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Novel Utilization of Biofertilizers in the Crop and Oil Improvement

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Abstract

The study was carried out to investigate the yield and soil quality of wheat (Triticum aestivum L.) and moong (Vigna radiate L.) crop. In order to obtain high precision in the results of the present investigation, the research trials were conducted for two consecutive years 2008-09 and 2009-10 under field conditions at Artoni (Agra) site. The experiment was laid out in RBD with five microbes (Azospirillum, Azotobactor, PSB, Azolla and Rhizobium) and four levels (120 & 60 kg N for wheat and 25 & 10 kg N for moong crop) of nitrogen. The results of this experiment proved that T_2 treatment (Azospirillum +60 kg N ha^{-1}) showed best treatment during both the years for wheat crop and in moong crop, the growth and yield parameters i.e. plant height, no. of branches plant^{-1} no. of pods plant^{-1}, pod length and grain yield were observed and treatment T_7 (Rhizobium +10 kg N ha^{-1}) was found to be better combination than others. The soil in respect to its physico-chemical properties showed an improvement due to the use of biofertilizers when compared to control and farmers practice.

Keywords : Biofertilizer, Triticum aestivum L. Vigna radiata L., Azospirillum, Azotobactor, PSB, Azolla and Rhizobium.

Introduction

Increased attention is now being paid to developing an Integrated Plant Nutrition System (IPNS) that maintain or enhances soil productivity through balanced use of all sources of nutrients, including chemical, organic and bio-fertilizer. **Integrated nutrient management (INM)** refers to maintenance of soil fertility and plant nutrient supply to an optimum level for sustaining the desired crop productivity through optimization of the benefits from all possible sources of plant nutrients in an integrated manner. Therefore, it is a holistic approach where we first know what exactly is required by plants for optimum level of production, in what different forms at what different timings in best possible method, and how best these forms can be integrated to obtain highest productivity levels with efficiency at economically acceptable limits in environmental friendly way.

Among organic inputs bio-fertilizers, more commonly known as microbial inoculants, are artificially multiplied cultures of certain soil organisms that can improve soil fertility and crop productivity. Hence, the cultured microorganisms packed in some carrier material for easy application in the field are called "Bio-fertilizers". These are capable of mobilizing nutritive elements from non-available forms to available form through biological processes.

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Biofertilizers contained 3.5% - 4% nitrogen, 2% - 2.5% phosphorus and 1.5% potassium. In terms of N: P: K, it was found to be superior to farmyard manure and other type of manure (Mukhopadhyay, 2006). Microorganisms used as Biofertilizers are- Azospirillum, Azotobactor, PSB, Azolla and Rhizobium.

Azotobactor s is the free living aerobic, photo autotrophic, non-symbiotic bacteria. They secretes vitamin-B complex, gibberellins, napthalene, acetic acid and other substances that inhibit certain root pathogens and improves root growth and uptake of plant nutrients. Azotobacter sp. can also produce antifungal compounds to fight against many plant pathogens. The application of Azotobacter resulted significantly in higher number of seeds/siliquae, branches/ plant and the length of siliquae in Indian mustard (Shukla et al., 2002).

Azospirillum is the gram negative, free living, associative symbiotic and non-nodule forming, aerobic bacteria, occurs in the roots of dicots and monocot plants i.e. corn, sorghum, wheat etc. It is easy to culture and identify. Azospirillum is found to be very effective in increasing 10-15% yield of cereal crops and fixes N_2 upto 20-40% Kg/ha. It is, an aerophilic bacterium, which has an oxidative type of metabolism and can use nitrate as an alternative electron acceptor (Alexandre et al., 2000). Chemotaxis may play an important role in bringing the bacteria in close proximity of the roots by sensing the chemical compounds released by the roots (Greer-Philips et al., 2004).

