"Effect of different bio-fertilizers, organic and inorganic nitrogen sources on the yield of direct seeded rice (*Oryza sativa*) grown under Punjab".

DISSERTATION-II REPORT

Submitted to the Lovely Professional University
in partial fulfilment of the requirements
for the degree of

Master of Science
in Agronomy

By

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Under the Guidance of

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CERTIFICATE-I

This is to certify that the thesis entitled "**Effect of different bio-fertilizers, organic and inorganic nitrogen sources on the yield of direct seeded rice (*Oryza sativa*) grown under Punjab"** submitted in partial fulfillment of the requirement for the award of the degree of **MASTER OF SCIENCE (AGRICULTURE) AGRONOMY** to Lovely Professional University, Phagwara, Punjab is a bona fide research work carried out by **Mr. Supreet Saajan** (Registration No. 11509218) under my guidance and Supervision. No part of the thesis has been submitted for any degree or diploma. The assistance and help received during the course of investigations have been fully acknowledged.

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Certificate- II

This is to certify that thesis entitled, **"Effect of different bio-fertilizers, organic and inorganic nitrogen sources on the yield of direct seeded rice (*Oryza sativa*) grown under Punjab"** submitted by **Mr. Supreet Saajan** (Registration No. 11509218) to Lovely Professional University, Phagwara, Punjab, in partial fulfillment of the requirements for the award of degree of **MASTER OF SCIENCE (AGRICULTURE) AGRONOMY** has been approved after the oral examination of the same in collaboration with the internal examiner.

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External Examiner

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Dr. Arun Kumar
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(Dean, School of Agriculture)

DECLARATION

I hereby declare that the project work entitle **"Effect of different bio-fertilizers, organic and inorganic nitrogen sources on the yield of direct seeded rice (*Oryza sativa*) grown under Punjab"** is an authentic record of my work carried at **Lovely Professional University** as requirements of Project work for the award of degree of **Master of Science in Agronomy**, Under the Guidance of **Dr. Hina Upadhyay**, Associate Professor, School of Agriculture, Lovely Professional University, Phagwara, Punjab, India. I also declare that the material contained in this thesis has not been published earlier in any manner.

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Place: LPU, Phagwara

Dated: April, 2017 ***(Supreet Saajan)***

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LIST OF SYMBOLS AND ABBREVIATIONS

RCBD	Randomized complete block design
%	Percentage
DAS	Days after sowing
RDN	Recommended dose of nitrogen
FYM	Farm yard manure
Kg	Kilogram
g	Gram
^{o}C	Degree Celsius
RH	Relative humidity
Temp.	Temperature
EC	Electric conductivity
m^2	Meter square
/	Per
Cm	centimeter
kg ha^{-1}	Kilogram per hectare
et al	et alibi and else where

Abstract

Rice is the most important food grain from among the cereal grain crops. In India rice demand increases because of increase in the population and diet change of the people. The research was conducted with aim to check influence of combination of organic and inorganic nitrogen sources on the yield of direct seeded rice. The field experiment was conducted at the farm of Lovely Professional University, Phagwara on rice (*Oryza sativa*) during *Kharif* season in year 2016-2017. Randomized complete block design were used with nine treatment and three replications. Treatment number T7 (Azotobacter + 25 % vermicompost + 50 % RDN) and treatment T9 (Azospirillum + 25 % vermicompost+ RDN) shows significant higher results as compare to control treatment. This is due to different nitrogen sources not only fulfill nitrogen requirement but also improve the soil physical, chemical and biological properties of soil which improves overall soil fertility and productivity.

Keywords: Synthetic fertilizer, Inorganic, Organic, Bio fertilizer, attributes, direct seeded, RDN

Introduction

Rice (*Oryza sativa*) is a major crop. Its chromosome number is 2n=24. It is grown from 44 degree north to 35 degree south. It is cultivated 2700 ft. above sea level. Rice is the most important food grain from cereal grain crops. It is widely consumed in world as a staple food by the large human population, mostly in Asian part of world. It is the very important food grain because of its nutrition and caloric value with respect to humans. It provides number of calories approximately near about one fifty which are consumed worldwide by human population. Currently rice is staple food about for 3 billion populations which are about 50% or half of the population of the world. Human population of Asian countries consumed rice in their diet daily. Rice is consumed by large population of world. It is the most important agricultural commodity with the third-highest rank in production after sugarcane and maize. More than 114 countries can grow rice in world and about more than 50 countries have production more from 0.1 million tons (FAO 2010). Worldwide rice is grown on over the 161 million hectares of land, with annual rice production of near about 678.7 million tons (FAO, 2009).In 2012 the total rice production was 738.1 million tones. The average yield of rice was 4.5 tons per hectare. For meet the increases world demand of rice, up to 2035 world needed additional 114 million tons of rice production, which is an overall increase 26% in rice production in the next 25 years. Rice covers around 155 million hectares and more from any other crop. So rice system is most important food production in the world. More than 90% of total rice production in world is produced and consumed in Asia. India and China is most important countries of Asia in rice production. China has 1st rank in world with production 205.643 Million metric tons. After china India has 2nd rank in world with 155.682 Million metric tons production of rice in 2015. Most of rice produced in tropical countries in irrigated and low land rainfed areas. Irrigated rice accounts 78% of total rice production. The rainfed is mostly grown in south and south East Asia.

Rice plays a very vital role in India. It is the back bone of Indian food security. The term“ rice is life’’, very appropriate for India. It is most prominent staple food grain of eastern and southern states of India. In India rice demand increases because of increase in the population and

diet change of the people. In Punjab rice crop occupied about 28.94 lakh hectare land from which the total production of 166.61 lakh tons of paddy production and 111.07 lakh tons of rice production during year 2014-2015. The average yield of paddy was 57.57 quintals per hectare and 23.29 quintals per acre.

INM Use in rice: INM is very use full tool of agriculture to meet the demand of nutrient of crop without any harm full effect to environment, soil fertility ,micro organism etc With the help of the INM we reduce the cost of cultivation of razing crop in field. Now a day's INM it is very important for increase the production of the food grain and meet the demand of human population in world. In INM we use all the possible way to provide the nutrient to crops without depending on only the chemical fertilizers. By the use of integrated nutrient management we are able to full fill then theory of sustainable agriculture (without any harm to natural resources and the environment). Integrated nutrient management not only help in meet the nutrient demand of crop but also help maintained long term fertility of soil, help in maintained growth of beneficial microorganism in soil which also help in providing nutrient to plant. Integrated nutrient management directly involve in the prevention of environment from highly use of chemical fertilizer. Biomagnifications of different chemicals can be controlled by the use integrated nutrient management because use of organic compound in crops production are easily degradable then the synthetic fertilizers. From many studies it also found that residual effect in soil after application of integrated nutrient management is very less with comparison to chemical fertilizer used as only source of nutrient. There are many component of integrated nutrients examples: bio fertilizer, farm yard manure, vermicompost, green manure, bio compost (made from kitchen or house waste), bone meal, bird waste, poultry waste etc. every component have different ratio of nutrient like farm yard manure has 0.5% nitrogen, 0.2% phosphorus, 0.5%potassium per hundred kg of farm yard manure. Integrated nutriment management reduces the emphasizes from synthetic fertilizer for full fill the nutrient demand but also help in increase the yield of crop. From many researches it found that INM not only gives good quantity of produce but also gives good quality of produce with rich in nutrient, less or no residual effect present in produce.

Integrated nutrient management provide balance nutrients and minimizes the antagonistic effects resulting from nutrient imbalance and deficiencies. Integrated nutrient management gives combine effect by providing nutrient to crop and also help in plant protection from many

diseases and insect, pest attacks. Integrated nutrient management change some environment condition at micro level which is not suitable for the growth of harmful organism. In future for sustainable agriculture integrated nutrient management play very important role. Is also not wrong to say without help of integrated nutrient management sustainable agriculture is not possible. INM maintain soil fertility and supply of nutrient to plant at desired level for optimum productivity from the intergraded sources. Integrated nutrient management minimizes or reduce the deterioration of soil, water, ecosystem and help in carbon sequestration which also help mitigate the risk of climate change on earth. So from this we can say there is great need of adoption of integrated nutrient management in future agriculture not only full fill food supply of population but also protect the environment from climate change.

.**Objectives of Study**:

1. To study the effect of bio-fertilizer and organic sources on yield of direct seeded rice grown under Punjab conditions.
2. To study the effect of different organic sources on yield of direct seeded rice.
3. To study the effect of different organic and Inorganic sources combination on yield of direct seeded rice.

Review of literature

2.1: Bio-fertilizer Nitrogen Contribution to rice

- Rice field provides favorable environmental conditions for the development of cyano-bacteria with to their essential requirement like light, moisture status, temperature demand, and humid environment and along with essential nutrients required for growth etc. Prasad estimated in experiment conducted in of South Bihar on addition of nitrogen in soils by cyano-bacterial and found that nitrogen input to crop from 12 to 16 kg/ha.

- De and Mandel (1956) also found in experiment conducted in West Bengal soils estimated nitrogen fixation by cyano-bacteria and found the values of nitrogen ranging to 44.4 kg nitrogen per hectare in cropped area, but the values of nitrogen were lower in fallow land.

- Watanabe *et al.*,(2013) observed an experiment in Japan on *(Tolypothrixtenuis)* cyano-bacteria and found the addition of nitrogen 20 kg/ha by the cyano-bacteria in the field**.**

- Watanabe and Cholitkul (1979) conducted an experiment by using acetylene reduction technique and found that an addition of nitrogen 18-45 kg nitrogen per hectare by cyano-bacteria. Inoculation of bio fertilizer increases in the nitrogen availability through nitrogen fixation.

- MacRae and Castro (1969) also conducted an experiment by using 15Nitrogen technique in rice fields and found that cyano-bacteria add 10-15 kg nitrogen per hectare. Cyanobacteria help in nitrogen fixation which increases in the nitrogen availability to plants.

- Dhanyan *et al*.,(2006) conducted a research in Karnataka and found that increase in yield components with inoculation of Azospirillum bio fertilizer. It has been due to the atmospheric nitrogen fixing by Azospirillum bio- fertilizer and which was made available to the rice crop.

- Hashem (2001) showed in a research that bio-fertilizer may able to provide 25-35% of nitrogen for rice production and also reclaimed the soils problem like acidity of soils and salinity of soils also with improves the fertility of soil.

2.2 Effect of FYM on growth characteristics and yield characteristics of crops

The use of farm yard manure for growing crop is very old practice of ancient world. FYM supplies organic matter with many nutrients like nitrogen, phosphors, potassium and also provides several micronutrients. It also increases cation exchange capacity (CEC) of soil, improve water holding capacity, act as buffers in soil against high and low pH of soil. It provides favorable condition for growth of beneficial soil micro-organisms. It also acts as a store house for nutrients and oxygen for soil organism.

- Budhar *et al*.,(1991) conducted an experiment in Coimbatore (Tamil nadu) and observed that used FYM gives significant result on the plant height and increase in number of tillers in clay and loam soil in rice.

- Singh *et al.* (1972) conducted an experiment and reported that increase in panicle length of rice, number of panicle per plant, grain weight of per panicles, weight of panicle per plant and number of filled grains per panicle were higher with the addition of 5.0tones of FYM per hectare. FYM increase in the microbial activity in soil which increase in the nutrient availability for proper growth and development.

- Chand *et al.,* (2006) conducted a research and found that integrated application of nutrients from farmyard manure (FYM) and chemical fertilizers played an important role in significant increase in crop production and maintained long term fertility of soil. Integrated application of nutrients not only increases the nutrient availability but also change the soil physical, chemical and biological properties of soil which increase the nutrient uptake at faster rate.

2.3 Effect of vermicompost on crop growth and yield characteristic

- An experiment was conducted by Forgaste and Babb in year 1972 on rice. Application of vermicompost five tons per hectare to rice in sandy loam soil showed increase in height of plant, tillers per plant, increase in length of panicles in rice crop, number of filled grains in panicles with respect to control. It Also showed higher grain yield 40.43 quintal per hectare

- Das *et al* in year 2002 found that significant increase in rice straw yield by the application of vermicompost in field. Vermicompost change the soil physical and chemical properties which gives the beneficial effect on the yield of rice.

- Reddy in year 1988 found in experiment in Coimbatore (Tamil nadu) increased in the growth of rice plant by addition of vermicompost in rice field. Use of vermicompost increase in the nutrient uptake at faster rate.

- Kale *et al*., (1992) reported that vermicompost were good source for providing nutrients to lowland rice crop. It helps in the increase in the organic matter content in soil which ultimately increases the nitrogen availability to plants.

- Koushal *et al*.,(2011)was conducted two year research in which he found Application of recommended dose of nitrogen100 % from chemical fertilizer through (urea) influenced the rice yield significantly in first year in experiment but in second year of experiment 50 % recommended dose of nitrogen applied from vermin-compost and the rest from

synthetic fertilizer (urea) gives significantly more grain and straw yield of rice in rice-wheat cropping system

- Kumar *et al.,* (2014) was also noticed that recommended fertilizer (RDF) and combine 5 tone of vermicompost per hectare was increased in 20.50% the number of panicles, increase length of panicle by 23.12%, increase in panicle weight by 13.02%, grain weight by 12.90%, grain yield 31.15% and straw yield 37.12% over the control treatment of experiment.

2.4 Effect of integrated nutrient management

- Jayakrishna Kumar *et al.*(1994) found in experiment that 50 percent Nitrogen was substituted through the use of FYM will helps in increased grain yield of rice. Combine use of nutrient effect the soil properties which increase in the nutrient uptake.

- Swarup and Yaduvanshi, in year 2000 found in experiment conducted by them that maximum rice grain yield was observed with use of organic sources. It is due to organic matter increase the nutrient availability which increases in the yield of plants.

- Satyanarayana *et al., (*2002) and again research done by Sharma (2013) found results that the growth , development, yield of rice was to be give best result when 50% Nitrogen applied through farmyard manure and 50% RDN was applied in rice crop.

- Khan et al., (2007) found significant result in increased grain yield of rice by the combine use of farm yard manure, vermicompost with inorganic source of nitrogen. Use of integrated nutrient application increase in soil fertility along with increase in the water holding capacity.

- Ranjitha *et al.,*(2013) found results that significantly increase in both grain and straw yield of rice was recorded with the use of 50 %nitrogen application through synthetic

fertilizer (urea) and 50 % recommended dose of nitrogen applied through vermi-compost.

- Khursheed *et al., (*2013) found in research was straw yield of rice 3.7 and 15.9 % more when nitrogen applied through farm yard manure and vermi-compost as compared to when nitrogen applied alone through chemical fertilizer.

- Larijani and Hoseini., (2012) also conducted research and found result that (28%) more numbers of tiller, 60 % more number of panicle from per m2, and 30.6% higher grain yield with use of organic and synthetic fertilizer combine as compared to alone use of synthetic fertilizer.

- Khan *et al*. (2007) conducted an experiment and found that significant increase in the rice grain yield by 28% over control treatment with combine use of FYM, vermicompost with inorganic source.

2.5. Effect of different nutrient sources on uptake of nutrients

- An experiment conducted by Rani and Srivastava, in year 1997 found that increase in Nitrogen uptake was found with the application of vermicompost. Nitrogen uptake increased with increased in the levels of vermi-compost at different growth stages, with respect to increasing inorganic fertilizers.

- Pankaj Singh *et al.,* (2006) conducted an experiment and found that the percent organic carbon content of soil estimated initially and after harvest of the crop is varied. It found that the treatment increased in organic content of soil with respect to treatments of FYM+RF. The organic carbon content increased over initial in all treatments except Control. The higher organic carbon in INM is may be due to addition of nutrient through various organic sources.

- Chaoui *et al*.,(2003) found in a research that Increased in the availability of NPK in the soils were observed with the application of different types organic material like FYM, vermicompost plus NPK in rice crop.

- García-Gil.,(2000) found in research that combine use fertilizers with compost output was significantly increases in soil carbon and some plant nutrients. It has also shown that the application of vermicompost improves soil properties by decreasing in the bulk density of soil and increasing in water holding capacity of soil.

- Grigatti *et al*.,(2007) show that application of compost and vermicompost are gives significant result increase in the growth of a various types of plant because the supply of nutrients is increased by the use of vermicompost.

2.6 Effect of bio-fertilizer and vermicompost on the yield of rice

The data of grain yield was influenced by application of different nutrient sources in combinations. From the many studies found that Chemical fertilizer, vermicompost and bacterial mixture enhance the soil fertility level which result increase in the yield of many crops. Soil organic matter can be improved by the application Biofertilizer and vermicompost. Prajapat *et al*. conducted an experiment on rice (Oryza sativa) in Nepal and found significant result the use Azotobacter (*chroococcum)* and Vermicompost. Combine use Vermicompost and azotobacter on rice plant gives Promotional Growth of plant. Treatment number T7 and T9 recorded higher number of leaves per plant, number of tiller, and plant height at various stages so from this we can expect the significant result for these treatments.

- Indirectly Chatterjee *et al*.(2012) found same result in experiment on combination use of vermicompost and azotobacter. In his experiment they found superiority of integrated use of vermicompost with bio fertilizer over the control treatment.

- Martin (2000),choudhury and kabi (2003) and again by vasudeven *et al.* found in experiment that bacterial formulation (azospirillum) has direct impact on the yield of rice plant .It enhance the nutrient status N,P and K of soil or also called improve the soil fertility of soil which ultimately increase in the yield of rice and many other crops.

