contains traces of micronutrients which are generally not supplied by the commercial fertilizers but essential for plants which acts as excellent source of organic manure and increases nutrient uptake (Jose *et al.* 1988 and Abusaleha, 1992).

Agrifound light red is a *Rabi* variety of onion growing widely throughout the country. Seeds of this variety are produced by bulb to seed method in particular areas of India.

The present research work was undertaken to study “Effect of different biofertilizers and organic manures on growth and yield of onion (*Allium cepa* L.)” with the following objectives

1. To find out the best combination of organic manure and biofertilizer on growth attributing of onion.
2. To find out the organic manure and biofertilizer their combination for yield and quality of onion.
3. To work out the economy of different treatments.

Chapter - II

REVIEW OF LITERATURE

A good deal of research work has been done in India and abroad to evaluate “Effect of different biofertilizers and organic manures on growth and yield of onion (*Allium cepa* L.)”. The up to date literature available on these aspects have been reviewed in this chapter under the following heads:.

2.1 Effect of biofertilizers on growth and yield of onion

Bhonde *et al.* (1997) carried out field trail conducted at Nasik with cv. Agrifound Light Red to know the effect of biofertilizers in combination with nitrogen through organic and inorganic sources on yield and quality and found that application of *Azotobacter* as a seedling dip (1500 g in 5 litre of water) along with 50% recommended dose of nitrogen gave the highest marketable bulb yield (230.62 q ha^{-1}).

Sule *et al.* (2002) studied the impact of biofertilizers (*Azospirillum, Azotobacter, Rhizobium* and phosphate solubilizing bacteria) on the productivity of onion. The positive results of average productivity (20.05 & 18.13 t ha^{-1}) were recorded under inoculation of bio-fertilizers and no inoculation.

Devi *et al.* (2003) reported that higher yields of onion (163.41 q ha^{-1}) was obtained with the application of 75 kg N + 45 kg P ha^{-1} + *Azospirillum* + phosphatika.

Yadav *et al.* (2003) reported that inoculation of *Azotobacter* alone or in combination with N @ 50, 75,100 kg ha^{-1} significantly increased seed yield of onion cv. Hissar-2 over the uninoculated control. The maximum plant height (10% more over the control) and number of umbels per plant (53% over the control) were also obtained with application of *Azotobacter* MSX-9 in combination with 75 and 100 kg N ha^{-1}, respectively.

Yadav *et al.* (2005) also concluded that 75% recommended dose of nitrogen along with *Azospirillum* application gave significantly highest onion bulb yield (328.49 q ha^{-1}).

Ghanti and Sharangi (2009) studied the treatments were *Azotobacter* + PSB, *Azotobacter* + VAM, *Azotobacter* + *Azospirillum*, *Azospirillum* + PSB, *Azospirillum* + VAM, PSB + VAM, NPK 100%, NPK 50% and Control. The height of the plant was maximum (43.46cm) with the application of *Azotobacter* + VAM. No. of leaves, no. of inflorescence / plot and bulb diameter were maximum of *Azotobacter* + *Azospirillum*. *Azotobacter* + *Azospirillum* and NPK 100% gave maximum length of bulbs (6.03cm). The maximum number of scale per bulb (9.81) was counted from NPK 50%.The plants raised under NPK 100% produced the maximum bulb weight 67.45g. TSS % was found maximum (12.29%) from NPK 100% but the highest reducing sugar (1.420%) and starch percentage (6.27%) were noted from NPK 50%. The total loss of weight (%) up to 60 days, was found minimum (11.5%) from *Azotobacter* + PSB followed by *Azotobacter* + *Azospirillum* (14.32%). It is therefore, concluded that *Azotobacter* + *Azospirillum* combination is the best for onion as compared to others so far as the sustainability in production and environmental consideration are concerned.

Mann *et al.* (2014) resulted that the interaction effect of chemical and bio-fertilizers on growth, yield and quality of onion. Maximum plant height (67.66 cm), bulb diameter (4.82 cm), bulb weight (56.92 g), total yield (30.20 t/ha) and marketable yield (28.43 t/ha) was recorded with the application of 100% RDF + PSB @ 2kg/ha +*Azospirillum* @ 2 kg/ha. Though, the interaction effect of chemical and biofertilizers were not significant on the results of leaves number and neck thickness, However maximum average leaves number (6.89) and neck thickness (1.42 cm), was reported by the application of 100% RDF + PSB + *Azospirillum*. Maximum dry matter (14.87%), total soluble solid (13.83 oB) and Pyruvic acid (4.16 µ mol/g) content of bulb was observed from the 75% RDF + PSB + *Azospirillum*, treatment. It is therefore concluded that application of biofertilizers (*Azospirillum* and PSB mixture) along with 100% recommended dose of fertilizers were recommended to obtain the highest bulb yield with better quality of onion bulbs.

Talwar *et al*. (2016) reported that the number of leaves per plant, plant height and leaf area was maximum with the application of *Azotobacter* along with recommended dose of fertilizers. *Azospirilum* produced the maximum

bulb weight 138.3g and total yield 299.6 q/ha when it was applied with recommended dose of fertilizer

Singh *et al*. (2017a) reported that the fertility level F3 (N120 : P60 : K80) with inoculation of M4 (*Azospirillum* + VAM) *i.e.,* M4F3 produced maximum plant height (51.96cm), number of leaves per plant (11.96), leaf length (45.71cm), fresh weight of leaves per plant (32.58g) as well as yield and its attributing components like bulb length (5.13cm), bulb diameter (5.85cm), bulb weight (81.44g), bulb volume (92.8cc), bulb yield (467.61q/ha), dry bulb weight (45.10q/h) and total dry weight of plants (63.92q/ha) were also achieved by M4F3 treatment. However, inoculation of *Azospirillum* + VAM with seedling treatment.

Singh *et al.* (2017b) studied in the experiment consisted 16 treatment combinations viz. T1-N+P+K (100% Recommended Full Does), T2 -75% N+P+K+25% *Azotobacter*, T3 -50% N+P+K+50% *Azotobacter*, T4 -25% N+P+K+75% *Azotobacter*, T5 - N+75%P+K+25% PSB, T6 - N+50%P+K+50% PSB, T7 – N + 25%P + K + 75% PSB, T8-75% N +75%P + K + 25%, T9-50% N + 50% P + K + 50% *Azotobacter* + 50%PSB, T10-25%N + 25% P + K + 75% *Azotobacter* +75% PSB, T11- 75%N +50%P + K + 25% *Azotobacter* +50%PSB, T12-50%N +75%P +K+ 50% *Azotobacter* + 25% PSB, T13-25%N +50%P +K +75%*Azotobacter* +50%PSB, T14-25%N+P+K+75%*Azotobacter* + 25%PSB, T15-75%N+ 25%P+K+25% *Azotobacter* +75%PSB and T16 -50% N + 25% P +K + 50% *Azotobacter* + 25% PSB *Azotobacter* + 25% PSB, which was laid out in randomized block design (RBD) with three replications. The result revealed that the application of 50:45:100 kg NPK/ha and inoculation of field with 1.25 ± 0.62 kg/hac and PSB significantly recorded the higher bulb yield of 303 q/hac.

2.2 Effect of organic manures on growth and yield of onion

Alkaff *et al.* (2002) obtained the highest onion bulb weight (44%) as noted with the mineral fertilizer. However the highest total yield was recorded with FYM, followed by the mineral fertilizer and biofertilizer.

Shashidhar *et al.* (2005) studied the effect of different organic manures (FYM, vermicompost, poultry manure, pressmud, sheep manures,

gliricidia and sunnhemp) on the yield and quality of garlic cv. BLG^{-1}. The highest yield per hectare (70.82 q ha^{-1}) was recorded with the application of sunnhemp @ 20 t ha^{-1}. However, it was statistically at par with the application of poultry manure (2.5 t ha^{-1}) and vermicompost (5.0 t ha^{-1}).

Ethel *et al.* (2009) recorded significantly higher plant height of onion with FYM @ 30 t ha^{-1} (30.3 - 45.2 cm) compared to other organic manures.

Sharma *et al.* (2009) conducted an experiment on okra, onion sequence and reported highest yield (11.10 and 11.63 t ha^{-1}) of okra under the treatment comprising 100% recommended dose of NPK + vermicompost @ 10 t ha^{-1}, during 2003 and 2004, respectively. Further, yield of onion bulb was obtained at par with the application of vermicompost @ 12.5 t ha^{-1} + 100% NPK (8.38 and 12.56 t ha^{-1}) and farm yard manure @ 25 t ha^{-1} + 100% NPK (8.86 and 12.08 t ha^{-1}) during 2003-04 and 2004-05.

Hari *et al.* (2009) recorded significantly higher bulb weight of onion (75.53 g) with the application of vermicompost @ 7 t ha^{-1} + 75 per cent of recommended dose of nitrogenous fertilizers than other treatments.

Chuda *et al.* (2009) revealed that application of 50% NPK + 50% FYM recorded significantly higher plant height (45.45 cm), number of leaves per plant (12.67), neck thickness (2.95 cm), bulb size (5.84 cm), bulb yield (141.47 q ha^{-1}) and TSS of onion bulb (12.11^{0}Brix).

Tembhare (2011) conducted experiment during 2010 at the JNKVV College of Agriculture, Rewa (M.P.) on integrated nutrient management in onion cv. Agrifound Light Red. Amongst the organic manures and inorganic fertilizers, 100% RDF (N: 100, P: 80, K: 60) Kg/ha proved the most beneficial for growing onion var. Agrifound Light Red in this region. It yielded the maximum onion bulbs (255.36 q/ha.) lowest bolting percentage (0.41%) with maximum number of scales/bulb (15.13). The second best treatments was 75% RDF (22.41 q/ha) yield, 0.65% bolting and 13.02 number of scales/bulb). The third best treatment was 50% RDF+FYM (212.76 q/ha) yield, 0.81% bolting and 12.97 number of Scales/bulb.

Damse *et al.* (2014) conducted an experiment on integrated nutrient management in garlic and found that application of (75:40:40:40 kg NPKS +

7.5 t FYM + 3.5 t poultry manure ha^{-1}) produced better bulb yield (150.41 q ha^{-1}). Thus, application of reduced dose of chemical fertilizers along with combination of two or three organic manures was found beneficial for garlic in *rabi* season.

Meena *et al.* (2014) reported that the application of 150% RND as poultry manure gave higher bulb (270.84 q ha^{-1}) and haulm yields of onion (35.13 q ha^{-1}) than other sources and levels of organic manures.

Prabhakar *et al.* (2017) studied the effect of different levels of farm yard manure (FYM) in organic as compared to chemical and conventional practices on growth, yield and quality of onion. The trial included five levels of farm yard manure and two inorganic nutrient supply treatments consisting of only chemical treatment (NPK fertilizers +chemical plant protection) and conventional practice (Recommended dose of FYM + NPK fertilizers +chemical plant protection).Conventional treatment recorded highest plant height (50.1 cm) as well as bulb yield (34.8 t/ha),while onion crop which had received organic manure equivalent to 100 per cent recommended dose of nitrogen (RDN) recorded highest number of leaves (10.5) per plant. This bulb yield was at par with the yields obtained in organic treatments receiving FYM equivalent to 50 to 100 per cent RDN. The lower bulb yields were with organic treatment receiving manures equivalent to 25 per cent RDN and treatment receiving only NPK fertilizers. There were no marked differences among the treatments for the quality parameters such as bulb dry matter and shelf life.

Petrovic *et al.* (2019) showed that all the results were affected by the growing season (higher values were recorded in 2016). In 'Stuttgarter Riesen', EkoBooster 2® application resulted in the highest bulb weight in 2016 (67.16 g) and in 2017 (55.17 g) and in the highest number of leaves in 2016 (6.66) and in 2017 (6.30), which led to the highest marketable bulb yield in 2016 (3.47 kg m^{-2}) and in 2017 (2.53 kg m^{-2}). In 'Rote Laaer' in 2016, EkoBooster 2® application resulted in the highest number of leaves (7.06), bulb diameter (54.32 mm) and bulb weight (79.30 g). In 2017, the largest bulb diameter (54.13 mm) and the highest bulb weight (71.79 g) and marketable bulb yield (2.39 kg m^{-2}) were determined after VermiFit A® application.

Vaghela *et al*. (2019) reported that the soil application of 50% RDF (50: 37.5: 37.5 NPK kg/ha) + 25% N from vermicompost + 5 ml Bio-NPK consortium was most effective treatment and which was recorded significantly maximum on growth and yield of onion parameters viz., plant height (70.11 and 86.70 cm at 45 and 90 DAT respectively), minimum bolting per cent (4.38), average bulb weight (129.30 g), bulb volume (136.70 cc), neck thickness (1.11 cm), bulb yield (24.18 kg/plot and 497.60 q/ha)and TSS (13.47 ^{o}Brix). While number of leaves per plant was non-significant.

Ahmed *et al*. (2020) reveals significant variation among the studied parameter. Tallest plants (47.37cm), more number of leaves per plants (10.04), Leaves length (36.43cm), leaves width (7.71cm), bulb diameter (57.73mm), Bulb weight (83.04g) and bulb yield (7.46t/ha) was recorded from cultivar Swat^{-1} planted plots. In case of fertilizers, Maximum plant height (47.74cm), Number of leaves per plant (10.35), Leaves length (37.94cm), Leaves width (8.26cm), Bulb diameter (65.19mm), Bulb weight (103.30g) and Bulb yield (8.90t/ha) was obtained from plots which were fertilized with poultry manure.

Gererufael *et al.* (2020) reported that the main effect of N, FYM as well as their interactions significantly ($P < 0.05$) influenced days to maturity, plant height, leaf number, leaf diameter, bulb diameter, neck diameter, average bulb weight, above ground dry biomass, marketable bulb yield and total bulb yield of onion. Similarly, main effects of N and FYM significantly ($P < 0.05$) affected leaf length, bulb length, unmarketable bulb yield and harvest index. The highest marketable bulb yield of 35.93 t ha^{-1} and 34.72 t ha^{-1} were obtained at combinations of 103.5 kg N ha^{-1} + 30 t FYM ha^{-1} and 103.5 kg N ha^{-1} + 20 t FYM ha^{-1} respectively. However, the lowest marketable bulb yield of 13.88 t ha^{-1} was obtained from the unfertilized plot.

2.3 Effect of biofertilizers and organic manures on economical parameters of onion

Bhonde *et al.* (1997) reported that the application of *Azotobacter* as a seedling dip (1500 g in 5 litre of water) along with 50% recommended dose of nitrogen gave the highest net returns of 37,196 ha^{-1}.

Devi *et al.* (2003) reported that maximum net returns (85,807 ha^{-1}) was obtained with the application of 75 kg N + 45 kg P ha^{-1} + *Azospirillum* + phosphatika in onion.

Yadav *et al.* (2005) also concluded that 75% recommended dose of nitrogen along with *Azospirillum* application gave significantly highest net returns of 31287 ha^{-1} with B: C ratio (10:1).

Damse *et al.* (2014) conducted an experiment on integrated nutrient management in garlic and found that application of (75:40:40:40 kg NPKS + 7.5 t FYM + 3.5 t poultry manure ha^{-1}) produced better benefit cost ratio (1.68). Thus, application of reduced dose of chemical fertilizers along with combination of two or three organic manures was found beneficial for garlic in *Rabi* season.

Meena *et al.* (2014) reported that the highest net return (Rs 74233 ha^{-1}) was obtained with 100% as poultry manure followed by 125% RND as poultry manure (Rs 72195 ha^{-1}). The net benefit: cost ratio was also highest with 100 RND applied as poultry manure (2.33).

Singh *et al*. (2017a) reported that the f soil application at the fertility level of N90 : P45 : K60 was the most effective combination for higher net return and B: C ratio (3.47) whereas the fertility level F3 (N120 : P60 : K80) with inoculation of M4 (*Azospirillum* + VAM) *i.e.,* M4F3 ranked 2^{nd} in merit having B:C ratio of 3.36.

Singh and Singh (2019) reported that the maximum net return (Rs.2, 08,054) was obtained from T5 treatment (PSB @1g /plant + paddy straw) while maximum B:C ratio (3.16:1) was obtained from T4 treatment (PSB@1g /plant). Whereas, minimum B: C ratio (1.12:1) was recorded under control.

Gererufael *et al.* (2020) reported that the highest marginal rate of return was obtained at combined application of 103.5 kg N ha^{-1} and 10 t FYM ha^{-1} and thus can be recommended for onion production in the experimental area.

