Indian J. Agric. Res.., **45** (4) : 346 - 349, 2011

AGRICULTURAL RESEARCH COMMUNICATION CENTRE
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SOIL PROPERTIES AND NUTRIENTS AVAILABILITY AS AFFECTED BY INTEGRATED NUTRIENT MANAGEMENT AFTER RAINFED CROPPING SEQUENCE

Bhabesh Gogoi

Department of Soil Science,
Assam Agricultural University, Jorhat - 785 013, India

Received : 03-06-2010 Accepted : 31-03-2011

ABSTRACT

The effect of integrated nutrient management (INM) on soil properties and availability of nutrients after rainfed rice (*Oryza sativa* L.)-niger (*Guizotia abyssinica* L.) cropping sequence studied during 2006- 08 revealed that the application of 50% recommended dose of fertilizers (RDF) + 50% N (FYM) showed the lowest bulk density and the highest water holding capacity of soil. The above treatment was at par with 50% N (inorganic) + 50% N (FYM) + PK (inorganic and adjusted) *i.e.* T_6. However, effect of integrated nutrient management had a non significant effect on pH of soil. At the end of the cropping sequence, significant soil organic carbon increased and higher available N, P_2O_5 and K_2O of soil were observed when 50% recommended dose of fertilizers (inorganic) substituted through 50% N FYM (organic) over RDF and control.

Key words : Soil properties, Nutrient availability, Integrated nutrient management.

INTRODUCTION

Agricultural sustainability depends to a large extent upon improvements in soil properties. Soil properties are controlled by many factors, of which the mineral nutrition is by and large most important. But, the application of all the needed nutrients through sole chemical fertilizers had deleterious effect on fertility and productivity status of soil (Jat *et al.,* 2006). No single source of nutrients is capable of supplying plant nutrients in adequate and balanced proportion, where as conjunctive use of the organic and inorganic sources of nutrients help in sustaining productivity and biological health of soil in one way and meet a part of chemical fertilizer requirements of crops on the other (Babu *et al.*, 2007). Use of biofertilizers in cropping sequence not only fixes the biological nitrogen but also solubilizes the insoluble phosphates in soil and improves fertilizer-use efficiency (Gogoi, 2008). Keeping these point in view, the present investigation was undertaken to study the effect of integrated nutrient management involving inorganic nutrients (NPK), FYM and biofertilizers on different soil properties and availability of nutrients in soil under rainfed rice (*Oryza sativa* L.)-niger (*Guizotia abyssinica* L.) cropping sequence, which is one of the main choices of cropping sequence of the farming community of Assam.

MATERIALS AND METHODS

The present investigation was carried out during 2006-2008 in rice (*Oryza sativa* L.)-niger (*Guizotia abyssinica* L.) cropping sequence, at Instructional-cum-Research Farm (located in 26°48 "N latitude, 95°50" E longitude and altitude 86.6

Author's email : gogoib@icfre.org, bg100777@yahoo.co.uk

m) of Assam Agricultural University (AAU), Jorhat, Assam. The initial soil is of sandy clay in texture with bulk density 1.3 Mg/m^3, water holding capacity 38.3%, mean weight diameter 0.69 mm, water stable aggregates of 46.34%, pH of 5.01, organic carbon 0.60%, CEC 5.2 cmol (p^+)/kg, EC 0.13 dS/m, available N 270 kg/ha, available P_2O_5 27.6 kg/ha, available K_2O 140 kg/ha and soil microbial biomass carbon 45.2 mg kg^{-1}. A total of 7 treatments replicating thrice with individual plot sizes of 4 x 6 sq. m (Table 1) were tested in randomized block design.

