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Integrated nutrient management for sustaining wetland rice (*Oryza sativa)* production in mid hills altitude of Meghalaya

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ABSTRACT

A field experiment was conducted, during rainy season of 2007 and 2008 at the research farm of ICAR Research Complex for NEH Region, Umiam, Meghalaya, to study the effect of organic and inorganic sources of nutrients in wetland rice. The results of two years study reveals that the growth parameters were improved with application of 5 tonnes/ha FYM + *Azolla* dual cropping + 75 per cent of the recommended dose of NPK (80:60:40 kg/ha, RDF). While higher yield attributes were recorded with 50% of the recommended dose of fertilizer in the presence of FYM 5 tonnes/ha + *Azolla* dual cropping resulted into maximum grain yield of 39.34 q/ha, which was 13.89% and 16.87% higher over alone application of recommended dose of NPK and bio-organics, respectively. Application of FYM 5 tonnes/ha + *Azolla* + *Azospirillum* found to produce grain yield equal with FYM 10 tonnes/ha and application of recommended dose of NPK without any bio-organic. The use of *Azospirillum* was promising in improving growth and yield of rice. The grain yield of rice recorded with FYM 5 tonnes/ha + seedling inoculation with *Azospirillum* in the presence of 75% recommended dose of NPK (38.34 q/ha) was significantly higher over that of 50% RDF with same bio-organics, but when *Azolla* dual cropping in place of *Azospirillum* was adopted, the maximum grain yield was recorded with 50% RDF, which was however, at par with that of 75 and 100% RDF applied together with same bio-organics, indicated that the use of biofertilizer can save 25-50 per cent of the recommended dose of NPK, besides substantial improvement in grain yield of wetland rice. The uptake of K was more than N and P. Maximum N and P uptake was recorded with FYM 5 tonnes/ha + *Azolla* dual cropping + 75 RDF, while maximum K uptake was recorded with the same bio-organics applied in the presence of 100 RDF. Highest net return with benefit : cost ratio was found with FYM 5 tonnes/ha + *Azolla* dual cropping + 50 RDF.

Key words: *Azolla, Azospirillum*, FYM, Nutrient management, Rice, Sustainable yield index

Rice (*Oryza sativa* L.) is a staple food and hub of food security in Meghalaya. It is grown in 0.16 m ha with a productivity of 14.27 q/ha which is about 33% less than the national average. The production potential of rice depends on the increased use of fertilizer, a costly input which are beyond the purchase power of poor farmers of the region. Secondly, the high cost of inorganic fertilizer and low purchasing power of hill farmers, due to their poor economic conditions, restrict the judicious use of inorganic fertilizer up to a level of recommended dose, besides it affects the physico-chemical properties of soil resulting poor yield of rice. Hence there is need to combine the bio-organic with inorganic sources of nutrients to increase the production and reduce the cost of cultivation. Application of organic manure and biofertilizer along with inorganic fertilizer lead to increase the crop productivity and also sustain the soil health. Organic manure on application can counteract the deleterious effect caused by continuous use of fertilizer on physico-chemical properties of soil (Singh *et al*. 2000). *Azolla* (water fern) and *Azospirillum* (a microbial inoculants) have been known as one of the components of integrated nutrient management system because of their ability to fix atmospheric nitrogen that enhances the rice yield, besides economizing the fertilizer doses. Therefore, the present investigation was undertaken to study the efficacy of FYM, *Azolla* and *Azospirillum* in conjunction with inorganic fertilizer on wetland rice in mid hill altitude of Meghalaya**.**

MATERIALS AND METHODS

A field experiment was conducted at the research farm of Agronomy Division of ICAR Research Complex for NEH Region, Umiam, Meghalaya, during *kharif* season of 2007 and 2008.The soil of the experimental site was haplaquant having pH 4.9, organic carbon 2.06%, available N, P and K, 261.2, 5.5 and 219.7 kg/ha, respectively. Fourteen treatments, viz. T_1 – Control, T_2 - FYM 10 tonnes/ha, T_3 – FYM 5 tonnes/ha + *Azospirillum*, T_4 – FYM 5 tonnes/ha + *Azolla* dual cropping, T_5 - FYM 5 tonnes/ha + *Azospirillum* + *Azolla* dual cropping.; T_6 – T_3 + 25% recommended dose of fertilizer (RDF); T_7 – T_3+ 50% RDF;

