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Effect of Biofertilizers (N-Fixers) on the Yield of Rice Varieties at Puducherry, India

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Abstract: The aim of this study to evaluate three biological preparation on rice at Puducherry condition. The efficiency of biofertilizers (*Azospirillum* and BGA) in an integrated manner on few ruling rice varieties was experimented in Puducherry, UT, India in both upland and lowland conditions, during 2005-2006 for three seasons. The results proved that there was a gradual increase in the efficiency of biofertilizer and its compatibility with inorganic fertilizers. Significant difference in the soil fertility status (available N, P and K) and the soil biota has increased in the plots treated with the biologicals in the later stage (the third season).

Key words: *Azospirillum*, BGA, biofertilizer, Integrated Nutrient Management (INM), rice

INTRODUCTION

Sustainable crop yield can be obtained with efficient use of available land and water (Krol, 1999) and judicious integration of organic and mineral fertilizers (Singh *et al*., 2002). *Azospirillum*, BGA and *Azolla* multiply fast, decompose and substitute N fertilizers up to 25% of the total crop requirement (Patel, 1998) thereby play a vital role in promoting rice productivity (Gupta *et al*., 1989). Here in Puducherry rice has been cultivated for 3 seasons of an year using chemical fertilizers alone, which deteriorates the soil and induces more pests and diseases. Despite the fact that microbial inoculants have long been incorporated into field practices worldwide, most of them have been used and evaluated on the legumes and to a lesser extent on cereal crops (Hedge and Brahmaprakash, 1992; Fages, 1994; Tang and Yang, 1997; Bashan, 1998; Gnanamanickam *et al*., 2002). Hence, the current study was undertaken to evaluate three biological preparations on rice at Puducherry conditions.

MATERIALS AND METHODS

The present study focuses on the effect of *Azospirillum* and BGA with 25% replacement of N chemical fertilizer (individual and/or in combination) on the yield of ruling rice varieties, ADT 37, IET 1444, CO 47 (low land) and ADT 37, White Ponni and Chinna Ponni (up land system) in three cropping seasons during 2005-2006, namely, Spring-Summer (April-July), Autumn-Winter (August-January) and Winter-Spring (January-April) in Melsathamangalam and Sorapet villages of Puducherry where mono cropping (rice) is practiced. Recommended doses of P and K were applied basally after soil testing. The trials were carried out in a Randomized Block Design with four replications each and the treatment were as follows: T_1-Control; T_2 - 100% NPK through inorganic fertilizer; T_3 - 75% N through inorganic fertilizer; T_4- T_3 + *Azospirillum*; T_5 - T_3 + BGA; T_6 - T_3 + *Azospirillum* + BGA. Grain yield (kg/acre) and the soil fertility status (nutritional and microbial) were analyzed.

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RESULTS AND DISCUSSION

Effect of Biofertilizers on Grain Yield and Fertility Status in Lowland System

The results (Fig. 1) indicated that in the lowland system, in the initial stages (Spring-Summer), the inorganic fertilizer (100%) resulted in the highest yield (2088 kg/acre in ADT 37), compared to others. A slight change was observed in the second crop, where T_3 showed the highest yield followed by T_2 and T_4, with no significant difference between them. However, in Winter-Spring season the yield of CO 47 in T_6 was on par with T_2 and T_3 (1200, 1231 and 1193 kg acre^{-1}). It shows a gradual increase in the efficiency of biological and its compatibility with inorganic fertilizers. Similarly repeated usage of phosphobacteria along with inorganic fertilizers resulted in higher crop value (Santhi and Selvakumari, 1999). High level of NPK was observed before harvest but later the nutrients declined (Table 1). This opined with Chinnusamy *et al*. (2006) wherein the microbial inoculants, blue-green algae, phosphate-solubilizing bacterium, vesicular-arbuscular mycorrhizal fungus positively interacted with one another and resulted in significant improvement in yield and nutritional parameters. Application of biofertilizers also substantially improved soil (peat) fertility status by increasing the nitrogen (N), phosphorous (P) and organic carbon content in the paddy crop.

Table 1a: Nutritional status of soil at pre and post harvest stages

		Post harvest						
Component	Pre	T_1	T_2	T_3	T_4	T_5	T_6	CD ($p<0.05$)
N	57.0	58.0	70.0	67.0	64.0	63.0	67.0	NS
P	2.5^b	7.5^b	5.0^b	17.5^a	5.0^b	5.0^b	2.5^b	5.5
K	120.0	210.0	235.0	260.0	260.0	255.0	265.0	NS

Table 1b:

		Post harvest						
Component	Pre	T_1	T_2	T_3	T_4	T_5	T_6	CD ($p<0.05$)
N	190^a	74^b	105.0^b	88.0^b	77.0^b	81.0^b	100.0^b	38.8
P	15^a	10^b	2.5^c	2.5^c	2.5^c	2.5^c	2.5^c	4.4
K	430^a	170^b	170.0^b	150.0^b	150.0^b	160.0^b	145.0^b	179.8