The recommended level (100%) of N, P_2O_5 and K_2O (60, 20 and 40 kg/ha for rice and 20, 10 and 10 kg/ha for niger) were applied in the form of urea, single super phosphate (SSP) and muriate of potash (MOP), respectively. On the basis of nitrogen content, the amount of FYM as organic source needed for a particular treatment was calculated, and applied as per the treatments except in biofertilizer based INM package. In T_6 and T_7, recommended dose of P and K was adjusted after subtracting their contribution through FYM. Biofertilizer culture *i.e. Azospirillium* + phosphate solubilizing bacteria (PSB) dual culture (count at 10^8 cfu/ g of carrier for both *Azotobecter* and PSB, separately) by Biofertilizer Section of AAU, Jorhat was applied @ 3 kg ha^{-1} before transplanting of *kharif* rice following root dip treatment. *Azotobecter* + PSB dual culture was applied @ 3 kg ha^{-1} following seed treatment in case of niger crop for about 2 hours before sowing. The treatment of biofertilizer based INM package was also added with FYM @ 3 ton/ha, rock phosphate (RP) @ 50 per cent of recommended dose of P_2O_5 and MOP @ 100 per cent of recommended dose of K_2O for both the crops. Half of urea, whole of SSP, RP and MOP were broadcasted at the time of transplanting of *kharif* rice. The remaining urea was splited as top dressing at the time of maximum tillering stage and panicle initiation stage of rice crop. In case of niger, whole of urea, SSP, RP and MOP was applied as basal to the soil at the time of sowing. The rice cultivar Basundhara was transplanted in July and harvested in November, followed by the niger crop (cv. NG-1) that was shown in November and harvested in March month of the year for both the sequence. The crop management practices were practised as per the standard recommendation of the region.

Soil samples were collected from effective root zone depth (0-30 cm) after the sequence *i.e.* after harvest of the *rabi* niger from each plot, air dried, processed to pass through a 2 mm sieve and stored in polythene bags for analysis. Bulk density, water holding capacity, pH, organic carbon, available N, P and K content of collected soil samples were determined using the standard procedures and all the data was subjected to statistical analysis.

RESULTS AND DISCUSSION

Soil properties

A perusal of data (Table 1 and 2) showed that integrated nutrient management (INM) showed a non-significant effect on bulk density of soil after the first sequence of rice-niger crops, and it was significantly affected by INM after the second sequence. The lowest bulk density for either cases were recorded from the treatment of 50% recommended dose of fertilizers (RDF) plus 50% N through FYM, and the bulk density was highest in the control plot. Earlier, similar findings were obtained by Bellakki and Badanur (1997). The integration of inorganic and organic sources of nutrients had a non-significant effect on water holding capacity of soil. Data showed a range from 38.8 to 41.7% and 39.0 to 42.8% after the first and second cropping sequence, respectively. The highest water holding capacity of soil was recorded in case of 50% of RDF + 50% N FYM for both the sequence. These observations corroborated with the findings of Selvi *et al.* (2005).

INM treatments showed non significant effect on pH of soil in the present investigation. However, T_4 treatment, *i.e.* application of 50% RDF

Table 1 : Soil properties after first cropping sequence of rice-niger as affected by INM practices.

Treatments	Bulk density ($Mg\ m^{-3}$)	Water holding capacity (%)	pH	Organic C(%)	Available N ($kg\ ha^{-1}$)	Available P_2O_5 ($kg\ ha^{-1}$)	Available K_2O ($kg\ ha^{-1}$)
T_1 : Control	1.64	38.8	4.8	0.44	230	15.1	46.4
T_2 : Recommended Dose Fertilizers (RDF)	1.60	39.3	5.0	0.51	252	20.3	52.3
T_3 : Biofertilizer based INM package	1.59	40.7	4.9	0.62	286	24.7	62.0
T_4 : 50% RDF (inorganic) + 50% N (FYM)	1.40	41.7	5.0	0.75	326	28.9	64.2
T_5 : 75% RDF (inorganic) + 25% N (FYM)	1.59	40.7	5.0	0.69	288	24.3	57.5
T_6 : 50% N (inorganic) + 50% N (FYM) + PK (inorganic and adjusted)	1.58	40.8	4.9	0.70	299	26.0	61.0
T_7 : 75% N (inorganic) + 25% N (FYM) + PK (inorganic and adjusted)	1.59	40.5	4.9	0.55	240	18.6	57.5
S.Ed(±)	-	-	-	0.28	13.6	1.49	1.53
CD (5%)	NS	NS	NS	0.06	29.7	3.24	3.31

in inorganic form and 50% N through FYM indicated slight increase in soil pH after the second sequence of rice-niger crops. There was a significant increase in organic carbon content of soil after the rice-niger cropping sequence due to integrated application of inorganic and organic sources of nutrients. The treatment of 50% RDF (inorganic) + 50% N (FYM) *i.e.* T_4 showed maximum 70.5% and 67.4% increase in soil organic C over the control treatment after first and second sequence of rice-niger crop, respectively. Banswasi and Bajpai (2006) earlier reported an increase in percentage of soil organic carbon due to regular application of organic and inorganic sources of nutrients to soil.

