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Comparative Study on Effect of Bio-Fertilizers and Chemical Fertilizers on Growth, Development and Yield of Paddy Crop (*Oryza sativa)*

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KEYWORDS

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ABSTRACT:

In response to rapidly increasing global human population from 6.1 billion in 2000 to 8 billion in 2022, global demand of food and food security is multiplying by folds every year. Factors like deforestation, land pollution, rapid urbanization etc. also leads to the availability of land available for agriculture. To cope with the increasing demand of food products, agricultural end products i.e pulses, grains, fruits, vegetables, oil seeds etc. farmers are dependent on synthetic/chemical fertilizers, these chemicals provide the plants with nutrients which boosts their growth and yield. These nutrients are naturally available in the soil but with time and when crops are grown on same patch of land again and again without following practices like crop rotation, these nutrients get depleted. These synthetic fertilizers, pesticides & herbicides have adverse effect on physiological properties of the soil i.e reduced soil fertility, soil pH imbalance, depletion of beneficial microorganisms etc. Rain, flooding of fields often washes away the applied agrochemicals into the fresh water bodies causing water pollution. There is no doubt in the fact that these chemical fertilizers do increase the growth and development of the crops but at the cost of environment. Compared to these agrochemicals biofertilizers are better alternative, Biofertilizers are living or dormant microbes that promote the growth, development and yield of the crops when applied in the soil and do not have any harmful effects like that of agrochemicals. They do boost the growth and development of the crops by use of mechanisms like nitrogen fixation, siderophore production, potassium solubilization, phytohormone production, phosphate solubilization etc. Biofertilizers are also capable of inducing plant growth promoting activities even under the biotic and abiotic stresses, they also provide resistance against many diseases by producing antibiotics. This research compares the effect of biofertilizers and chemical fertilizers on growth, development, yield of crops and also conc. Of nutrients and micronutrients of the obtained end product i.e fruit, grains.

1. Introduction

Agriculture being one of the most important human activities has been practiced for food production by rearing cattle and growing crops for centuries. Traditional agricultural activities play an important role in fulfilling the food demands of exponentially growing population of humans around the globe, with this increasing population agriculture land also decreasing day by day, which lead to increasing dependence of farmers on Chemical Fertilizers and pesticides to meet the demand [1]. Chemical fertilizers are industrially manipulated, substances which are composed of Nitrogen(N),Phosphorus(P) and Potassium(K) in known quantities, over exploitation of these chemical fertilizers is responsible for Air pollution , water pollution , disturbance in pH of soil and also causes harm to humans if consumed [2]. To prevent all these harmful effects and to achieve to goal of increasing production and yields of crops better alternatives like Biofertilizers were introduced, which not only increases the production and yield but also causes no effect to the ecosystem. [3]

Microbes associated to soil and plants have a crucial role in ecosystem by carrying several biogeochemical processes and cycles and also degradation of organic matter. It is one of many reasons that biofertilizers are considered as a better alternative to chemical fertilizers

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and a hope for sustainable agriculture and conserving and maintaining soil health and fertility. [4].

Microbes and bacteria residing in the rhizosphere are crucial to the soil fertility. They help in aggregation of soil, moisture retention and microbial growth proliferation. They do acts as potassium solubilizers, phosphorus mobilizers and nitrogen fixers. Some of them are capable of converting organic matter into simpler forms and act as decomposers. Apart from it they also produces various hormones & anti metabolites which helps in the growth of the roots, and when inoculated with soil or seed these microbes boosts the growth by about 16 to 27%.

On an average they are known to increase crop yield by 17 to 35%, algae when used as a biofertilizer proved to be useful as it was able to improve yield of rice bby 15 to 40% [14]. Microbial colonization of these fertilizers in the plant roots induces drought tolerance by improving the water and turgor potential, apart from it, it also improves the soil profile and plant growth without side effects [5].

In cereal crop like Oryza sativa inoculation of microbes like Azotobacter, Azospirillum, Azolla and Rhizobium as a biofertilizer provided results which showed changes that showed improvement in the root morphology. Azotobacter has a vital role biological nitrogen cycle because it possesses certain metabolic functions. Not only this but azotobacter produces vitamins such as thiaine and riboflavin, and plant hormones like Indole Acetic Acid, Gibberellins and Cytokinin[10]. It's inoculation alters morphology of root by producing plant growth regulating substances via siderophore production, increase in number of lateral roots & enhancement in formation of root hairs to absorb sufficient nutrients [11]. Inoculants with rhizobium as a main microbe were found to be increasing the production of cereal crops by releasing specific hormones and increasing photosynthetic performance of crops.