Chapter - III

MATERIAL AND METHODS

The present investigation entitled “Effect of different biofertilizers and organic manures on growth and yield of onion (*Allium cepa* L.)” was carried out at Horticulture Research Farm, R.A.K College of Agriculture, Sehore (M.P.). The details of methods and material followed during the experiment are described below:

3.1 Experimental site

The experiment was conducted at Horticulture Research Farm, R.A.K College of Agriculture, Sehore, Madhya Pradesh.

3.2 Geographic situation

The experimental site, Horticulture Research Farm, R.A.K College of Agriculture, Sehore (M.P.) is situated at 22.94 north latitude, 77.10 east longitudes and an altitude of 427 meters above mean sea level in district of Madhya Pradesh.

3.3 Climatic conditions

The region comes under semi-arid and sub-tropical climate with extreme weather condition having hot and dry summer and cold winter. Generally, monsoon sets in the last week of June. Annual rainfall ranges from 700 to 800 mm, most of which falls during last week of June to the middle of September. Winter rains are occasional and uncertain. The maximum temperature goes up to 47^0C during summer and minimum as low as 2.8^0C during winter. Frost also expected from the last week of December to the first week of February. Usually the monsoon arrives in the second fortnight in June and lasts till September. Occasionally, light rains are expected during winter.

3.4 Weather condition during the study period

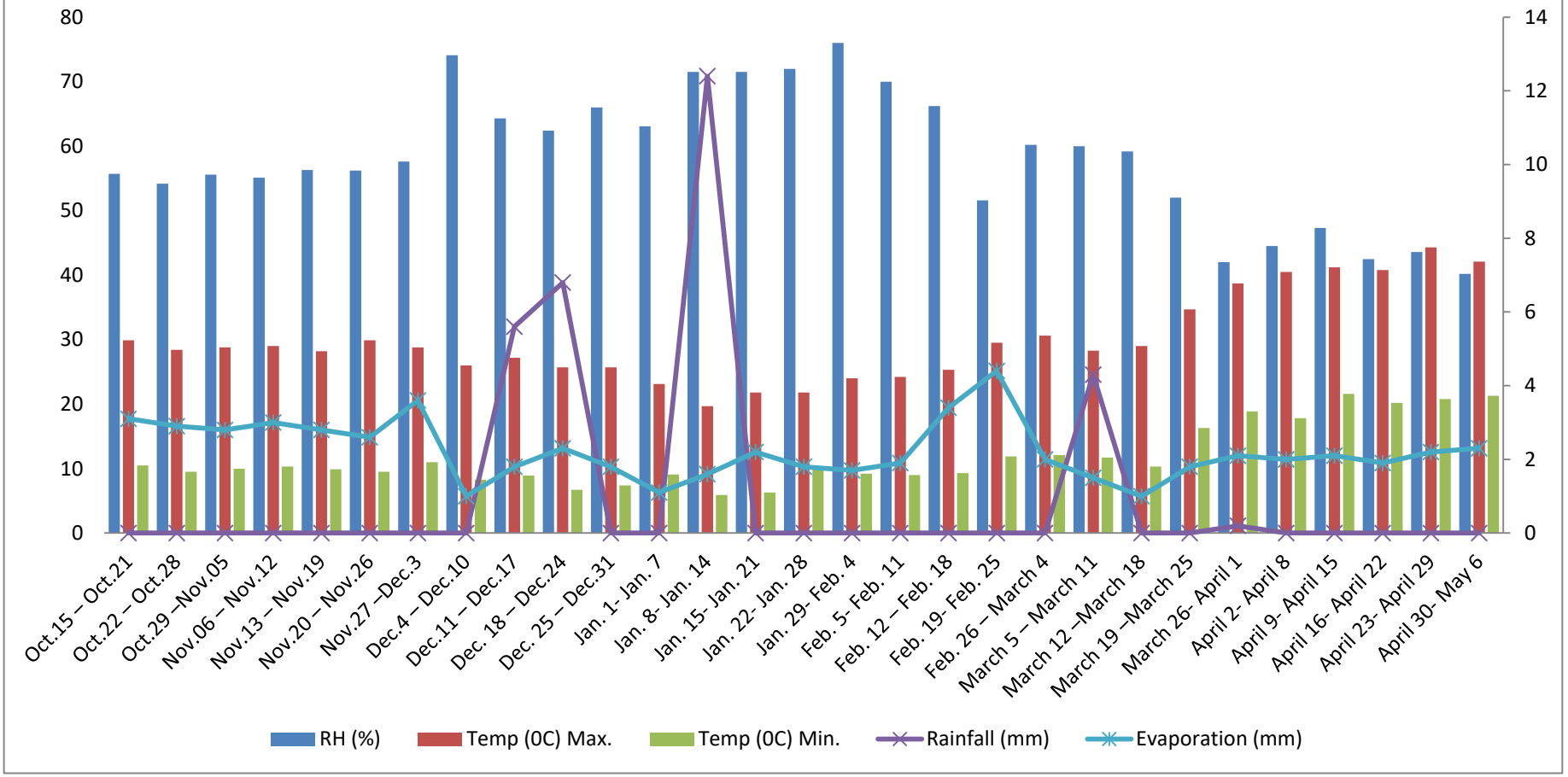
Weather conditions during the study period 2021-22 recorded as per metrological observatory college of agriculture, Sehore (M.P.) is given in table 3.4 and depicted figure 3.4

Table 3.4 Meteorological data during crop growth period from the 15th October, 2021 to 6th May, 2022

SMW	Month and date	RH (%)	Temp (^{0}C)		Rainfall (mm)	Evaporation (mm)
			Max.	Min.		
38	Oct.15 – Oct.21	55.7	29.9	10.5	000.0	3.1
39	Oct.22 – Oct.28	54.2	28.4	9.5	000.0	2.9
40	Oct.29 –Nov.05	55.6	28.8	10.0	000.0	2.8
41	Nov.06 – Nov.12	55.1	29.0	10.3	000.0	3.0
42	Nov.13 – Nov.19	56.3	28.2	9.9	000.0	2.8
43	Nov.20 – Nov.26	56.2	29.9	9.5	000.0	2.6
44	Nov.27 –Dec.3	57.6	28.8	11.0	000.0	3.6
45	Dec.4 – Dec.10	74.1	26.0	8.3	000.0	1.0
46	Dec.11 – Dec.17	64.3	27.2	8.9	5.6	1.8
47	Dec. 18 – Dec.24	62.4	25.7	6.7	6.8	2.3
48	Dec. 25 – Dec.31	66.0	25.7	7.4	000.0	1.8
49	Jan. 1- Jan. 7	63.1	23.1	9.1	000.0	1.1
50	Jan. 8- Jan. 14	71.5	19.7	5.9	12.4	1.6
51	Jan. 15- Jan. 21	71.5	21.8	6.3	000.0	2.2
52	Jan. 22- Jan. 28	72.0	21.8	10.3	000.0	1.8
53	Jan. 29- Feb. 4	76.0	24.0	9.2	000.0	1.7
54	Feb. 5- Feb. 11	70.0	24.2	9.0	000.0	1.9
55	Feb. 12 – Feb. 18	66.2	25.3	9.3	000.0	3.4
56	Feb. 19- Feb. 25	51.6	29.5	11.9	000.0	4.4
57	Feb. 26 – March 4	60.2	30.6	12.1	000.0	2.0
58	March 5 – March 11	60.0	28.3	11.7	4.3	1.5
59	March 12 –March 18	59.2	29.0	10.3	000.0	1.0
60	March 19 –March 25	52.0	34.7	16.3	000.0	1.8
61	March 26- April 1	42.0	38.7	18.9	0.2	2.1
62	April 2- April 8	44.5	40.5	17.8	000.0	2.0
63	April 9- April 15	47.3	41.2	21.6	000.0	2.1
64	April 16- April 22	42.5	40.8	20.2	000.0	1.9
65	April 23- April 29	43.6	44.3	20.8	000.0	2.2
66	April 30- May 6	40.2	42.1	21.3	000.0	2.3
Total		-	-	-	-	-
Average		58.31	29.90	11.86	1.00	2.23

Source: Meteorological Observatory, R.A.K. College of Agriculture, Sehore (M.P.)

Fig. 3.4 Meteorological data during crop growth period from the 15th October, 2021 to 6th May, 2022



3.5 Soil type

The soil of the experimental field was sandy loam with good drainage and uniform texture with very low, medium and medium NPK status, respectively.

3.5.1 Soil

In order to determine the textural class and fertility status of the experimental area, the soil samples were collected randomly from each plot with the help of soil auger before planting from the experimental field. Primary samples were mixed to prepare and composite soil sample from each replication was drawn to study physico-chemical properties of the experimental field. The soil samples were analyzed in the Department of Agricultural Chemistry & Soil Science, R.A.K., College of Agriculture, Sehore (M.P.). The data pertaining to various physico-chemical properties have been presented in Table 3.5.

The soil of the experimental field was sandy loam with 17.07% clay, 22.25% silt and 60.68% sand with pH ranging from 7.8 (normal). The soil was very low in available nitrogen, medium in available phosphorus and medium in available potassium.

Table 3.5 Chemical properties of experimental field

S.No.	Soil constituents	Value obtain	Method of determination
1. Mechanical composition			
(i) (ii) (iii)	Sand (%) Silt (%) Clay (%)	60.68 22.25 17.07	Bouyoucos Hydrometer method (Piper, 1950)
2. Chemical components			
(i)	Soil pH (1:2 soil- water ratio)	7.8	pH meter (Jackson, 1967)
(ii)	Electrical conductivity (ds/m)	0.14	Conductivity meter at 25ºC (Jackson, 1967)
(iii)	Organic carbon (g/kg)	4.83	Walkley and Black method (1934)
(iv)	Available nitrogen (kg/ha)	218.0	Alkaline potassium permanganate method (Subbaih and Asija, 1956)
(v)	Available phosphorus P_2O_5 (kg/ha)	15.12	Olsen's method (Olsen *et al.* 1954)
(vi)	Available potassium K_2O (kg/ha)	192.0	Flame photometer (Jackson, 1967)

3.6 Cropping history of the experimental field

The knowledge about previous crops on experimental field is essential to know its previous history. The experimental field was planted to different crops during past three years. A brief history of crops sequence followed during the last three years is shown in the table 3.6.

Table 3.6 Cropping history of experimental field

Year	Kharif	Rabi	Summer
2017-2018	Brinjal	Cabbage	Fallow
2018-2019	Okra	Tomato	Fallow
2019-2020	Brinjal	Potato	Fallow

3.7 Experimental details

The experiment was laid out in Randomized Block Design (RBD) with three replications. Each replication consists of twelve treatments. All the treatments were randomized separately in each replication. The experiment consisting of different levels of biofertilizers i.e. *Azotobactor* and PSB with different organic manures i.e. FYM and vermicompost were applied before planting of onion variety Agri Found Light Red (AFLR).

3.7.1 Details of experiments

Name of crop	:	Onion (*Allium cepa* L.)
Variety	:	Agri Found Light Red (AFLR)
Experimental Design	:	Randomized Block Design (RBD)
Plot size	:	2.1 x 1.8 m
Row to row spacing	:	15 cm
Plant to plant spacing	:	10 cm
Treatment	:	12
Replication	:	3
Total no. of plots	:	36

Distance between plot to plot : 50 cm

Distance between replication : 1m

Total number of plants/plot : 252

Season : 2021 -22 (Rabi)

Recommended dose of fertilizers (RDF) : N: P: K 120:60:30 kg / ha + FYM @ 20t/ha

3.7.2 Treatment details

T_0 : Control (RDF N: P: K 120:60:30 kg/ha + FYM@20 t/ha)

T_1 : FYM@20 t/ha+ PSB@2.5kg/ha

T_2 : FYM@20t/ha + Azotobactor@2kg/ha

T_3 : FYM@20 t/ha + Azotobactor@1kg/ha + PSB@1.25kg/ha

T_4 : Vermicompost@5t/ha + PSB@2.5kg/ha

T_5 : Vermicompost@5t/ha+ Azotobactor@2kg/ha

T_6 : Vermicompost@5t/ha + Azotobactor@1kg/ha+ PSB@1.25kg/ha

T_7 : Poultry manure@2t/ha+ PSB@2.5kg/ha

T_8 : Poultry manure@2t/ha + Azotobactor@2kg/ha

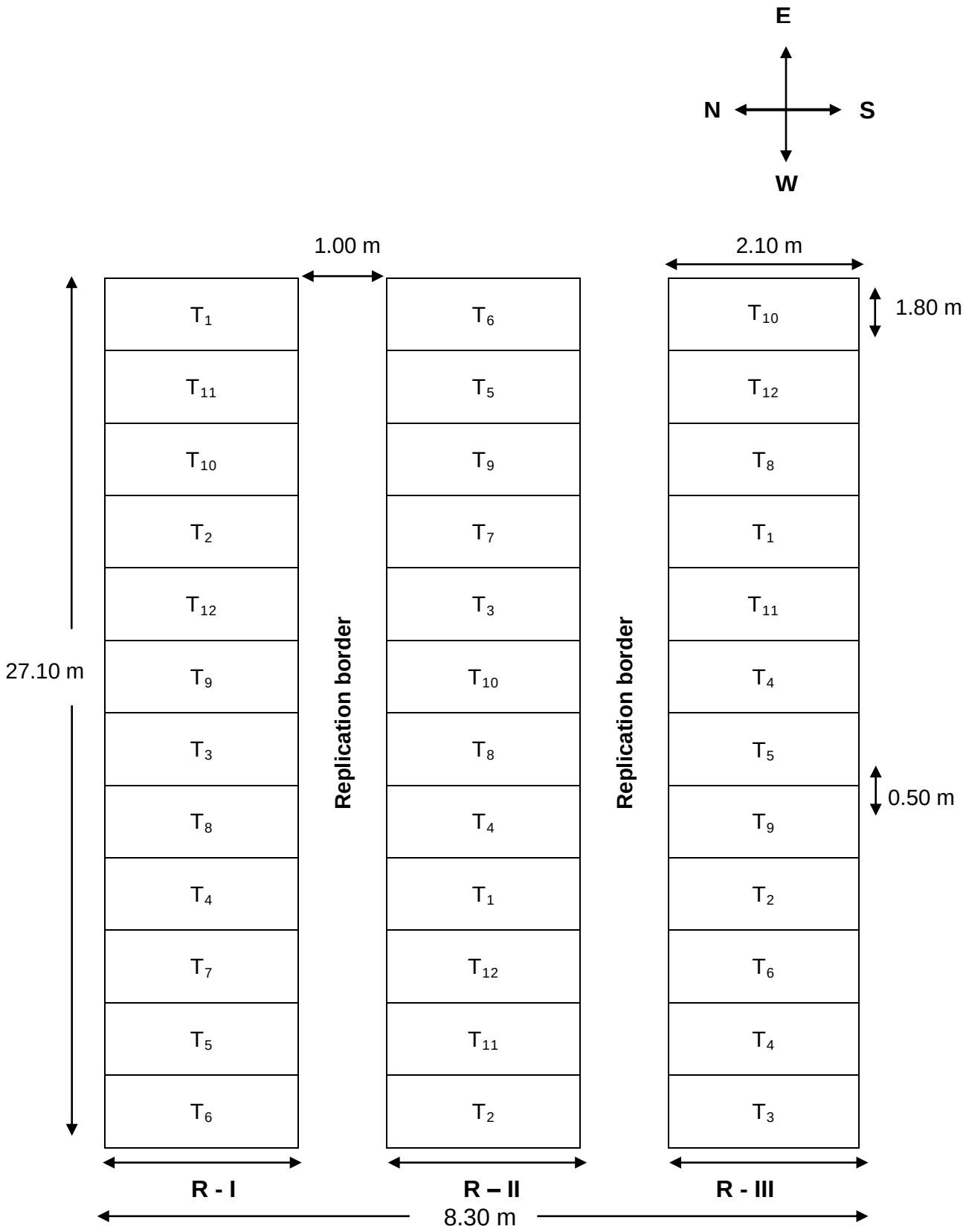
T_9 : Poultry manure@2t/ha + Azotobactor@1kg/ha +PSB@1.25kg/ha

T_{10} : FYM@10t/ha+ Vermicompost@2.5t/ha + PSB@1.25kg/ha

T_{11} : FYM@10t/ha + Vermicompost@2.5t/ha +Azotobactor@1kg/ha

(RDF- Recommended dose of fertilizer, PSB- Phosphorus Solubilizing Bacteria., t – tons, FYM- Farm Yard manure.)