- Bio-fertilizers applications are increase crop yield by 20-30 percent and help in replacing the chemical fertilizer by providing Nitrogen 25%. Bio fertilizers act as natural growth promoter and increase in the plant growth, it also activate soil microbes and restore the soil fertility. Inoculation of Bio-fertilizer makes plant drought resistance and provides resistance against some soil borne diseases (Anonymous, 2009b).

- Malliga and Subramanian (2002) again found in research that increase in production with integrated use of bio-fertilizer and organic fertilizers in the crop production. They also found that they are highly beneficial in sustainable crop production.

- Datta *et al.,* (2001) conducted a research and found that the combined use of synthetic fertilizer combine with bio-fertilizer and organic fertilizer increased the growth of rice and yield components in rice crop which gives significant result difference in these treatments.

- Ahmed *et al.,* (2004) conducted research and reported that combine use of inorganic fertilizer with bio-fertilizer and organic source help in production of more number of panicles per unit area in rice which resulted increase in the yield of the rice per unit area. Ahmed also reported more percent filled grain by combine use of used bio-fertilizer and chemical fertilizer in rice crop

- Kamil Sabier Saeed *et al.,* (2014) conducted a experiment in agriculture institute of Iraq in comparison between bio fertilizer azotobacter and chemical fertilizer (urea) found that there was significant increase in the yield of crop in which bio-fertilizer was used. The correlation analysis shows s positive relationship. This study shows that bio-fertilizegives significant increase in the growth and the yield of crop.

MATERIAL AND METHODS

An Experiment was conducted at the field Department of Agronomy, school of agriculture, Lovely Professional University, Phagwara on rice (*Oryza sativa*) during *Kharif* season in year 2016-2017 with title "**Effect of different bio-fertilizers, organic and inorganic nitrogen sources on the yield of direct seeded rice (*Oryza sativa*) grown under Punjab"**. Randomized complete block design **(RCBD)** has been used with nine different treatments and three replications. The detailed of different treatments, material used and procedure followed are presented in this chapter. This chapter consist description of location of experiment, climate, soil characteristic, experimental design, land preparation, method of sowing, different agronomical practices and data recorded from different parameters are described under blow sub-heading.

3.1 EXPERIMENTAL SITE DESCRIPTION

3.1.1 Experimental site location:

Experiment was conducted at the farm of lovely professional university Phagwara district kapurthala during Kharif season in year 2016-2017. The farm is situated at $31^0$22'31.81'' North latitude and $75^0$23'03.02" East longitude with 252m average elevation above mean sea level. It is at 350 km distance from capital of India (Delhi) in Punjab fall under sub tropical region in central plane of state agro climatic zone.

3.1.2 Weather and climatic condition:

Region of experimental site comes under sub tropics with cool weather in winter season, hot weather in summers and distant rainfall period in month of July, August and September. South west monsoon is main source of rainfall in this region. During winter season the temperature never goes below zero degree especially in the month of December and January.

Highest temperature reached 42^{o}C during summer month April, May and June. From the last week of June, monsoon rain fall started and continuous to end of September if there is not delayed in south west monsoon winds. Month of July receives highest amount of rainfall. Average different Weather variable (temperature maximum, temperature minimum and rainfall) data was recorded at crop growth cycle.

Normally rice is best suited to high temperature, high humidity, prolonged sunshine and assured water supply throughout the crop growth cycle. A temperature range from 20 to 37.5^{o}C is required for optimum crop growth. Rice required initially some low temperature but high temperature at tillering stage. Temperature range from 26.5 to 29.5 is required at blossoming. 83 to 85 percent range of relative humidity is favorable for rice growth

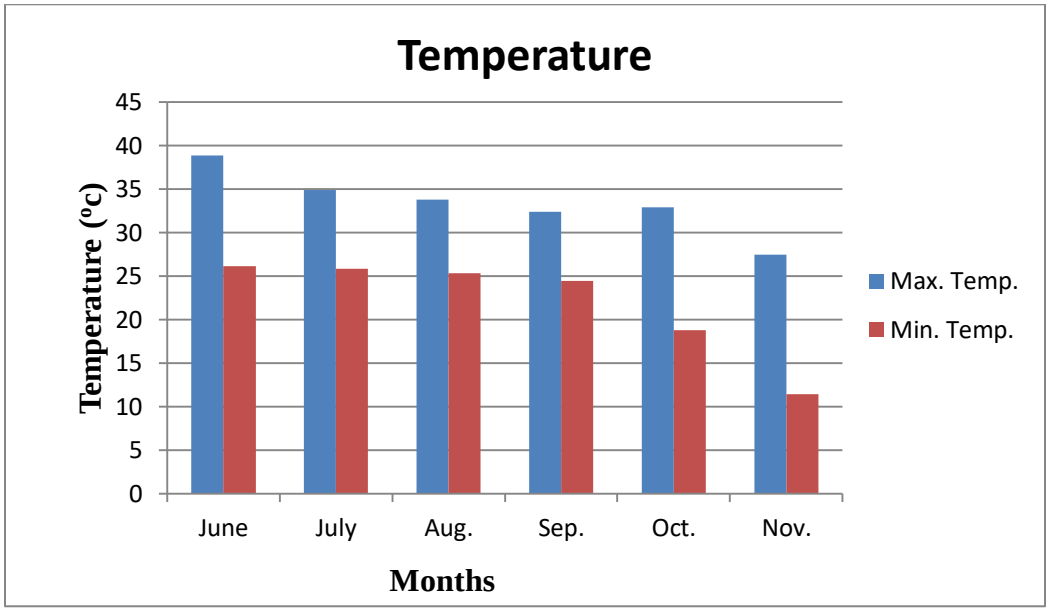

Fig. 3.1 Weather conditions of Experimental Design

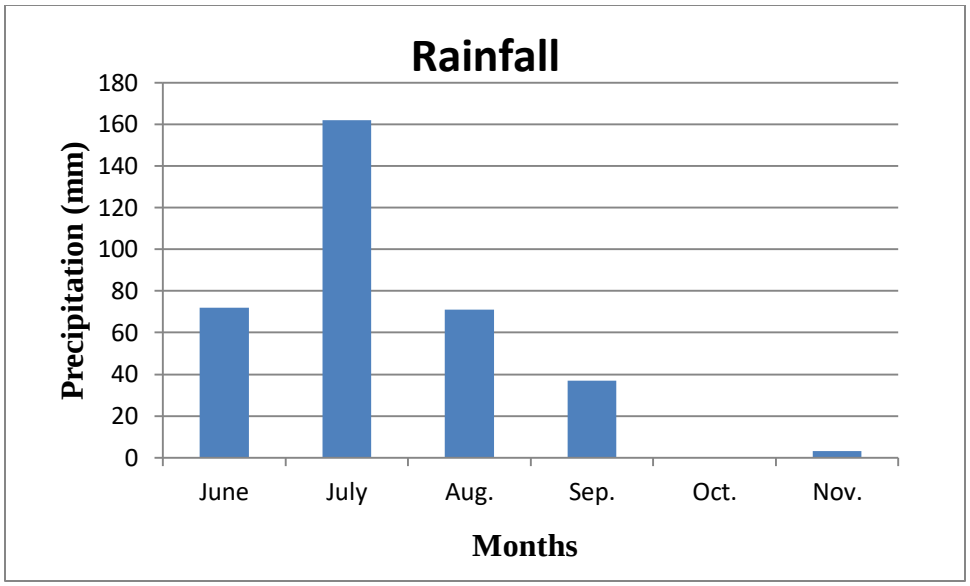

Fig 3.2 Rainfall data of experimental field

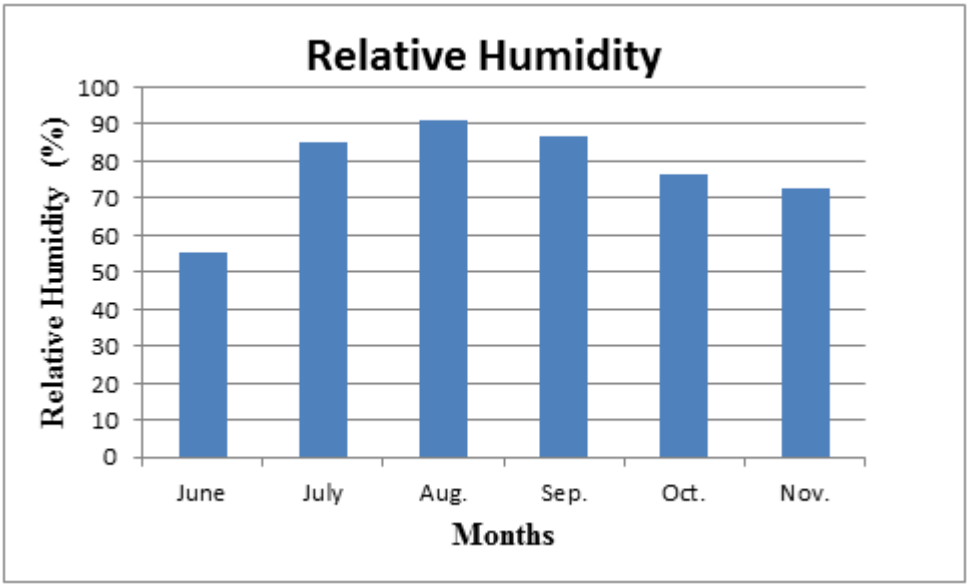

Figure 3.3 Relative Humidity of Experimental Site during the Crop Trial

3.1.3 Soil characteristics:

Experiment was conducted at farm of lovely professional university Phagwara district kapurthala during *Kharif* season in year 2016-2017. Before conducting the experiment soil sample were collected from field randomly. Surface scrap and v-shaped cut is made to depth of 6 inches and about 1inch" thick slice of soil is collected from one side of cut. Similarly 7 to 8 sample were collected in zigzag from the field. After mixing sample about half kg soil were taken for analyzed soil physical and chemical properties. Status of soil fertility site of experimental presented in table 3.1.

(a) Soil pH:

Soil pH is estimated with pH meter. Soil sample was collected at different layers to measure pH. Soil and distilled water taken in 1:2 ratio in 100 ml beaker and stirs it for half an hour. Calibrate pH meter against buffer solution and take the reading by dipping rod in soil solution.

(b) Soil EC:

Electric conductivity of soil is measure with the help of EC meter. 1:2 ratio soil and distilled water were taken in 100 ml beaker. Shaker is done for half an hour and kept it over night. Instrument is calibrated with KCL. Measure the electric conductivity of 0.01M KCl at the same temperature of soil suspensions. Insert the cell into soil suspension without disturbing soil sample. Note the readings.

(c) Organic carbon:

Soil organic carbon is estimated by wet combustion method discover by Walkley and Black in 1934. Take 2g soil in 150ml conical flask. Add 10ml of 1N $K_2Cr_2O_7$. Add 20 ml of conc. H_2SO_4 and leave the flask to cool. Then add 10ml of orthophosphoric acid and 10 ml distilled water. Shake it vigorously. Add 2-3 drops of diphenylamine indicator, which appeared violent color. Dilute the content by adding 100 ml of distilled water. Titrate the content with N/ 2 ferrous

ammonium sulphates. End point is colour change from violet to bright green. Note the reading N/ 2 ferrous ammonium sulphate is used.

(d) Soil texture:

Soil texture is defined as the relative proportion of the primary particle of soil. The common field method of find the texture is finger feel method. Take a pinch of soil. Moisten it to field capacity and rub it between thumb and figure. Sand feel gritty and its particle can see easily. Silt feel like flour when dry. Clay feels plastic and stickiness when wet and hard under dry condition.

Table no.3.1 Physical properties of soil at experimental site

Characteristics	Percentage (%)
Sand content	70
Silt content	14.3
Clay content	15.7
Soil texture	Sandy Loam

Table no. 3.2 Chemical properties of soil at experimental site

Plot no.	Texture of soil	pH	EC (mmhos/cm)	Organic carbon (%)
1	Sandy Loam	7.6	0.56	0.75
2	Sandy Loam	7.8	0.55	0.74
3	Sandy Loam	7.6	0.47	0.67
4	Sandy Loam	7.7	0.43	0.57
5	Sandy Loam	7.8	0.39	0.65
6	Sandy Loam	7.9	0.51	0.69
7	Sandy Loam	7.7	0.48	0.73
8	Sandy Loam	8.0	0.48	0.75
9	Sandy Loam	7.8	0.47	0.71

3.2 SOURCES OF NUTRIENTS USED IN THE EXPERIMENT

1) Organic sources:

(a) Farm yard manure (0.5% nitrogen)

(b) Vermicompost (2.5%nitrogen)

2) In organic source: urea (46% nitrogen).

3) Bio fertilizer: Cyanobacteria, Azotobacter and Azospirillum

3.3 HISTORY OF CROPPING SITE

At the experiment site farm of lovely professional university, Phagwara district kapurthala, Rice –Wheat rotation is followed from many previous years. Wheat crop is planted as previous crop before planting the experiment.

3.4 DETAILED OF EXPERIMENT DESIGN

A Randomized complete block design was used with eight treatment and three replications. Nine numbers of treatments with three numbers of replications has been used in this experiment. Detailed number of treatment were presented in table 3.3

Table no 3.3 Treatment Details

S. No	Treatment
T1	Control (100% urea)RDN
T2	50 % RND + 50% FYM
T3	50 %RND + 50% vermicompost
T4	50%RND + 25%FYM + 25 % cyanobacteria
T5	50%RND + 25%vermicompost +25% cyanobacteria
T6	50%RND + 25%FYM + 25% azotobacter
T7	50%RND + 25%vermicompost + 25%azotobacter
T8	50%RND + 25%FYM + 25%Azospirillum
T9	50%RND + 25%vermicompost + 25%Azospirillum

3.4.1Experiment layout detailed:

Number of treatments : 9

Number of replications: 3

Number of plots : 9X3=27

Plot size : 4X2 m^2

Land required : 27X8=216m^2

Extra land required : 20% extra

Total land required : 260 m^2

Row to row distance : 20cm

3.4.2 Detailed of Variety:

Pusa basmati 1121 was used in this experiment. It was released in 2008 and recommended by Punjab agricultural university (PAU) to grow in Punjab. It is about 120 cm tall. It has extra long grain also with good cooking quality. It matures in about 137 days. It is susceptible to bacterial blight in Punjab state.

3.5 AGRONOMIC PRACTICES

3.5.1 Field preparation:

Proper leveling of field was done for the improvement of irrigation efficiency. Field was ploughed twice one with disk harrow and other with cultivator followed by planking for ensure better germination.

3.5.2 Sowing time:

Seed was sown 16 June in *Kharif* season 2016 at the farm of lovely professional university.

3.5.3 Seed rate and method of sowing:

Ten kg seed rate per acre was used for direct seeding rice with recommended row to row spacing of 20cm. The seed was sown about approximately depth of 2-3cm.

3.5.4 Weed management:

For weeds controlling pre emergency application of stomp 30EC (pendimethalin) 1.0 liter per acre was applied after sowing. For controlling weed species *Echinochloa* (Swank) Nominee gold (bispyribac) at the rate of 100 ml per acre was applied after emergence of weed. Field was also infested with *Cyperus rotundus* (paddy motha) for the control of *Cyperus rotundus* herbicide Segment (azimsulfuron) at the rate of 16 g per acre were applied to whole experiment area.

3.5.5 Irrigation:

First irrigation was applied immediately after sowing. Then second irrigation was applied one week after first irrigation. After that irrigation applied at interval depending on moisture availability and rainfall. Last irrigation applied 20 days before harvesting.

3.5.6 Plant protection:

Symptoms of plant hopper were observed sucking of cell sap particularly from leaves. For control of plant hoppers attack one spray of chlorpyriphos 20EC 1 liter per acre was applied which gives the effective control over plant hoppers in the field.

3.5.6 Harvesting and threshing of crop:

The crop manually harvested when the straw has change colour to yellow and become dried. Threshing was also done manually by beating the sheaves against hard surface just after harvesting. Each plot harvested and threshed separately.

3.6 TREATMENT EVALUATION

3.6.1 Growth parameter:

1) Plant height:

Average plant height was taken by selected five plants randomly from every plot and take the height from ground. Height data recorded at 30 DAS, 45 DAS, 60 DAS, 75DAS and at harvesting time.

2) Number of tillers:

Average tillers per plant observed by selecting five plants randomly from each plot at different days interval. Tillers data was recorded 30 DAS, 45 DAS, 60 DAS, and 75 DAS by counting number of tillers per plant.

3) Number of leaves:

Random five plants were selected from each plot and count the total number of leaves per plant at 30 DAS, 45 DAS, 60 DAS and 75 DAS. The Data was observed from each plot of the experiment site.

3.6.2 Yield parameters:

1. **Number of panicle per hill:**

   Data of panicle were taken by count the number of panicle per hill by random selected five hills from each plot and same procedure was repeated for every different treatment.

2. **Length of panicle (cm):**

   Length of panicle was taken by selected panicle randomly and length was observed by measuring panicle with scale.

3. **Grain per panicle:**

   After randomly selected panicles numbers of grains were observed simply by counting the number of fertile grains per panicle.

4. **1000 grain weight (g):**

   1000 grains was taken from seed lot by counted and weight was taken on weighing balance.

5. **Grain Yield per pot (kg):**

   Each plot harvested and threshed separately and after threshing of rice the yield was observed by weighing of grain.

6. **Straw yield per plot (kg):**

   After threshed grain yield from paddy plant straw yield was observed by taken the weight of whole straw of plot.