Objective

- Collecting different types of biofertilizers that can be used for paddy along with synthetic fertilizers.
- Growing paddy in different isolated patches of land and treating it with biofertilizers and synthetic fertilizers.
- Evaluation and comparison of total growth and yield of paddy treated with biofertilizers and synthetic fertilizers.
- Analyse and comparison of the nutritional content of grains produced by the enhancement of biofertilizers and chemical fertilizers.

2. Material and Methods

The experiment was conducted at Agricultural Farms dist. Kathua, Jammu and Kashmir in 2022 Kharif season. Below mentioned is the method used for biofertilizer application, similarly NPK(12:32:16) was used for chemical fertilizer treatment instead of biofertilizer inoculation and biofertilizer application. In the third field none of the enhancements were used.

3. NURSERY

a) Forming seedbeds:-

i. 3 Plots length 5m and breadth 4 meters were marked, with 30cm wide channels around it.

ii. Puddled soil was collected from the channels and was spread on the seedbed.

iii. Levelling of surface of seedbed, to allow water to drain into the channel.

iv. Preparing a mixture of 40grams of Azospirillum, 40gm Phosphobacter, 2 kg of organic manure and 1kg soil by mixing them in a container and then spreading the mixture over the seed beds.

b) Seed treatment

i. Preparing an inoculum by mixing 20gm Azospirillum,20gm Phosphobacter, 1kg soil, 2.5 kg organic manure and water.

ii. 2 kg rice seeds were soaked overnight in the inoculum overnight ~ 8 hours.

iii. Seeds were then sown in the seed beds followed by pouring the remaining slurry of the prepared inoculum in the seedbeds having sufficient water.

c) Water management:-

i. After 24 hours of sowing, water was drained out.

ii. Appropriate care was taken to prevent stagnation of water in the seedbed.

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iii. Water was allowed to saturate in the soil after 3 days of sowing to day 5, after 5th day water level was increased and water level was maintained at 2.5cm afterwards.

d) Nursery - Nutrient Management:

i. Decomposed farm yard manure was applied and was spread uniformly over the soil.

4. MAIN FIELD

a) Land preparation: -

i) 8000 square feet land was ploughed for transplantation and further growing the crop.

ii) field was flooded 4 days prior to ploughing and after field surface was covered with water.

b) Pulling out the seedlings:

i) Seedlings were pulled out form the nursery after they attained the 4th leaf stage.

c) Seedling Treatment:

i) Azospirillium inoculum was prepared by mixing 4kg farmyard manure and 200grams azospirillium in it, later water was added to make a slurry.

ii) Seedlings after being pulled were kept in a container containing the slurry, in a way that it's roots were submerged in the inoculum slurry for about 30 minutes before transplanting.

iii) seedlings were transplanted in the main field after soaking their roots for 30 minutes.

d) Biofertilizer application

i. 10kg soil based blue green algae flakes were broadcasted 10 days after day of transplantation and water level was maintained for its multiplication.

ii. Azolla was raised as a dual cropRaise azolla as a dual crop by inoculating 2.5 kg/6000 sq.m and afterwards incorporating it weeding.

iii. Afterwards 2kg Phosphobacteria, 2kg Azospirillium and 4kg azophos inoculants with 25 kg farm yard manure were mixed and then broadcasted uniformly in the main field before transplantation of crops, pseudomonas fluorescens 2.5kg was mixed with 5 kilo farm yard manure and 5 kg of soil and was uniformly broadcast in the main field prior to transplanting.

e) Harvesting

i. When 75% of rice panicles turned into straw brown color, the crop is almost ready to be harvested and water was drained at this stage.

ii. after 85% of the total crop panicles turned brown straw colour, the crop is matured and is ready to be harvested.

iii. Maturity was confirmed after dehusking a few grains from the most matured tillers, and rice was found to be firm and clear, which means it is in it's hard dough stage and it's maturity is further confirmed.

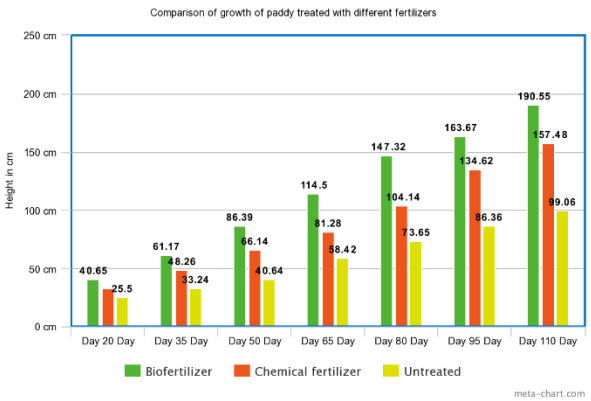
iv. Crops were harvested most of the grains were at hard dough stage, crops were harvested and grains were threshed and winnowed.

v. Grains were then dried.