Phosphate Solubilizing Microorganisms help to convert insoluble inorganic phosphate into simple or soluble forms for use by crops. They reduce the pH of soil by producing various types of organic acids in the soil. In such conditions, insoluble fixed phosphate changes in to soluble free phosphate which is readily available for plants. Release of P by PSB from insoluble and fixed/adsorbed forms is an import aspect regarding P availability in soils. Microbial biomass assimilates soluble P and presents it from adsorption or fixation (Khan and Joergesen, 2009).

Azolla is a free floating, aquatic fern found on water surface having a cyanobacterial symbiont Anabaena- azollae in their leaves. It fixes atmospheric nitrogen in paddy field and excrete organic nitrogen in water during its growth and also immediately upon trampling. Peoples et al., (1995) estimated that Azolla can fix 22-40 kg N ha^{-1} per month, while driving 52-99% of its nitrogen from the atmosphere.

Rhizobium is the most important nitrogen fixing gram - negative soil bacteria. It forms a symbiotic association with leguminous plants to form nodules in the roots of host plant. These nodules are the sites of nitrogen fixation. Active nodules contain a red pigment called leghaemoglobin. When rhizobial culture is inoculated in field, pulse crops yield can be increased due to rhizobial symbiosis (Dubey, 2001). Rhizobium can fix 15-20 N/ha and increase crop yield upto 20%.

Triticum aestivum L. (Wheat), a member of family Poaecae, is most important cereal crop of the world. Firstly, wheat is cultivated on 240 million hectares in each year, an area bigger than that of any crop, secondly, wheat delivers more calories and more protein in the world's diet than any other food crop, thirdly, world trade in wheat exceeds than all other grains together (Hansom et al., 1994). It is a long day winter crop, which thrive best in temperate zones.

Vigna radiata L. (Green gram) belongs to family Leguminacae and subfamily Paplionacae. Green gram is best suited to areas having an annual rainfall of 60-75 cm. A well drained loamy to sandy loam soil is best suited for moong cultivation unusually grown on low to medium elevations in the tropics as a rain fed crop (Ahmad and Jan, 2002).

The aim of the study was to evaluate the novel utilization of biofertilizers in the crop and soil improvement under environmental conditions. Biofertilizers have been used as sources to improve plant nutrients in sustainable agriculture.

Materials and Methods

The experiment was laid out in a Randomized Block Design (RBD) with five microbes (biofertilizers) and two levels of nitrogen. The graded levels of nitrogen (120, 60, 25 and 10 kg ha^{-1}) were used for the preparation of different combinations with microbial fertilizers. Biofertilizers were applied through seed inoculation just prior to sowing.

Selected microbial fertilizers i.e. Azotobacter, Azospirillum, Phosphate Solubilizing Bacteria (PSB), Azolla and Rhizobium were obtained from Indian Agriculture Research Institute, New Delhi. All the biofertilizers except Azolla were obtained in powdery form and Azolla was grown in tubs.

Plot treatment to wheat crop-

T_0- Control (without treatment)

T_1- Farmers practice (N120: P60:K40 kg ha^{-1})

T_2- Azospirillum (Azs) + 60 kg N ha^{-1}

T_3- Phosphate Solubilising Bacteria (PSB) + 60 kg N ha^{-1}

T_4- Azotobacter (Azt) + 60 kg N ha^{-1}

T_5- Azs + PSB+ Azt + 60 kg N ha^{-1}

T_6- Azolla alone

T_7- Azolla + 60 kg N ha^{-1}

Treatment for Moong crop-

T_0- Control (without treatment)

T_1- Farmers practice (N25: P50:K25 kg ha^{-1})