Plan of layout



3.8 Agronomical operations

3.8.1 Nursery raising

After selection of the site, the soil was ploughed to a good tilth. All weed plants, stones and other undesirable materials were collected and removed from the field. The beds were prepared and finally levelled. Beds were 2 x 2 meter in size and raised up to 15 cm from ground level. Prior to sowing, seeds were treated with mancozeb and sown in furrows opened 1 to 2 cm deep at 5 to 7 cm apart and just after dropping the seeds in the furrows they were covered well with fine soil and mulched with dry grass to facilitate early and uniform germination. Immediately, then light irrigation was given.

3.8.2 After care of seedlings

After sowing of seeds, the seedlings were regularly irrigated till the seedling was ready for transplanting. Weeding and plant protection measure was done as and when required.

3.8.3 Field preparation

The field was properly ploughed by disc harrow and then pulverized by disking and harrowing. There after field was levelled properly with heavy wooden planking by tractor and plots were prepared according to layout plan.

3.8.4 Application of manure and fertilizer

The calculated quantities of fertilizers were applied to the respective plot. The source of nutrients were nitrogen (DAP, Urea) phosphorus (DAP), potash (MOP). Half of nitrogen and whole of phosphorus and potash were applied as basal dose prior to transplanting of onion seedlings. While the rest of nitrogen was given in 2 equal split doses in transplanted onion seedling, first at 30 and second 45 days of transplanting.

3.8.5 Application of biofertilizers

The process of inoculation of onion seedlings with *Azotobactor* and PSB culture or both was carried as per treatment plan, using standard

methods. Suspension of one kg biofertilizer in 15 litres of water was prepared for treatment of seedlings of one acre crop. The respective culture packet was mixed in cold jaggery water and dipped the roots of onion seedling in the solution for 10 minutes before transplanting.

3.8.6 Variety

The variety used in this experiment was Agrifound Light Red developed by NHRDF, Nasik which is having light red colour bulbs, 5-7 cm in diameter, moderately pungent, TSS-13% and good keeping quality.

3.8.7 Transplanting and gap filling

Forty five days old seedlings of uniform height were selected and transplanted in the field with the spacing of 15 cm row to row and 10 cm plant to plant. Gap filling was carried out 10 days after transplanting to maintain plants in each plot and light irrigation was given just after gap filling of seedlings.

3.8.8 Irrigation

Optimum soil moisture was maintained in the field by regular irrigation as given below:

Irrigation	Date
1st	08th November, 2021
2nd	16th November, 2021
3rd	23th November, 2021
4th	29th November, 2021
5th	08th December, 2021
6th	19th December, 2021
7th	03rd January, 2022
8th	15th January, 2022
9th	28th January, 2022
10th	12th February, 2022
11th	23rd February, 2022
12th	03rd March, 2022
13th	12th March, 2022
14th	20th March, 2022
15th	28th March, 2022
16th	06th April, 2022
17th	13th April, 2022
18th	20th April, 2022

3.8.9 Weeding

It was done manually at 35 and 45 days after transplanting.

3.8.10 Plant protection measures

Spray of insecticide (Metasystox @ 1ml/l of water) and fungicide (Dithane M-45 @ 1g/l of water) with neem oil was done at interval of 15 days of transplanting for protection of crop from insect pest and diseases.

3.8.11 Harvesting

Harvesting was done manually by hand digger at neck fall stage on 13 May, 2022. The observations on different bulb parameters were recorded after proper curing. Then the bulbs were graded as ‘A’ ‘B’ and ‘C’ and sold in the market.

3.9 Observations to be recorded

3.9.1 Growth characters

3.9.1.1 Plant height (cm) at different intervals (30, 60 and 90 DAT)

Five plants were randomly selected in each plot and tagged. The plant height of each tagged plant was measured from base of the plant to tips of the highest leaf by meter scale and average of five plants was recorded as mean plant height at 30, 60 and 90 DAT.

3.9.1.2 Number of leaves per plant at different intervals (30, 60 and 90 DAT)

Total numbers of leaves were counted from randomly selected plants to compute the mean number of leaves per plant at 30, 60 and 90 DAT.

3.9.1.3 Neck thickness (cm) of bulb at different intervals (30, 60 and 90 DAT)

The neck thickness of bulb of randomly selected onion bulbs was measured with the help of vernier callipers at 30, 60 and 90 DAT of the crop.

3.9.1.4 Leaf area (cm^2)

The area of randomly selected (5 numbers) leaves was measured with Leaf Area Meter (CI 203) at first cutting and average value was worked out and expressed in cm^2.

3.9.1.5 Leaf area index

From the samples collected for dry matter estimation, leaves of 5 plants were plucked and leaf area was measured with the help of leaf area meter (LA-3100). After recording leaf area, these leaves were again mixed with the samples of dry matter estimation. The leaf area for each sample so recorded was averaged to give leaf area/plant. Land area/plant was used to compute LAI at each stage by following relationship (Watson, 1958)

$$LAI = \frac{A}{P}$$

where,

A= Leaf area

P= Ground area

3.9.2 Yield attributes of onion

3.9.2.1 Fresh weight of bulb (g)

The fresh weight of the bulb (g) was measured with the help of electronic weighing balance and expressed in gram.

3.9.2.2 Dry weight of bulb (g)

The dry weight of the bulb was measured after dehydrating the bulbs first by sun drying and then oven drying and then obtaining the weight through electronic weighing balance and expressed in gram.

3.9.2.3 Bulb yield per plot (kg)

Bulbs of all the plants in each plot including 5 observational plants except border row were harvested and weighted separately for total yield per plot and expressed in kg.

3.9.2.4 Bulb yield per ha (q)

Bulb yield in quintals per hectare was calculated on the basis of the yield obtained per plot.

3.9.2.5 Equatorial diameter of bulb (cm)

Equatorial diameter of selected onion was measured with the help of vernier calipers at maximum width of the bulbs at harvest.

3.9.2.6 Polar diameter of bulb (cm)

Similarly, polar diameter of selected onion bulbs was also measured from the neck surface to the bottom root surface of the bulb with the help of vernier callipers at harvest and recorded in centimetres.

3.9.3 Quality parameter

3.9.3.1 T.S.S. (%)

Total soluble solids (TSS) percentage was determined with the help of hand refractometer at the time of harvesting of bulb and final TSS measured after adding and / or substrate the correction values from table at 200 C.

3.9.3.2 Moisture%

Fresh onion leaves (10 g) homogenized pulp was taken in three replications and dried completely at 100-102 ºC. Weights of dry samples were noted till constant weights were obtained. The percentage of moisture content was calculated as the following:

$$\text{Moisture content (\%)} = \frac{\text{Wt. of fresh pulp} - \text{Wt. of dry pulp}}{\text{Wt. of fresh pulp}} \times 100$$

3.9.4 Economical parameters

3.9.4.1 Gross returns (₹/ha)

Gross returns are the total monetary value of economic produce and by products obtained from the crop raised in the different treatments is calculated based on the local market prices.

3.9.4.2 Net returns (₹/ha)

It is computed by subtracting cost of cultivation from gross returns. It is good indicator of suitability of a cropping system since this represents the actual income of the farmer. Monetary returns for different treatments were calculated with the help of prevailing market rates of produce and different inputs used in the experiments.

$$\text{Net monetary returns (₹/ha)} = \text{Gross return (₹/ha)} - \text{Cultivation cost (₹/ha)}$$

3.9.4.3 Benefit cost ratio

It is the ratio of gross returns to cost of cultivation. It is expressed as returns per rupee invested. This index provides an estimate of the benefit a farmer derives for the expenditure he incurs in adopting a particular cropping system. Any value above 2.0 is considered safe as the farmer gets Rs. 2 for every rupee invested.

Benefit cost ratio = Gross return (₹/ha) / Cost of cultivation (₹/ha)

3.10 Statistical analysis

The data obtained from set of observation for each character were subjected to "Analysis of Variance" as advocated by Panse and Sukhatme (1985). The Skeleton of ANOVA as per design is as given in Table 3.10

Table 3.10 Skeleton of analysis of variance

Source of variation	**Degree of freedom**	**Sum of square**	**Mean sum of square**	**"F" Value Calculated**	**"F" tab. $t_{5\%}$**
Replications	2	SSR	MSR	-	
Treatment	11	SST	MST	MST / MSE	
Error	22	SSE	MSE	-	
Total	35				

The significance of the treatment difference was judged by using critical difference (C.D.), which was calculated by using formula given by Panse and Sukhatme (1985).

S. Em. $\pm$ = $\sqrt{}$EMSS/replication

S. Ed. $\pm$ = $\sqrt{}$2 × EMSS/ replication

C. D. = S. Ed. × t 5% at error df

Where,

df = Degree of freedom

SS = Sum of square

MSS= Mean sum of square

Experimental view- A

Experimental view- B

Chapter - IV

RESULTS

The present investigation entitled “Effect of different biofertilizers and organic manures on growth and yield of onion (*Allium cepa* L.)” was carried out at Horticulture Research Farm, R.A.K College of Agriculture, Sehore (M.P.). The experiment was laid out in Randomized Block Design (RBD) with three replications. Each replication consists of twelve treatments. The experiment consisting of different levels of biofertilizers i.e. *Azotobactor* and PSB with different organic manures i.e. FYM and vermicompost were applied before planting of onion variety Agri Found Light Red (AFLR). The observations on different aspects such as growth parameters (viz., plant height (cm), no. of leaves per plant, neck thickness of the bulb (cm) at different intervals (30, 60 and 90 DAT), leaf area (cm^2) and leaf area index), yield attributes of onion (viz., fresh weight of bulb per plant (g), dry weight of bulb per plant (g), bulb yield per plot (kg), bulb yield per ha (q), equatorial diameter of bulb (cm) and polar diameter of bulb (cm)), quality parameter (viz., T.S.S. % and moisture%) and economical parameters (viz., Gross return (₹/ha), net return (₹/ha) and benefit cost ratio) were calculated. The findings of the investigations presented in this chapter in tabular form and illustrated with suitable diagram wherever found necessary.

4.1 Growth parameters

4.1.1 Plant height (cm)

Glance of data on plant height (cm) at 30, 60 and 90 days after transplanting is presented in table 4.1.1. It is also depicted graphically in figure 4.1.1. The analysis of variance (ANOVA) is given in appendix- I, II and III.

Result reported that the different treatments of biofertilizers and organic manures were significantly influenced the plant height of onion. It was recorded the treatment T_6 (Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha) was found the best treatment for influencing the plant height of onion and it gave the maximum plant height (23.12, 31.05 and 46.70 cm) at 30, 60 and 90 days after transplanting. It was at par to treatment T_9

(Poultry manure @ 2t/ha + *Azotobactor* @ 1kg/ha + PSB @ 1.25kg/ha) at 30 days after transplanting and T_9 (Poultry manure @ 2t/ha + *Azotobactor* @ 1kg/ha + PSB @ 1.25kg/ha) and T_{11} (FYM @ 10t/ha + Vermicompost @ 2.5t/ha + *Azotobactor* @ 1kg/ha) at 60 and 90 days after transplanting. However the treatment T_0 (control) shows the minimum plant height (13.91, 21.92 and 35.53 cm) at 30, 60 and 90 days after transplanting as compared to other treatments.

4.1.2 Number of leaves per plant

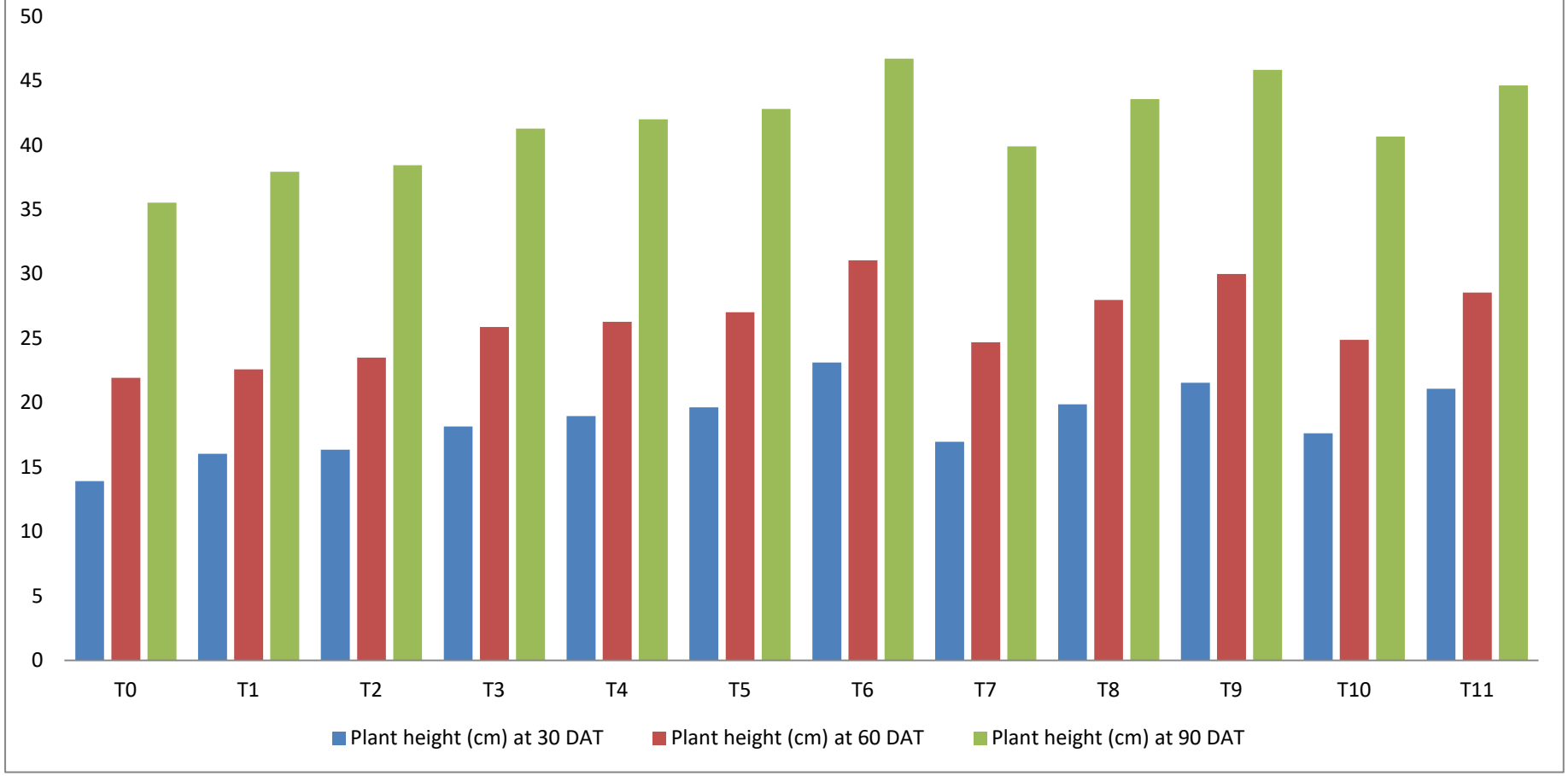
The data regarding number of leaves per plant at 30, 60 and 90 days after transplanting is presented in table 4.1.2, illustrated in figure 4.1.2 and analysis of variance given in appendix-IV, V and VI.

It is evident from the data that treatment T_6 (Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha) was significantly influenced the different growth parameters of onion and it gave the maximum number of leaves per plant (6.60, 9.95 and 12.63) at 30, 60 and 90 days after transplanting. It was at par to treatment T_9 (Poultry manure @ 2t/ha + *Azotobactor* @ 1kg/ha + PSB @ 1.25kg/ha) and T_{11} (FYM @ 10t/ha + Vermicompost @ 2.5t/ha + *Azotobactor* @ 1kg/ha) at 30 and 60 days after transplanting and only T_9 (Poultry manure @ 2t/ha + *Azotobactor* @ 1kg/ha + PSB @ 1.25kg/ha) at 90 days after transplanting while the minimum number of leaves per plant (4.10, 5.42 and 7.84) at 30, 60 and 90 days after transplanting were recorded under treatment T_0 (control).