5. Results and Discussion

Comparison of height/growth –

At intervals of 15 days since the day of sowing average height of paddy plants were noted by taking 15 plants at random and measuring their height then finding it's average.



Comparison of yield

A total of thirty intact plants were randomly selected from batch of biofertilizer treated and chemical treated and then average number of grains produced by each was calculated.

$$\text{Average number of grains} = \frac{\text{Grains by plant 1 + grains by plant 2 by plant 30}}{30}$$

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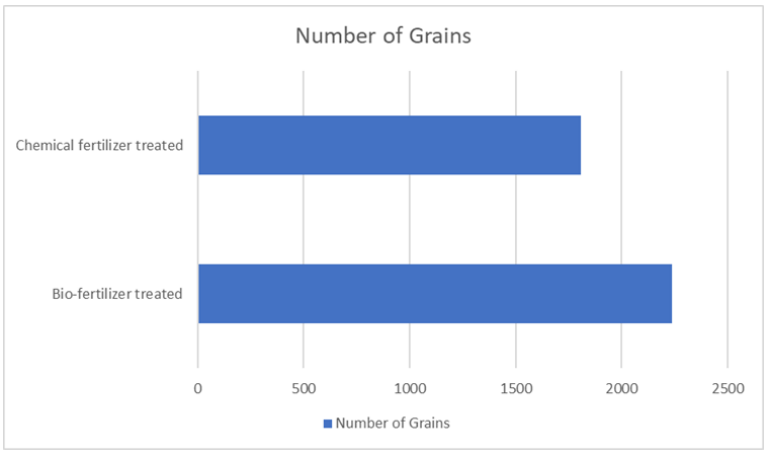

Comparison of concentration of different chemicals and nutrients.

For this samples of grains were sent to Equinox Lab for testing of their nutritional content.

S.No	Parameter	Method	Conc. In biofertilizer treated crops (mg/100g)	Conc. In chemical fertilizer treated crops (mg/100g)
1	Potassium (K)	By FSSAI manual for cereal and cereal products(8.7) : 2016 By FSSAI manual for cereal and cereal products(8.7) : 2016	189.36	77.73
2	Phosphorus (P)	By FSSAI manual for oil and oil products(34.0) : 2016	183.24	159.38
3	Nitrogen (N)	By FSSAI manual for cereal and cereal products(8.7) : 2016	1.66	1.34
4	Sulphur (S)	JAOCS	0.6	15.0
5	Copper(Cu)	By FSSAI manual for cereal and cereal products(8.7) : 2016	0.49	0.23
6	Zinc (Zn)	By FSSAI manual for cereal and cereal products(8.7) : 2016	2.61	1.94
7	Magnesium (Mg)	By FSSAI manual for cereal and cereal products(8.7) : 2016	94.55	35.71

6. Conclusion

With this experimentation it is concluded that Biofertilizers are a better alternative to chemical fertilizers and do boost the yield of the crops farther than chemical fertilizers. They increase crop growth, development and yield by the help of methods like nitrogen fixation, phosphorus and potassium solubilization etc., ultimately by increasing the concentration of such important macronutrients in the soil, which was further confirmed by the increased concentration of nitrogen, potassium and phosphorus in the grains of crops produced by treatment with biofertilizers. It is also evident that biofertilizers improve the growth as plants treated with biofertilizers had higher growth rate and after maturation their overall height was taller than that of chemical fertilizers by 22.29%. Apart from it biofertilizers also increased the yield of rice crops

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in comparison to chemical fertilizers treated plants by 22.41%, and concentration of essential nutrients and micronutrients were higher in grains produced from crops treated with biofertilizers in comparison to that treated with chemical fertilizers which tells us that there is increased uptake of nutrients in crops treated with biofertilizers as they increase the concentration of these nutrients and micronutrients in the soil naturally, these grains are more health to consume as compared to others as they are rich in nutrients. Not only this but biofertilizers also improved the soil quality by converting insoluble complexes into soluble forms. Grains treated with biofertilizers had lower conc. Of harmful Sulphur in comparison to that of chemical treated rice, this shows us that biofertilizers not only improve the growth development, and nutritional content of plants but also reduces the conc. Of such compounds in produced crops by bioremediation.

Conflict of interest

There is no conflict of interest between authors.

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