7. Harvesting index:

Harvesting index was taken by dividing economic yield by total biological yield and multiplied by 100 to express in percentage.

$$\text{Harvesting index} = \frac{\text{Economic yield (kg ha}^{-1}\text{)}}{\text{Biological yield (kg ha}^{-1}\text{)}} \times 100$$

3.7 STATISTICAL ANALYSIS:

To check the signification of different variables or effect of different treatment data obtained from this experiment is analyzed by **SPSS** software at 95 % level of significant.

8. Demonstrations

Fig. No. 3.4 Field after germination

Fig. No. 3.5 15 DAS

Fig. No. 3.6 Maximum Tillering Stage

Fig. No. 3.7 Panicle stage of Rice

Fig. No. 3.8 Inflorescence of Rice

Fig. No. 3.9 Brown Spot of Rice

Fig. No. 3.10 Field near Harvesting

Fig. No. 3.11 Harvested Field

Chapter IV

Result and discussion

The result of field experiment with title "**Effect of different bio-fertilizers, organic and inorganic nitrogen sources on the yield of direct seeded rice (*Oryza sativa*) grown under Punjab"** was conducted at the farm of lovely professional university Phagwara district Kapurthala during *Kharif* season in year 2016-2017. It was laid out in randomized complete block design **(RCBD)** with nine treatments and three replications have been used. Data observed from this experiment shows that different treatments influenced on the growth (Height, number of tillers, number of leaves) and yield parameter (number of ear, number of grain per panicle, yield per plot) has been statistically analyzed for significant test of results. Test shows significant result of treatments over the control treatment.

4.1 Effect of different nitrogen sources on growth characteristic of direct seed rice:

4.1.1 Plant height

Plant height has been observed at different growth stages first at 30 DAS, 45 DAS, 60 DAS and 75 DAS. Variation in growth parameter (height) has been observed at different stages under different treatments. The data of height at different growth stage expressed in table 4.1

Plant height at 30 days:

The plant height Data was recorded at 30 days found that treatment number T7 (azotobacter + 25% vermicompost+50%RDN) and T9 (Azospirillum +25% vermicompost+50% RND) shows the 12.11% and 10.58 % more growth over the control treatment (100% urea). There is statistically no difference between height of treatment number T7 and T9.

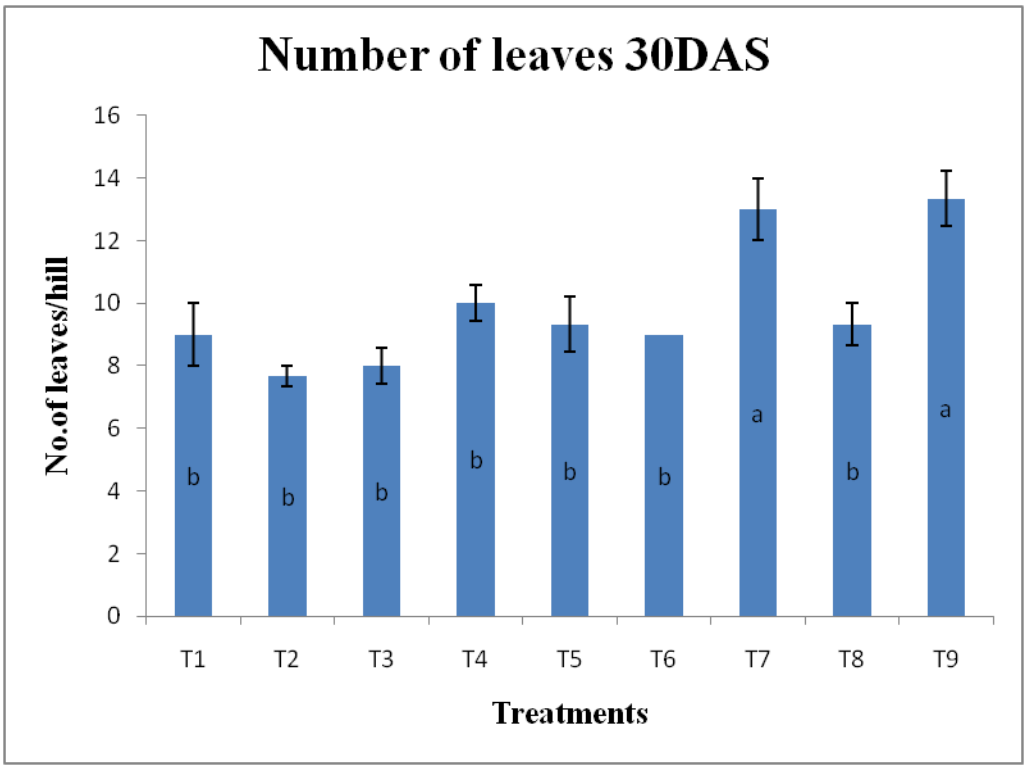

Fig.no.4.1: Effect of different nitrogen sources on the plant height at 30 DAS

The mean followed by different alphabets are significantly different at P <0.05, according to Duncun's multiple range test (DMRTC) for separation of means.

Plant height at 45 days:

The height Data recorded at 45 days found that treatment number T7 (azotobactor+25% vermicompost+50%RDN) and T9 (Azospirillum+25%vermicompost+50%RND) have 10.71% and 9.836% more growth over the control treatment (100% urea) and T2 (50% FYM+50% RDN) shows the 4.98% less growth from the control treatments. Treatment no T5 (cyanobacteria +25%FYM+50%RDN) and treatment number T6 (cyanobacteria+25%vermicompost+50%RDN) statistically similar to each other but not significant.

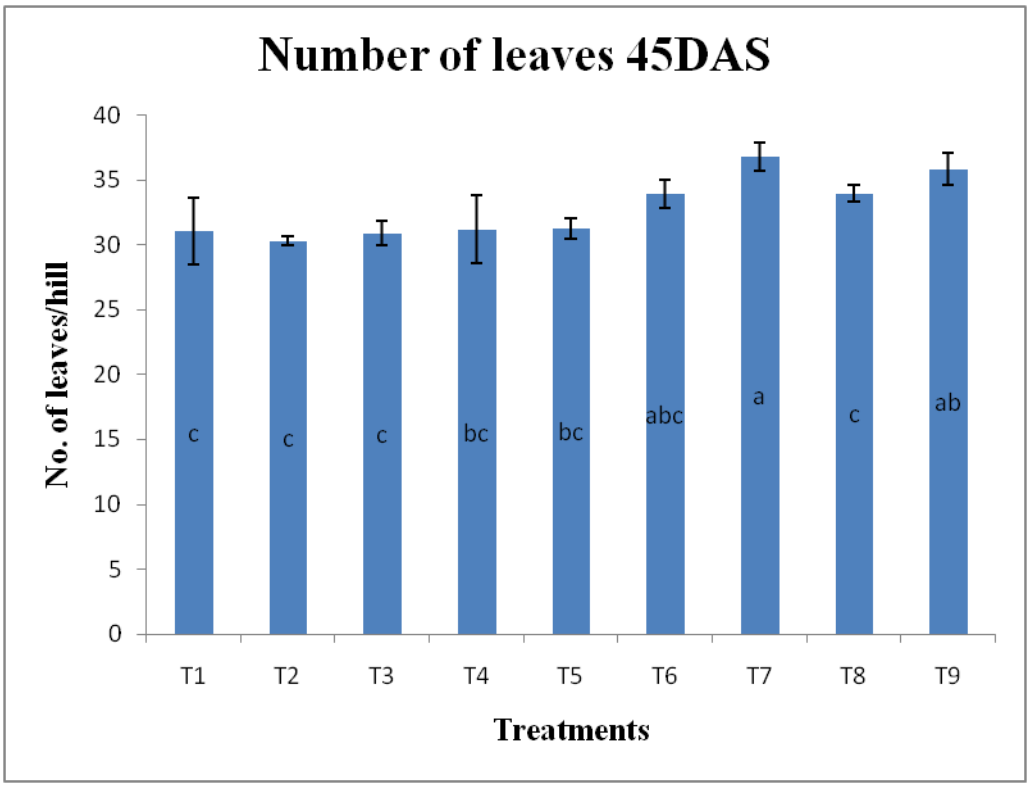

Fig.no.4.2: Effect of different nitrogen sources on the plant height 45 at DAS

The mean followed by different alphabets are significantly different at P <0.05, according to Duncun's multiple range test (DMRTC) for separation of means.

Plant height at 60 days:

Data found from this experiment at 60 days treatment number T2 (50% FYM+50% RND) shows the least growth from among the treatments and treatment number T7 (azotobactor+25% vermicompost+50%RDN) and T9 (Azospirillum+50% vermicompost + 50%RND) maximum plant height at 60 days. Treatment number T7 shows 4.03% and treatment number T9 3.41% higher growth over the control treatment. All the other treatment show no statically difference between them.

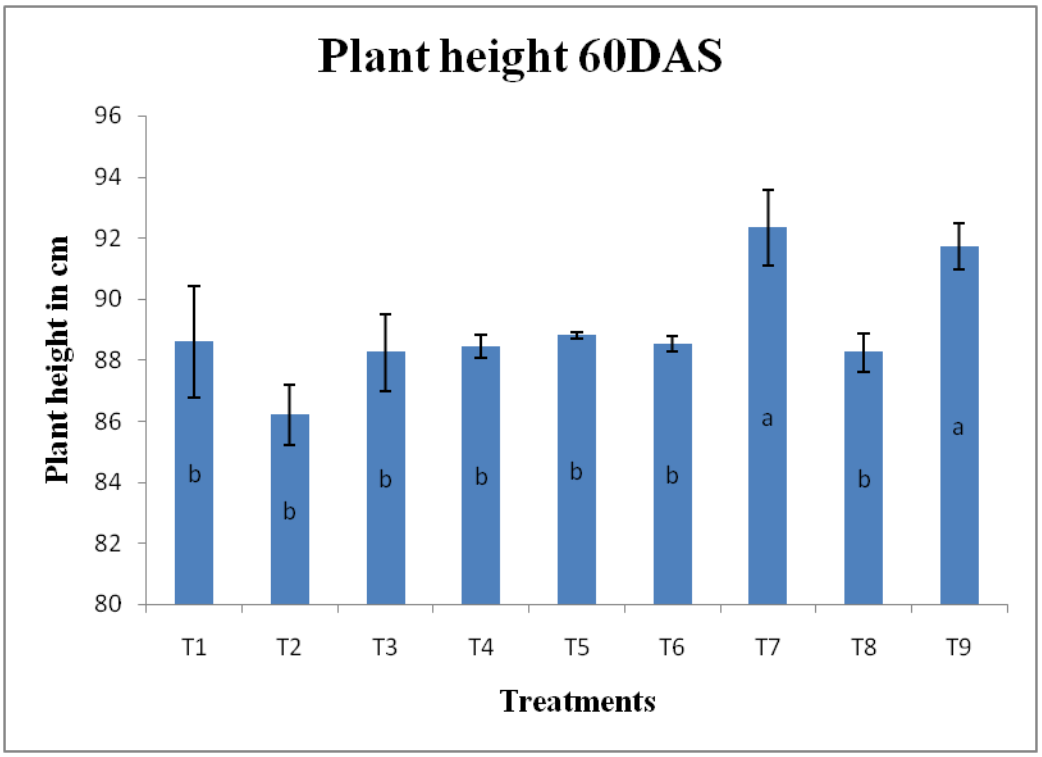

Fig.no.4.3: Effect of different nitrogen sources on the plant height at 60 DAS

The mean followed by different alphabets are significantly different at P <0.05, according to Duncun's multiple range test (DMRTC) for separation of means.

Plant height at 75 days:

Height of plant observed at 75 days treatment number T7 (azotobactor+25 %vermicompost+50%RDN) and T9 (Azospirillum+ 25%vermicompost + 50%RDN) shows 4.64% and 3.63% higher plant height than control treatment. But all other treatment shows no statistically difference. All other treatment shows statically same and no variation between them.

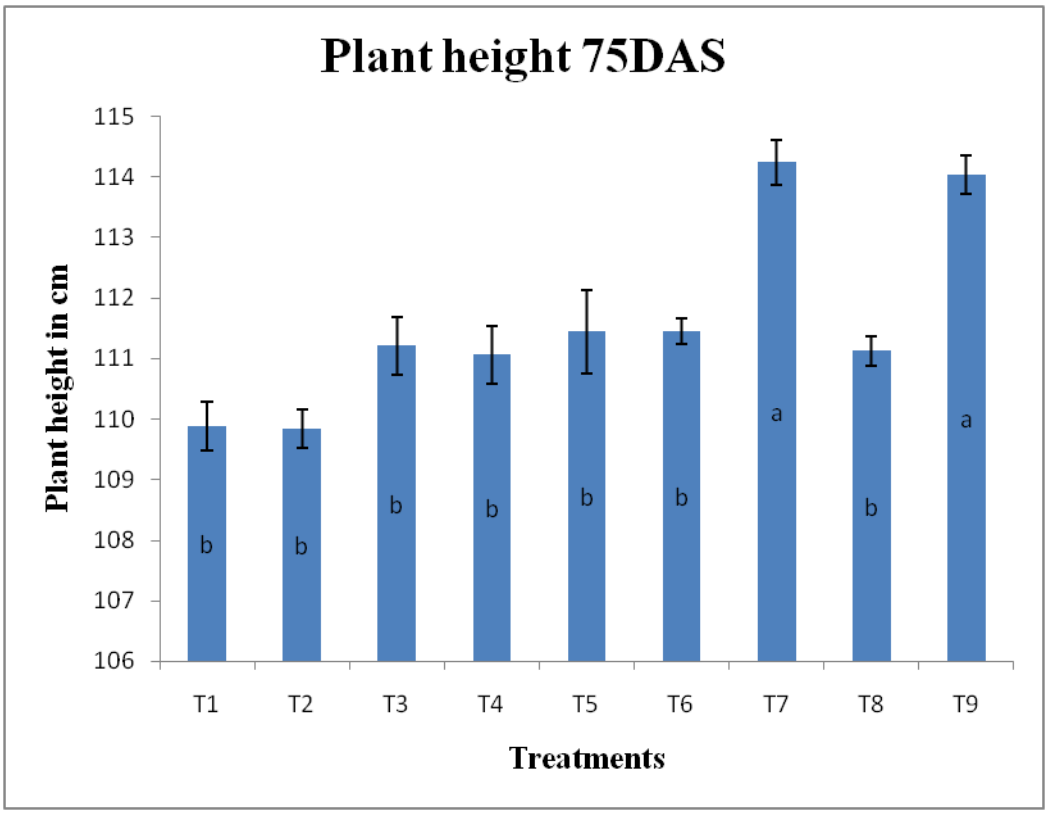

Fig.no.4.4: Effect of different nitrogen sources on the plant height at75 DAS

The mean followed by different alphabets are significantly different at P <0.05, according to Duncun's multiple range test (DMRTC) for separation of means.

Table no 4.1-Effect of different nitrogen sources on the height of direct seeded rice

Treatment	Height- 30 DAS	height -45 DAS	height -60 DAS	Height- 75 DAS
1	33.80 ^{bc} ± 1.30	55 ^{bcd} ±2.00	88.6 ^{b} ± 1.83	109.88 ^{b} ± 0.41
2	31.40 ^{c} ± 0.2	52.26 ^{d} ± 1.89	86.20 ^{b} ± 1.00	109.84 ^{b} ± 0.32
3	32.93 ^{bc} ± 0.9	53.26 ^{cd} ± 1.39	88.26 ^{b} ± 1.26	111.21 ^{b} ± 0.48
4	35.13 ^{bc} ± 0.6	56.40^{bcd} ± 0.50	88.46 ^{b} ± 0.37	111.06 ^{b}± 0.48
5	35.06 ^{b} ± 0.54	57.60^{ab} ± 0.40	88.8 ^{b} ± 0.11	111.44 ^{b} ± 0.68
6	35 ^{b} ± 0.83	58.53^{ab} ± 0.74	88.53 ^{b} ± 0.26	111.45 ^{b} ± .21
7	38.46 ^{a} ± 0.93	61.60^{a} ± 1.33	92.33 ^{a} ± 1.23	115.23 ^{a} ± 0.37
8	35.13 ^{b} ± 0.24	57.40^{abc} ± 1.38	88.26 ^{b} ± 0.63	111.12 ^{b} ± 0.24
9	37.80 ^{a} ± 1.11	61.00^{a} ± 1.47	91.73 ^{a} ± 0.75	114.03 ^{a} ± 0.32

The mean followed by different alphabets are significantly different at P <0.05, according to Duncun's multiple range test (DMRTC) for separation of means.

4.1.2 Number of Tillers

Data of tillers has been observed at different growth stages first at 30 DAS, 45 DAS, 60 DAS and 75 DAS. Variation in growth parameter (tillers) has been observed at different stages under different treatments. The data of tillers at different growth stage expressed in table 4.1.2

Tillers at 30 DAS:

Data of tillers observed at 30 DAS treatment number T7 (azotobactor+25% vermicompost+25%RDN) and T9 (Azospirillum+25%vermicompost+50%RDN) shows significant difference from control treatment. Treatment number T7 35.64% and T9 30.31% higher no of tillers over control treatment. Treatment number T2 (50%FYM+50%RDN) shows least growth of tillers. Statistically treatment T7 and T9 were significant but both are similar to each other and no variation between them.