4.1.1 Effect of different biofertilizers and organic manures on plant height (cm) at 30, 60 and 90 DAT of onion

Treatment Details	Plant height (cm) at 30 DAT	Plant height (cm) at 60 DAT	Plant height (cm) at 90 DAT
T_0: Control (RDF N: P: K 120:60:30 kg/ha + FYM@20 t/ha)	13.91	21.92	35.53
T_1: FYM @ 20 t/ha + PSB @ 2.5kg/ha	16.02	22.59	37.93
T_2: FYM @ 20t/ha + *Azotobactor* @ 2kg/ha	16.34	23.50	38.44
T_3: FYM @ 20 t/ha + *Azotobactor* @ 1kg/ha + PSB @ 1.25kg/ha	18.16	25.87	41.27
T_4: Vermicompost @ 5t/ha + PSB @ 2.5kg/ha	18.96	26.27	42.00
T_5: Vermicompost @ 5t/ha + *Azotobactor* @ 2kg/ha	19.64	27.01	42.81
T_6: Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha	23.12	31.05	46.70
T_7: Poultry manure @ 2t/ha + PSB @ 2.5kg/ha	16.96	24.68	39.89
T_8: Poultry manure @ 2t/ha + *Azotobactor* @ 2kg/ha	19.87	27.98	43.57
T_9: Poultry manure @ 2t/ha + *Azotobactor* @ 1kg/ha + PSB @ 1.25kg/ha	21.55	29.99	45.83
T_{10}: FYM @ 10t/ha+ Vermicompost @ 2.5t/ha + PSB @ 1.25kg/ha	17.63	24.88	40.67
T_{11}: FYM @ 10t/ha + Vermicompost @ 2.5t/ha + *Azotobactor* @ 1kg/ha	21.08	28.55	44.62
SEm ±	**0.669**	**1.011**	**0.723**
CD 5%	**1.961**	**2.965**	**2.119**

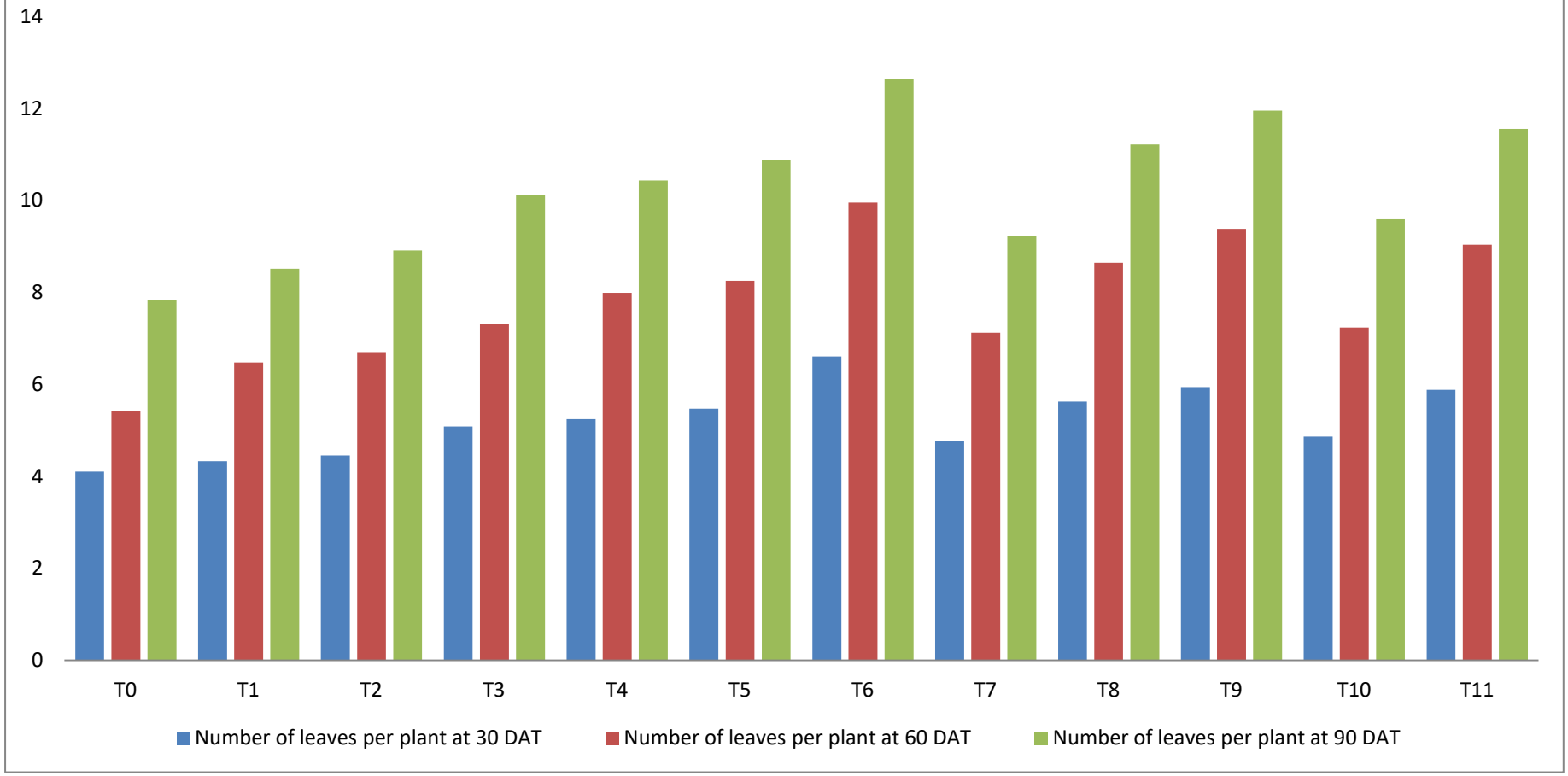
Fig. 4.1.1 Effect of different biofertilizers and organic manures on plant height (cm) at 30, 60 and 90 DAT of onion



4.1.2 Effect of different biofertilizers and organic manures on number of leaves per plant at 30, 60 and 90 DAT of onion

Treatment Details	Number of leaves per plant at 30 DAT	Number of leaves per plant at 60 DAT	Number of leaves per plant at 90 DAT
T_0: Control (RDF N: P: K 120:60:30 kg/ha + FYM@20 t/ha)	4.10	5.42	7.84
T_1: FYM @ 20 t/ha + PSB @ 2.5kg/ha	4.33	6.47	8.51
T_2: FYM @ 20t/ha + *Azotobactor* @ 2kg/ha	4.45	6.70	8.91
T_3: FYM @ 20 t/ha + *Azotobactor* @ 1kg/ha + PSB @ 1.25kg/ha	5.08	7.31	10.11
T_4: Vermicompost @ 5t/ha + PSB @ 2.5kg/ha	5.24	7.99	10.43
T_5: Vermicompost @ 5t/ha + *Azotobactor* @ 2kg/ha	5.47	8.25	10.87
T_6: Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha	6.60	9.95	12.63
T_7: Poultry manure @ 2t/ha + PSB @ 2.5kg/ha	4.77	7.12	9.23
T_8: Poultry manure @ 2t/ha + *Azotobactor* @ 2kg/ha	5.62	8.64	11.21
T_9: Poultry manure @ 2t/ha + *Azotobactor* @ 1kg/ha + PSB @ 1.25kg/ha	5.94	9.38	11.95
T_{10}: FYM @ 10t/ha+ Vermicompost @ 2.5t/ha + PSB @ 1.25kg/ha	4.86	7.23	9.60
T_{11}: FYM @ 10t/ha + Vermicompost @ 2.5t/ha + *Azotobactor* @ 1kg/ha	5.88	9.03	11.55
SEm ±	**0.297**	**0.200**	**0.368**
CD 5%	**0.871**	**0.586**	**1.079**

Fig. 4.1.2 Effect of different biofertilizers and organic manures on number of leaves per plant at 30, 60 and 90 DAT of onion



4.1.3 Neck thickness of bulb (cm)

The mean data of neck thickness of bulb (cm) at 30, 60 and 90 days after transplanting is given in table 4.1.3. Its graphical presentation has been shown in figure 4.1.3. The ANOVA is given in appendix-VII, VIII and IX.

The investigation revealed that the maximum neck thickness of bulb (0.73, 0.83 and 1.59 cm) at 30, 60 and 90 days after transplanting was recorded in treatment T_6 (Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha) and it was found the best treatment combination of organic manure and biofertilizers. It was at par to treatment T_9 (Poultry manure @ 2t/ha + *Azotobactor* @ 1kg/ha + PSB @ 1.25kg/ha) at 30 and 90 days after transplanting and was at par to T_9 (Poultry manure @ 2t/ha + *Azotobactor* @ 1kg/ha + PSB @ 1.25kg/ha) and T_{11} (FYM @ 10t/ha + Vermicompost @ 2.5t/ha + *Azotobactor* @ 1kg/ha) at 60 days after transplanting only. However the minimum neck thickness of bulb (0.38, 0.49 and 1.30 cm) at 30, 60 and 90 days after transplanting was observed in control treatment T_0.

4.1.4 Leaf area (cm^2)

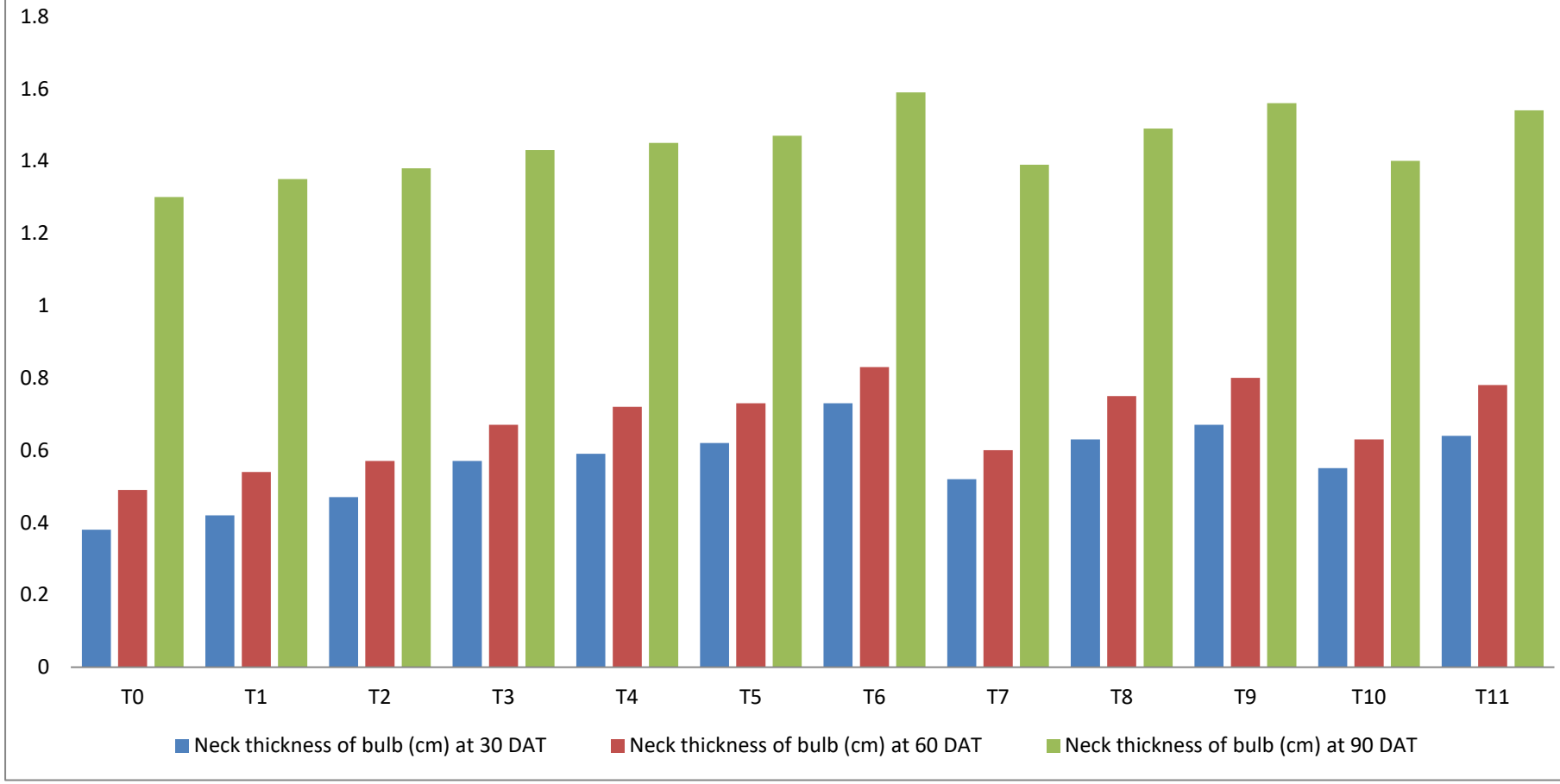
Data recorded on leaf area (cm^2) at 30, 60 and 90 days after transplanting is presented in table 4.1.4, illustrated in figure 4.1.4 and analysis of variance given in appendix-X, XI and XII.

The investigation revealed that the different treatments of biofertilizers and organic manures were significantly influenced the leaf area of onion plant and treatment T_6 (Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha) was found the best treatment for influencing the leaf area of onion plant and it gave the maximum leaf area (171.63, 328.99 and 628.46 cm^2) at 30, 60 and 90 days after transplanting. It was at par to treatment T_9 (Poultry manure @ 2t/ha + *Azotobactor* @ 1kg/ha + PSB @ 1.25kg/ha) only at 60 DAT. However the control treatment T_0 shows the minimum leaf area (70.50, 158.67 and 360.79 cm^2) at 30, 60 and 90 days after transplanting as compared to other treatments.

4.1.3 Effect of different biofertilizers and organic manures on neck thickness of bulb (cm) at 30, 60 and 90 DAT of onion

Treatment Details	Neck thickness of bulb (cm) at 30 DAT	Neck thickness of bulb (cm) at 60 DAT	Neck thickness of bulb (cm) at 90 DAT
T_0: Control (RDF N: P: K 120:60:30 kg/ha + FYM@20 t/ha)	0.38	0.49	1.30
T_1: FYM @ 20 t/ha + PSB @ 2.5kg/ha	0.42	0.54	1.35
T_2: FYM @ 20t/ha + *Azotobactor* @ 2kg/ha	0.47	0.57	1.38
T_3: FYM @ 20 t/ha + *Azotobactor* @ 1kg/ha + PSB @ 1.25kg/ha	0.57	0.67	1.43
T_4: Vermicompost @ 5t/ha + PSB @ 2.5kg/ha	0.59	0.72	1.45
T_5: Vermicompost @ 5t/ha + *Azotobactor* @ 2kg/ha	0.62	0.73	1.47
T_6: Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha	0.73	0.83	1.59
T_7: Poultry manure @ 2t/ha + PSB @ 2.5kg/ha	0.52	0.60	1.39
T_8: Poultry manure @ 2t/ha + *Azotobactor* @ 2kg/ha	0.63	0.75	1.49
T_9: Poultry manure @ 2t/ha + *Azotobactor* @ 1kg/ha + PSB @ 1.25kg/ha	0.67	0.80	1.56
T_{10}: FYM @ 10t/ha+ Vermicompost @ 2.5t/ha + PSB @ 1.25kg/ha	0.55	0.63	1.40
T_{11}: FYM @ 10t/ha + Vermicompost @ 2.5t/ha + *Azotobactor* @ 1kg/ha	0.64	0.78	1.54
SEm ±	**0.028**	**0.021**	**0.018**
CD 5%	**0.081**	**0.062**	**0.053**

