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Response of rice to an Integrated Nutrient Management treatment in soils collected from the long term fertility experiment

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ABSTRACT

A long-term fertility experiment was initiated during Kharif 1996 at Regional Agricultural Research Station (RARS), Titabor. Soil samples from four treatments viz control, 100 per cent N, 100 per cent NPK and 50 per cent N (Urea) + 50 per cent N (FYM) + 100 per cent PK after 12 years of this experiment were collected at the time of harvest of Winter rice 2007. Pot experiments were conducted for Summer rice 2008 to determine resilience of soils of four treatment plots of the long term fertility experiment. Application of an Integrated Nutrient Management (INM) package to the soils of different treatments in pot increased grain yield and other dry matter yield. In soils of treatments 3 and 4 response to the INM package in terms of grain yield of Summer rice was more than other treatments (9.6 to 16.8 % increase in grain yield over the normal field treatments). The results suggested that cultivation of rice for 12 years brought significant change in soil quality parameter and resilience of soil was adversely affected. These results also suggested that deterioration of soil under rice-rice cropping system could be reduced by application of balanced fertilizers and combined application of organic and inorganic fertilizers.

Keywords: Integrated Nutrient Management, long term fertility, summer rice

INTRODUCTION

In Assam annual fertilizer consumption is very low (17 kg/ha) as compared to national average (70 kg/ha) and probably due to this reason rice productivity of the state is low. Rice is the main crop of the state that covers 92 per cent of the cultivated area (25.2 lakh ha) and economy of small and marginal farmers of the state is greatly dependent on productivity of rice. Increasing fertilizer consumption in rice cultivation can increase rice productivity but during post-green revolution era, experience on ill effects from excessive use of chemical inputs like fertilizers has also necessitated research into alternative and environmentally safe method of nutrient management in farming. Integrated Nutrient Management (INM) and organic farming practices are being increasingly advocated as environmentally

friendly alternatives for nutrient management. Imbalance fertilization may deteriorate soil quality to a greater extent than the use of balanced fertilization on long-term basis. Therefore there is a need to develop quantitative parameters to determine soil quality under different fertilizer management practices. Such scientific efforts may also help to determine suitable combination of organic, inorganic fertilizers and bio-fertilizer in right proportion for maintaining soil quality to ensure crop production on sustainable basis. This research programme was formulated to study the effect of long term application of imbalance and balanced dose of inorganic fertilizers and organic manures.

MATERIAL AND METHODS

A series of pot experiments were conducted during Summer season 2008 using soils collected from the long term fertility experiment. The soils from the following treatments were collected.

T_1 Control

T_2 100 per cent recommended N (urea @ 40 kg N/ha)

T_3 100 per cent recommended NPK (N, P_2O_5 and K_2O @ 40, 20 and 20 kg/ha respectively)

T_4 50 per cent N as urea + 50 per cent N as FYM + 100 per cent PK (P_2O_5 and K_2O @ 20 and 20 kg/ha)

Soils from each treatment plot were divided into two halves. To one half fertilizer doses were applied as per the doses used for the last 12 years and to the other half an INM package consisting of Azospirillum + PSB biofertilizer + organic manure @ 5 t/ha + RP @ 20 kg/ha + K @ 20 kg/ha was applied. The scheme of the treatment followed in the pot experiment is presented in Plate 1. Pots were transplanted with 30 day old seedlings of rice variety Gopinath on 23 April 2008. Two seedlings were planted per pot. About 5 cm standing water was maintained in the pots up to the grain filling stage of the crop and weeding was carried out as and when required. Plant height and tiller number were recorded 65 days after transplanting. Crop was harvested 84 days after transplanting and panicle length, grain and straw yield were recorded.

The data obtained from pot experiments were analyzed through Completely Randomized Design (CRD) using standard statistical procedure, comparison between treatment means was made by Least Significant Difference (LSD) test and paired t-test was used to compare the data obtained from pot experiments (Gomez and Gomez 1984).

RESULTS AND DISCUSSION

Twelve years of cultivation with rice-rice rotation under four different fertilizer treatments brought about changes in physico-chemical and biological

properties of soil. This was reflected in rice grain yield of the pot experiment. Grain yield of Summer rice (var Gopinath) in the unfertilized control plots was 11.9 g/pot while in control + INM plot was 13.9 g/pot (Table 1). Yield increased significantly with application of INM. The increase in grain yield ranged from 9.6-16.8 per cent over the field treatment. Dry matter yield, effective tiller number, plant height and panicle length of Summer rice (var Gopinath) followed a similar trend under the two treatments (Table 2).