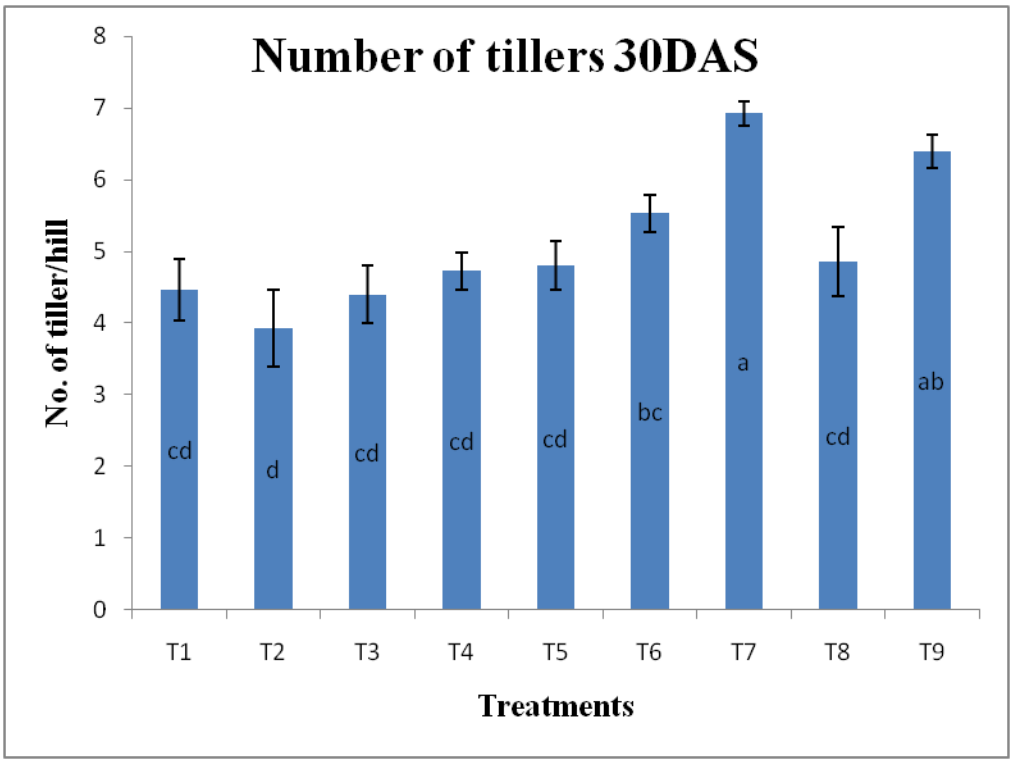

Fig.no.4.5: Effect of different nitrogen sources on the growth of tillers at 30 DAS

The mean followed by different alphabets are significantly different at P <0.05, according to Duncun's multiple range test (DMRTC) for separation of means.

Tillers at 45 DAS:

Data observed at 45 DAS statically show no difference between among the treatments but T7 (azotobactor+25% vermicompost+50%RDN) and T9 (Azospirillum+25% vermicompost + 50%RDN) recorded 12.06% higher number of tillers than control treatment. On basis of statistically analysis no variation are present in all treatments. All the treatments were statistically similar.

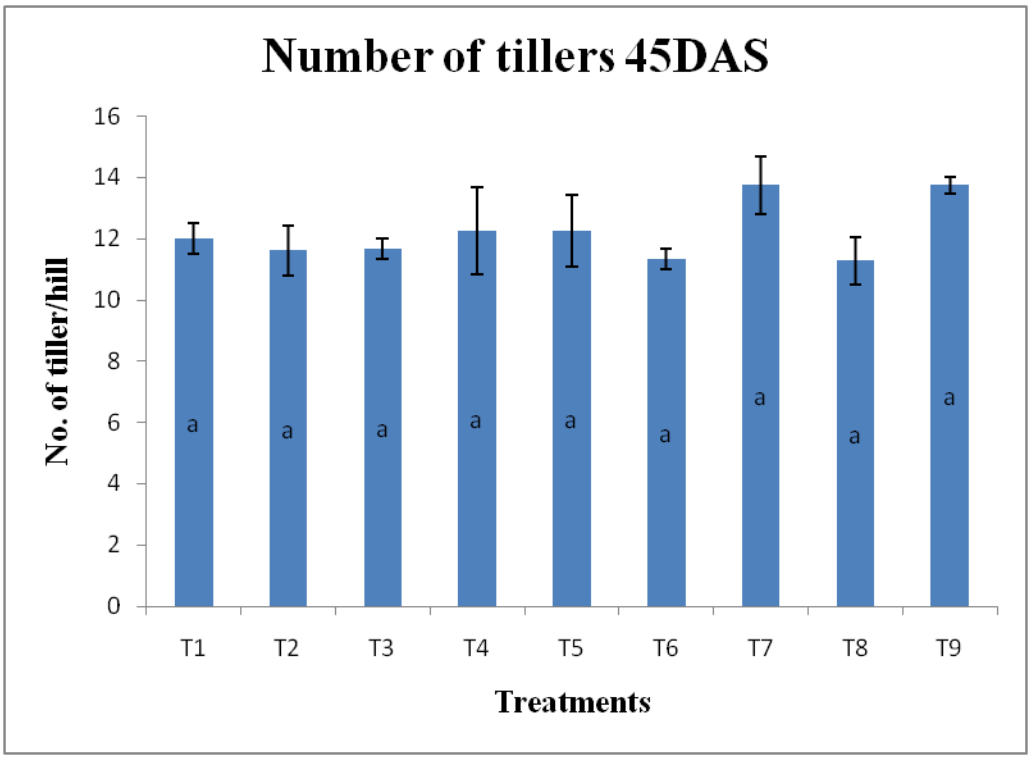

Fig.no.4.6: Effect of different nitrogen sources on the growth of tillers at 45 DAS

The mean followed by different alphabets are significantly different at P <0.05, according to Duncun's multiple range test (DMRTC) for separation of means.

Tillers at 60 DAS:

Data recorded at 60DAS from this experiment found that T7 (azotobactor+25% vermicompost+50%RDN) and T9 (Azospirillum+25% vermicompost + 50%RDN) gives significant result on the basis of statistical analysis. Treatment number T7 15.73% and T9 15.39% higher growth of tillers in comparison of control treatment. All other treatment is statistically same and shows no variation between them.

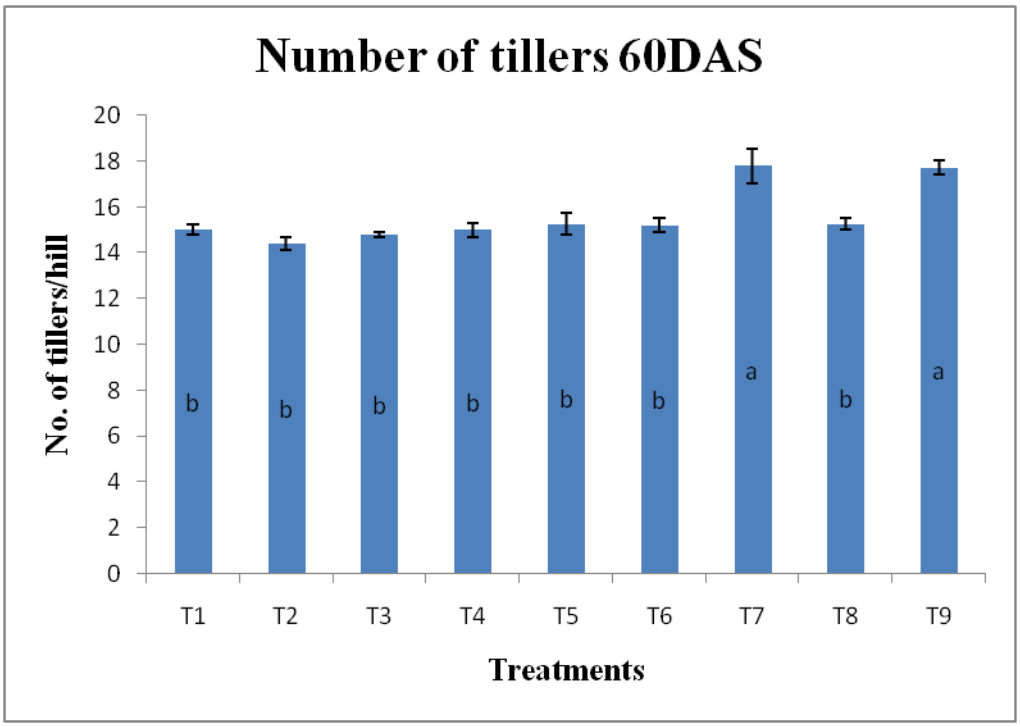

Fig.no.4.7: Effect of different nitrogen sources on the growth of tillers at 60 DAS

The mean followed by different alphabets are significantly different at P <0.05, according to Duncun's multiple range test (DMRTC) for separation of means.

Tiller at 75 DAS:

On basis of statistical analysis data found at 75DAS from this experiment the treatment number T7 (azotobactor+25%vermicompost+50%RDN) and T9 (Azospirillum+25% vermicompost + 50%RDN) Gives 31.15% and 29.19% higher growth of tillers in comparison to control treatment. Treatment number T3 (50%vermicompost+50%RDN) shows 7.38% less growth of tillers than control treatment. Treatment number T7 and T9 is statistically similar to each other with significant variation from control treatment. From this we can say nitrogen from different sources has significant effect on tillers growth in direct seeded rice.

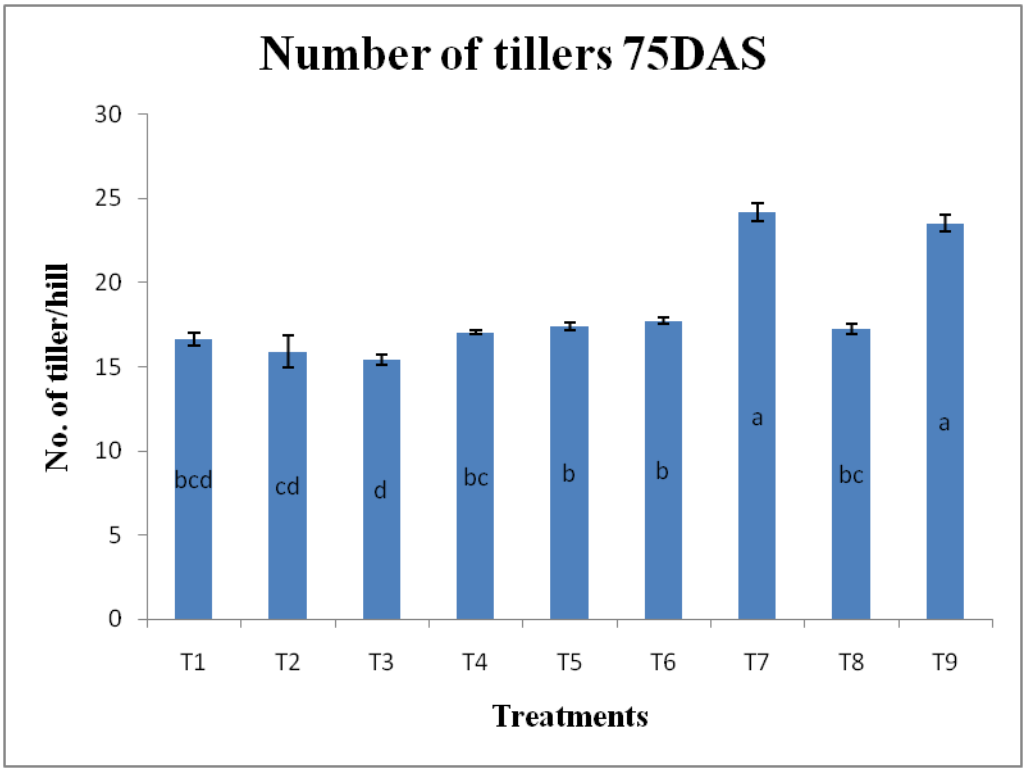

Fig.no.4.8: Effect of different nitrogen sources on the growth of tillers at 75 DAS

The mean followed by different alphabets are significantly different at P <0.05, according to Duncun's multiple range test (DMRTC) for separation of means.

Table no 4.1.2- Effect of different nitrogen sources on the growth of tillers in direct seeded rice

Treatment	Tillers- 30 DAS	Tillers- 45 DAS	Tillers- 60 DAS	Tillers -75 DAS
1	4.46 ^{cd} ± 0.43	12 ^{a} ± 0.52	15 ^{b} ± 0.23	16.66^{bcd} ± .37
2	3.93 ^{d} ± 0.54	11.60 ^{a} ± 0.83	14.40 ^{b} ± 0.30	15.90 ^{cd} ± .96
3	4.40 ^{cd} ± 0.40	11.66 ^{a}± 0.33	14.80 ^{b} ± 0.11	15.43 ^{d} ± 0.29
4	4.73 ^{cd} ± 0.26	12.26 ^{a} ± 1.42	15 ^{b} ± 0.30	17.06 ^{bc} ± .12
5	4.80 ^{cd} ± 0.34	12.26 ^{a} ± 1.18	15.26 ^{b} ± 0.48	17.43 ^{b} ± 0.23
6	5.53 ^{bc} ± 0.26	11.33 ^{a}± 0.33	15.20 ^{b} ± 0.30	17.73 ^{b} ± 0.17
7	6.93 ^{a} ± 0.17	13.73 ^{a} ± 0.93	17.8 ^{a} ± 0.74	24.20 ^{a} ± 0.52
8	4.86 ^{cd} ± 0.48	11.26 ^{a} ± 0.78	15.26 ^{b} ± 0.26	17.26 ^{bc} ± 0.29
9	6.40 ^{ab} ± 0.23	13.73 ^{a} ± 0.26	17.73 ^{a} ± 0.29	23.53 ^{a} ± 0.52

The mean followed by different alphabets are significantly different at P <0.05, according to Duncun's multiple range test (DMRTC) for separation of means.

4.1.3 Number of leaves

Data of leaves were taken by counting the leaves per hill. Average data was taken from every plot of each replication. Data recorded at different growth stages first at 30DAS, 45DAS, 60DAS and 75DAS. Data recorded from this experiment were statistically analyzed to check the variation due to effect of different treatments. The data observed at different growth stages expressed in table 4.1.3

Number of leaves at 30 DAS:

Data observed by counting number of leaves at 30 DAS found that treatment number T7 (azotobactor+25%vermicompost+50%RDN) and T9 (Azospirillum+25% vermicompost + 50%RDN) recorded higher number of leaves. Treatment number T7 found 30% and treatment T9 found 32.48% higher numbers of leaves in comparison to control treatment. Treatment number T2 (50%FYM+50%RDN) and T3 (50%vermicompost+50%RDN) shows 14.8% and 11.11% less growth over control treatment. But statistically all treatment except treatment number T7 and T9 all are similar to each other and no statistically difference between them. Treatment number T7 and T9 gives significant result over the control treatment.

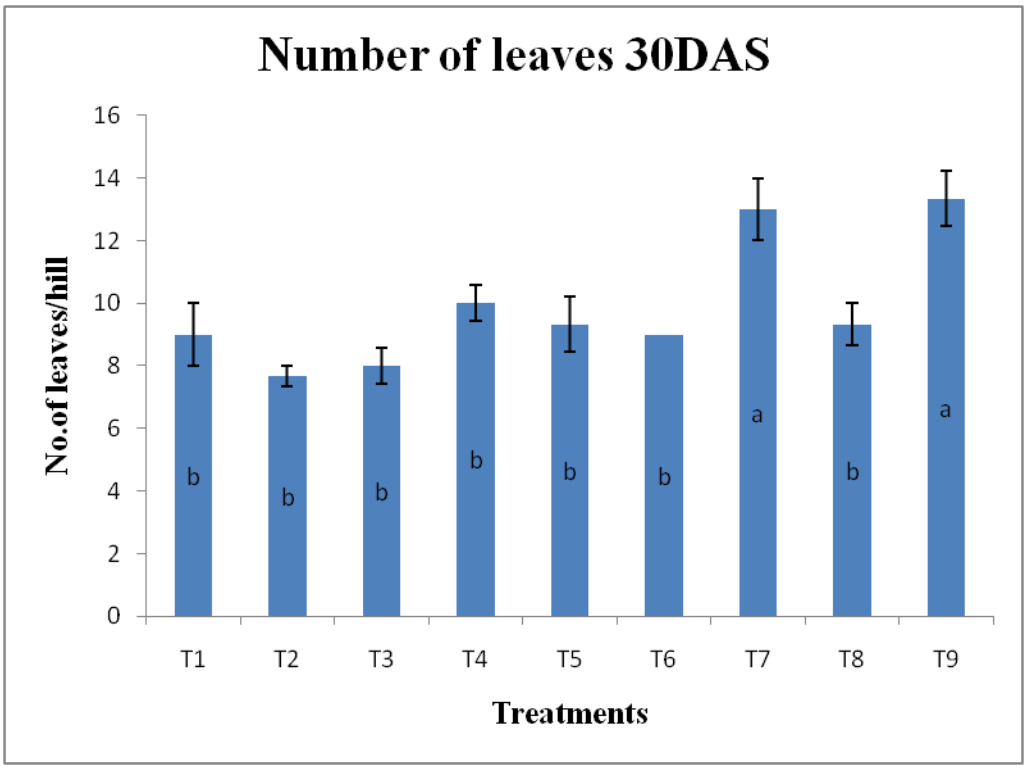

Fig.no.4.9: Effect of different nitrogen sources on the growth of leaves at 30 DAS

The mean followed by different alphabets are significantly different at P <0.05, according to Duncun's multiple range test (DMRTC) for separation of means.

Number of leaves at 45 DAS:

Data recorded at 45 DAS in this experiment found that treatment number T7 (azotobactor+25%vermicompost+50%RDN) and T9 (Azospirillum+25% vermicompost + 50%RDN) recorded higher number of leaves than control treatment. Treatment number T7 has 15.59% higher number of leaves than control treatment but according to statistically analysis treatment number T6 (50%RND + 25%FYM + 25% + azotobacter), T8 (50%RND + 25%FYM + 25%+ Azospirillum) and T9 (50%RND + 25%vermicompost + Azospirillum) similar to each other. They do not show any statistically difference between them.