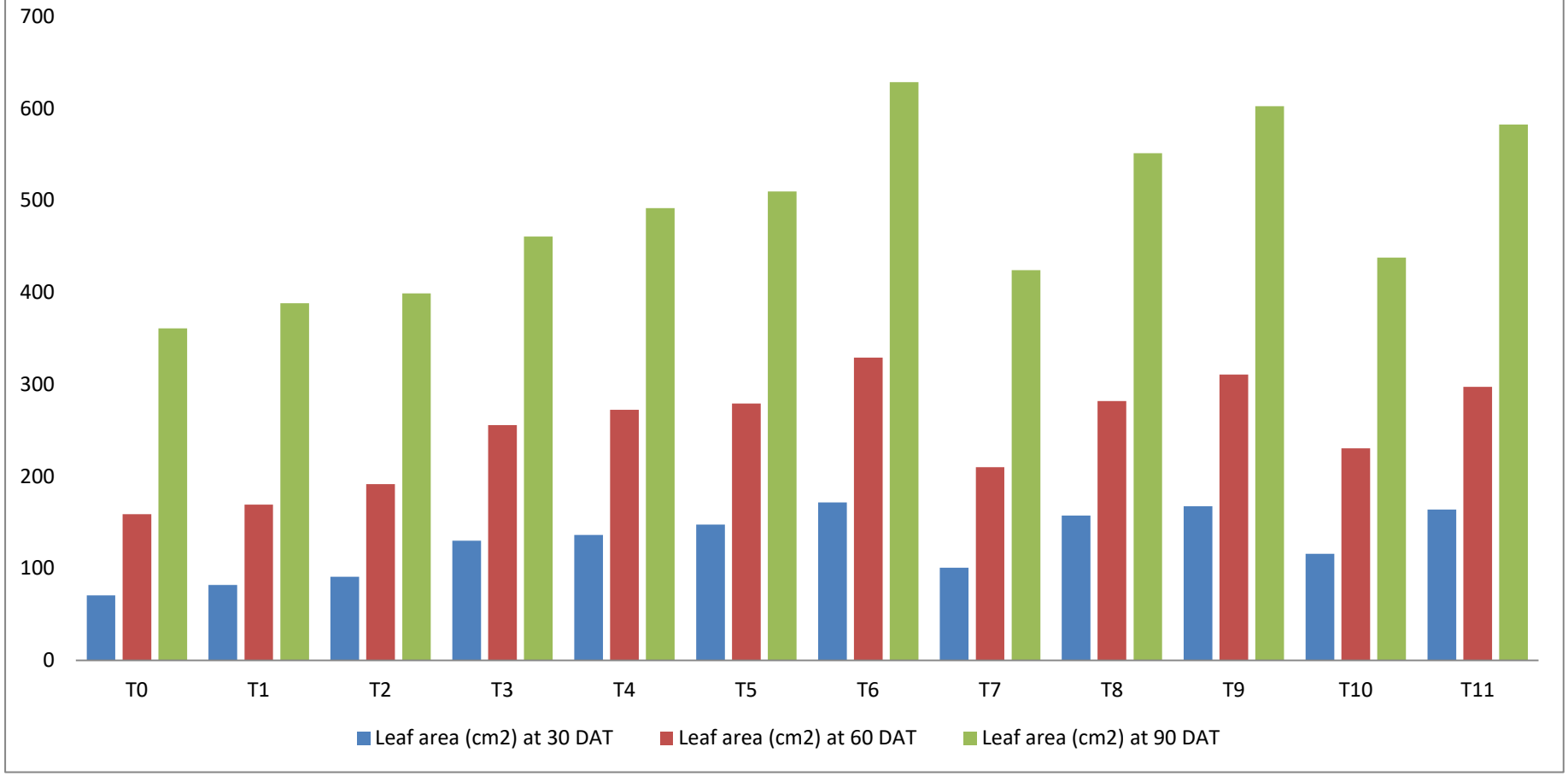
Fig. 4.1.3 Effect of different biofertilizers and organic manures on neck thickness of bulb (cm) at 30, 60 and 90 DAT of onion



4.1.4 Effect of different biofertilizers and organic manures on leaf area (cm^2) at 30, 60 and 90 DAT of onion

Treatment Details	Leaf area (cm^2) at 30 DAT	Leaf area (cm^2) at 60 DAT	Leaf area (cm^2) at 90 DAT
T_0: Control (RDF N: P: K 120:60:30 kg/ha + FYM@20 t/ha)	70.50	158.67	360.79
T_1: FYM @ 20 t/ha + PSB @ 2.5kg/ha	81.92	169.31	387.94
T_2: FYM @ 20t/ha + *Azotobactor* @ 2kg/ha	90.90	191.53	398.78
T_3: FYM @ 20 t/ha + *Azotobactor* @ 1kg/ha + PSB @ 1.25kg/ha	129.89	255.66	460.41
T_4: Vermicompost @ 5t/ha + PSB @ 2.5kg/ha	136.11	272.26	491.29
T_5: Vermicompost @ 5t/ha + *Azotobactor* @ 2kg/ha	147.57	279.12	509.50
T_6: Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha	171.63	328.99	628.46
T_7: Poultry manure @ 2t/ha + PSB @ 2.5kg/ha	100.60	209.88	423.89
T_8: Poultry manure @ 2t/ha + *Azotobactor* @ 2kg/ha	157.36	281.65	551.23
T_9: Poultry manure @ 2t/ha + *Azotobactor* @ 1kg/ha + PSB @ 1.25kg/ha	167.35	310.41	602.13
T_{10}: FYM @ 10t/ha+ Vermicompost @ 2.5t/ha + PSB @ 1.25kg/ha	115.61	230.40	437.57
T_{11}: FYM @ 10t/ha + Vermicompost @ 2.5t/ha + *Azotobactor* @ 1kg/ha	163.83	297.23	582.25
SEm ±	**1.183**	**9.256**	**2.394**
CD 5%	**3.470**	**27.148**	**7.021**

Fig. 4.1.4 Effect of different biofertilizers and organic manures on leaf area (cm^2) at 30, 60 and 90 DAT of onion



4.1.5 Leaf area index

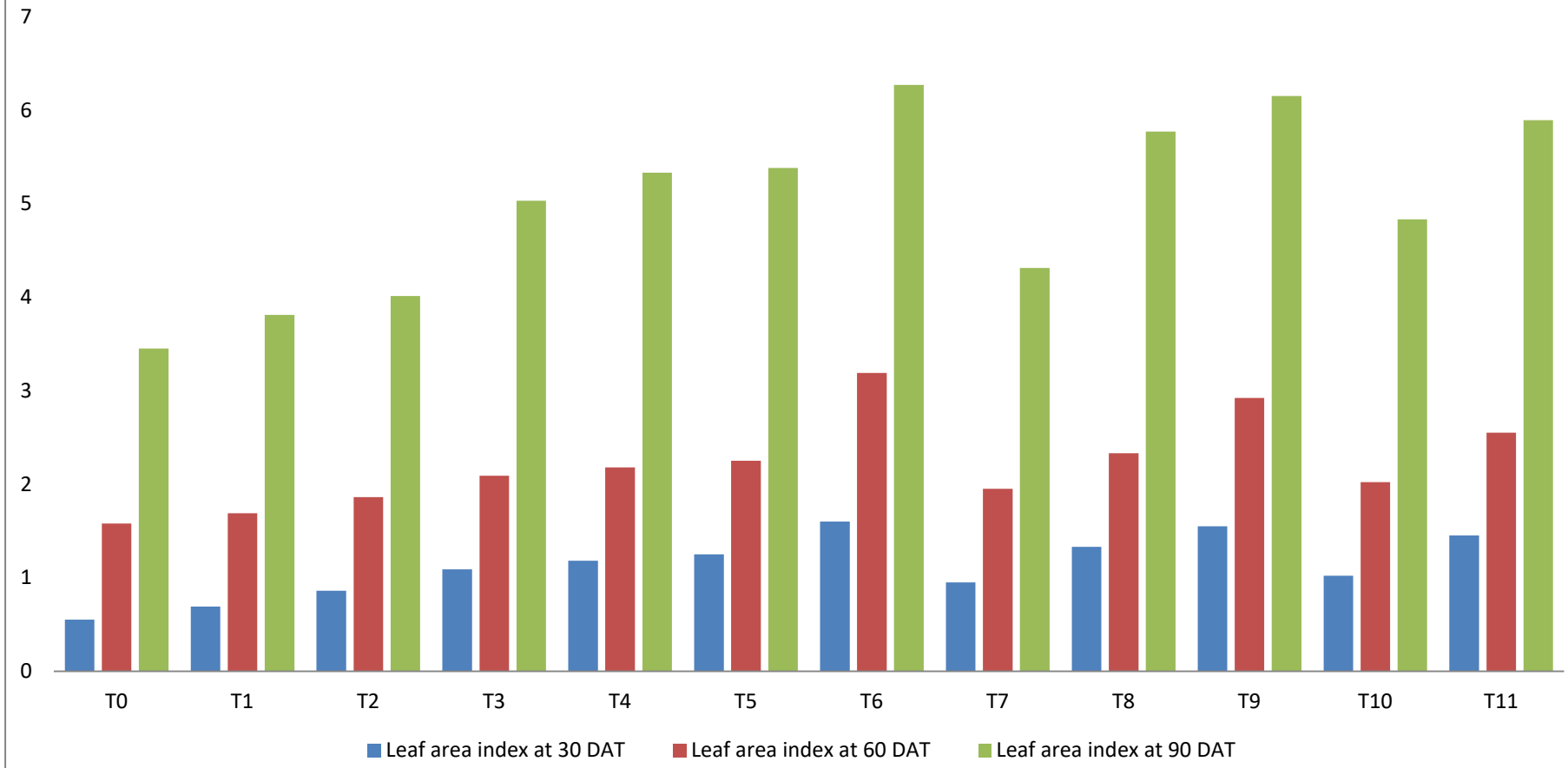
The data pertaining to leaf area index at 30, 60 and 90 days after transplanting is presented in table 4.1.5 and graphically representation in figure 4.1.5. The analysis of variance (ANOVA) is given in appendix- XIII, XIV and XV.

The result revealed that the maximum leaf area index (1.60, 3.19 and 6.27) at 30, 60 and 90 days after transplanting was observed in treatment T_6 (Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha) and it was found the best treatment combination of organic manure and biofertilizers. It was at par to treatment T_9 (Poultry manure @ 2t/ha + *Azotobactor* @ 1kg/ha + PSB @ 1.25kg/ha) only at 90 days after transplanting. However the minimum leaf area index (0.55, 1.58 and 3.45) at 30, 60 and 90 days after transplanting was noted in control treatment T_0.

4.1.4 Effect of different biofertilizers and organic manures on leaf area index at 30, 60 and 90 DAT of onion

Treatment Details	Leaf area index at 30 DAT	Leaf area index at 60 DAT	Leaf area index at 90 DAT
T_0: Control (RDF N: P: K 120:60:30 kg/ha + FYM@20 t/ha)	0.55	1.58	3.45
T_1: FYM @ 20 t/ha + PSB @ 2.5kg/ha	0.69	1.69	3.81
T_2: FYM @ 20t/ha + *Azotobactor* @ 2kg/ha	0.86	1.86	4.01
T_3: FYM @ 20 t/ha + *Azotobactor* @ 1kg/ha + PSB @ 1.25kg/ha	1.09	2.09	5.03
T_4: Vermicompost @ 5t/ha + PSB @ 2.5kg/ha	1.18	2.18	5.33
T_5: Vermicompost @ 5t/ha + *Azotobactor* @ 2kg/ha	1.25	2.25	5.38
T_6: Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha	1.60	3.19	6.27
T_7: Poultry manure @ 2t/ha + PSB @ 2.5kg/ha	0.95	1.95	4.31
T_8: Poultry manure @ 2t/ha + *Azotobactor* @ 2kg/ha	1.33	2.33	5.77
T_9: Poultry manure @ 2t/ha + *Azotobactor* @ 1kg/ha + PSB @ 1.25kg/ha	1.55	2.92	6.15
T_{10}: FYM @ 10t/ha+ Vermicompost @ 2.5t/ha + PSB @ 1.25kg/ha	1.02	2.02	4.83
T_{11}: FYM @ 10t/ha + Vermicompost @ 2.5t/ha + *Azotobactor* @ 1kg/ha	1.45	2.55	5.89
SEm ±	**0.017**	**0.018**	**0.046**
CD 5%	**0.050**	**0.052**	**0.134**

Fig. 4.1.4 Effect of different biofertilizers and organic manures on leaf area index at 30, 60 and 90 DAT of onion



4.2 Yield attributes of onion

4.2.1 Fresh weight of bulb per plant (g)

Data obtained on fresh weight of bulb per plant (g) is presented in table 4.2.1 and graphically representation in figure 4.2.1. The analysis of variance (ANOVA) is given in appendix- XVI.

A perusal of data indicates that treatment T_6 (Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha) was significantly influenced the different yield parameters of onion and it gave the maximum fresh weight of bulb per plant (69.40 g). It was at par to treatment T_9 (Poultry manure @ 2t/ha + *Azotobactor* @ 1kg/ha + PSB @ 1.25kg/ha) while the minimum fresh weight of bulb per plant (54.41 g) was recorded under treatment T_0 (control).

4.2.2 Dry weight of bulb per plant (g)

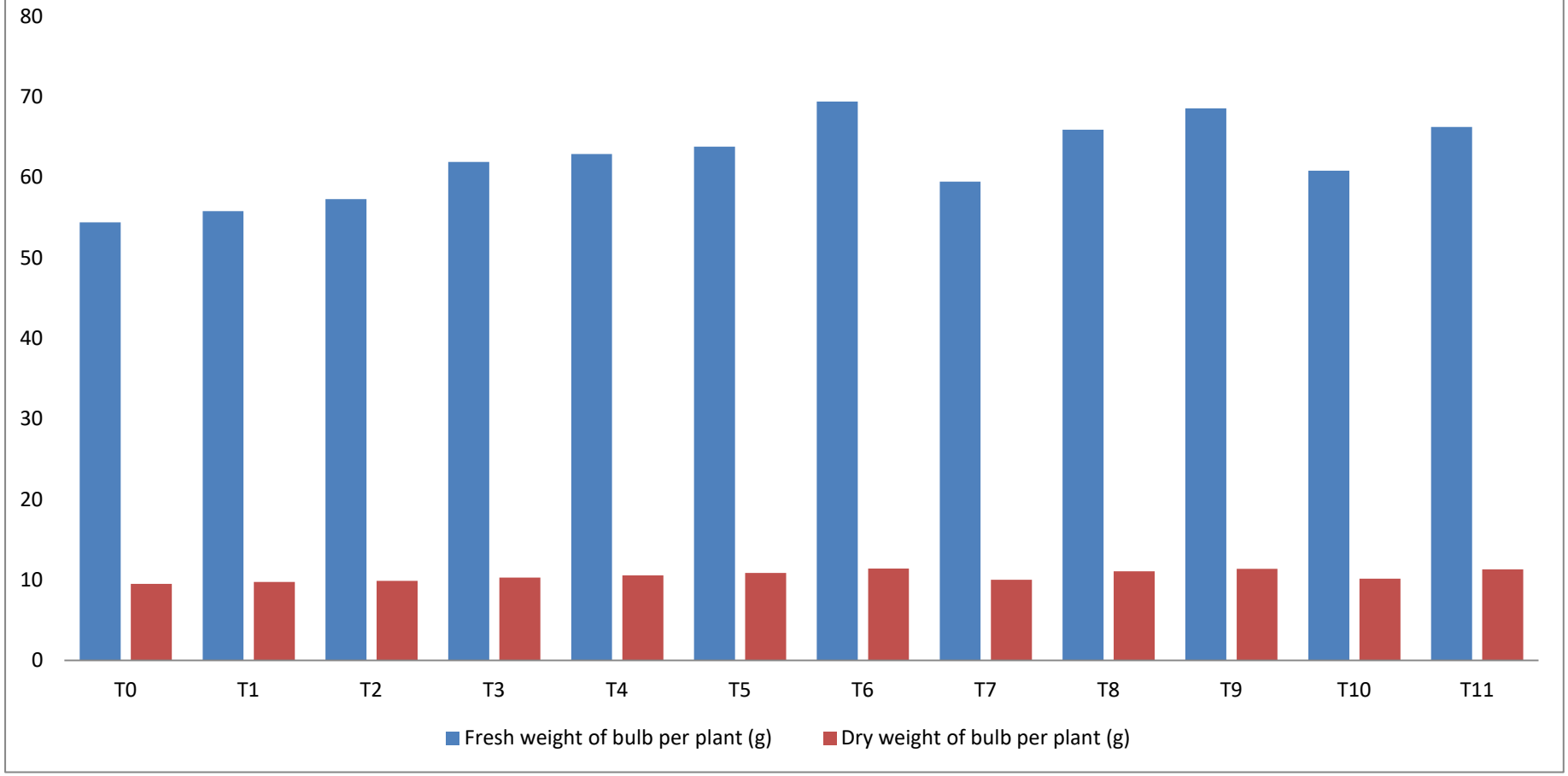
Data in respect of dry weight of bulb per plant (g) is presented in table 4.2.1, illustrated in figure 4.2.1 and analysis of variance given in appendix-XVII.

Result revealed that the different treatments of biofertilizers and organic manures were significantly influenced the dry weight of bulb per plant of onion. It was recorded the treatment T_6 (Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha) was found the best treatment for influencing the dry weight of bulb of onion and it gave the maximum dry weight of bulb per plant (11.40 g). It was at par to treatment T_9 (Poultry manure @ 2t/ha + *Azotobactor* @ 1kg/ha + PSB @ 1.25kg/ha) and T_{11} (FYM @ 10t/ha + Vermicompost @ 2.5t/ha + *Azotobactor* @ 1kg/ha). However the treatment T_0 (control) shows the minimum dry weight of bulb per plant (9.50 g) as compared to other treatments.