Each value mean of 4 replicates, The common letter(s) shared in each row do not differ significantly as per DMRT at 5% level, (1a) Upland; (1b) Lowland; T_1: Control; T_2: 100% NPK Inorg. Ferti; T_3: 75% N Inorg. Ferti; T_4: 75% N Inorg. Ferti. + *Azospirillum*; T_5: 75% N Inorg. Ferti. + BGA; T_6: 75% N Inorg. Ferti. + *Azospirillum* + BGA

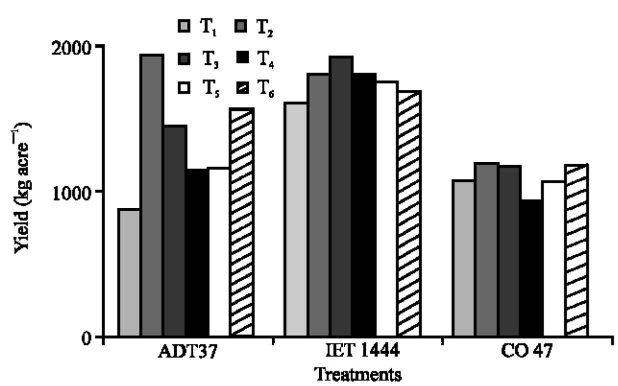

Fig. 1: Effect of biofertilizers on rice yield in lowland system, T_1: Control; T_2: 100% N Inorg. Ferti; T_3: 75% N Inorg. Ferti; T_4: T_3+ *Azospirillum*; T_5: T_3 + BGA; T_6: T_3 + *Azospirillum* + BGA

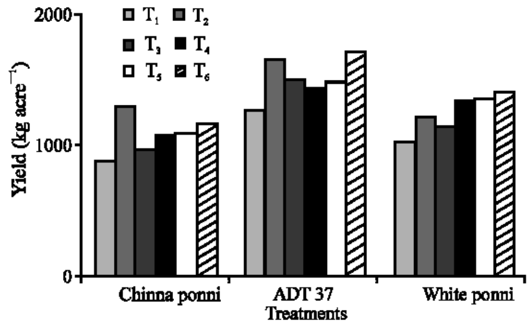

Fig. 2: Effect of biofertilizers on rice yield in upland system, T_1: Control; T_2: 100% N Inorg. Ferti; T_3: 75% N Inorg. Ferti; T_4: T_3+ *Azospirillum*; T_5: T_3 + BGA; T_6: T_3 + *Azospirillum* + BGA

Table 2a: Microbial analysis of soil pre and post harvest stages at trial plots

Microbial population	Pre	Post harvest T_1	T_2	T_3	T_4	T_5	T_6	CD ($p<0.05$)
Bacteria$\times 10^5$	17^c	18^c	65^{bc}	78^{abc}	244^{ab}	272^a	254^{ab}	203.0
Actinomycetes$\times 10^4$	1^c	3^c	8^{bc}	9^{bc}	16^b	31^a	37^a	12.4
Fungi$\times 10^3$	7^b	32^{ab}	42^a	40^a	48^a	52^a	60^a	28.5

Table 2b

Microbial population	Pre	Post harvest T_1	T_2	T_3	T_4	T_5	T_6	CD ($p<0.05$)
Bacteria$\times 10^5$	14^b	7^b	38^{ab}	12^b	56^a	64^a	23^b	31.7
Actinomycetes$\times 10^4$	2^{bc}	3^b	2^{bc}	1^c	1^c	5^a	3^b	1.9
Fungi$\times 10^3$	23^b	17^b	26^{ab}	15^b	18^b	37^a	37^a	13.0

Each value mean of 4 replicates, the common letter(s) shared in each row do not differ significantly as per DMRT at 5% level, (2a) Upland; (2b) Lowland T_1: Control; T_2: 100% N Inorg. Ferti; T_3: 75% N Inorg. Ferti; T_4: T_3+ *Azospirillum*; T_5: T_3 + BGA; T_6: T_3 + *Azospirillum* + BGA

Effect of biofertilizers on grain yield and fertility status in upland system

The results of Fig. 2 show positive correlation between the usage of microbes and consistent increase in crop yield. The highest yield during first season (Winter-Spring-Chinna Ponni) was observed in T_2 (1289 kg acre^{-1}), while in the subsequent two generations, T_6 recorded highest yield (1705 and 1400 kg acre^{-1} respectively) followed by T_5 and T_4. This compatibility and integration of microbes with inorganic fertilizers and its role in enhancing the yield of rice closely resembled with earlier research by Martin (2000) and Choudhury and Kabi (2003). Further, as per Vasudevan *et al.* (2002) the bacterial formulations have direct impact on grain yield (1000-grain weight).