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T_8 – T_3 + 75% RDF; T_9 – T_3 + 100% RDF; T_{10} - T_4 + 25% RDF; T_{11} - T_4 + 50% RDF; T_{12} - T_4 + 75% RDF; T_{13}- T_4+ 100% RDF; and T_{14}-100% recommended dose of NPK, i e (80:60:40 kg/ha) were arranged in a randomized block design with three replications. The N: P: K contents in FYM were 0.56: 0.25: 0.53, respectively. Rice cultivar Shasarang 1 was transplanted on 6 and 10 July during 2007 and 2008, respectively. Well decomposed FYM, treatment wise was broadcast and incorporated into the soil 10 days before transplanting. For *Azospirillum* treatment, *Azospirillum* slurry was prepared by mixing 200 g *Azospirillum* culture with 4-5 liters of water. In this slurry, the roots of rice seedlings were dipped for 20 minutes and then used for transplanting. In *Azolla* dual crop treatment, 500 kg/ha fresh *Azolla* was released into the paddy field one week after transplanting. Half dose of N through urea and full doses of P and K through single super phosphate and muriate of potash were applied at the time of transplanting. Remaining half of N was top dressed at active tillering stage and at panicle initiation stage. Rest of the package of practices was same as recommended for rice. Nutrient content in seed and straw of rice were estimated following the standard methods and these contents were multiplied by corresponding treatment seed and straw yield to obtain the nutrient uptake. The observations recorded were analyzed following standard statistical methods.

RESULTS AND DISCUSSION

Plant height significantly influenced due to various treatments. Crop grown with 75% of recommended dose of NPK + 5 tonnes FYM/ha in the presence of *Azolla* dual cropping produced tallest plants which were statistically at par with 50% and 100% of recommended dose of fertilizer (RDF) applied in the presence of same bio-organics. Increase in growth attributes might be owing to improvement in physico-chemical properties of soil and availability of essential nutrients in optimum quantity, which might have supported the vegetative growth of plant. Seedling inoculation with *Azospirillum* in the presence of 75% RDF improved growth attributes as compared to control, which were, however, at par with the 100% recommended dose of fertilizer applied without biofertilizer and organic manure. Maximum panicles/m^2, panicle length and number of grains/ panicle were recorded with FYM 5 tonnes/ha + *Azolla* coupled with 75% of recommended dose of fertilizer (T_{12}) which were closely followed by FYM 5 tonnes/ha + *Azolla* dual cropping in the presence of 50 and 100% of recommended dose of fertilizer (T_{11} and T_{13}). However, 1000 grain weight was higher with FYM 5 tonnes/ha + *Azolla* coupled with 100% RDF followed by the same bio-organics in the presence of 75 per cent RDF (Table 1). The overall improvement in growth and yield attributes reflected on grain and straw yields as compared to control. Maximum grain yield of 39.96 and 39.83 q/ha were recorded with FYM 5 tonnes/ha + *Azolla* + 75 and 100% of RDF, respectively, which were however, statistically on par with that of 50% RDF + FYM 5 tonnes/ha + *Azolla* dual cropping (Table 1). Seedling inoculation with *Azospirillum* and application of 75% and 100% RDF recorded yield, which was on par with highest yield treatment.

The grain yield of 39.34 q/ha recorded with FYM 5 tonnes/ha + *Azolla* dual cropping + 50% RDF was 12.27% and 16.87% higher over alone application of recommended dose of fertilizer (RDF) and *Azospirillum* + *Azolla* dual cropping + 5 tonnes FYM showing that application of FYM 5 tonnes/ha and dual cropping of *Azolla* can increase rice yield and save fertilizer requirement up to 50% of their recommended dose (RDF). Application of FYM 5 tonnes/ ha + *Azolla* without inorganic fertilizer was not sufficient to realize optimum yield of rice. This indicated that application of inorganic fertilizer in combination with Azolla bio-fertilizer and organic manure (FYM) could sustain higher