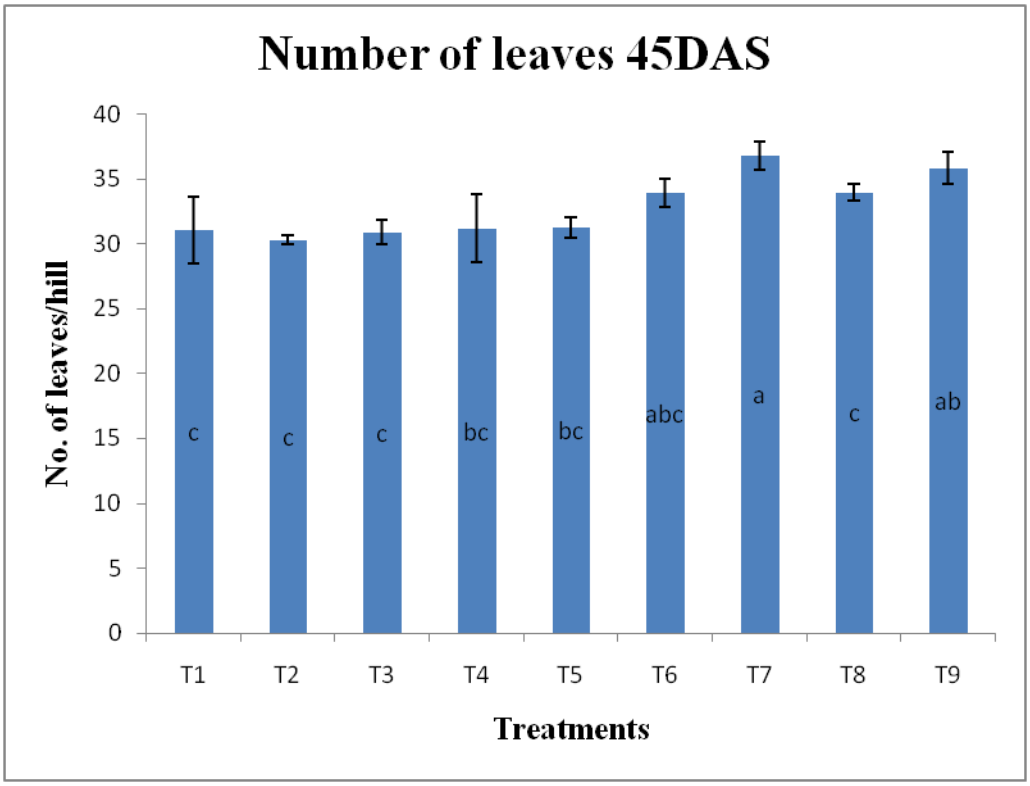

Fig.no.4.10: Effect of different nitrogen sources on the growth of leaves at 45 DAS

The mean followed by different alphabets are significantly different at P <0.05, according to Duncun's multiple range test (DMRTC) for separation of means.

Numbers of leaves at 60 DAS:

Data observed at 60 DAS in this experiment found that treatment number T7 (azotobactor+25%vermicompost+50%RDN), T8 (50%RND + 25%FYM + 25%+ Azospirillum) and T9 (Azospirillum+25%vermicompost + 50%RDN) shows higher number in leaves growth. Treatment number T7 9.70%, T8 3.20% and T9 7.18% higher number of leaves than control treatment. Treatment number T7, T8 and T9 are statistically same to each other. There is no variation present in between them.

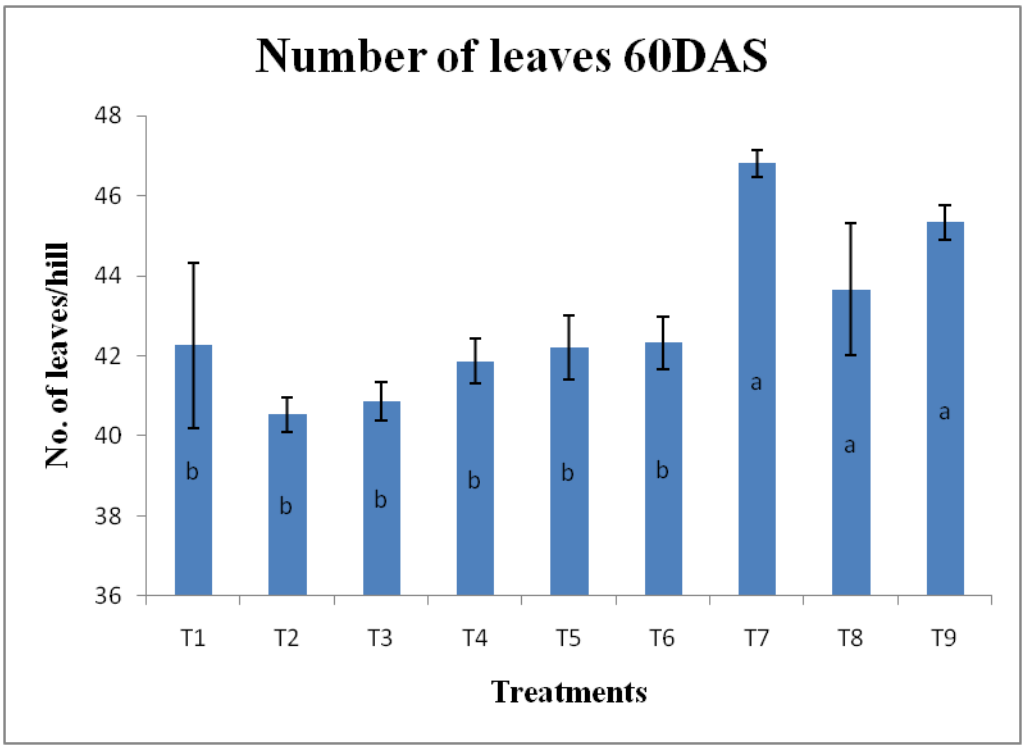

Fig.no.4.11: Effect of different nitrogen sources on the growth of leaves at 60 DAS

The mean followed by different alphabets are significantly different at P <0.05, according to Duncun's multiple range test (DMRTC) for separation of means.

Number of leaves at 75 DAS:

Data recorded at 45 DAS from this experiment found that treatment number T7 (azotobactor+25%vermicompost+50%RDN) and T9 (Azospirillum+25% vermicompost + 50%RDN) gives significant result. Treatment number T7 has 11.67% and T9 has 10.44% higher number of leaves than control treatment. These treatments statistically prove superior from control and other treatments. All other treatment are statistically similar to each other. They shows variation between them.

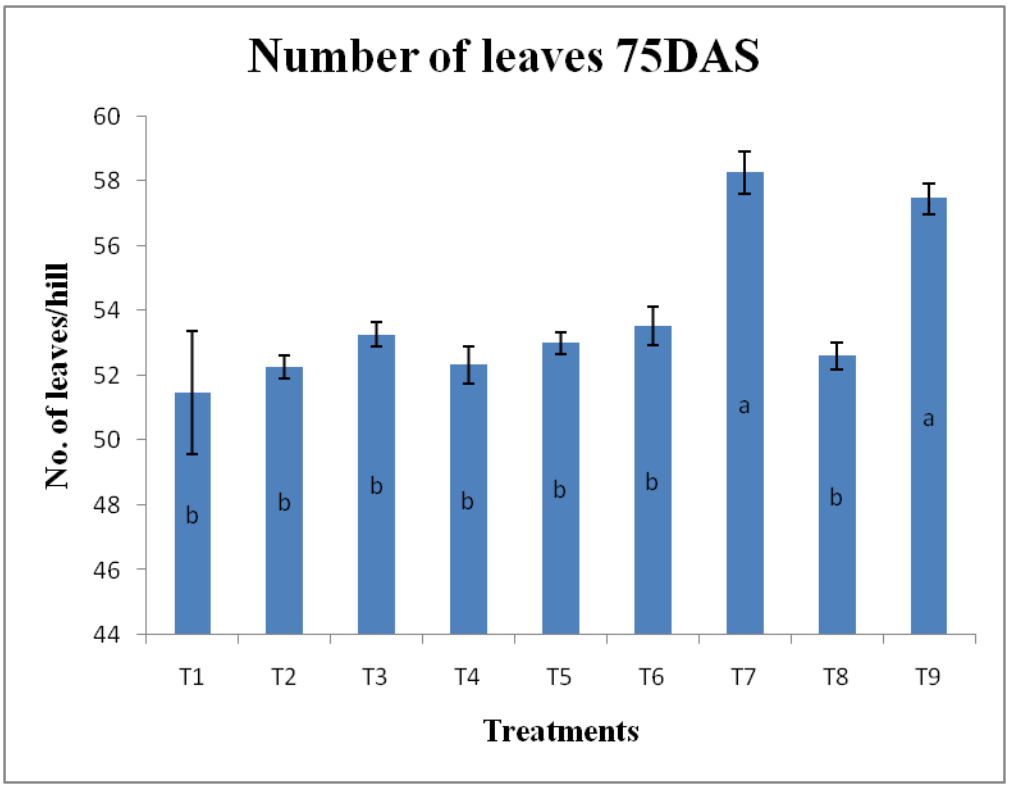

Fig.no.4.12: Effect of different nitrogen sources on the growth of leaves at 75 DAS

The mean followed by different alphabets are significantly different at P <0.05, according to Duncun's multiple range test (DMRTC) for separation of means.

Table no 4.1.3- Effect of different nitrogen sources on the growth of leaves in direct seeded rice

Treatment	Leaves- 30 DAS	Leaves- 45 DAS	Leaves- 60 DAS	Leaves - 75 DAS
1	$9^{b} \pm 1.00$	$31.06^{c} \pm 2.55$	$42.26^{b} \pm 2.06$	$51.46^{b} \pm 1.90$
2	$7.66^{b} \pm 0.33$	$30.33^{c} \pm 0.33$	$40.53^{b} \pm 0.43$	$52.26^{b} \pm 0.36$
3	$8^{b} \pm 0.57$	$30.93^{c} \pm 0.93$	$40.86^{b} \pm 0.48$	$53.26^{b} \pm 0.37$
4	$10^{b} \pm 0.57$	$31.20^{bc} \pm 2.6$	$41.86^{b} \pm 0.56$	$52.33^{b} \pm 0.56$
5	$9.33^{b} \pm 0.88$	$31.26^{bc} \pm .81$	$42.20^{b} \pm 0.80$	$53^{b} \pm 0.34$
6	$9^{b} \pm 0.00$	$33.93^{abc} \pm 1.06$	$42.33^{b} \pm 0.66$	$53.53^{b} \pm 0.58$
7	$13^{a} \pm 1$	$36.80^{a} \pm 1.1$	$46.80^{a} \pm 0.34$	$58.26^{a} \pm 0.66$
8	$9.33^{b} \pm 0.66$	$34^{abc} \pm 0.64$	$43.66^{a} \pm 1.65$	$52.60^{b} \pm 0.40$
9	$13.33^{a} \pm 0.88$	$35.86^{ab} \pm 1.20$	$45.53^{a} \pm 0.43$	$57.46^{a} \pm 0.48$

The mean followed by different alphabets are significantly different at $P < 0.05$, according to Duncun's multiple range test (DMRTC) for separation of means.

4.2 Effect of different nitrogen sources on yield characteristic of direct seeded rice:

4.2.1 Panicle per hill:

Data recorded from this experiment found that treatment number T7 (azotobactor+25%vermicompost+50%RDN) and T9 (Azospirillum+25% vermicompost + 50%RDN) gives significant result in which treatment number T7 shows 23.55% and treatment number T9 shows 19.85% higher number of panicle from control treatment. Treatment number T2 (50 % RND + 50% FYM) and T3 (50 %RND + 50% vermicompost) shows least number of panicle and all other treatment are statistically similar to each other. Observed data expressed in table number 4.2.1.

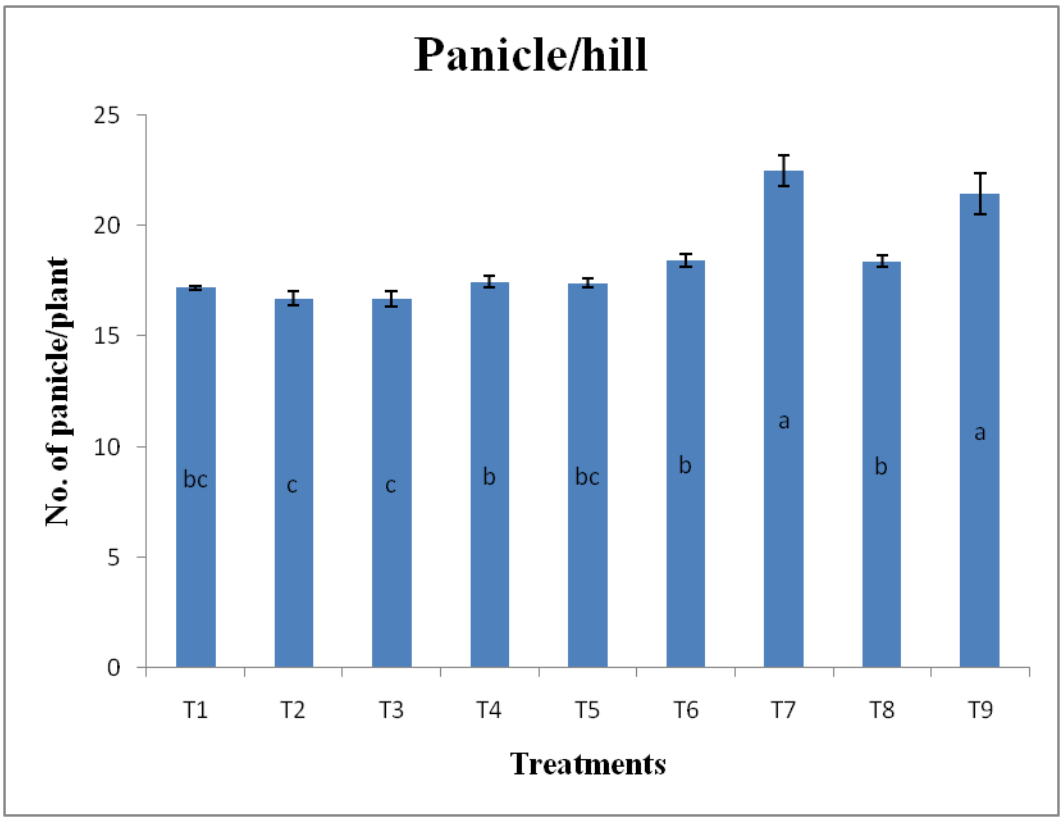

Fig.no.4.13: Effect of different nitrogen sources on the panicles in direct seeded rice

The mean followed by different alphabets are significantly different at P <0.05, according to Duncun's multiple range test (DMRTC) for separation of means.

Table no 4.2.1- Effect of different nitrogen sources on panicles in direct seeded rice

Treatment	Panicle / plant
1	17.20 ^{bc} ± 0.1
2	16.73 ^{c} ± 0.31
3	16.70 ^{c} ± 0.35
4	17.46 ^{b} ± 0.27
5	17.43 ^{bc} ± 0.20
6	18.46 ^{b} ± 0.29
7	22.50 ^{a} ± 0.70
8	18.40 ^{b} ± 0.27
9	21.46 ^{a} ± 0.93

4.2.2 Panicle length:

Data observed from this experiment found that treatment number T7 (azotobactor+25%vermicompost+50%RDN) and T9 (Azospirillum+25% vermicompost + 50%RDN) are superior from among the treatments. Treatment number T7 has 14.08% and T9 has 13.55% superior in comparison to control treatment but both treatment are statistically similar to each other. Observed data of panicle length given in table number 4.2.2.

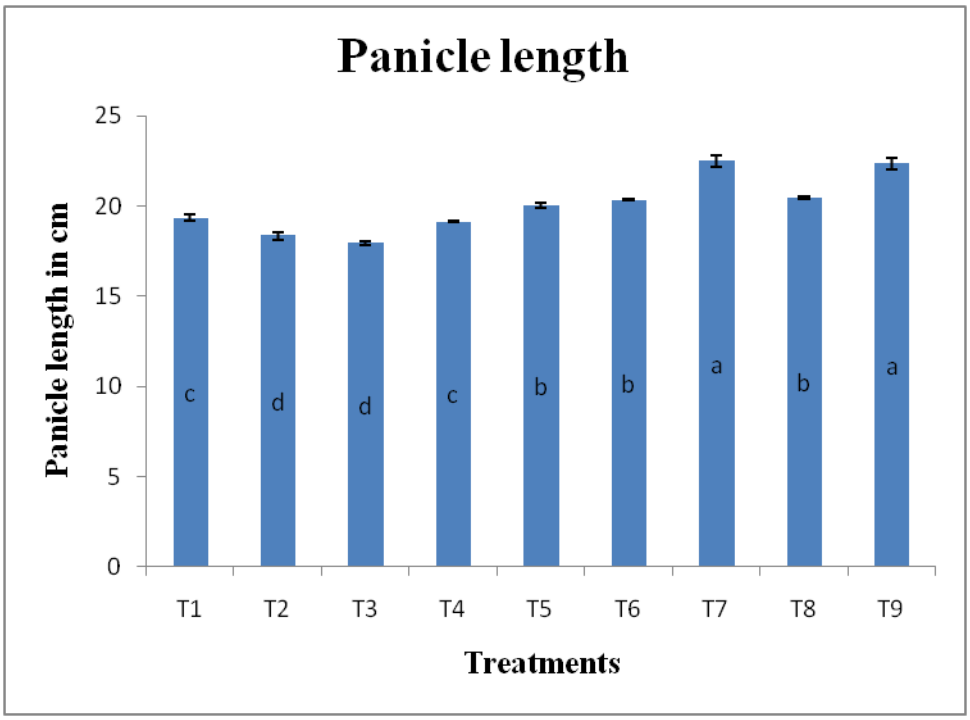

Fig.no.4.14: Effect of different nitrogen sources on the panicles length

The mean followed by different alphabets are significantly different at P <0.05, according to Duncun's multiple range test (DMRTC) for separation of means.

