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Effect of Integrated Nutrient Management on Physico-Chemical Properties of Soil in Rice-Niger Sequence in an Inceptisol of Assam

N. ARUN, K. SINGH[1], A. BASUMATARY AND N. G. BARUA

Department of Soil Science, Assam Agricultural University, Jorhat 785013, India
[1]Division of Agricultural Engineering, ICAR Research Complex for NEH Region
Umiam, Meghalaya 793103, India
E-mail : naoremarun@yahoo.co.in

Abstract

A field experiment was conducted in rice-niger sequence during 2005-2006 to assess the effect of integrated management of fertilizers and farm yard manure on soil physico-chemical properties in rice-niger cropping system. Combined application of inorganic fertilizers (NPK) along with either 25% N or 50% N substitutions through FYM registered higher value in soil physico-chemical properties than recommended dose of NPK and biofertilizer based INM package. Integrated treatment receiving 50% of NPK along with 50% N through FYM resulted lower value for bulk density and higher values for mean weight diameter and water stable aggregates after rice-niger sequence. Organic carbon content and pH of the surface and sub-surface soils were found to be maximum in treatments involving either 50 or 75% of NPK along with FYM. In surface soil, application of 50% of NPK along with 50% N of FYM exhibited significantly the highest value of CEC after harvest of rice.

Key words : Integrated nutrient management, Physico-chemical properties, Farm yard manure, Rice-niger sequence.

Integrated nutrient management is an important component of sustainable agricultural intensification. The supplementary and complementary use of organic manures and inorganic chemical fertilizers augment the efficiency of both the substances to maintain a high level of soil productivity and soil fertility. In Assam, some information is available on effect of integrated nutrient management on sustaining soil fertility and productivity under rice-rice and rice-legume-rice sequence. But, till now, no study has been made to evaluate the impact of integrated nutrient management on sustaining soil fertility under rice-niger sequence. Keeping this in view, the present investigation was conducted to monitor the effect of integrated nutrient management on soil chemical and physical properties under rice-niger sequence in an Inceptisol of Assam.

Methods

The investigation was conducted at Instructional cum Research Farm of Assam Agricultural University, Jorhat during 2005-06 which is located at a latitude of 26°48´ N and longitude of 95°50´E. The experimental soil was sandy clay in texture. The initial values of bulk density, water holding capacity, mean weight diameter and water stable aggregates of surface and sub-surface soil were 1.30 (Mg/m^3), 1.31 (Mg/m^3); 46.53%, 44.58%; 0.67 mm, 0.71 mm; 45.62% and 47.06%, respectively. Likewise, pH, organic carbon, cation exchange capacity and base saturation of surface and sub-surface soil were 5.01, 5.08, 0.45%, 0.30%, 5.17 ([cmol (p^+)/kg^1], 5.23 ([cmol (p^+)/kg^1], 44.80% and 44.93%, respectively. The experiment was laid out in randomized block design with seven treatments and three replications, as follows—T_1 : Control, T_2 : 100% NPK, T_3 : Biofertilizer based INM package, T_4 : 50% NPK + 50% N through FYM, T_5 : 75% NPK + 25% N through FYM, T_6 : 50% N (inorganic) + 50% N through FYM + PK (less present in FYM) and T_7 : 75% N (inorganic) + 25% N FYM + PK (less present in FYM).

The recommended level (100%) of N, P_2O_5 and K_2O based on soil testing were 60, 20 and 40 kg/ha applied in the form of urea, single super phosphate (SSP) and muriate of potash (MOP), respectively. The organic source used for integration was farm yard manure (FYM). Biofertilizer based INM package for

Table 1. Effect of integrated nutrient management on physical properties of soil in rice-niger sequence.

	Rice				Niger			
	Bulk density (Mg/m^3)		Water holding capacity (%)		Bulk density (Mg/m^3)		Water holding capacity (%)	
Treatments	0—15 cm	15—30 cm	0—15 cm	15—30 cm	0—15 cm	15—30 cm	0—15 cm	15—30 cm
T_1 : Control	1.31	1.42	42.46	41.20	1.64	1.90	41.87	41.00
T_2 : 100% NPK	1.28	1.39	43.32	41.33	1.60	1.83	42.00	41.05
T_3 : Biofertilizer based INM package	1.23	1.38	44.32	42.63	1.59	1.81	42.67	41.91
T_4 : 50% NPK + 50% N FYM	1.21	1.35	48.84	43.31	1.40	1.63	43.40	42.77
T_5 : 75% NPK + 25% N FYM	1.24	1.35	46.07	43.43	1.59	1.65	46.10	42.54
T_6 : 50% N (inorganic) + 50% N FYM + PK (less present in FYM)	1.22	1.37	44.77	43.17	1.58	1.71	43.26	42.54
T_7 : 75% N (inorganic) + 25% N FYM + PK (less present in FYM)	1.27	1.41	44.78	42.72	1.59	1.79	43.60	42.26
CD 0.05	NS	NS	NS	NS	NS	NS	NS	NS