The nutrients N, P and K got enhanced after post harvest stage (Table 1) indicates the steady increase in the fertility status and water-holding capacity of the soil due to the residual effect (Dey and Paul, 1999; Kumar *et al.*, 2000).

Microbial Analysis

Though there was not much difference in the initial stages, the microbial population increased due to repeated application of biologicals and organic matter. Similarly, organic amendments such as vermicompost from household solid waste, horse and rabbit manure and chicken manure resulted in higher soil organic carbon (Ferreras *et al.*, 2006). In the upland system, T_5 and T_6 exhibited more number of bacterial and actinomycetal colonies, whereas a definite correlation has not been arrived in the case of lowland (Table 2).

CONCLUSION

The experimental results proved that the biofertilizers play a major role in improving the soil fertility and thereby increase the crop yield. In addition, it improves the soil biota and minimizes the sole use of inorganic fertilizers and the cost of cultivation.

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REFERENCES

Bashan, Y., 1998. Inoculants of plant growth-promoting bacteria for use in agriculture. Biotechnol. Adv., 16: 729-770.

Chinnusamy, M., B.D. Kaushik and P. Radha, 2006. Growth, nutritional and yield parameters of wetland rice as influenced by microbial consortia under controlled conditions. Food Sci. Nutr., 29: 857-871.

Choudhury, A. and M.C. Kabi, 2003. Effect of N_2 fixing biofertilizer and FYM in presence of fertilizer nitrogen on rice. Environ. Ecol., 21: 196-199.

Dey, J.K. and S.R. Paul, 1999. Effect of *in situ* greengram (*Phaseolus radiatus*) residue and nitrogen levels on toria (*Brassica rapa*) in rice (*Oryza sativa*)-greengram-toria sequence in Ultic Haplustalf. Indian J. Agric. Sci., 69: 763-766.

Fages, J., 1994. Azospirillum Inoculants and Field Experiments. In: Azospirillum/plant Associations. Okon, Y. (Eds.), CRC Press: Boca Raton, FL., pp: 87-110.

Ferreras, L., E. Gomez, S. Toresan, I. Firpo and R. Rotondo, 2006. Effect of organic amendments on some physical, chemical and biological properties in a horticultural soil. Bioresour. Technol., 97: 635-640.

Gnanamanickam, S.S., P. Vasudevan, M.S. Reddy, G. Défago and J.W. Kloepper, 2002. Principles of Biological Control. In: Biological Control of Crop Diseases. Gnanamanickam, S. (Eds.), Marcel Dekker, Inc., NY. pp: 1-9.

Gupta, A., B.M. Sharma and P.N. Kerni, 1989. Comparative efficacy of *Azospirillum*, *Azotobacter* and BGA in submerged rice culture. Res. Dev. Rep., 6: 169-171.

Hedge, S.V. and G.P. Brahmaprakash, 1992. A dry granular inoculant of Rhizobium for soil application. Plant and Soil, 144: 309-311.

Krol, M.J, 1999. *Azospirillum* associational bacteria in sustainable agriculture. Folia Universitatis Agriculture Stetinensis Agricultura, 78: 93-102.

Kumar, V., B.C. Ghosh and R. Bhat, 2000. Complementary effect of crop wastes and inorganic fertilizers on yield, nutrient uptake and residual fertility in mustard (*Brassica juncea*)-rice (*Oryza sativa*) cropping sequence. Indian J. Agric. Sci., 70: 69-72.

Martin, G.J., 2000. Integrated nitrogen management of lowland transplanted rice of west zone of Tamil Nadu. Madras Agric. J., 86: 542-546.

Patel, J.R., 1998. Effect of blue green algae and nitrogen fertilizer on rice yield. Bhartiya Krishi Anusandhan Patrika, 13: 48-52.

Santhi, R. and G. Selvakumari, 1999. Effect of soil fertility and integrated plant nutrition system on yield and nutrient uptake by crops in a rice based cropping sequence. Indian J. Agric. Res., 33: 129-135.

Singh, S., J. Prasad and B. Kumar, 2002. Effect of green manuring, FYM and biofertilizer in relation to fertilizer nitrogen on yield and major nutrient uptake by upland rice. J. Indian Soc. Soil Sci., 50: 313-314.

Tang, W. H. and H. Yang, 1997. In: Plant Growth-Promoting Rhizobacteria-Present Status and Future Prospects. Ogoshi, A. *et al*. (Eds.), OCED, Paris, 1997, pp: 4-9.

Vasudevan, P., M.S. Reddy, S. Kavitha., P. Velusamy, R.S. David PaulRaj, S.M. Purushothaman, V. Brindha Priyadarisini, S. Bharathkumar, J.W. Kloepper and S.S. Gnanamanickam, 2002. Role of biological preparations in enhancement of rice seedling growth and grain yield. Cur. Sci., 83: 1140-1143.