Grain yield of Summer rice was found to follow similar trend as observed in case of the treatments in the field (Table 1). Grain yield in the fertilizer + FYM treatment was found to be highest (20.5 g/pot). In control pot the grain yield was lowest (13.9 g/pot). Lower yield of grain in soils of unfertilized plots towards the latter year of long-term fertility experiment has been attributed to drawdown of initially available nutrients leading to decline in soil fertility (Nambiar 1994). Imposition of the INM package to these soils increased grain yield of ahu rice to varying extent. The per cent increases in grain yield due to the INM package in control plot soil was highest (16.8) and in NPK plot soil lowest (9.6). However there was no significant difference in grain yield of rice grown in soils of the fertilized plots due to the INM package. These results indicated that the control plot soil had been deteriorated to great extent and it had failed to respond to an improved management. Many other workers reported improvement of soil quality due to application of INM treatment (Yaduvanshi 2001, Powlson and Johnston 1992, Mishra and Sharma 1997, Balasubramanium et al 1972, Yaduvanshi et al 1985, Filser et al 1995).

Table 1. Grain yield of Ahu Rice grown during 2001 in pots given additional INM treatment using soils from the long term fertility experiment plots $P_{0.05}$

Treatment	Grain yield (g/pot)		% Increase	Paired t-test ($\mathbf{P_{0.05}}$)
	Field treatment	Field treatment +INM*		
Control	11.9	13.9	16.8	
100%N	15.3	17.0	11.1	Cal: 2.8*
100%NPK	16.7	18.3	9.6	Table : 2.1
50% N (Urea) + 50% N (FYM) + 100% PK	18.05	20.5	13.6	
LSD ($P_{0.05}$)	4.23	4.12		

* INM comprised of organic matter (OM) @ 5 t/ha, *Azospirillum amazonense* A10 and PSB (*Bacillus megaterium* P5) biofertilizer, Rock Phosphate @ 20 kg/ha and K fertilizer at recommended dose

Table 2. Response of Ahu rice to an INM package applied to soils of differently fertilized plots under long term fertility experiment during 2001 in plots

Treatment	Dry matter yield (g/pot)		Effective tiller		Plant height (cm)		Panicle length (cm)	
	FT*	FT + INM**	FT*	FT + INM**	FT*	FT + INM**	FT*	FT + INM**
Control	15.9	19.6	15.0	16.0	57.2	61.8	20.5	22.4
100% N	21.8	25.0	16.8	17.8	64.4	65.4	21.6	23.3
100% NPK	20.0	25.3	17.0	18.0	58.8	62.4	21.9	23.1
50% N (urea) + 50% N(FYM) + 100% PK	22.1	27.3	18.5	21.3	64.7	67.9	23.7	24.5
LSD ($P_{0.05}$)	NS	NS	NS	1.50	4.61	3.09	1.46	0.89
Paired t-test ($P_{0.05}$)	6.00*	3.03*	5.48*	6.93*				

* FT, as per the field treatment

** FT + INM, in addition to field treatment, INM Package (Organic matter @ 5 t/ha, *Azospirillum amazonense* A10 and PSB (*Bacillus megaterium* P5) biofertilizer, Rock Phosphate @ 20 kg/ha and K fertilizer at recommended dose)

Thus this study indicates that cultivation with rice-rice system and without application of fertilizer or organic manure is deleterious for maintaining soil productivity. Even imbalance fertilizer application (nitrogen alone or nitrogen + phosphorus) is not adequate in maintaining grain yield and soil quality. Application of recommended doses of fertilizers or mixture of organic manures and inorganic fertilizers may not sustain yield of rice-rice system. This is mainly due to the fact that the soil qualities could not be kept intact due to intense cultivation over long period although application of organic manures and fertilizer can reduce deterioration to certain extent. There is a need for setting up more long-term fertility experiments which will aim at developing techniques of nutrient management which can keep soil quality intact even after long years of cultivation.

CONCLUSION

Application of an INM package to the soils of different treatments in pot during Summer rice 2008 increased grain yield and other plant parameters. These results of pot experiments suggested that deterioration in soil quality and productivity under long term cultivation without fertilization or with imbalance fertilization can be overcome by supplying the deficient nutrients and improving overall soil conditions. These results need to be tested in field experiments for practical application.

Control Control soil + INM

100% N 100% N + INM

100% NPK 100% NPK + INM

50% N (urea) + 50% N (FYM) + 100% PK

50% N (urea) 50% N (FYM) 100% PK+INM

PLATE 1. GROWTH OF *AHU* RICE (2008) IN SOILS FROM THE LONG TERM FERTILITY EXPERIMENT AMENDED DIFFERENTLY

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