4.2.1 Effect of different biofertilizers and organic manures on fresh and dry weight of bulb per plant (g) of onion

Treatment Details	Fresh weight of bulb per plant (g)	Dry weight of bulb per plant (g)
T_0: Control (RDF N: P: K 120:60:30 kg/ha + FYM@20 t/ha)	54.41	9.50
T_1: FYM @ 20 t/ha + PSB @ 2.5kg/ha	55.80	9.73
T_2: FYM @ 20t/ha + *Azotobactor* @ 2kg/ha	57.28	9.87
T_3: FYM @ 20 t/ha + *Azotobactor* @ 1kg/ha + PSB @ 1.25kg/ha	61.89	10.27
T_4: Vermicompost @ 5t/ha + PSB @ 2.5kg/ha	62.88	10.54
T_5: Vermicompost @ 5t/ha + *Azotobactor* @ 2kg/ha	63.79	10.83
T_6: Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha	69.40	11.40
T_7: Poultry manure @ 2t/ha + PSB @ 2.5kg/ha	59.46	10.00
T_8: Poultry manure @ 2t/ha + *Azotobactor* @ 2kg/ha	65.89	11.05
T_9: Poultry manure @ 2t/ha + *Azotobactor* @ 1kg/ha + PSB @ 1.25kg/ha	68.54	11.35
T_{10}: FYM @ 10t/ha+ Vermicompost @ 2.5t/ha + PSB @ 1.25kg/ha	60.80	10.13
T_{11}: FYM @ 10t/ha + Vermicompost @ 2.5t/ha + *Azotobactor* @ 1kg/ha	66.24	11.29
SEm ±	**0.663**	**0.051**
CD 5%	**1.944**	**0.151**

Fig. 4.2.1 Effect of different biofertilizers and organic manures on fresh and dry weight of bulb per plant (g) of onion



4.2.3 Bulb yield per plot (Kg)

The data gathered on bulb yield per plot (g) is given in table 4.2.2. Its graphical presentation has been shown in figure 4.2.2. The ANOVA is given in appendix-XVIII.

The data present in table shows that the maximum bulb yield per plot (17.49 kg) was observed in treatment T_6 (Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha) and it was found the best treatment combination of organic manure and biofertilizers to influencing the bulb yield in onion. It was at par to treatment T_9 (Poultry manure @ 2t/ha + *Azotobactor* @ 1kg/ha + PSB @ 1.25kg/ha). However, the minimum bulb yield per plot (13.71 kg) was found in treatment T_0 (control).

4.2.4 Bulb yield per hectare (q)

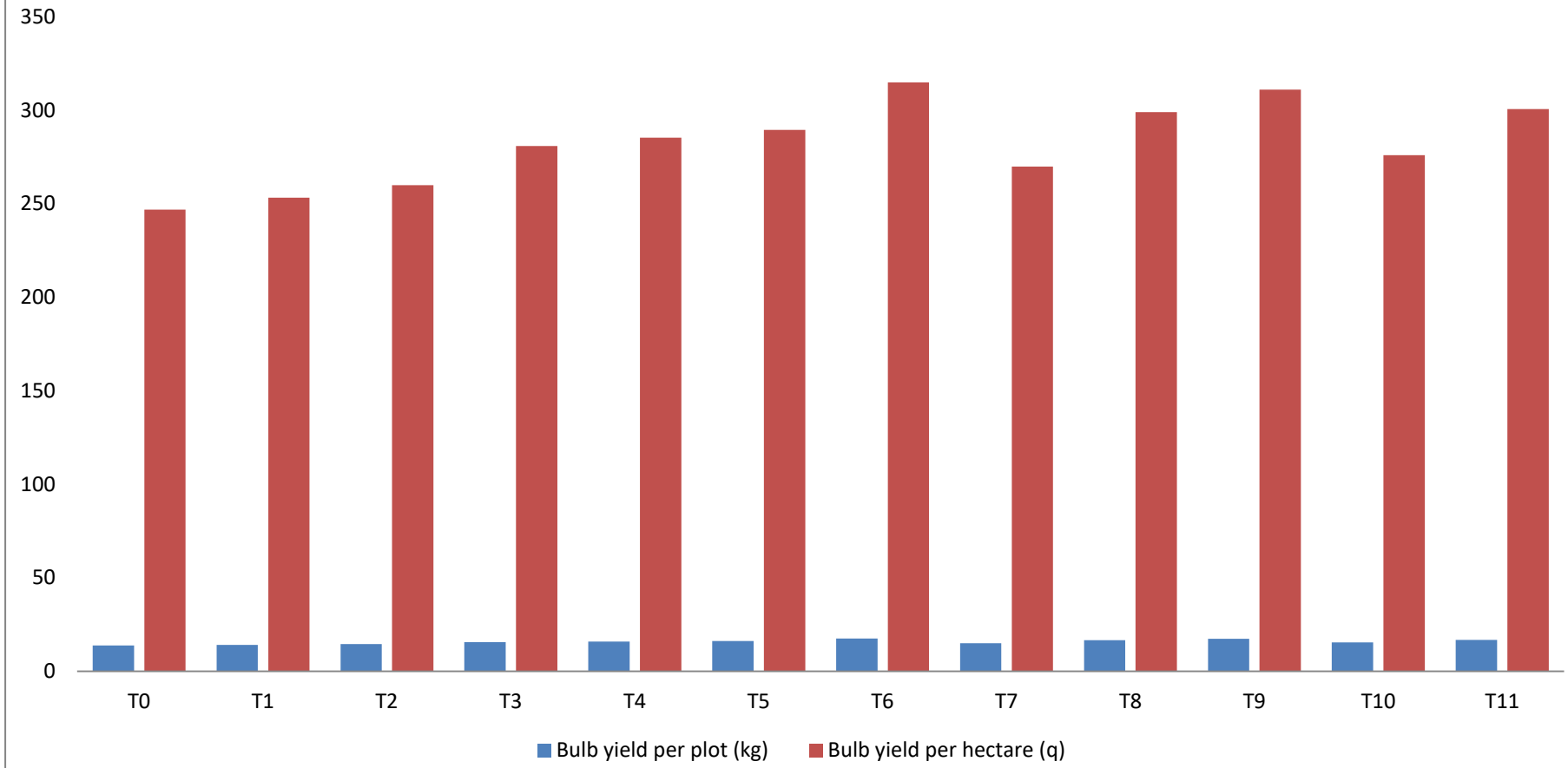
Glance of data on bulb yield per hectare (q) is presented in table 4.2.2. It is also depicted graphically in figure 4.2.2. The analysis of variance (ANOVA) is given in appendix-XIX.

Result reported that the different treatments of biofertilizers and organic manures were significantly influenced the bulb yield per hectare in onion and treatment T_6 (Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha) was found the best treatment for influencing the bulb yield of onion plant and it gave the maximum bulb yield per hectare (314.81 q). It was at par to treatment T_9 (Poultry manure @ 2t/ha + *Azotobactor* @ 1kg/ha + PSB @ 1.25kg/ha). However the control treatment T_0 shows the minimum bulb yield per hectare (246.82 q) as compared to other treatments.

4.2.2 Effect of different biofertilizers and organic manures on bulb yield per plot (kg) and per hectare (q) of onion

Treatment Details	Bulb yield per plot (kg)	Bulb yield per hectare (q)
T_0: Control (RDF N: P: K 120:60:30 kg/ha + FYM@20 t/ha)	13.71	246.82
T_1: FYM @ 20 t/ha + PSB @ 2.5kg/ha	14.06	253.11
T_2: FYM @ 20t/ha + *Azotobactor* @ 2kg/ha	14.43	259.81
T_3: FYM @ 20 t/ha + *Azotobactor* @ 1kg/ha + PSB @ 1.25kg/ha	15.60	280.72
T_4: Vermicompost @ 5t/ha + PSB @ 2.5kg/ha	15.85	285.22
T_5: Vermicompost @ 5t/ha + *Azotobactor* @ 2kg/ha	16.08	289.37
T_6: Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha	17.49	314.81
T_7: Poultry manure @ 2t/ha + PSB @ 2.5kg/ha	14.98	269.71
T_8: Poultry manure @ 2t/ha + *Azotobactor* @ 2kg/ha	16.61	298.89
T_9: Poultry manure @ 2t/ha + *Azotobactor* @ 1kg/ha + PSB @ 1.25kg/ha	17.27	310.90
T_{10}: FYM @ 10t/ha+ Vermicompost @ 2.5t/ha + PSB @ 1.25kg/ha	15.32	275.80
T_{11}: FYM @ 10t/ha + Vermicompost @ 2.5t/ha + *Azotobactor* @ 1kg/ha	16.69	300.48
SEm ±	**0.167**	**3.006**
CD 5%	**0.490**	**8.817**

Fig. 4.2.2 Effect of different biofertilizers and organic manures on bulb yield per plot (kg) and per hectare (q) of onion



4.2.5 Equatorial diameter of bulb (cm)

Data in respect of equatorial diameter of bulb (cm) in leaf is presented in table 4.2.3 and graphically representation in figure 4.2.3. The analysis of variance (ANOVA) is given in appendix- XX.

A perusal of data indicates that the maximum equatorial diameter of bulb (7.25 cm) was found in treatment T_6 (Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha) and it was found the best treatment combination of organic manure and biofertilizers to influencing the diameter of onion bulb. It was at par to treatment T_9 (Poultry manure @ 2t/ha + *Azotobactor* @ 1kg/ha + PSB @ 1.25kg/ha) and T_{11} (FYM @ 10t/ha + Vermicompost @ 2.5t/ha + *Azotobactor* @ 1kg/ha). However, the minimum equatorial diameter of bulb (6.25 cm) was noted in treatment T_0 (control).

4.2.6 Polar diameter of bulb (cm)

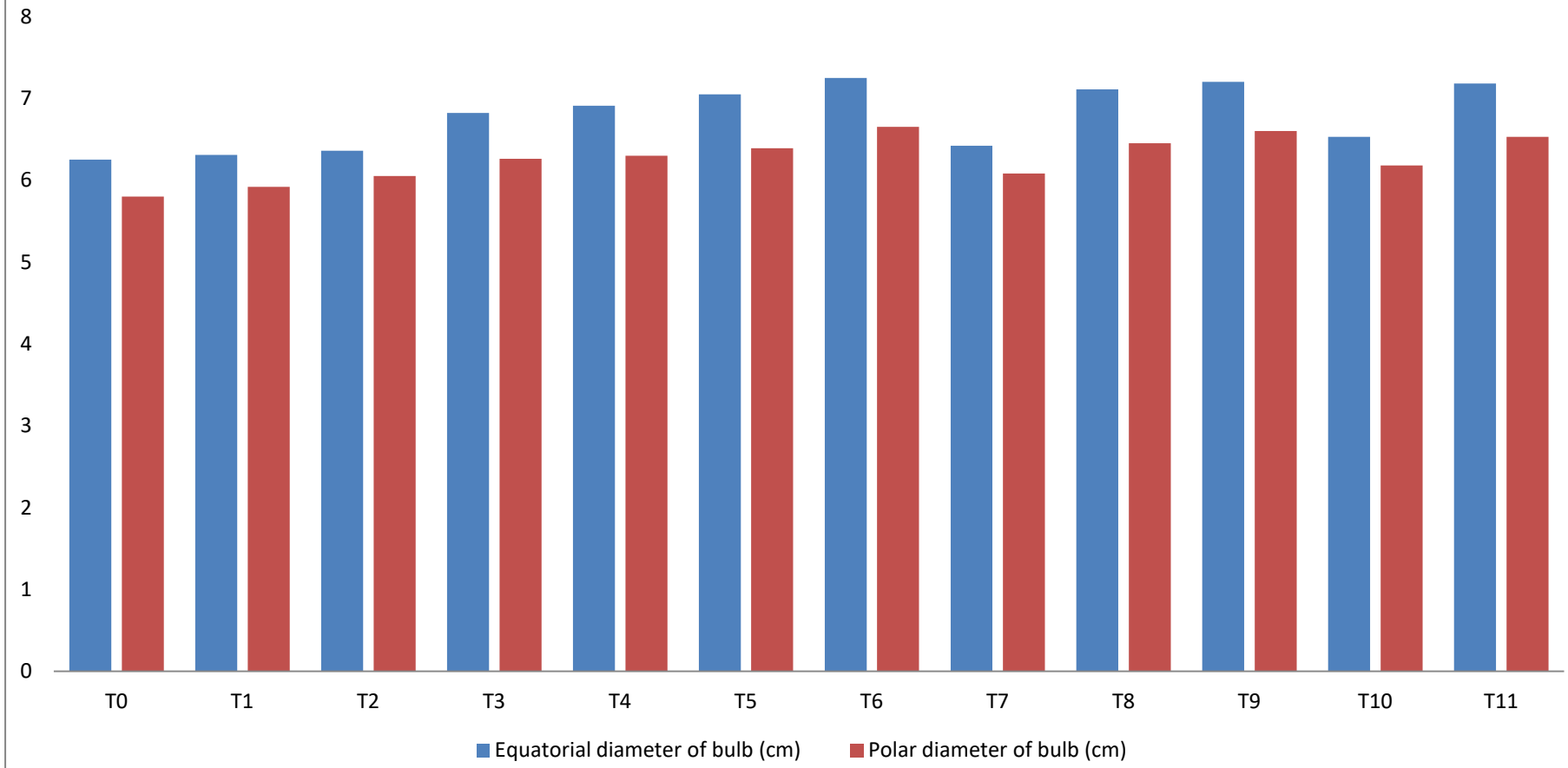
The data pertaining to polar diameter of bulb (cm) is presented in table 4.2.3 and graphically representation in figure 4.2.3. The analysis of variance (ANOVA) is given in appendix-XXI.

Table 4.2.6 shows that the maximum polar diameter of bulb (6.65 cm) was found in treatment T_6 (Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha) and it was found the best treatment combination of organic manure and biofertilizers to influencing the diameter of onion bulb. It was at par to treatment T_9 (Poultry manure @ 2t/ha + *Azotobactor* @ 1kg/ha + PSB @ 1.25kg/ha) and closely followed by treatment T_{11} (FYM @ 10t/ha + Vermicompost @ 2.5t/ha + *Azotobactor* @ 1kg/ha). However, the minimum polar diameter of bulb (5.80 cm) was recorded in treatment T_0 (control).

4.2.3 Effect of different biofertilizers and organic manures on equatorial and polar diameter of bulb (cm) of onion

Treatment Details	Equatorial diameter of bulb (cm)	Polar diameter of bulb (cm)
T_0: Control (RDF N: P: K 120:60:30 kg/ha + FYM@20 t/ha)	6.25	5.80
T_1: FYM @ 20 t/ha + PSB @ 2.5kg/ha	6.31	5.92
T_2: FYM @ 20t/ha + *Azotobactor* @ 2kg/ha	6.36	6.05
T_3: FYM @ 20 t/ha + *Azotobactor* @ 1kg/ha + PSB @ 1.25kg/ha	6.82	6.26
T_4: Vermicompost @ 5t/ha + PSB @ 2.5kg/ha	6.91	6.30
T_5: Vermicompost @ 5t/ha + *Azotobactor* @ 2kg/ha	7.05	6.39
T_6: Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha	7.25	6.65
T_7: Poultry manure @ 2t/ha + PSB @ 2.5kg/ha	6.42	6.08
T_8: Poultry manure @ 2t/ha + *Azotobactor* @ 2kg/ha	7.11	6.45
T_9: Poultry manure @ 2t/ha + *Azotobactor* @ 1kg/ha + PSB @ 1.25kg/ha	7.20	6.60
T_{10}: FYM @ 10t/ha+ Vermicompost @ 2.5t/ha + PSB @ 1.25kg/ha	6.53	6.18
T_{11}: FYM @ 10t/ha + Vermicompost @ 2.5t/ha + *Azotobactor* @ 1kg/ha	7.18	6.53
SEm ±	**0.025**	**0.036**
CD 5%	**0.074**	**0.104**

Fig. 4.2.3 Effect of different biofertilizers and organic manures on equatorial and polar diameter of bulb (cm) of onion



4.3 Quality parameters

4.3.1 TSS (%)

Data recorded on TSS (%) in leaf is presented in table 4.3.1, illustrated in figure 4.3.1 and analysis of variance given in appendix- XXII.

Result revealed that treatment T_6 (Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha) was significantly influenced the different quality parameters of onion and it gave the maximum TSS (12.80 %). It was at par to treatment T_9 (Poultry manure @ 2t/ha + *Azotobactor* @ 1kg/ha + PSB @ 1.25kg/ha) and closely followed by treatment T_{11} (FYM @ 10t/ha + Vermicompost @ 2.5t/ha + *Azotobactor* @ 1kg/ha) while the minimum TSS (11.60 %) was recorded under treatment T_0 (control).