Table no 4.2.2- Effect of different nitrogen sources on panicle length in direct seeded rice

Treatment	Panicle length
1	$19.33^{c} \pm 0.18$
2	$18.36^{d} \pm 0.21$
3	$17.96^{d} \pm 0.12$
4	$19.13^{c} \pm 0.03$
5	$20.03^{b} \pm 0.12$
6	$20.33^{b} \pm 0.03$
7	$22.50^{a} \pm 0.34$
8	$20.46^{b} \pm 0.06$
9	$22.36^{a} \pm 0.32$

4.2.3 Grains per panicles:

Data found from this experiment from each different treatments, the treatment number T7 (azotobactor+25%vermicompost+50%RDN) and T9 (Azospirillum+25% vermicompost + 50%RDN) has significantly higher number of grains per panicles. Treatment number T7 has 10.42% and 10.06% higher number of grains than control treatment. Both the treatment gives significant result on basis of statistically analysis. Data of grains per panicle are given in table .no.4.2.3.

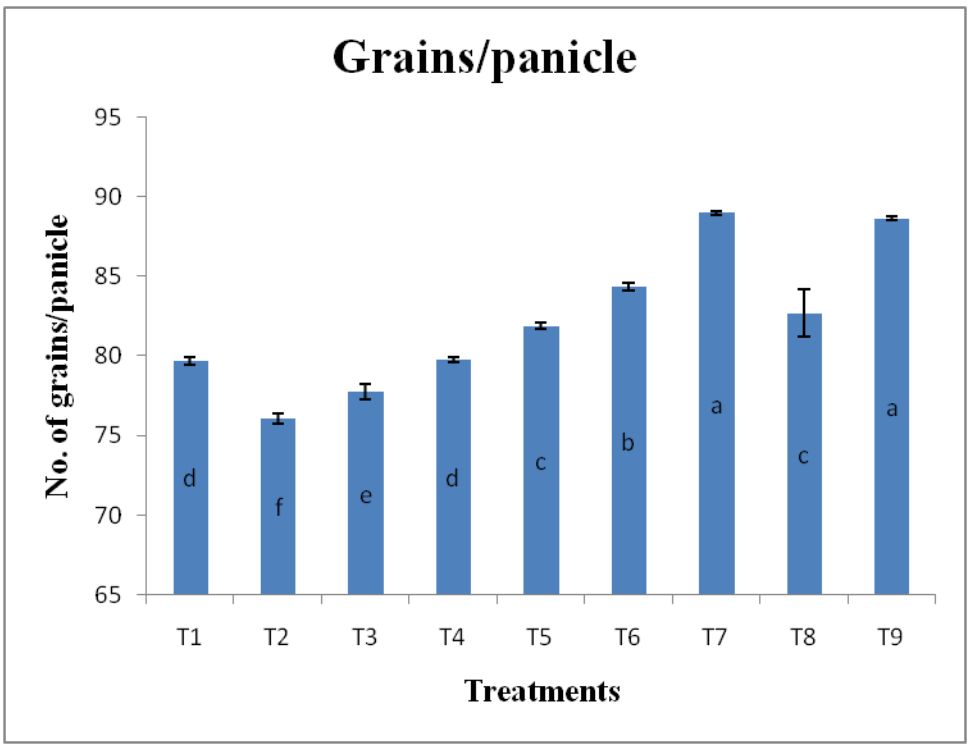

Fig.no.4.15: Effect of different nitrogen sources on the grain/panicle

The mean followed by different alphabets are significantly different at P <0.05, according to Duncun's multiple range test (DMRTC) for separation of means.

Table no 4.2.3- Effect of different nitrogen sources on grain/panicle in direct seeded rice

Treatment	grain/ panicle
1	79.70 [d] ± 0.23
2	76.03 [f] ± 0.32
3	77.75 [e] ± 0.52
4	79.77 [d] ± 0.16
5	81.86 [c] ± 0.20
6	84.34 [b] ± 0.24
7	88.98 [a] ± 0.12
8	82.66 [c] ± 1.49
9	88.62 [a] ± .12

4.2.4 1000 grain weight:

Data observed by counting 1000 grain from each treatment grain weight of that treatment number T7 (azotobacter + 25% vermicompost +50% RDN) and T9 (Azospirillum+25% vermicompost + 50%RDN) have higher test weight from all the treatment. Treatment number T7 has 11.54% and treatment number T9 has 10.75% higher test weight than control treatment. Treatment T7 and T8 gives significant result on basis of statistically analysis. Observed Data of test weight are given in table number 4.2.4.

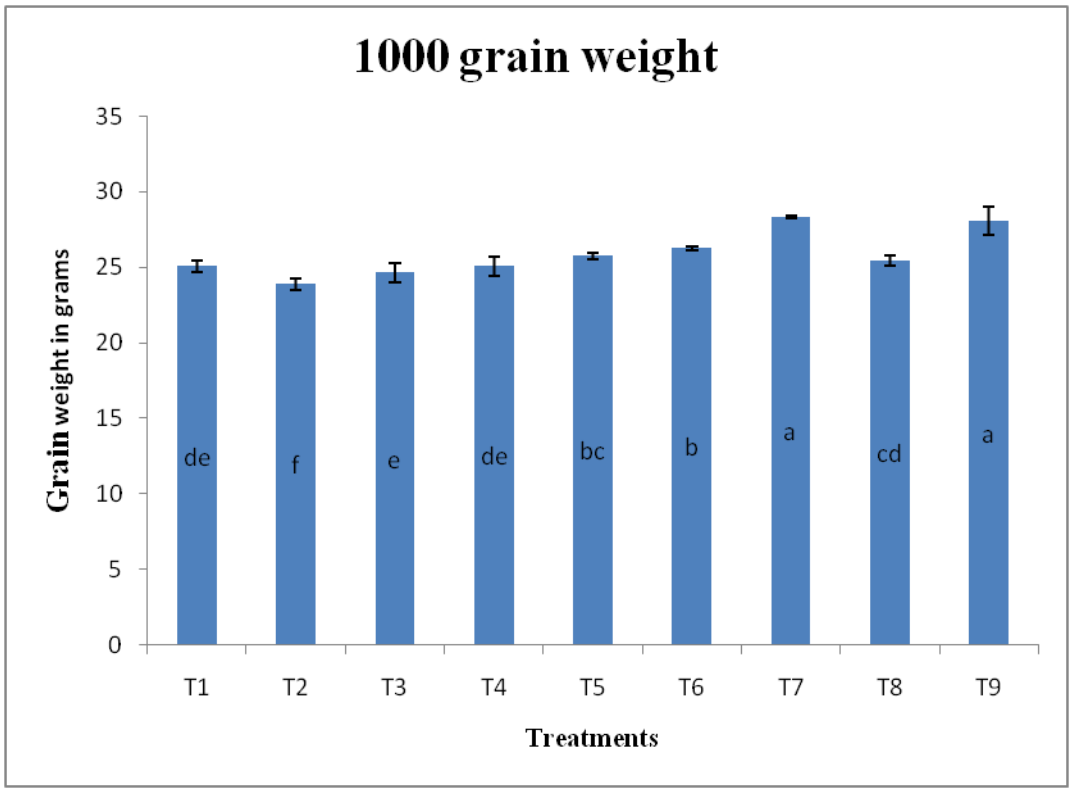

Fig.no.4.16: Effect of different nitrogen sources on the grain weight

The mean followed by different alphabets are significantly different at P <0.05, according to Duncun's multiple range test (DMRTC) for separation of means.

Table no 4.2.4- Effect of different nitrogen sources on the grain weight in direct seeded rice

Treatment	1000 grain weight
1	$25.06^{de} \pm 0.40$
2	$23.90^{f} \pm 0.40$
3	$24.62^{e} \pm 0.65$
4	$25.10^{de} \pm 0.64$
5	$25.75^{bc} \pm 0.19$
6	$26.28^{b} \pm 0.12$
7	$28.33^{a} \pm 0.10$
8	$25.43^{cd} \pm 0.33$
9	$28.08^{a} \pm 0.92$

4.2.5 Grain yield per plot:

Harvesting and threshing was done separately for each different treatment. Grain yield data was observed from every treatment found that treatment number T7 (azotobacter + 25% vermicompost +50% RDN) and T9 (Azospirillum+25% vermicompost + 50%RDN gives significant result. Treatment number T7 shows 27.04% and T9 shows 25.95% higher grain yield from the control treatment. Both the treatments are given higher significant results but they were statically similar to each other. From this we can say different nitrogen sources affect the grain yield in direct seeded rice. Data observed of grain yield expressed in table 4.2.5.

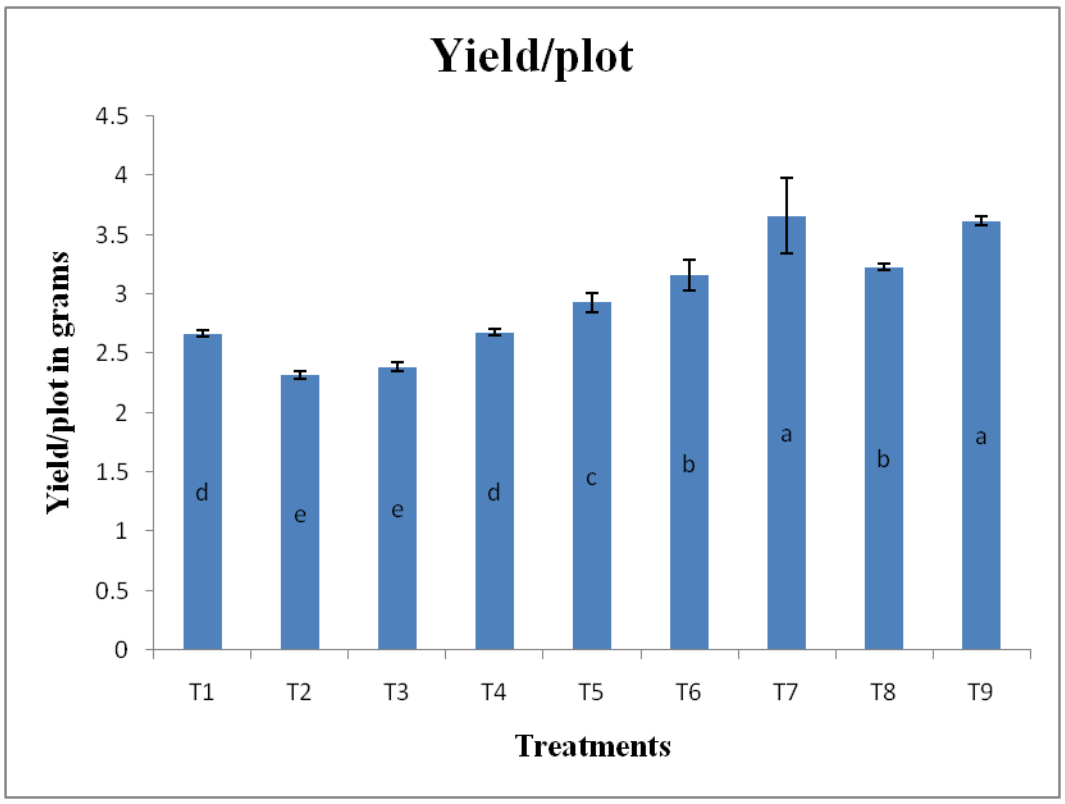

Fig.no.4.17: Effect of different nitrogen sources on the grain yield

The mean followed by different alphabets are significantly different at P <0.05, according to Duncun's multiple range test (DMRTC) for separation of means.

Table no 4.2.5- Effect of different nitrogen sources on the grain yield in direct seeded rice

Treatment	Yield per plot
1	$2.67^{d} \pm 0.03$
2	$2.32^{e} \pm 0.031$
3	$2.39^{e} \pm 0.04$
4	$2.68^{d} \pm 0.03$
5	$2.93^{c} \pm 0.08$
6	$3.16^{b} \pm 0.13$
7	$3.66^{a} \pm 0.32$
8	$3.23^{b} \pm 0.03$
9	$3.62^{a} \pm 0.04$

The mean followed by different alphabets are significantly different at P <0.05, according to Duncun's multiple range test (DMRTC) for separation of means.

4.2.6 Harvesting index:

Harvesting index was taken by dividing economic yield by total biological yield and multiplied by 100 to express in percentage. Data observed from this experiment that treatment number T7 (azotobacter + 25% vermicompost +50% RDN) and T9 (Azospirillum+25% vermicompost + 50%RDN have higher harvesting index. Both the treatment gives the significant result. Treatment number T7 shows 18.56% and T9 shows 13.57% significant higher harvesting index from the control treatment (100%RDN urea). Treatment number T2 (50 % RND + 50% FYM) shows least harvesting index. Treatment number T2 shows 4.13% less harvesting index from control treatment. Treatment number T4 (50%RND + 25%FYM + 25% + cyanobacteria) are statistically similar to control treatment. Treatment number T6 (50%RND + 25%FYM + 25% + azotobacter) and T8 (50%RND + 25%FYM + 25%+ Azospirillum) shows superior to control treatment but non- significant. This result shows different nitrogen sources affect the growth and grain yield in direct seeded rice. Observed data of harvesting index expressed in table number 4.2.6

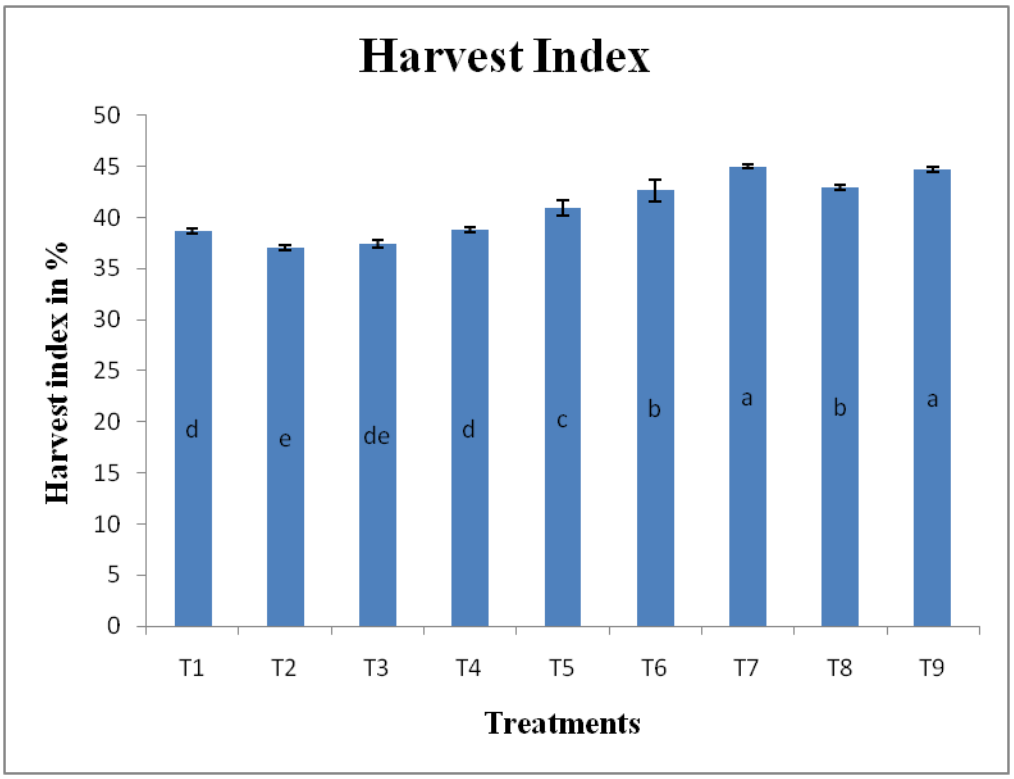

Fig.no.4.18: Effect of different nitrogen sources on the harvesting index (H.I)

The mean followed by different alphabets are significantly different at P <0.05, according to Duncun's multiple range test (DMRTC) for separation of means.

Table no 4.2.6- Effect of different nitrogen sources on harvesting index (H.I)

Treatment	HI
1	38.66 ^{d} ± 0.24
2	37.06 ^{e} ± 0.24
3	37.47 ^{de} ± 0.38
4	38.85 ^{d} ± 0.26
5	40.91 ^{c} ± 0.75
6	42.67 ^{b} ± 1.05
7	45.02 ^{a} ± 0.20
8	42.95 ^{b} ± 0.20
9	44.73 ^{a} ± 0.29

The mean followed by different alphabets are significantly different at P <0.05, according to Duncun's multiple range test (DMRTC) for separation of means.

DISCUSSION

The result of field experiment with title "**Effect of different bio-fertilizers, organic and inorganic sources on the yield of direct seeded rice (*Oryza sativa)* grown under Punjab"** was conducted at the farm of lovely professional university Phagwara district kapurthala during *Kharif* season in year 2016-2017. From this study number of variable found significant results in different treatments. Different growth parameter was response to different nitrogen sources which are shown in tables and graphs. Use of nitrogen from different sources in combination significantly affects the growth and yield attributes in direct seeded rice. Many workers also confirmed the similar finding in their research. Many scientists prove significant role of different nitrogen sources in growth and yield of rice cultivation in their researches.