T_2- Azospirillum (Azs) + 10 kg N ha^{-1}

T_3- Phosphate Solubilising Bacteria (PSB) + 10 kg N ha^{-1}

T_4- Azotobacter (Azt) + 10 kg N ha^{-1}

T_5- Azs + PSB+ Azt + 10 kg N ha^{-1}

T_6- Rhizobium (0.16 kg ha^{-1}) + 10 kg N ha^{-1}

T_7- Rhizobium (0.20 kg ha^{-1}) + 10 kg N ha^{-1}

Result and Discussion

Biofertilizers inoculation exhibited significant effects on the growth and yield attributes over uninoculated control and farmers practice. It was resulted that yield and growth parameters were increased at both the crops in experimental site. During the wheat crop experiment significant difference was observed in biofertilizers treatment regarding the plant height (cm), length of spike (cm), grain yield (t ha^{-1}), straw yield (t ha^{-1}), and harvest index (%) during both the years. The results of this experiment proved that T_2 treatment (Azospirillum +60 kg N ha^{-1}) showed best treatment during both the years(Table-1). Other biofertilizers also showed good results. Yadav et al. (2011) reported that Azospirillum, Azotobacter and PSB in combination with NPK resulted significant improvement in wheat germination and growth. It is evident from the results that the biofertilizers had a beneficial effect on growth, this may be attributed to the plant growth regulating substances such as IAA, GA and/ or cytokines which is produced by Azospirillum known to promote better growth (Rethati et al., 2000; Panward and Elanchezhian, 1999).

In moong crop, the growth and yield parameters i.e. plant height, no. of pods $plant^{-1}$, pod length and grain yield were observed and treatment T_7 (0.20 Rhizobium +10 kg N ha^{-1}) was found to be better combination than others (Table-2). Shanthi et al. (2004) reported that biofertilizers increased the no. of pods $plant^{-1}$ up to 20% over control. Rhizobium inoculation in moong bean increased no. of pods and seed yield (Ashraf et al., 2003; Bhuiyan, 2004).

The soil in respect to its physico-chemical properties showed an improvement due to the use of biofertilizers when compared to control and farmers practice. The pH (from 8.3 to 7.65) and EC (from 0.7 to 0.52) was decreased by the use of biofertilizers.

Percentage of organic carbon was found to be increased from 0.28 to 0.33% (Artoni) during the 2009-10. The nitrogen content and organic carbon (OC), available P_2O_5, K_2O of the soil increased from initial status of the soil due to the biofertilizers and increase in cropping intensity.

Soluble cations (Na^+, K^+, Ca^{++} and Ca^{++}+Mg^{++}) and Soluble anions (CO_3^{--}+HCO_3^-, SO_4^{--}) of the experiment showed that there was improvement in soluble cations and soluble anions of the experimental site. The above results are in agreement with the findings of Moyin et al. (2007) and Selvi et al. (2003).

Therefore, it might be concluded from the above findings that wheat – moong cropping system is found to be beneficial in terms of yield and economic parameters. Instead of recommended dose of chemical fertilizer, low dose of chemical fertilizer supplemented with biofertilizer can be recommended in order to reduce the amount of chemicals in wheat and moong fields to increase productivity in an ecological safe and more viable manner. The statistical analysis was done to evaluate the difference in the mean value among the different levels of treatments applied to wheat and moong crop.

Table :-1 GROWTH AND YIELD PARAMETERS OF WHEAT (Triticum aestivum L.)

T.NO.	Treatments	2008-09 (Mean Value) Pt. Height (120DAS)	Length of spike (120 DAS)	Grain yield	Straw yield (qha^{-1})	2009-10 (Mean Value) Pt Height (120DAS)	Length of (120 DAS)	Grain yield	Straw yield (qha^{-1})
T_0	Control	58.95	7.21	20	39.16	59.38	7.9	22.5	42.66
T_1	Farmer's practice	63.85	9.43	43.66	56	65.97	9.72	49.33	69
T_2	Azs+10 Kg N ha^{-1}	92.33	13.56	53.33	79.33	92.92	14.46	55.83	85.66
T_3	PSB+10 Kg N ha^{-1}	89.52	14.48	52.66	77.33	90.13	14.82	54.66	84.00
T_4	Azt+10 Kg N ha^{-1}	82.82	13.01	50.33	76.66	84.85	13.28	53.66	81
T_5	Azs+PSB+Azt +10 Kg N ha^{-1}	84.38	13.07	50.83	76	86.97	13.57	54.33	81.66
T_6	Azolla alone	72.83	11.41	48.83	66	74.21	12.35	51	75.66
T_7	Azolla +60 Kg N ha^{-1}	75.36	11.96	49.50	71.66	75.13	12.81	52.16	76.66
SD±	P	P=<0.001	P=<0.001	P=<0.001	-	P=<0.001	P=<0.001	P=<0.001	-