4.3.2 Moisture (%)

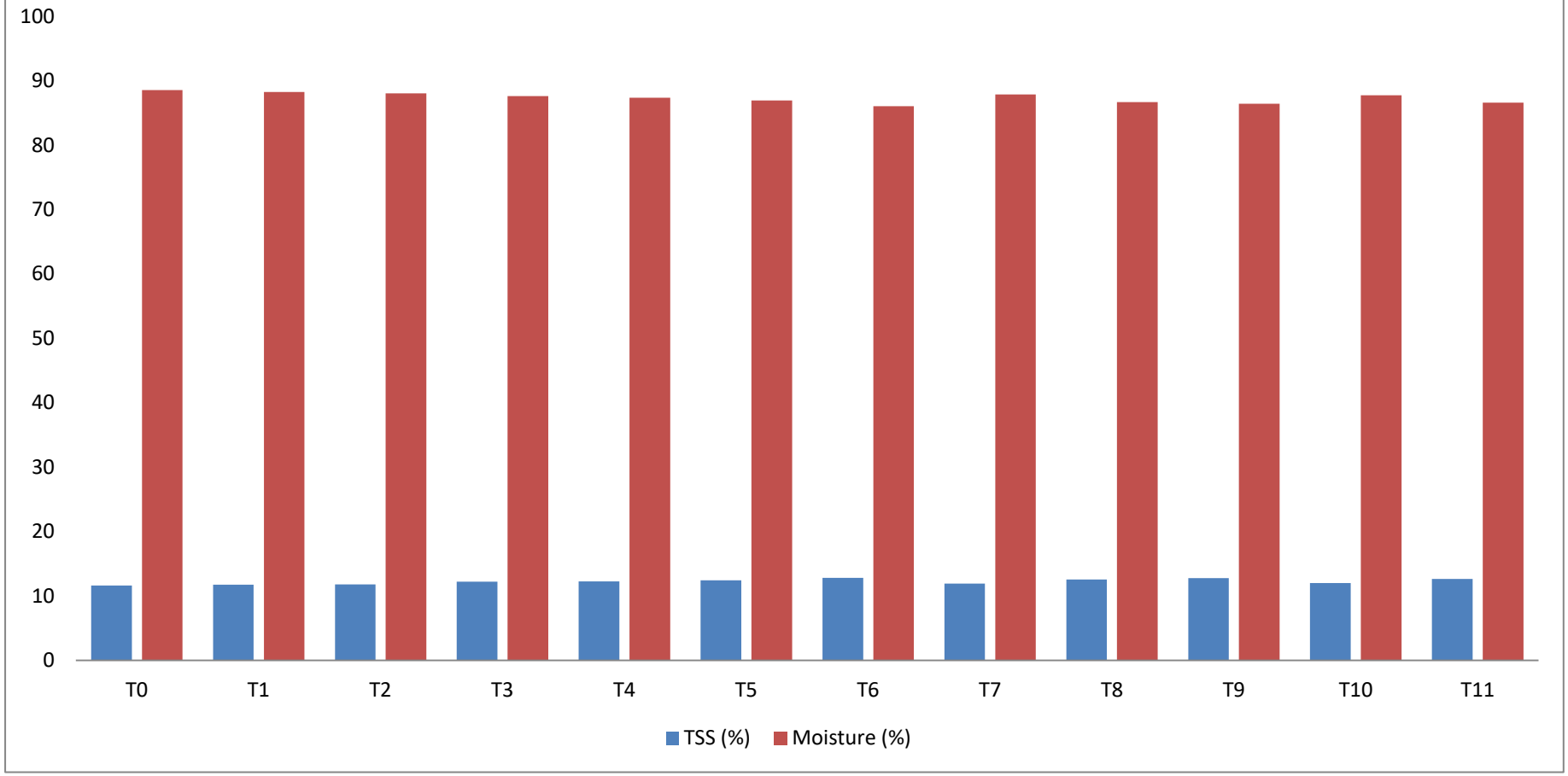
The data pertaining to moisture (%) is presented in table 4.3.1 and graphically representation in figure 4.3.1. The analysis of variance (ANOVA) is given in appendix- XXIII.

The result reported that the minimum moisture content (86.03 %) was observed in treatment T_6 (Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha) and it was found the best treatment combination of organic manure and biofertilizers. It was closely followed by treatment T_9 (Poultry manure @ 2t/ha + *Azotobactor* @ 1kg/ha + PSB @ 1.25kg/ha) and closely followed by treatment T_{11} (FYM @ 10t/ha + Vermicompost @ 2.5t/ha + *Azotobactor* @ 1kg/ha). However the maximum moisture content (88.54 %) was noted in control treatment T_0.

4.3.1 Effect of different biofertilizers and organic manures on TSS and moisture (%) of onion

Treatment Details	TSS (%)	Moisture (%)
T_0: Control (RDF N: P: K 120:60:30 kg/ha + FYM@20 t/ha)	11.60	88.54
T_1: FYM @ 20 t/ha + PSB @ 2.5kg/ha	11.72	88.24
T_2: FYM @ 20t/ha + *Azotobactor* @ 2kg/ha	11.77	88.03
T_3: FYM @ 20 t/ha + *Azotobactor* @ 1kg/ha + PSB @ 1.25kg/ha	12.20	87.59
T_4: Vermicompost @ 5t/ha + PSB @ 2.5kg/ha	12.25	87.36
T_5: Vermicompost @ 5t/ha + *Azotobactor* @ 2kg/ha	12.42	86.91
T_6: Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha	12.80	86.03
T_7: Poultry manure @ 2t/ha + PSB @ 2.5kg/ha	11.89	87.87
T_8: Poultry manure @ 2t/ha + *Azotobactor* @ 2kg/ha	12.54	86.66
T_9: Poultry manure @ 2t/ha + *Azotobactor* @ 1kg/ha + PSB @ 1.25kg/ha	12.75	86.42
T_{10}: FYM @ 10t/ha+ Vermicompost @ 2.5t/ha + PSB @ 1.25kg/ha	11.98	87.71
T_{11}: FYM @ 10t/ha + Vermicompost @ 2.5t/ha + *Azotobactor* @ 1kg/ha	12.62	86.57
SEm ±	**0.033**	**0.077**
CD 5%	**0.097**	**0.226**

Fig. 4.3.1 Effect of different biofertilizers and organic manures on TSS and moisture (%) of onion



4.4 Economics of the treatments

The economics of the treatments are presented in table 4.4 and illustrated in figure 4.4. The result revealed a significant variation among the different treatment combination of organic manure and biofertilizers. The maximum cost of cultivation (₹ 89000 /ha) was found in treatment T_4 (Vermicompost @ 5t/ha + PSB @ 2.5kg/ha), while the maximum gross returns (₹ 314814 /ha), net returns (₹ 229014 /ha) and B:C ratio (3.7) was recorded in treatment T_6 (Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha) and it was found the best treatment combination of organic manure and biofertilizers for influencing the economical parameters of onion. However the minimum cost of cultivation (₹ 83000 /ha) was found in treatment T_1 (FYM @ 20 t/ha + PSB @ 2.5kg/ha), while minimum gross returns (₹ 246819 /ha), net returns (₹ 161819 /ha) and B:C ratio (2.9) was noted in treatment T_0 (control).

4.4 Effect of different biofertilizers and organic manures on economical parameters of onion

Treatment Details	Common cost (₹/ha)	Treatment cost (₹/ha)	Total cost (₹/ha)	Gross returns (₹/ha)	Net returns (₹/ha)	Benefit cost ratio
T_0: Control (RDF N: P: K 120:60:30 kg/ha + FYM@20 t/ha)	60000	25000	85000	246819	161819	2.9
T_1: FYM @ 20 t/ha + PSB @ 2.5kg/ha	60000	23000	83000	253109	170109	3.0
T_2: FYM @ 20t/ha + *Azotobactor* @ 2kg/ha	60000	25600	85600	259807	174207	3.0
T_3: FYM @ 20 t/ha + *Azotobactor* @ 1kg/ha + PSB @ 1.25kg/ha	60000	28800	88800	280718	191918	3.2
T_4: Vermicompost @ 5t/ha + PSB @ 2.5kg/ha	60000	29000	89000	285224	196224	3.2
T_5: Vermicompost @ 5t/ha + *Azotobactor* @ 2kg/ha	60000	27600	87600	289367	201767	3.3
T_6: Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha	60000	25800	85800	314814	229014	3.7
T_7: Poultry manure @ 2t/ha + PSB @ 2.5kg/ha	60000	26000	86000	269711	183711	3.1
T_8: Poultry manure @ 2t/ha + *Azotobactor* @ 2kg/ha	60000	25600	85600	298892	213292	3.5
T_9: Poultry manure @ 2t/ha + *Azotobactor* @ 1kg/ha + PSB @ 1.25kg/ha	60000	25800	85800	310897	225097	3.6
T_{10}: FYM @ 10t/ha+ Vermicompost @ 2.5t/ha + PSB @ 1.25kg/ha	60000	28000	88000	275796	187796	3.1
T_{11}: FYM @ 10t/ha + Vermicompost @ 2.5t/ha + *Azotobactor* @ 1kg/ha	60000	25300	85300	300480	215180	3.5

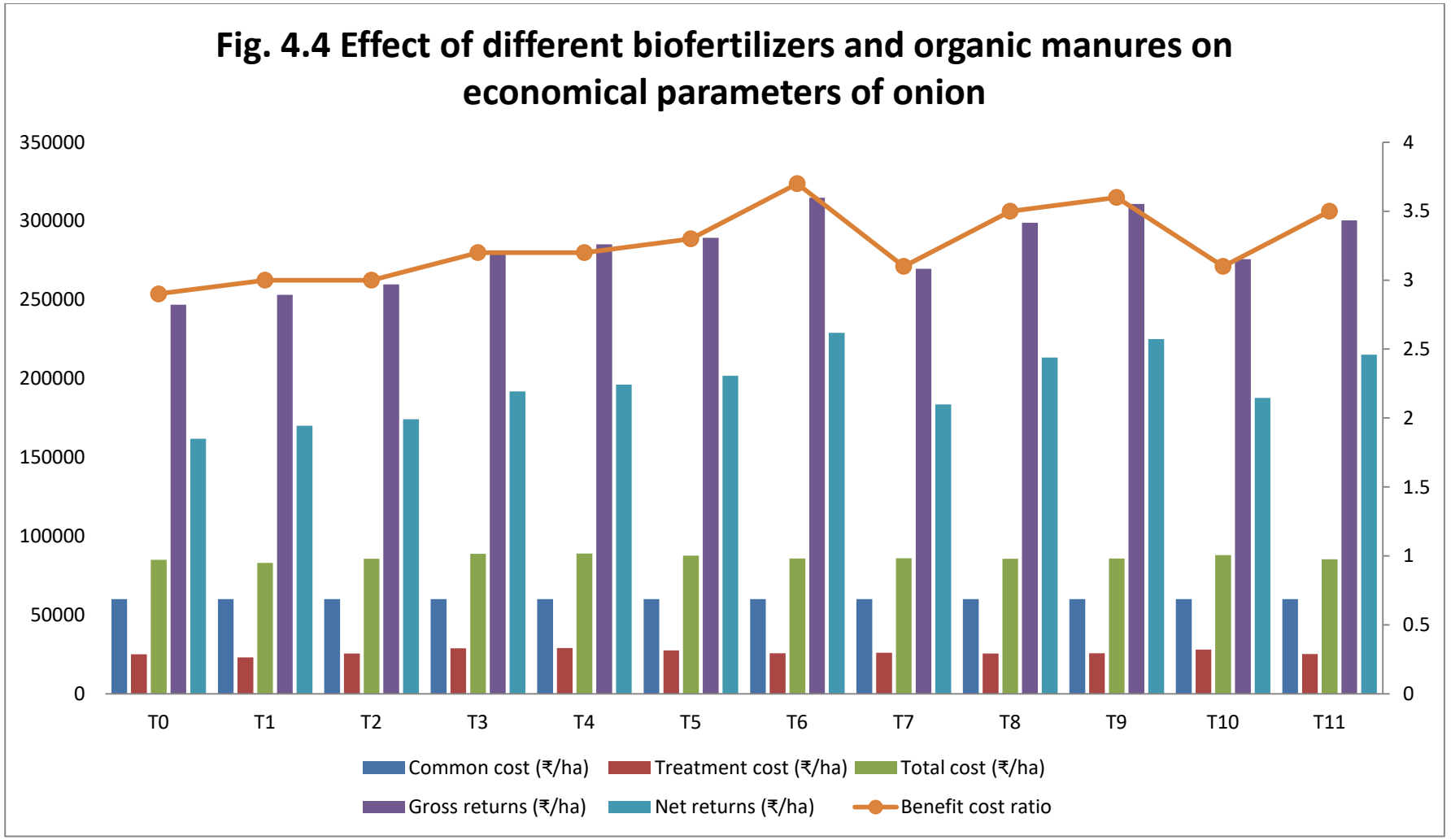


Fig. 4.4 Effect of different biofertilizers and organic manures on economical parameters of onion
350000
300000
250000
200000
150000
100000
50000
0
4
3.5
3
2.5
2
1.5
1
0.5
0
T0
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11
Common cost (₹/ha)
Treatment cost (₹/ha)
Total cost (₹/ha)
Gross returns (₹/ha)
Net returns (₹/ha)
Benefit cost ratio

Chapter - V

DISCUSSION

5.1 Discussion

On the basis of the findings, an attempt has been made in this chapter to explain the possible reasons of variations obtained due to different treatments. The result has been discussed in the light of literature available for the different characters under study. The experiment was laid out in Randomized Block Design (RBD) with three replications consists of twelve treatments. The experiment consisting of different levels of biofertilizers i.e. *Azotobactor* and PSB with different organic manures i.e. FYM and vermicompost were applied before planting of onion variety Agri Found Light Red (AFLR) has been presented in the preceding chapter.

The findings are briefly discussed and interpreted in support of the findings of the previous research work pertaining to “Effect of different biofertilizers and organic manures on growth and yield of onion (*Allium cepa* L.)”. During the course of discussion an effort has been made to establish relationship between different growth parameters (viz., plant height, no. of leaves per plant, neck thickness of the bulb, leaf area and leaf area index), yield attributes of onion (viz., fresh weight of bulb per plant, dry weight of bulb per plant, bulb yield per plot, bulb yield per ha, equatorial diameter of bulb and polar diameter of bulb), quality parameters (viz., T.S.S. and moisture %) and economical parameters (viz., gross returns, net returns and benefit cost ratio). However, the results on thesis aspects given in the preceding chapter are being discussed as under:

5.1.1 Weather conditions during growing season

Weather may influence the yield of onion apart from the other factors tested during the experimentation. Hence, it is of paramount importance to have information about prevailing weather condition during the period of experimentation. Crop growth is mainly dependent on environmental factors *viz.,* soil, and environment and weather factors. Fluctuations in the soil and

weather conditions greatly influence the growth, development and yield potential of the onion.

5.1.2 Effect of different biofertilizers and organic manures on growth parameters of onion

Result reported that the different treatments of biofertilizers and organic manures were significantly influenced the growth parameters of onion. It was recorded the treatment T_6 (Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha) was found the best treatment as compared to others and it gave the maximum plant height and number of leaves per plant at 30, 60 and 90 days after transplanting. However the treatment T_0 (control) shows the minimum plant height and number of leaves per plant at 30, 60 and 90 days after transplanting as compared to other treatments. Application of biofertilizers like *Azotobacter* and PSB and organic manures improves nutrient status of the soil because it is free nitrogen fixers and phosphorus solubilizer. Efficient and healthy strain of *Azotobacter* in rhizosphere, which in turn have resulted in greater fixation of atmospheric nitrogen and consequently use by the plant resulting in vigorous growth of it. Similar results for most of the characters were also reported by Farooq *et al.* (2015), Talwar *et al*. (2016), Prabhakar *et al.* (2017), Singh *et al*. (2017a), Vachan and Tripathi (2017), Bhati *et al.* (2018), Kumar *et al.* (2019), Meena *et al.* (2019), Singh and Singh (2019), Ahmed *et al*. (2020), Gererufael *et al.* (2020) and Singh *et al.* (2020).

It is evident from the data that the maximum neck thickness of bulb at 30, 60 and 90 days after transplanting was recorded in treatment T_6 (Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha) and it was found the best treatment combination of organic manure and biofertilizers. However the minimum neck thickness of bulb at 30, 60 and 90 days after transplanting was observed in control treatment T_0. It is due to the good absorption of nutrients which increase the size of bulb and increase neck thickness of bulb. These results are supported by the findings of Singh *et al*. (2017a), Vachan and Tripathi (2017), Kumar *et al.* (2019), Meena *et al.* (2019), Vaghela *et al*. (2019) and Gererufael *et al.* (2020).

It is evident from the data that treatment T_6 (Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha) was significantly influenced the different growth parameters of onion and it gave the maximum leaf area and leaf area index. However, the minimum leaf area and leaf area index was recorded under treatment T_0 (control). The application of organic manures and biofertilizers improves the availability of nutrients to plants which help to increase in leaf and leaf area in plants. These results are supported by the findings of Talwar *et al*. (2016), Singh *et al*. (2017a), Vachan and Tripathi (2017), Kumar *et al.* (2019) and Singh and Singh (2019).