5.1Effect of different nitrogen sources on growth characteristic of direct seeded rice:

5.1.1 Azotobacter inoculation in combination with organic and Inorganic source

(a) Growth characteristics:

In this experimental study it was found that treatment number T7 combination of bio-fertilizer (azotobacter) with 25% vermicompost and 50% recommended dose of inorganic nitrogen (urea) gives significant higher result in growth and yield parameter over the control treatment. *Md Adbul Kader et al., (2001)* conducted this research in Bangladesh Agriculture University. Inoculation of azotobacter bio-fertilizer with different level of organic and inorganic sources increased in growth characteristics like plant height at different days in rice cultivation because use of azotobactor bio fertilizer in combination with organic and inorganic sources increased in the organic matter in soil, which increase in the nutrient uptake and increase in the plant growth. Use of vermicompost with combination of inorganic fertilizer reduced the emphasis on chemical fertilizer also with significant increase in the growth characteristic like plant height and number of tillers, it is due to combination of different sources increase the nutrient status of soil also with increase in cation exchange capacity and increase water holding capacity of soil which increase uptake of nutrients through mass flow M.Tejada *et al., (2009)*

conducted this research in America. In a study conducted on bio fertilizer found that use of Azotobacter *chroococcum* inoculation in different crops increase in the dry weight of plant as compare to control treatment (where the bio fertilizer are not used) because the bio fertilizer promote the production of phytohormones (auxins, cytokinin and gibberellins) this is observed by Puertas and Gonzales (1999).

(b) Yield characteristics:

Similarly in another experiment combined use of Bio-fertilizer with vermicompost in rice *(Oryza sativa)* gives significant result increase in number of panicles, length of panicles and shoot length was observed by Kamil Prajapati et al.,(2008) in Nepal while study conducted on promotional effect of azotobacter (*chroococcum spp.).* They found that use of vermicompost with azotobacter bio-fertilizer shows significantly higher results over the control treatment, due to bio-fertilizer increase in the nutrient uptake of plant by changing the physical and chemical properties of soil. Treatment inoculated with azotobacter bio-fertilizer with combine use of vermicompost and inorganic source of fertilizer over all shows the best results over control treatment. Inoculation with azotobacter shows the promotional effect in the growth of rice cultivation because Azotobacter inoculation enhances the nitrogen fixation, mineralization like soil activities which are beneficial and shows positive response in growth and development of rice crop. It was confirmed by K.K. Kapoor *et al* (1983). Indirectly Chatterjee *et al.*(2012) also found in experiment combination use of vermicompost and azotobacter shows more number of panicle per plant, superiority in panicle length and yield result with integrated use of vermicompost with bio fertilizer over the control treatment. It is due to bio fertilizer combination with organic and inorganic influenced the soil biological properties which helpful in increase in the growth and yield parameters. Use of different organic, inorganic combination and bio fertilizers established a symbiotic relationship with plant which increases the supply and nutrient uptake in plants.

Research conducted in international crop research institute for the semi arid tropics (ICRISAT) Hyderabad on rice variety (suhasini) with application of bio-fertilizer azotobacter with organic and inorganic fertilizer found that its gives significant result increase in the yield of crop over the treatment where bio fertilizer were not used. Use of bio fertilizer azotobacter gives

significant increase in the yield of rice crop due to bio fertilizer increases in the organic matter of soil which help increase in the growth and yield of many crops. It is observed by Wani et al., (2011) and again supported by V. Rajaramamohan Rao in their research in 1987. Pandey and Kumar, 1989 reported that with the inoculation of azotobacter bio fertilizer shows significant increase in grain yield in many different crops range from 2 to 45 percent because bio fertilizer act as growth promoter by synthesis of many natural plant growth hormone. Bio fertilizer inoculation shows significant increase in the growth, grain yield and Stover yield. Use bio fertilizer also shows much beneficial effect to plant growth and development it is because bio fertilizer makes entophyte bacterial relationships with plant help on plant growth through its life cycle .This is supported by Sturz et al., (2000).

5.1.2 Azospirillum inoculation in combination with organic and Inorganic source on Growth and yield characteristics

(a) Growth characteristics:

Zhihua Bao *et al.*, (2013) confirmed in experiment on rice with use of azospirillum bio-fertilizer with combination of organic and inorganic nitrogen sources in rice found that significant increase in tillers growth, shoot length and some other growth parameters. Result observed with Inoculation of azospirillum gives significantly increase in the number of tillers by 8.6% and shoot growth increased by 3.1% as compare to control treatment found in experiment conducted in Hokkaido, Japan. Now these days' continuous chemical or inorganic fertilizer shows unbalance manner of nutrient status in soil fertility which create many problem like reduce in soil fertility, loss of several micro nutrient from soil and loss of many beneficial micro organism from soil Rhizosphere which ultimately effect the growth of plant. So with the use of different organic sources we full fill the demand of nutrient which affect the increase in growth and yield of crop.

Densilin DM *et al.*,(2011) again reported in experiment combine use of vermicompost with bio-fertilizer found significant increase in the growth and yield parameters because bio-fertilizer change the microbial status of the soil which improve the nutrient status and increase soil fertility. Bio-fertilizers applications are increase crop yield by 20-30 percent and help in

reduce the emphasis on chemical or inorganic fertilizer by providing Nitrogen 25%. Bio-fertilizers applications are increase crop yield by 20-30 percent and help in replacing the chemical fertilizer by providing sufficient amount of Nitrogen required by plants. Bio fertilizers act as natural growth promoter and increase in the plant growth, it activates soil microbes and restore the soil fertility. Inoculation of Bio-fertilizer makes plant drought resistance and provides resistance against some soil borne diseases (Anonymous, 2009b).

(b) Yield characteristic:

According to Md. Mozammel Hossain (2015) inoculation of azospirillum Biofertilizer increase in germination percent in rice variety "BRRI dhan-28" as compare to control treatment. Treatment inculcated with bio-fertilizer also gives significant increase in yield of rice crop, numbers of grains per panicle and number of panicle per plant this is due to bio fertilizer increases the microbial activities in soil which increase the nutrient availability of plant. Inoculation of azospirillum gives significant increase in the yield attributes (plant dry matter, number of panicle, panicle per plant, number of grain per panicle) through released of carbohydrate, polyamine, amino acid, pectin and enzyme in extracellular medium. Number of azospirillum spp. is able to produce many growth promoter hormones like auxins, cytokines (CK) and nitro oxide. This is reported by Cassan *et al*., (2009).

Okon, Y (1995) also found the similar findings combined use of azospirillum bio-fertilizer with organic and in organic nitrogen sources shows significant increase in the yield of the of cereals crops because It improves the rate of root growth which ultimately increases in the water and nutrient uptake from soil. Use of bio fertilizers also help in nitrogen fixation and provide nitrogen to plants. Garcia de Salamone et al (2010) confirmed in a research conducted on a Vertic Argiudol type soil in Argentina in $60m^2$ areas and found that azospirillum inoculation increase in the nitrogen content of rice plant 16 and 50 kg per hectare because Use of bio-fertilizer azospirillum found increase in aerial biomass at tillering stage and grain filling stage. It helps in the growth of microbes in soil which help in more nitrogen fixation. Azospirillum bio-fertilizer also helps increase in total nitrogen accumulation in rice. It becomes very use full tool for the farmers to increase production without any adverse effect to

natural resources. Bio-fertilizers inoculation maintained long term soil fertility and also reduces the cost of cultivation of crops.

Researchers found that use of bio fertilizers in different crops increased in the growth and total biological yield because bio fertilizer increase the organic matter into the soil and also maintained sustainable system in soil atmosphere. Use combination of different nitrogen sources best way to maintained organic carbon and total nitrogen in soil which increase soil fertility and help in nutrient uptake from soil this is supported by S.A.Wani (2012). Bio-fertilizer with combined use with other sources of nitrogen increase in the grain yield by 4.5 kg per hectare and straw yield by 8.5 kg per hectare as compare to control treatment where the bio fertilizer were not used. This is observed by Das and Saha in 2007. According to many research conducted on bio-fertilizer in world supported that bio fertilizer has potential to provide good to supply of nitrogen to crops. 30-50% Nitrogen requirement of plant can replace by Biofertilizer. Inoculation of azospirillum increase in the number of grain, increase in the grain weight which ultimately increase in the grain yield through improve the morphology of roots which increase the surface area and increase in the nutrient uptake at faster rate .This also supported by Choudhury *et al*., (2004).

Mohammad Abdus Sattar *et al*., (2014) observed that inoculation of bio azospirillum bio fertilizer recorded maximum yield 8.43t/ha from among the treatments as compare where the bio fertilizer are not used. In investigation found that inoculation of azospirillum bio fertilizer shows beneficial effect on plant growth with significant increase in the grain yield and straw yield because Interaction of bio fertilizer with organic and inorganic shows positive effect on plant growth at different stages. Combine use of bio fertilizer with organic and inorganic nitrogen source gives 22% increase in rice grain yield in field trail with respect to control treatment. This is also supported by Malik *et al*., (2002). Bio fertilizer is very helpful tool to reduce emphasis from chemical fertilizer. It also helps in sustainable agriculture production without any harmful effect to environment. Higher grain and straw yield is obtained with the combine use of bio fertilizer, vermicompost with 50% recommended dose of nitrogen because Integrated use of nutrient affects the physico-chemical properties of soil which improve the nutrient status of soil. This is supported by Singhl *et al., (*2011).

Sathish *et al.*,(2011) reported that application of integrated nitrogen sources gives the higher yield from among the treatments because combine use of nitrogen source increase in the nutrient uptake by improving the soil nutrient status. Again research conducted by the Zayed *et al.*, (2013) found that integrated application of organic and inorganic nitrogen sources combine with bio fertilizer gives significant increase in grain and straw yield. Again virdia and Mehta (2009) supported that combine use of bio fertilizer with organic an in organic nitrogen sources gives statistically significant increase in yield and yield attribute in rice crop. Sarwar (2005) reported that combine application of Biofertilizer in combination with organic and inorganic gives significant increase in rice grain and straw yield because combine use of organic and inorganic increase in the biomass which improves nutrient status of soil.

Chapter V

SUMMARY & CONLUSION

This experiment research trail shows that Treatment T7 (azotobacter + 25%vermicompost + 50%RDN) and T9 (azospirillum +25% vermicompost +50% RDN) recorded the higher plant growth parameters over the other treatments. Both the treatments recorded more number of tillers per hill, number of panicle, panicle length, number of grain per panicle also with grain and straw yield significantly higher over control treatment. From many researchers found that use of bio fertilizer with synthetic fertilizer and organic fertilizer helps increase in production per unit area in rice. Combined use of different sources enhance the nutrient status N, P and K of soil to sufficient amount which improve the soil fertility of soil and ultimately increase in the yield of rice and also in many other crops. Integrated nutriment management reduces the emphasis from synthetic fertilizer and fulfills the nutrient demand which also help in increase the yield of crop. Many researches supported that INM not only gives good quantity of produce but also gives good quality of produce with rich in nutrient, less or no residual effect present in produce. Integrated nutrient management not only help in meet the nutrient demand of crop but also helps to maintained long term fertility of soil, maintained growth of beneficial microorganism in soil which helps in providing nutrient to plant .Use of Integrated nutrient management also helps in manage residual waste of agriculture and other wastes by use as nutrient sources combined with chemical fertilizers.

Data recorded at different growth stages from different treatments shows that significant result in those treatments where inoculation of azotobacter or azospirillum combined with vermicompost and inorganic fertilizer are used. The use of bio fertilizer in combination with organic and inorganic nutrient sources effect the overall soil environment by improving the soil organic matter, soil water holding capacity, soil micro organism, soil physical and chemical properties, which all combined together make soil more productive. Integrated application of different nutrient sources makes sustainable soil environment which shows synergetic effect on the growth and yield of different crops. Application of nitrogen from different sources makes a balance in agro-ecosystem with no adverse effect on the environment. Combination of

Biofertilizer with organic and chemical fertilizer shows the positive effect on the growth and yield of different crops because combination of different nutrient sources improve the fertility status of soil which make availability of the all essential nutrients. Long term use of synthetic fertilizers shows unbalance in nutrient availability which result decrease in productivity of crops. Combined used of Biofertilizer with organic and inorganic fertilizer shows significant higher result on the growth and yield attributes because Biofertilizer also act as growth promoter it help in synthesis of many growth hormones like auxins, cytokinin and gibberellins, which increased in growth of different crops. Combination of different nutrient sources not only provide nutrient during crop cycle but also helps in maintained long term soil fertility which is highly beneficial for next succeeding crops. Many researches supported combined use of bio fertilizer with organic and inorganic sources make plant resistance against biotic and abiotic environmental stresses by changing environment condition at micro level. Combined use of different nitrogen sources increases the nitrogen efficiency and help in control pollution through run off and leaching loss of nitrogen. Combine use of bio fertilizer with organic and inorganic sources are very beneficial tool in sustainable production of different crops.

CONCLUSION

From the result of this experiment with title "**Effect of different bio-fertilizers, organic and inorganic nitrogen sources on the yield of direct seeded rice *(Oryza sativa)* grown under Punjab"** found the facts are following:

- Application of nitrogen form bio-fertilizer azotobacter combine with vermicompost and 50% recommended dose of nitrogen gave the significant higher result in growth characteristics (plant height, number of tillers , number of leaves) and yield characteristics (panicle per plant, panicle length, grain yield per plot and harvesting index) over the control treatment.
- Application of bio-fertilizer azospirillum combine with vermicompost and 50%recommended dose of nitrogen also exhibited statistical significant result over the control treatment in direct seeded rice.
- From the above result it was found that nitrogen from different sources shows the statistical significant increase growth and yield of direct seeded rice.

Literature Cited

Abadi, V. A. J. M., & Sepehri, M. (2016). Effect of Piriformospora indica and Azotobacter chroococcum on mitigation of zinc deficiency stress in wheat (Triticum aestivum L.). *Symbiosis*, *69*(1), 9-19.

Ahmad A, Al-Noaim and Hamad S H. (2004). Effect of bio-fertilization along with different levels of nitrogen fertilizer application on the growth and grain yield of Hassawi rice (*Oryza sativa* L.). Sci. J. King Faisal Univ., (Basic and Appl. Sci), 5: 215-225.

Anonymous. (2009b). Bio-fertilizer and sustainable forming. In: Bio-Fertilizer for Sustainable Agriculture (Jain, V. K eds.). p. 149-179.

Budhar, M. N., Palaniappan, S. P and Rangaswamy, A. (1991).Effect of farm wastes and green manures on low land rice.*Indian Journal of Agronomy 36 (2): 251-252*.

Chand S, Anwar M and Patra D D. (2006). Influence of long-term application of organic and inorganic fertilizer to build up soil fertility and nutrient uptake in mint mustard cropping sequence. Comm. Soil Sci. & Pl. Ana., 37: 63-76.

Chaoui I, Zibiliske M and Ohno T. 2003.Effects of earthworm casts and compost on soil microbial activity and plant nutrient availability. *Soil Biology and Biochemistry 35: 295-302.*

Chatterjee R.; Jana J. C. and Paul P. K.(2012). Enhancement of head yield and quality of cabbage (*Brassica oleracea*) by combining different sources of nutrients. *Indian Journal of Agricultural Sciences.*82(4):323-327.

Choudhury, A.T.M.A. & Kennedy (2004) Prospects and potentials for systems of biological nitrogen fixation in sustainable rice production I.R. Biol Fertil Soils 39: 219. doi:10.1007/s00374-003-0706-2

Das P.K., (1996). In: Organic Farming and Sustainable Agriculture. *National Seminar, G.B.PUAT, Pantnagar, p. 45*

Das, A.C. and Saha, D. (2007). Effect of Diazotrophs on mineralization of organic nitrogen in the rhizosphere soils of rice (*Oryza sativa* L.). *Journal of Crop Weed* **3**: 69-74.

Datta J K, Banerjee A, Sikdar M S, Gupta S and Mondal N K. (2001). Impact of combined exposure of chemical, fertilizer bio-fertilizer and compost on growth, physiology and productivity of *Brassica campestries*in old alluvial soil. *J. Environ. Biol*., 30: 797-800.

De P.K., and Mandal *(1956)* Soil Organic Matter and its Role in Crop Production *LN Soil Sci 81 453-458*

Densilin DM, Srinivasan S, Manju P, Sudha S (2011) Effect of Individual and Combined Application of Biofertilizers, Inorganic Fertilizer and Vermicompost on the Biochemical Constituents of Chilli (Ns - 1701). J Biofertil Biopestici 2:106. doi:10.4172/2155-6202.1000106

Dhanya V. Mathews, P. L. Patil and G. S. Dasog (2006) Effect of Nutrients and Biofertilizers on Yield and Yield Components of Rice in Coastal Alluvial Soil of Karnataka *Karnataka J. Agric. Sci.*,19(4): 799-803

Forgaste, OT and Babb. M.R. (1972).effect of vermicompost application on the soil properties nutrient availability,uptake and yield of rice DairySci.~ 55: 870-872.

García de Salamone, Luciana P. Di Salvo Jhovana S. Escobar Ortega,Paulo M. F. Boa Sorte, Segundo Urquiaga,Kátia R. S. Teixeira (2000) Field response of rice paddy crop to *Azospirillum* inoculation*:* physiology of rhizosphere bacterial communities and the genetic diversity of endophytic bacteria in different parts of the plants Plant and Soil

Garcia-Gil JC, Plaza C, Soler-Rovira P and Polo A. 2000. Long-term effects of municipal solid waste compost application on soil enzyme activities and microbial biomass. *Soil Biology and Biochemistry* 32 (13), 1907-1913.