SD= Statistical Difference

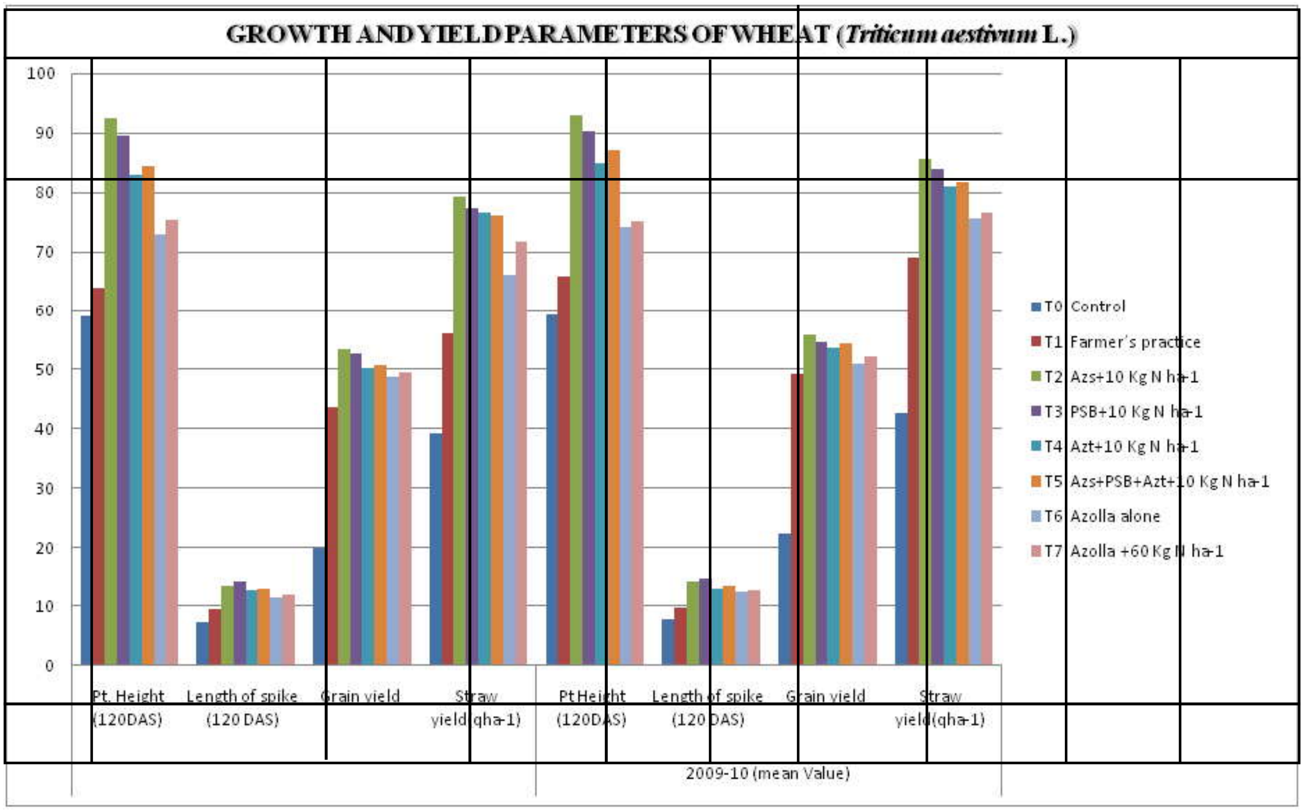