5.1.3 Effect of different biofertilizers and organic manures on yield parameters of onion

A perusal of data indicates that treatment T_6 (Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha) was significantly influenced the different yield parameters of onion and it gave the maximum fresh and dry weight of bulb per plant while the minimum fresh and dry weight of bulb per plant was recorded under treatment T_0 (control). Due to application of organic manure good soil condition is provide to plants for better root development and absorption of nutrients and more nutrients make to available by biofertilizers which help to increase in fresh and dry weight of onion bulb. Similar results for most of the characters were also reported by Talwar *et al*. (2016), Singh *et al*. (2017a), Vachan and Tripathi (2017), Bhati *et al.* (2018), Mahala *et al*. (2018), Kumar *et al.* (2019), Meena *et al.* (2019) and Ahmed *et al*. (2020).

The result shows that the maximum bulb yield per plot and per hectare was observed in treatment T_6 (Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha) and it was found the best treatment combination of organic manure and biofertilizers to influencing the bulb yield in onion. However, the minimum bulb yield per plot and per hectare was found in treatment T_0 (control). Biofertilizers inoculation and application of organic manures might have helped in increasing nitrogen, phosphorus and potassium availability. It colonizes the root mass, fixes nitrogen, phosphorus and potassium in loose association with plants which reflected in the better yield attributes. Application of different organic manures and biofertilizers increased

activity of plant growth substances like gibberellic acid, indole acetic acid and NAA in *Azotobacter* inoculated plant, which in turn might have improved the yield. Findings are in agreement with those of Talwar *et al*. (2016), Singh *et al*. (2017a), Singh *et al.* (2017b), Vachan and Tripathi (2017), Mahala *et al*. (2018), Meena *et al.* (2019), Petrovic *et al*. (2019), Vaghela *et al*. (2019), Ahmed *et al*. (2020), Gererufael *et al.* (2020) and Singh *et al.* (2020).

A perusal of data indicates that the maximum equatorial and polar diameter of bulb was found in treatment T_6 (Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha) and it was found the best treatment combination of organic manure and biofertilizers to influencing the diameter of onion bulb. However, the minimum equatorial and polar diameter of bulb was noted in treatment T_0 (control). Application of organic manures and biofertilizers might have helped in increasing nitrogen, phosphorus and potassium availability. It colonizes the root mass, fixes nitrogen, phosphorus and potassium in loose association with plants which reflected in the increment of bulb diameter. The results are in confirmation with the results achieved by Singh *et al*. (2017a), Vachan and Tripathi (2017), Kumar *et al.* (2019), Meena *et al.* (2019), Petrovic *et al.* (2019), Ahmed *et al*. (2020) and Gererufael *et al.* (2020).

5.1.4 Effect of different biofertilizers and organic manures on quality parameters of onion

Result revealed that treatment T_6 (Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha) was significantly influenced the different quality parameters of onion and it gave the maximum TSS while the minimum TSS was recorded under treatment T_0 (control). Biofertilizers like *Azotobacter*, PSB and KSB might have fixed higher amount of nitrogen, phosphorus and potassium in soil and made available to the plants. PSB would have caused more mobilization and solubilization of insoluble P in the soil and improved the availability of phosphorus which might have caused an increase in uptake of phosphorus by plants. Organic manures may also increase the aeration in soil and improve the roots growth which results better absorption of essential nutrients by plant and improve the quality of onion bulb. Findings are in agreement with those of Meena *et al.* (2015), Mahala *et*

al. (2018), Kumar *et al.* (2019), Meena *et al.* (2019), Singh and Singh (2019) and Singh *et al.* (2020).

The result reported that the minimum moisture content was observed in treatment T_6 (Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha) and it was found the best treatment combination of organic manure and biofertilizers. However the maximum moisture content was recorded in control treatment T_0. Similar results for most of the characters were also reported by Meena *et al.* (2015), Meena *et al.* (2019) and Singh and Singh (2019).

5.1.5 Effect of different biofertilizers and organic manures on economical parameters of onion

The result revealed a significant variation among the different treatment combination of organic manure and biofertilizers. The maximum cost of cultivation was found in treatment T_4 (Vermicompost @ 5t/ha + PSB @ 2.5kg/ha), while the maximum gross returns, net returns and B:C ratio was recorded in treatment T_6 (Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha) and it was found the best treatment combination of organic manure and biofertilizers for influencing the economical parameters of onion. However the minimum cost of cultivation was found in treatment T_1 (FYM @ 20 t/ha + PSB @ 2.5kg/ha), while minimum gross returns, net returns and B:C ratio was noted in treatment T_0 (control).

Chapter - VI

SUMMARY, CONCLUSION AND SUGGESTIONS FOR FURTHER WORK

6.1 Summary

The present investigation entitled “Effect of different biofertilizers and organic manures on growth and yield of onion (*Allium cepa* L.)” was carried out at Horticulture Research Farm, R.A.K College of Agriculture, Sehore (M.P.). The experiment was laid out in Randomized Block Design (RBD) with three replications consists of twelve treatments. The experiment consisting of different levels of biofertilizers i.e. *Azotobactor* and PSB with different organic manures i.e. FYM and vermicompost were applied before planting of onion variety Agri Found Light Red (AFLR). The observations on different aspects such as growth parameters (viz., plant height, no. of leaves per plant, neck thickness of the bulb, leaf area and leaf area index), yield attributes of onion (viz., fresh weight of bulb per plant, dry weight of bulb per plant, bulb yield per plot, bulb yield per ha, equatorial diameter of bulb and polar diameter of bulb), quality parameters (viz., T.S.S. and moisture %) and economical parameters (viz., gross returns, net returns and benefit cost ratio) were calculated. The obtained results are summarized below.

6.1.1 Effect of different biofertilizers and organic manures on growth parameters of onion

The maximum plant height at 30, 60 and 90 days after transplanting was recorded in treatment T_6 (Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha). However the treatment T_0 (control) shows the minimum plant height at 30, 60 and 90 days after transplanting as compared to other treatments.

The maximum number of leaves per plant at 30, 60 and 90 days after transplanting was recorded in treatment T_6 (Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha) whereas the minimum number of

leaves per plant at 30, 60 and 90 days after transplanting was observed in control treatment T_0.

The maximum neck thickness of bulb at 30, 60 and 90 days after transplanting was recorded in treatment T_6 (Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha). However the minimum neck thickness of bulb at 30, 60 and 90 days after transplanting was observed in control treatment T_0.

It was recorded that treatment T_6 (Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha) gave the maximum leaf area and leaf area index. However, the minimum leaf area and leaf area index was recorded under treatment T_0 (control).

6.1.2 Effect of different biofertilizers and organic manures on yield parameters of onion

A perusal of data indicates that treatment T_6 (Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha) gave the maximum fresh and dry weight of bulb per plant while the minimum fresh and dry weight of bulb per plant was recorded under treatment T_0 (control).

The result shows that the maximum bulb yield per plot and per hectare was observed in treatment T_6 (Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha). However, the minimum bulb yield per plot and per hectare was found in treatment T_0 (control).

A perusal of data indicates that the maximum equatorial and polar diameter of bulb was found in treatment T_6 (Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha), whereas the minimum equatorial and polar diameter of bulb was noted in treatment T_0 (control).

6.1.3 Effect of different biofertilizers and organic manures on quality parameters of onion

Result revealed that treatment T_6 (Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha) gave the maximum TSS while the minimum TSS was recorded under treatment T_0 (control).

The minimum moisture content was observed in treatment T_6 (Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha), whereas the maximum moisture content was recorded in control treatment T_0.

6.1.4 Effect of different biofertilizers and organic manures on economical parameters of onion

The maximum cost of cultivation was found in treatment T_4 (Vermicompost @ 5t/ha + PSB @ 2.5kg/ha), while the maximum gross returns, net returns and B:C ratio was recorded in treatment T_6 (Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha). However the minimum cost of cultivation was found in treatment T_1 (FYM @ 20 t/ha + PSB @ 2.5kg/ha), while the minimum gross returns, net returns and B:C ratio was noted in treatment T_0 (control).

6.2 Conclusion

Result concluded that the different treatments of biofertilizers and organic manures were significantly influenced the growth, yield, quality and economical parameters of onion. It was recorded the treatment T_6 (Vermicompost @ 5t/ha + *Azotobactor* @ 1kg/ha+ PSB @ 1.25kg/ha) was found the best treatment as compared to other treatments and it gave the maximum growth, yield, quality and economical parameters at different growth stages, whereas the minimum growth, yield, quality and economical parameters were observed in treatment T_0 (control).

6.3 Suggestions for future research work

On the basis of the result obtained after completion of present investigation following suggestions are being made for future line of work:

1. The further research work is needed to confirm the findings of the present investigation.
2. The different organic manure treatments may also be tested for growth, yield and quality of onion.
3. The different biofertilizers treatments may also be tested for growth, yield and quality of onion.

Chapter - VII

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Appendices

Appendix –I

ANOVA TABLE					
SOURCE	**DF**	**SS**	**MS**	**F Cal.**	**F Tab. 5%**
Replication	2	4.280	2.140	1.596	3.44
Treatments	11	227.073	20.643	15.393	2.26
Error	22	29.504	1.341		
Total	35	260.857			

Appendix –II

ANOVA TABLE					
SOURCE	**DF**	**SS**	**MS**	**F Cal.**	**F Tab. 5%**
Replication	2	3.082	1.541	0.503	3.44
Treatments	11	270.135	24.558	8.011	2.26
Error	22	67.440	3.065		
Total	35	340.657			

Appendix –III

ANOVA TABLE					
SOURCE	**DF**	**SS**	**MS**	**F Cal.**	**F Tab. 5%**
Replication	2	7.113	3.556	2.271	3.44
Treatments	11	368.133	33.467	21.369	2.26
Error	22	34.454	1.566		
Total	35	409.700			

Appendix –IV

ANOVA TABLE					
SOURCE	**DF**	**SS**	**MS**	**F Cal.**	**F Tab. 5%**
Replication	2	0.829	0.414	1.567	3.44
Treatments	11	18.230	1.657	6.266	2.26
Error	22	5.818	0.264		
Total	35	24.877			

Appendix –V

ANOVA TABLE					
SOURCE	**DF**	**SS**	**MS**	**F Cal.**	**F Tab. 5%**
Replication	2	0.254	0.127	1.064	3.44
Treatments	11	57.584	5.235	43.773	2.26
Error	22	2.631	0.120		
Total	35	60.470			

Appendix –VI

ANOVA TABLE					
SOURCE	**DF**	**SS**	**MS**	**F Cal.**	**F Tab. 5%**
Replication	2	3.504	1.752	4.317	3.44
Treatments	11	71.112	6.465	15.930	2.26
Error	22	8.928	0.406		
Total	35	83.543			

Appendix –VII

ANOVA TABLE					
SOURCE	**DF**	**SS**	**MS**	**F Cal.**	**F Tab. 5%**
Replication	2	0.008	0.004	1.806	3.44
Treatments	11	0.350	0.032	13.787	2.26
Error	22	0.051	0.002		
Total	35	0.409			

Appendix –VIII

ANOVA TABLE					
SOURCE	**DF**	**SS**	**MS**	**F Cal.**	**F Tab. 5%**
Replication	2	0.007	0.003	2.466	3.44
Treatments	11	0.395	0.036	26.789	2.26
Error	22	0.030	0.001		
Total	35	0.432			

Appendix –IX

ANOVA TABLE					
SOURCE	**DF**	**SS**	**MS**	**F Cal.**	**F Tab. 5%**
Replication	2	0.004	0.002	1.981	3.44
Treatments	11	0.256	0.023	23.555	2.26
Error	22	0.022	0.001		
Total	35	0.282			

Appendix –X

ANOVA TABLE					
SOURCE	**DF**	**SS**	**MS**	**F Cal.**	**F Tab. 5%**
Replication	2	13.971	6.986	1.664	3.44
Treatments	11	41280.283	3752.753	893.987	2.26
Error	22	92.351	4.198		
Total	35	41386.606			

Appendix –XI

ANOVA TABLE					
SOURCE	**DF**	**SS**	**MS**	**F Cal.**	**F Tab. 5%**
Replication	2	557.623	278.811	1.085	3.44
Treatments	11	104229.370	9475.397	36.868	2.26
Error	22	5654.116	257.005		
Total	35	110441.109			

Appendix –XII

ANOVA TABLE					
SOURCE	**DF**	**SS**	**MS**	**F Cal.**	**F Tab. 5%**
Replication	2	77.301	38.650	2.248	3.44
Treatments	11	262920.130	23901.830	1390.401	2.26
Error	22	378.193	17.191		
Total	35	263375.624			

Appendix –XIII

ANOVA TABLE					
SOURCE	**DF**	**SS**	**MS**	**F Cal.**	**F Tab. 5%**
Replication	2	0.002	0.0011	1.255	3.44
Treatments	11	3.613	0.3285	383.371	2.26
Error	22	0.019	0.0009		
Total	35	3.634			

Appendix –XIV

ANOVA TABLE					
SOURCE	**DF**	**SS**	**MS**	**F Cal.**	**F Tab. 5%**
Replication	2	0.004	0.0021	2.207	3.44
Treatments	11	7.526	0.6842	719.020	2.26
Error	22	0.021	0.0010		
Total	35	7.551			

Appendix –XV

ANOVA TABLE					
SOURCE	**DF**	**SS**	**MS**	**F Cal.**	**F Tab. 5%**
Replication	2	0.029	0.0146	2.322	3.44
Treatments	11	29.625	2.6931	427.809	2.26
Error	22	0.138	0.0063		
Total	35	29.792			

Appendix –XVI

ANOVA TABLE					
SOURCE	**DF**	**SS**	**MS**	**F Cal.**	**F Tab. 5%**
Replication	2	3.510	1.755	1.332	3.44
Treatments	11	781.399	71.036	53.918	2.26
Error	22	28.985	1.317		
Total	35	813.894			

Appendix –XVII

ANOVA TABLE					
SOURCE	**DF**	**SS**	**MS**	**F Cal.**	**F Tab. 5%**
Replication	2	0.031	0.015	1.928	3.44
Treatments	11	14.980	1.362	171.397	2.26
Error	22	0.175	0.008		
Total	35	15.186			

Appendix –XVIII

ANOVA TABLE					
SOURCE	**DF**	**SS**	**MS**	**F Cal.**	**F Tab. 5%**
Replication	2	0.223	0.111	1.332	3.44
Treatments	11	49.622	4.511	53.918	2.26
Error	22	1.841	0.084		
Total	35	51.686			

Appendix –XIX

ANOVA TABLE					
SOURCE	**DF**	**SS**	**MS**	**F Cal.**	**F Tab. 5%**
Replication	2	72.216	36.108	1.332	3.44
Treatments	11	16077.524	1461.593	53.918	2.26
Error	22	596.370	27.108		
Total	35	16746.110			

Appendix –XX

ANOVA TABLE					
SOURCE	**DF**	**SS**	**MS**	**F Cal.**	**F Tab. 5%**
Replication	2	0.006	0.003	1.457	3.44
Treatments	11	4.878	0.443	231.035	2.26
Error	22	0.042	0.002		
Total	35	4.925			

Appendix –XXI

ANOVA TABLE					
SOURCE	**DF**	**SS**	**MS**	**F Cal.**	**F Tab. 5%**
Replication	2	0.015	0.008	2.011	3.44
Treatments	11	2.427	0.221	58.220	2.26
Error	22	0.083	0.004		
Total	35	2.525			

Appendix –XXII

ANOVA TABLE					
SOURCE	**DF**	**SS**	**MS**	**F Cal.**	**F Tab. 5%**
Replication	2	0.017	0.009	2.593	3.44
Treatments	11	5.780	0.525	159.960	2.26
Error	22	0.072	0.003		
Total	35	5.870			

Appendix –XXIII

ANOVA TABLE					
SOURCE	**DF**	**SS**	**MS**	**F Cal.**	**F Tab. 5%**
Replication	2	0.038	0.019	1.074	3.44
Treatments	11	21.076	1.916	107.397	2.26
Error	22	0.392	0.018		
Total	35	21.506			

VITAE

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For the partial fulfilment of the M.Sc. (Ag.) Horticulture (Vegetable Science) degree programme he was allotted a field research experiment on **"Effect of different biofertilizers and organic manures on growth and yield of onion (*Allium cepa* L.)"** which was successfully conducted by her and being submitted in the form of this thesis.

(Priyanka Kashyap)