Table 1 Effect of integrated nutrient management on growth and yield of rice

Treatment	Plant height (cm)	No. of panicles/m^2	Panicle length (cm)	No. of grains/ panicle	1000-seed weight (g)	Grain yield (q/ha) 2007	2008	Pooled	Straw yield (q/ha)	Harvest index
T1	42.50	274.80	19.60	91.05	20.15	23.50	48.84	27.85	25.68	34.44
T2	52.50	319.45	21.75	104.10	21.50	34.48	58.38	33.77	34.13	36.89
T3	47.05	285.45	21.20	100.95	21.35	28.41	52.50	30.38	29.40	35.88
T4	51.35	302.80	21.40	101.60	21.45	34.74	55.19	31.02	32.88	37.30
T5	53.60	306.55	21.50	104.10	21.95	35.46	56.92	31.86	33.66	37.15
T6	55.85	311.10	21.60	104.90	21.80	30.95	54.00	30.72	30.84	36.35
T7	57.50	325.55	22.15	108.55	22.20	32.50	59.18	36.52	34.51	36.82
T8	59.05	327.40	22.40	111.30	22.65	35.75	63.21	40.94	38.35	37.72
T9	59.00	328.45	22.25	112.65	22.80	36.30	64.26	41.44	38.87	37.66
T10	56.30	317.90	21.80	109.35	22.30	32.46	60.64	36.27	34.37	36.15
T11	60.55	343.60	23.00	116.70	22.85	37.57	61.22	41.11	39.34	39.10
T12	62.80	354.00	23.05	118.00	23.00	38.48	66.58	41.44	39.96	37.50
T13	62.50	353.50	22.95	116.25	23.05	37.01	67.35	42.64	39.83	37.13
T14	58.95	287.10	22.60	113.95	22.65	33.77	59.93	36.30	35.04	36.89
CD (P=0.05)	2.35	12.56	0.48	5.26	0.47	3.75	3.46	3.36	2.95	0.57

Table 2 Nutrient uptake, residual fertility and economics of integrated nutrient management in rice

Treatment	Nutrient uptake (kg/ha)						Fertility status of soil (kg/ha)			Net return (₹/ha)	Benefit : cost ratio
	N		P		K		N	P	K	(mean of two years)	
	2007	2008	2007	2008	2007	2008					
T_1	49.4	54.6	12.1	14.9	72.1	75.1	248.4	5.6	202.5	8 653	0.81
T_2	72.2	68.2	20.1	19.4	98.4	102.5	266.7	6.7	223.4	12 490	0.95
T_3	58.7	59.3	15.1	17.1	84.2	88.1	262.3	6.1	220.5	10 093	0.84
T_4	69.7	61.2	19.6	16.5	92.1	88.7	264.4	6.3	220.8	12 710	1.06
T_5	71.5	65.2	21.1	17.4	108.7	91.4	255.9	6.5	221.7	13 195	1.09
T_6	63.0	62.6	18.2	18.8	93.2	93.4	265.3	6.2	221.3	10 532	0.84
T_7	67.3	74.2	18.8	24.3	98.4	109.2	267.3	6.7	222.4	12 653	0.96
T_8	74.8	82.2	22.2	26.3	110.4	114.1	268.4	6.8	222.4	14 885	1.07
T_9	71.6	84.4	21.6	26.2	110.4	117.3	271.7	6.8	224.5	14 642	1.01
T_{10}	68.5	76.2	19.1	24.5	104.2	108.1	266.5	6.6	222.4	13 180	1.05
T_{11}	77.4	81.0	23.3	25.8	110.5	112.6	269.3	6.9	224.7	16 275	1.23
T_{12}	79.1	85.6	24.5	26.9	114.1	127.7	273.7	7.2	226.4	16 100	1.16
T_{13}	78.3	82.1	24.0	24.6	115.4	128.7	278.7	7.2	226.3	15 355	1.06
T_{14}	66.4	76.7	21.1	22.7	102.4	109.4	256.4	6.0	217.8	12 745	0.97
CD (P=0.05)	4.3	2.2	4.7	3.2	7.1	5.7	1.2	0.4	0.3	715	
Soil initial values							261.2	5.5	219.7		

productivity and is better than the application of organic and in-organic fertilizer separately. The yield advantage in rice due to combined application of organic or inorganic fertilizers was also reported by Bandyopadhyay and Puste (2002).

Application FYM 5 tonnes/ha + *Azolla* + *Azospirillum* significantly improved grain yield (33.66 q/ha), which was nearly equal to the yield of 34.13 q/ha recorded with FYM 10 tonnes/ha indicating that the use of biofertilizer can economies the dose of organic manure because bio-fertilizer and organic manure besides releasing nutrients also brought about an improvement in physico-chemical properties of soil which help in realizing optimum grain yield of rice. Among the biofertilizers, the yield recorded with *Azolla* dual cropping was 11.84% higher over *Azospirillum*. However, alone application of *Azospirillum* significantly improved yield over control. It was also noted that increasing level of inorganic fertilizer in the presence of *Azospirillum*, improved yield up to 75% RDF. The increase in grain yield owing to *Azospirillum* was mainly because of increase in growth and yield parameters. Thereafter, at 100% RDF no beneficial effect of *Azospirillum* was noticed showing that at higher level of chemical nutrients, the nitrogenase activity decreased (Sumner 1990). These results are in conformity with those of Gopalaswamy *et al.* (1997) and Acharya *et al.* (1999) who reported that *Azospirillum* inoculation along with 75% recommended dose of N significantly increased the grain yield of rice. They also reported that at 100% recommended dose of nitrogen, *Azospirillum* did not show significant beneficial effect. Contrary to this Singh and Ngachan (2001) reported maximum grain yield of rice due to seedling treatment with *Azospirillum* along with 100% RDF. The trend in straw yield was also similar to that of grain yield. Maximum straw yield of 67.35 and 66.58 q/ha was recorded with FYM 5 tonnes/ha + *Azolla* dual cropping + 100% and 75 per cent RDF. Harvest index was improved due to bio-organics when integrated with inorganic sources of nutrient supply recording maximum values of 39.10 with $T_{11,}$ indicated that balance nutrient management and continuous release of nitrogen by *Azolla* helped in partitioning the net assimilates towards reproductive parts of plant.