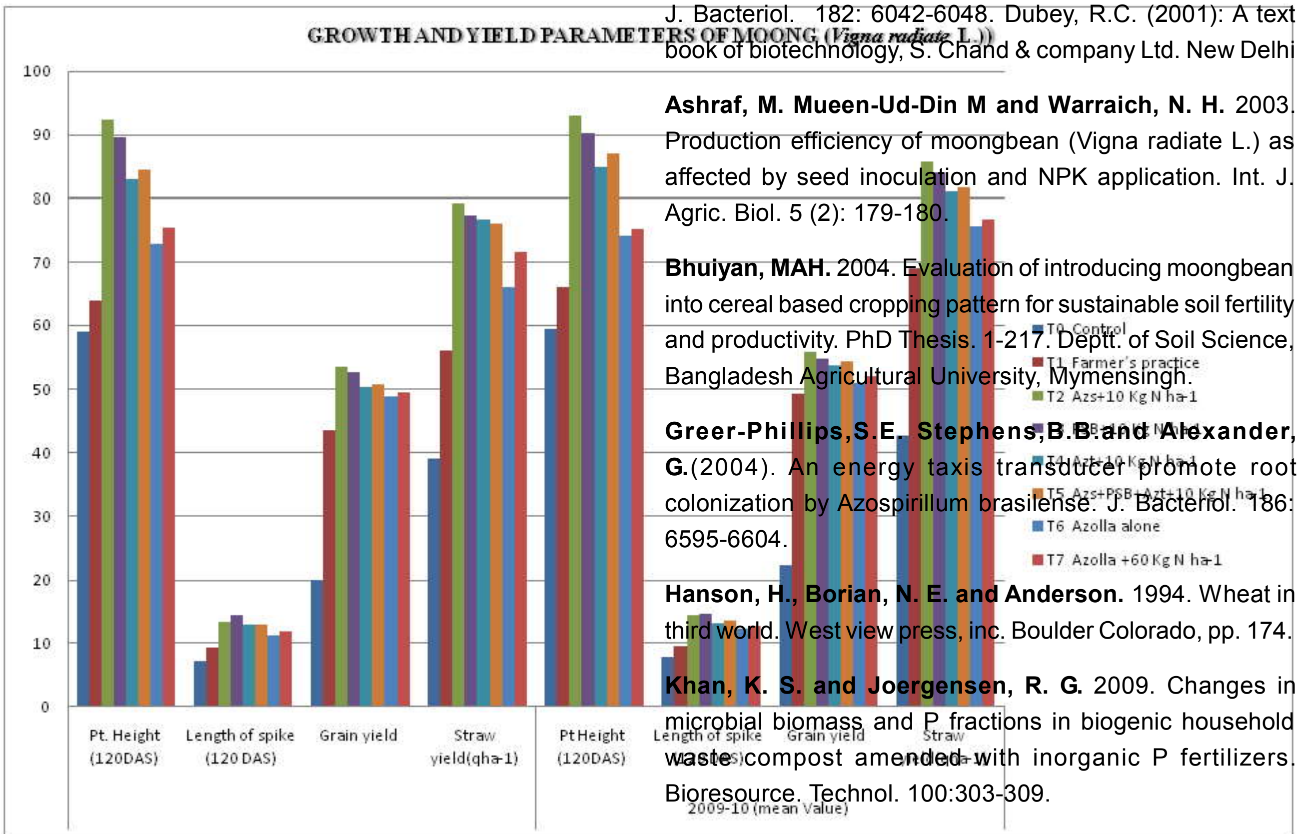