Nutrient availability

A significant increase in soil fertility due to different treatments of integrated supply of nutrients was observed after the rice-niger sequence. Available nitrogen content in soil varied from 230 to 326 kg ha^{-1} after the first cropping sequence and 236 to 332 kg ha^{-1} after the second cropping sequence of rice-niger. The highest availability of nitrogen in soil was recorded from 50% RDF + 50% N FYM treatment followed by the treatment of 50% N (inorganic) + 50% N (FYM) + PK (inorganic and adjusted). Increase in available nitrogen due to addition of nitrogenous fertilizer along with FYM helped in narrowing down C:N ratio and thus, increased mineralization resulted in rapid conversion of organically bound N to inorganic forms (Singh *et al.*, 2006).

Phosphorus availability in soil varied from 15.1 to 28.9 kg ha^{-1} and 16 to 29.8 kg ha^{-1} after first and second sequence of rice-niger, respectively, due to INM-based practices (Table 1 and 2). Application of 50% recommended dose of fertilizers along with 50% N through FYM *i.e.* T_4 treatment showed significantly higher availability of phosphorus over recommended dose of fertilizers (T_2) and control treatment (T_1). The favourable effect of combined application of inorganic and organic source of nutrients in enhancing the P availability may be defined as the reduction in fixation of water soluble P and increase in mineralization that enhanced the availability of P. The organic anions and hydroxyl acids liberated during the decomposition of organic matter may complex or chelate Fe, Al, Mg and Ca and prevented them from reacting with phosphate (Sharma *et al.* 2001).

A significant effect of different treatments of integrated nutrient management on available potassium in soil was observed after rice-niger cropping sequence. Application of 50% RDF + 50% N FYM (*i.e.* T_4) showed highest potassium

Table 2 : Soil properties after second cropping sequence of rice-niger as affected by INM practices.

Treatments	Bulk density ($Mg\ m^{-3}$)	Water holding capacity (%)	pH	Organic C (%)	Available N ($kg\ ha^{-1}$)	Available P_2O_5 ($kg\ ha^{-1}$)	Available K_2O ($kg\ ha^{-1}$)
T_1 : Control	1.62	39.0	4.8	0.46	236	16.0	45.9
T_2 : Recommended Dose Fertilizers (RDF)	1.58	41.1	4.9	0.56	262	22.7	52.7
T_3 : Biofertilizer based INM package	1.52	41.9	5.0	0.64	295	25.1	60.6
T_4 : 50% RDF (inorganic) + 50% N (FYM)	1.39	42.8	5.1	0.77	332	29.8	62.0
T_5 : 75% RDF (inorganic) + 25% N (FYM)	1.50	42.1	5.0	0.70	300	26.0	57.0
T_6 : 50% N (inorganic) + 50% N (FYM) + PK (inorganic and adjusted)	1.45	42.5	5.0	0.75	318	26.9	58.5
T_7 : 75% N (inorganic) + 25% N (FYM)+ PK (inorganic and adjusted)	1.60	42.0	4.9	0.60	256	22.2	55.7
S.Ed(±)	0.02	-	-	0.03	6.52	1.65	3.45
CD (5%)	0.05	NS	NS	0.06	14.2	5.05	6.63

availability in soil followed by biofertilizer based INM package (T_3) and 50% N (inorganic) + 50% N (FYM) + PK (inorganic and adjusted) (T_6) treatment. There were maximum of 38.36% and 35.08% increase in available K_20 after the first and second sequence of rice-niger crops, respectively. Whereas, significantly lowest value was observed under control. However, the decline in K availability in soil over the initial value in all treatments might be due to a gap between the removal and supplementation of K into the soil. Insufficient addition of K through fertilizers and FYM, and consequently higher removal by crops might be the possible reason of decrease in K availability in soil. Such negative balance of K in soil in rice-rice sequences in Jorhat district of Assam was also reported earlier by Basumatary and Talukdar (1999).

Overall, the results obtained from this work indicated an improvement of various properties and nutrients availability in soil with INM practices over 100% RDF and control treatment under rice-niger cropping sequence. A substitution of RDF to the extent of 50% with organic sources of nutrients using FYM is possible to maintain the soil properties and increased nutrients availability in soil.

Acknowledgement

The author gratefully acknowledge Dr. (Mrs.) N. G. Barua, Professor; Dr. D. K. Borah, Professor & Head, Soil Science Department, AAU, Jorhat and Dr. T. C. Baruah, Associate Dean, Biswanath College of Agriculture, Biswanath Chariali, Assam, for their valuable suggestion and kind cooperation to carry out this work.

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