Grigatti M, Giorgonni ME and Ciavatta C. 2007. Compost-based growing media: infuence on growth and nutrient use of bedding plants. *Bio resource Technol* 98, 3526-3534.

Hashem M A. (2001). Problems and prospects of cyanobacterial biofertilizer for rice cultivation.*Aust. J. Pl. Physiol.*, 28: 881-888.

Jayakrishnakumar, V. C. Vennila, C. Jayanthi and K. Nalini (1994).Nitrogen management in wet seed seed rice *Agric. Rev.*,28 (4): 270-276, 2007

K.K. Kapoor, K.S. yadav,D.P singh, M.M missira and P. Taruro (1983) Enrichment of compost by *Azotobacter* and phosphate solubilising microorganisms an international journal Agricultural Wastes, Volume 5, Issue 3, Pages 125-133

Kale, R. D. and Seenappa, S. N., 1992, Composting of City Solid Organic Waste. In: *Proc. Workshop on Biogas slurryUtilization.*Publ: CORT, pp. 1-6.

Kamil Prajapati, K. D. Yami, A. Singh (2008) Plant Growth Promotional Effect of *Azotobacter chroococcum*, *Piriformospora indica* and Vermicompost on Rice Plant Nepal Journal of Science and Technology > Vol 9 ISSN 1994-1412 Regd. No. 87/055/56 DAO/MOH/GON

Kamil Sabier Saeed, Sarkawt Abdulla Ahmed, Ismael Ahmaed Hassan and Pshtiwan Hamed Ahmed, 2015. Effect of Bio-fertilizer and Chemical Fertilizer on Growth and Yield in Cucumber (*Cucumis sativus*) in Green House Condition. *Pakistan Journal of Biological Sciences, 18: 129-134.*

Khan M. U., Qasim M. and Khan I. U. 2007. Effect of Integrated Nutrient Management on Crop Yields in Rice-Wheat Cropping System. *Sarhad J. Agric*. Vol. 23, No. 4.pp. 1020-1026.

Khursheed S., Arora S., and Ali T. 2013.Effect of Organic Sources of Nitrogen on Rice (*Oryza sativa L.*) and SoilCarbon Pools in Inceptisols of Jammu. Columbia International Publishing, *International Journal of Environmental Pollution and Solutions*.1: pp.17-21.

KoushalS.,Sharma A.K. and Singh A.2011. Yield Performance, Economics and Soil Fertility through Direct and Residual Effects of Organic and Inorganic Sources of Nitrogen as Substitute to Chemical Fertilizer in Rice-Wheat Cropping System. *Research Journal of Agricultural Science*, 43 (3), pp.189-193.

Kumar A., Meena R. N, Yadav L. and Gilotia Y. K. 2014. Effect of Organic and Inorganic Sources of Nutrient on Yield, Yield Attributes and Nutrient Uptake of Rice. Rice, Cv. Prh-10.*International Quarterly Journal of Life Science.* 9(2): 595-597.

Larijani B. A. and Hoseini S.J. 2012.Comparison of Integrated Chemical and Organic Fertilizer Management on Rice Growth and Yield under System of Rice Intensification (SRI).*International journal of AgronomyandPlant Production.* Vol. 3 (S): pp.726-731.

M. Tejada and J. L. González (2009) Application of Two Vermicomposts on a Rice Crop: Effects on Soil Biological Properties and Rice Quality and Yield American Society of Agronomy Vol. 101 No. 2, p. 336-344

M.Kannahiand R.Ramya (2015), Effect of biofertilizer, vermicompost, biocompost and chemical fertilizer on different morphologica land phytochemical parameter of lycopersicum.*world journal of pharmacy and pharmaceutical sciences* vol 4,Issue 09 , 1460-1469

MacRae IC and Castro TF (1969) Nitrogen Fixation in Bacteria and Higher Plants *Soil Sci103* 277

Malik, K. A., Mirza, M. S., Hassan, U., Mehnaz, S., Rasul, G., Haurat, J., ... & Normand, P. (2002). The role of plant-associated beneficial bacteria in rice-wheat cropping system. *Biofertilisers in action. Rural industries research and development Corporation, Canberra*, 73-83.

Malliga P and Subramanian G. (2002). Cyanobacteria bio-fertilizer for sustainable agriculture.Bioinoculants for Sustainable Agric. & Forestry, p. 99-106.

Martin, G.J.,2000. Intergrated nitrogen management of lowland transplanted rice of west zone of timalnadu*madras agric.j*.,86:542-546

Md Adbul Kader and *Mymensingh* (2001) Effects of Azotobacter inoculation of rice and nutrient status of post harvest soil, University of the Philippines at Los Baños

Mohammad Abdus Sattar,Mohammad Fazlar Rahman, Dipak Kumar Das, and Abu T.M.A. Choudhury (2014) prospect of using azotobactor, azospirillum and cyanobacteria as supplement of urea in rice production in Bangladesh..Researchgate.net/publication/242181320 November 2010, Volume 336, Issue 1, pp 351–362

Okon, Y. (1995). Azospirillum as a potential inoculant for agriculture. Trends in Biotechnology. 3, 223-228.

Pandey, A. and Kumar, S.J. 1989. Soil beneficial bacterial and their role in plant growth promotion. *Science Indian Research* 48: 134-144.

Pankaj Singh, Sobaran Singh and A. K. Chaubey (2006) Effect of INM on soil fertility, nutrient uptake and yield in rice *Internat. J. agric. Sci. Vol.2 No.2: (613-617)*

Prajapati, K., Yami, K. D., & Singh, A. (2008). Plant growth promotional effect of Azotobacter chroococcum, Piriformospora indica and vermicompost on rice plant. *Nepal Journal of Science and Technology*, *9*, 85-90.

Prasad R C and Prasad B N (2001).Cyanobacteria as a source Biofertilizer for sustainable agriculture in Nepal.*Journal in Plant Science BotanicaOrientalis*127-133.

Prasad, B.N. and Mehrotra, R.K. (1979): Cyanophycean flora of some North Indian crop fields. *Geophytology*9(2): 147-157.

Puertas, A., Gonzales, L.M. 1999. Aislamiento de cepas nativas de *Azotobacter chroococcum* en la provincia Granmay evaluacion de su actividad estimuladora en plantulas de tomate. Cell. Mol. Life Sci., 20: 5-7.

Rani and Srivastava **(**1997**)''**role of vermicompost in sustainable agriculture'' *arccjournals.com articles/ar251003*

Ranjitha P. Sri., Kumar R. M., and Jayasree G.2013.Evaluation of Rice (*Oryza sativa* L.)Varieties and Hybrids inRelation to Different Nutrient Management Practices for Yield, Nutrient Uptake and Economics in SRI.Annals of Biological Research. 4 (10):25-28.

Rao, V. R., Jena, P. K., & Adhya, T. K. (1987). Inoculation of rice with nitrogen-fixing bacteria—problems and perspectives. *Biology and fertility of soils*, *4*(1), 21-26.

Reddy, T. Y., & Wall, R. J. (1988). Axial compression of foam-filled thin-walled circular tubes. *International Journal of Impact Engineering*, *7*(2), 151-166.

Roychowdhury D, Mondal S, Banerjee SK (2017) The Effect of Biofertilizers and the Effect of Vermicompost on the Cultivation and Productivity of Maize - A Review. Adv Crop Sci Tech 5: 261. doi: 10.4172/2329-8863.1000261

Sarwar, G. 2005. Use of Compost for Crop Production in Pakistan. Okologie und Umweltsicherung Germany. 26.pp: 1-203.

Sathish, A., Govinda Gowda V., Chandrappa, H. & Nagaraja Kusagur.2011. Long Term Effect of Integrated Useof Organic and Inorganic Fertilizers on Productivity, Soil Fertility and Uptake of Nutrients In Rice &Maize Cropping System. International Journal of Science and Nature. Vol. 2(1) 2011: 84-88.

Satyanarayana V., Murthy V. R. K., Vara Prasad P. V. and Boote K. J.2002. Influence of Integrated Use of Farmyard Manure and Inorganic Fertilizers on Yield and Yield Components of Irrigated Lowland Rice.*Journal of Plant Nutrition*. Vol. 25, No.10, pp. 2081-2090.

Singh, A.P., Mittra, B.N. and Tripathi, R.S. 1999. Effect of soil enrichment in conjunction with organics and chemical fertilizer on rice (*Oryza sativa*)-chickpea (*Cicerarietinum*) cropping system. *Indian J. Agron*. 44(2): 223-227.

Singhl A. K., Bisen J. S., Bora D. K., Kumar R. and Bera B. 2011. Comparative Study of Organic, Inorganic andIntegrated Plant Nutrient Supply on the Yield of Darjeeling Tea and Soil Health. Two and A Bud 58:58-61.

Sturz, A.V., Christie, B.R., Nowak J. 2000. Bacterial Endophytes: Potential Role in Developing Sustainable Systems of Crop Production. Critical Reviews in Plant Sciences, **19**: 1-30.

Swarup, A. and N.P.S. Yaduvanshi, 2000.Effect of integrated nutrient management on soil properties and yield of rice in Alkali soils. *J. In. Soc. Soil Sci.,* 48: 279-282.

Virdia H.M. and Mehta H.D. 2009. Integrated Nutrient Management in Transplanted Rice (*Oryza sativa L.*).Journal of Rice Research, Vol.2, No.2.pp.99-104.

Wani, S P and Shinde, P A and Konde (2011) *Response of rice (Oryza sativa L.) to Azotobacter inoculation.* Current Research, 5 (12). pp. 209-210.

Wani, S. A. (2012). *Effect of balanced NPKS, biofertilizer (Azotobacter) and vermicompost on the Yield and Quality of Brown sarson (Brassica rapa L.)* (Doctoral dissertation, M. Sc thesis, Sher-e-Kashmir University of Agriculture Sciences and Technology, Kashmir, Srinagar).

Watanabe A, KAUSHIK B D and Konishi C (2013). Developments in CyanobacterialBiofertilizer*Proc Indian NatnSciAcad*80 No. 2 June 2014 Spl. Sec. pp. 379-388*Nature 108 (1951) 748*

Watanabe I and Cholitkul W (1979).*Nitrogen and Rice, IRRI Pub Los Banos Philippines*

Zhihua Bao, Kazuhiro Sasaki, Takashi Okubo, Seishi Ikeda, Mizue Anda, Eiko Hanzawa, Kaori Kakizaki, Tadashi Sato, Hisayuki Mitsui and Kiwamu Minamisawa (2013), Impact of *Azospirillum* sp. B510 Inoculation on Rice-Associated Bacterial Communities in a Paddy Field Microbes Environ. 2013 Dec; 28(4): 487–490.

Appendix-1

Detail of cultural operations at research trial during crop cycle from June to November, 2016

Table A-1: Detail of cultural practices in rice research trial

Date	Operation preformed
06June 2016	field preparation
07 June 2016	making of plots
08 June 2016	Pre Sowing irrigation
15 June 2016	seed Soaking and seed treatment
16 June 2016	sowing of direct-seeded rice
17 June 2016	Application of herbicide
20 June 2016	Irrigation
7 July 2016	application of fertilizers (Urea)
11 July 2016	post-emergence herbicide spray
28 July 2016	2ndapplication of fertilizers (Urea)
18 Aug 2016	3rdapplication of fertilizers (Urea)
20Aug 2016	Application of insecticide
5 Sep 2016	Application of fungicide
25 Nov 2016	Harvesting and threshing

Appendix-2

Table A-3: Standard chart to determining the fertility status of the experimental soil.

Parameters	Low	Medium	High
Soil pH	<6.0	6.0-8.7	>8.8
Organic matter (%)	<0.4	0.4-0.75	>0.75
Available N (%)	<0.10	0.1-0.2	>0.2
Available P_2O_5 (Kg/ha)	<30	30-55	>55
Available K_2O	<110	110-280	>280

Appendix-3

ANOVA

				Sum of Squares	df	Mean Square	F	Sig.
Replications	Between Groups	(Combined)		.296	8	.037	.040	1.000
		Linear Term	Contrast	.089	1	.089	.096	.760
			Deviation	.207	7	.030	.032	1.000
	Within Groups			16.667	18	.926		
	Total			16.963	26			
Height-30 DAS	Between Groups	(Combined)		115.683	8	14.460	7.400	.000
		Linear Term	Contrast	72.708	1	72.708	37.208	.000
			Deviation	42.975	7	6.139	3.142	.024
	Within Groups			35.173	18	1.954		
	Total			150.856	26			
Height-45 DAS	Between Groups	(Combined)		242.199	8	30.275	5.547	.001
		Linear Term	Contrast	169.362	1	169.362	31.031	.000
			Deviation	72.837	7	10.405	1.906	.128
	Within Groups			98.240	18	5.458		
	Total			340.439	26			

Height-60 DAS	Between Groups	(Combined)		104.320	8	13.040	4.500	.004
		Linear Term	Contrast	47.844	1	47.844	16.510	.001
			Deviation	56.476	7	8.068	2.784	.038
	Within Groups			52.160	18	2.898		
	Total			156.480	26			
Height-75 DAS	Between Groups	(Combined)		11946.677	8	1493.335	1.000	.469
		Linear Term	Contrast	41.857	1	41.857	.028	.869
			Deviation	11904.820	7	1700.689	1.139	.383
	Within Groups			26887.966	18	1493.776		
	Total			38834.643	26			
Tillers-30 DAS	Between Groups	(Combined)		23.301	8	2.913	7.123	.000
		Linear Term	Contrast	13.448	1	13.448	32.889	.000
			Deviation	9.853	7	1.408	3.442	.016
	Within Groups			7.360	18	.409		
	Total			30.661	26			
Tillers-45 DAS	Between Groups	(Combined)		21.052	8	2.631	1.275	.316
		Linear Term	Contrast	4.171	1	4.171	2.021	.172
			Deviation	16.881	7	2.412	1.169	.368
	Within Groups			37.147	18	2.064		
	Total			58.199	26			

Tillers-60 DAS	Between Groups	(Combined)		38.607	8	4.826	11.272	.000
		Linear Term	Contrast	19.734	1	19.734	46.092	.000
			Deviation	18.873	7	2.696	6.297	.001
	Within Groups			7.707	18	.428		
	Total			46.314	26			
Tillers-75 DAS	Between Groups	(Combined)		116.607	8	14.576	19.560	.000
		Linear Term	Contrast	57.574	1	57.574	77.261	.000
			Deviation	59.034	7	8.433	11.317	.000
	Within Groups			13.413	18	.745		
	Total			130.021	26			
Leaves-30 DAS	Between Groups	(Combined)		96.741	8	12.093	7.593	.000
		Linear Term	Contrast	49.089	1	49.089	30.823	.000
			Deviation	47.652	7	6.807	4.274	.006
	Within Groups			28.667	18	1.593		
	Total			125.407	26			
Leaves-45 DAS	Between Groups	(Combined)		136.827	8	17.103	2.667	.040
		Linear Term	Contrast	99.756	1	99.756	15.554	.001
			Deviation	37.071	7	5.296	.826	.579
	Within Groups			115.440	18	6.413		
	Total			252.267	26			

Leaves-60 DAS	Between Groups	(Combined)		104.243	8	13.030	4.278	.005
		Linear Term	Contrast	60.552	1	60.552	19.880	.000
			Deviation	43.691	7	6.242	2.049	.104
	Within Groups			54.827	18	3.046		
	Total			159.070	26			
Leaves -75 DAS	Between Groups	(Combined)		137.333	8	17.167	9.436	.000
		Linear Term	Contrast	65.522	1	65.522	36.016	.000
			Deviation	71.811	7	10.259	5.639	.001
	Within Groups			32.747	18	1.819		
	Total			170.080	26			
1000 Grain weight	Between Groups	(Combined)		53.892	8	6.737	56.124	.000
		Linear Term	Contrast	31.912	1	31.912	265.866	.000
			Deviation	21.980	7	3.140	26.161	.000
	Within Groups			2.161	18	.120		
	Total			56.053	26			
Grain per panicle	Between Groups	(Combined)		486.294	8	60.787	64.883	.000
		Linear Term	Contrast	341.193	1	341.193	364.184	.000
			Deviation	145.101	7	20.729	22.126	.000
	Within Groups			16.864	18	.937		
	Total			503.158	26			

Panicle per plant	Between Groups	(Combined)		105.201	8	13.150	21.337	.000
		Linear Term	Contrast	60.089	1	60.089	97.500	.000
			Deviation	45.112	7	6.445	10.457	.000
	Within Groups			11.093	18	.616		
	Total			116.294	26			
Panicle length	Between Groups	(Combined)		60.453	8	7.557	65.605	.000
		Linear Term	Contrast	41.184	1	41.184	357.550	.000
			Deviation	19.269	7	2.753	23.898	.000
	Within Groups			2.073	18	.115		
	Total			62.527	26			
Grain yield per plot	Between Groups	(Combined)		5.814	8	.727	62.746	.000
		Linear Term	Contrast	4.576	1	4.576	395.118	.000
			Deviation	1.238	7	.177	15.265	.000
	Within Groups			.208	18	.012		
	Total			6.022	26			
Harvesting index	Between Groups	(Combined)		223.847	8	27.981	37.943	.000
		Linear Term	Contrast	184.976	1	184.976	250.834	.000
			Deviation	38.871	7	5.553	7.530	.000
	Within Groups			13.274	18	.737		
	Total			237.121	26			