Table :-2 Growth and Yield Parameters of Moong (Vigna radiate L.)

T.NO.	Treatments	2008-09 (Mean Value) Pt. Height (120DAS)	Length of spike (120 DAS)	Grain yield	Straw yield (qha^{-1})	2009-10 (Mean Value) Pt Height (120DAS)	Length of (120 DAS)	Grain yield	Straw yield (qha^{-1})
T_0	Control	14.17	41.00	3.71	8.50	15.68	43.11	3.82	8.66
T_1	Farmer's practice	18.35	50.55	4.18	11.16	21.00	52.77	4.38	11.83
T_2	Azs+10 Kg N ha^{-1}	25.83	73.77	5.44	13.00	27.00	74.22	5.78	13.661
T_3	PSB+10 Kg N ha^{-1}	23.20	74.00	5.81	13.16	26.08	75.88	6.03	13.83
T_4	Azt+10 Kg N ha^{-1}	20.63	66.88	5.00	12.00	22.05	69.22	5.13	12.16
T_5	Azs+PSB+Azt+10 Kg N ha^{-1}	21.63	72.11	5.35	12.60	23.73	73.11	5.42	12.33
T_6	0.16Kg Rhizo. +10 Kg N ha^{-1}	27.11	78.44	6.84	14.00	29.14	79.00	6.88	14.66
T_7	0.20Kg Rhizo. +10 Kg N ha^{-1}	28.18	80.44	6.6	14.16	31.35	81.55	7.08	15.00
SD±	P	P=<0.001	P=<0.001	P=<0.001	-	P=<0.001	P=<0.001	P=<0.001	-

SD= Statistical Differene



References

Ahmad, I. and Jan, A. 2002. Food Legumes.In: Text Book of Agriculture. 219-24. New Millennium Edition Cropping Technology. National Book Foundation Islamabad.

Alexandre, G., Greer, S.E. and Zhulin, I. B. (2000). Energy taxis is the dominant behavior in Azospirillum brasilense. J. Bacteriol. 182: 6042-6048. Dubey, R.C. (2001): A text book of biotechnology, S. Chand & company Ltd. New Delhi

Ashraf, M. Mueen-Ud-Din M and Warraich, N. H. 2003. Production efficiency of moongbean (Vigna radiate L.) as affected by seed inoculation and NPK application. Int. J. Agric. Biol. 5 (2): 179-180.

Bhuiyan, MAH. 2004. Evaluation of introducing moongbean into cereal based cropping pattern for sustainable soil fertility and productivity. PhD Thesis. 1-217. Deptt. of Soil Science, Bangladesh Agricultural University, Mymensingh.

Greer-Phillips,S.E. Stephens,B.B.and Alexander, G.(2004). An energy taxis transducer promote root colonization by Azospirillum brasilense. J. Bacteriol. 186: 6595-6604.

Hanson, H., Borian, N. E. and Anderson. 1994. Wheat in third world. West view press, inc. Boulder Colorado, pp. 174.

Khan, K. S. and Joergensen, R. G. 2009. Changes in microbial biomass and P fractions in biogenic household waste compost amended with inorganic P fertilizers. Bioresource. Technol. 100:303-309.

Moyin-Jesu E. L. 2007. Use of plant residues for improving soilfertility, pod nutrients, root growth and pod weight of Okra. Nigeria. 98 (II):2057-64.

Mukhopadhyay, S.N. (2006): Ecofriendly products through process biotechnology in the provision of biotechnology economy-Recent advances. Technorama, A. Supplement to IEI News, March.

Panward, J. D. and R. Elanchezhian, 1999. Effect of 2, 4-D and Azospirillum brasilense on growth and yield in the nodule induced transplanted wheat. Indian J. of plant physiology. 3:143-146.

People, M. B., R. R. Gault, b. Lean, J. D. Sykes and J. Brockwell. 1995b. Nitrogen fixation by soybean in commercial irrigated crops of central and southern New South Wales. Soil. Bio. Biochem. 27: 553-561.

Rethati, B., Dallmann, K., Simon, I., and Balint, A. K. 2000. Characterization of Hungarian rice cultivars in nitrogen fixing associations with bacteria, Cereal Res. Communication. 28:9-16.

Selvi, D., Selvaseelan, A., Santhy, P. and Raj, K.B. 2003. Efficacy of mushroom spent rice straw compost as on organic manure substitute on potato dry matter yield and nutrient availability in laterite soils of Nilgiris. Ad. Plant Sci.