The uptake of nutrients was improved due to integrated nutrient management. In general, the uptake of K was more than N and P. The uptake of nutrients was lowest in the plots receiving no fertilizer (Table 3) might be due to lower yield obtained in control. Maximum N and P uptake was recorded with the application 75% RDF in conjunction with FYM 5 tonnes/ha + *Azolla* dual cropping and it was statistically superior to rest of the treatments, except 75% RDF + FYM 5 tonnes/ha + *Azolla.* This increase in nutrient uptake due to inorganic fertilizer and bio-organics might be due to added supply of nutrients and proliferous root system developed under balanced nutrient management resulting in better absorption of water and nutrients. Moreover, organic matter after decomposition released both macro and micro-nutrients, which become available to the plant and thus increase the uptake (Minhas and Sood 1994).

The soil residual status revealed that N, P and K status change due to application of organic manure, biofertilizer and chemical fertilizer used either alone or in combination (Table 3). Maximum soil N,P and K values were recorded with T_{12} (FYM 5 tonnes/ha + *Azolla* dual cropping in the presence of 75% RDF). Beillaki *et al.* (1998) reported significant improvement in soil available NPK with the use of FYM either alone or in combinations. Highest net return

(₹ 16 275/ha) with B:C ratio 1.23 was recorded when FYM 5 tonnes/ha + *Azolla* dual cropping in the presence of 50% RDF applied which was followed by net return of ₹ 16 100 with 1.16 B:C ratio was recorded with the same bio-organics applied in the presence of 75% RDF. While at 100% RDF applied in combination with bio-organics was not economical.

It can be concluded from the study that application of 50% of the recommended dose of fertilizer along with FYM 5 tonnes/ha + *Azolla* dual cropping may be advocated for obtaining higher yield net return and benefit : cost ratio of wet land rice under mid hill altitude of Meghalaya. This helps in reducing 50% recommended dose of NPK and thereby expenditure chemical fertilizer.

REFERENCES

Acharya A, Sharma C R and Dev S P. 1999. Effect of *Azospirillum* inoculation on production of rice crop in Alfisols of Himachal Pradesh. *Indian Journal of Hill Farming* **12** (1&2): 42–6.

Bandyopadhyaya S and Puste A N. 2002.Effect of integrated nutrient management on productivity and residual soil fertility status under different rice(*Oryza sativa*) based cropping system in rainfed lateritic belt of West Bengal. *Indian Journal of Agronomy* **47**(1): 33–40.

Beillaki M A, Badaaue V P and Setty R A. 1998. Effect of long term integrated nutrient management on some important properties of a vertisol. *Journal of Indian society of Soil Science* **46**: 176–80.

Gopalaswamy G, Anthony Raj and Ranganathan T B. 1997. Biofertilizer application strategy to rice. *Indian Journal of Agronomy* **42** (1): 68–73.

Minahas R S and Sood A. 1994. Effect of inorganic and organics on yield and nutrient uptake by three crops in rotation in acid Alfisols. *Journal of Indian Society of Soil Science* **42**: 257–60.

Singh A K, Amgain L P and Sharma S K. 2000. Root characteristics, soil physical properties and yield of rice as influenced by integrated nutrient management in rice-wheat cropping system. *Indian Journal of Agronomy* **45** (2): 217–22.

Singh K P and Ngachan S V. 2001. Effect of biofertilizer and crop residue for sustainable rice (*Oryza sativa*) production in Manipur. *Indian Journal of Hill Farming* **14** (2): 57–60.

Sumner M F. 1990. Crop responses to *Azospirillum* inoculation. *Advances in Soil Sciences* **12**: 53–123.