rice was developed by the biofertilizer section of AAU. The N, P and K content of FYM are 0.486%, 0.610%, 1.13%, respectively. The amount of FYM needed for a particular treatment was calculated on the basis of their nitrogen content and applied as per the treatments. FYM was incorporated in the soil 15 days prior to transplanting of rice and 15 days before sowing of niger crop. Biofertilizer was applied at 3 kg/ha before transplanting of *kharif* rice following root dipped treatment and seed treatment in case of niger crop at least for 2 hours before sowing. At the time of transplanting of *kharif* rice, half of urea, whole of SSP and MOP were broadcast. The remaining urea was applied as top dressing in two splits, at the time of maximum tillering stage and panicle initiation stage. In niger, the whole of urea, SSP and MOP was applied as basal to the soil at the time of sowing. Nitrogen was applied based on N content of FYM in all the treatments except biofertilizer based INM package. In treatments T_6 and T_7, no inorganic P and K were supplied as the P and K contents of FYM were sufficient to supply the required amount. The treatment imposed in *kharif* and in *rabi* crop was same except the recommended dose (100% NPK). for *kharif* rice it was 60:20:40 kg and for *rabi* crop it was 20:10:10 kg N: p_2O_5 : K_2O per hectare, respectively. Soil samples were collected before and after harvest of rice and niger crop. The soil samples were then subjected to soil physical properties viz. bulk density and water holding capacity by Keen-Rackzowski Box method, mean weight diameter and water stable aggregate by modified Yoders wet sieving method of Van Bavel (1) and chemical properties viz. pH, organic carbon, cation exchange capacity and base saturation by following standard methods.

Table 2. Effect of integrated nutrient management on physical properties of soil in rice-niger sequence.

	Mean weight diameter (mm)		Water stable aggregates (%)	
Treatments	0—15 cm	15—30 cm	0—15 cm	15—30 cm
T_1 : Control	0.674	0.711	45.62	47.06
T_2 : 100% NPK	0.702	0.736	47.44	49.24
T_3 : Biofertilizer based INM package	0.790	0.778	47.80	50.14
T_4 : 50% NPK + 50% N FYM	0.794	0.799	55.84	62.14
T_5 : 75% NPK + 25% N FYM	0.786	0.777	51.68	56.26
T_6 : 50% N (inorganic) + 50% N FYM + PK (less present in FYM)	0.773	0.781	54.28	56.99
T_7 : 75% N (inorganic) + 25% N FYM + PK (less present in FYM	0.761	0.771	48.86	51.80
CD 0.05	0.06	0.05	0.53	0.31

Table 3. Effect of integrated nutrient management on chemical properties of soil after harvest of rice.

Treatments	pH		Organic carbon (%)		Rice CEC [cmol (p^+) kg]		Base saturation (%)	
	0—15 cm	15—30 cm	0—15 cm	15—30 cm	0—15 cm	15—30 cm	0—15 cm	15—30 cm
T_1 : Control	5.00	5.08	0.45	0.40	5.15	5.19	38.00	38.16
T_2 : 100% NPK	5.19	5.30	0.51	0.46	5.30	5.36	38.58	38.88
T_3 : Biofertilizer based INM package	5.31	5.40	0.62	0.55	5.45	5.49	39.41	39.65
T_4 : 50% NPK + 50% N FYM	5.32	5.44	0.74	0.65	5.52	5.54	39.36	39.65
T_5 : 75% NPK + 25% N FYM	5.54	5.66	0.68	0.61	5.45	5.51	39.54	40.61
T_6 : 50% NPK + 50% N FYM +PK (less present in FYM)	5.26	5.35	0.64	0.58	5.42	5.49	39.00	39.74
T_7 : 75% NPK + 25% N FYM + pk (less present in FYM)	5.20	5.34	0.52	0.48	5.38	5.43	38.80	39.25
CD 0.05	0.24	NS	0.06	0.03	0.04	0.06	NS	NS

Results and Discussion

Physical Properties of Soil

Bulk Density and Water Holding Capacity. Results revealed that there was a non-significant effect of treatments on bulk density and water holding capacity of surface (0—15cm) and sub-surface (15—30 cm) soils after the harvest of both rice and niger crop (Table 1). However, the lowest value for both surface and sub-surface soils was recorded in T_4 (50% of recommended NPK doses + 50% N through FYM) in both rice and niger crops. The reduction in bulk density in FYM applied plots might be ascribed to better aggregation. Similar results were reported by Muthuvel et al. (2) and Sheeba and Kumarswamy (3) who observed a decrease in bulk density with increase in organic matter content.

Water holding capacity was found to be higher under integrated nutrient treatment combination as compared to control and recommended NPK dose. The values of water holding capacity of the soil were higher in the surface soil than in the sub-surface layer. This might be attributed to the condition due to increased organic matter content of the soil and improvement in structural condition. These results are in confirmity with the findings of Bellakki and Badanur (4) and Sharma et al. (5).

Mean Weight Diameter and Water Stable Aggregates. A significant increase in the mean weight diameter and water stable aggregates was recorded in integrated treatments where FYM was applied along with NPK fertilizers (Table 2). The highest value was recorded in the treatment T_4 (50% NPK + 50% N FYM). This increase in FYM applied plots could mainly be the result of basal application of FYM which significantly improved organic matter resulting better soil aggregation (6). The improvement might also be attributed to the beneficial effect of certain polysaccharides formed during decomposition of organics Mishra and Sharma (7).

Chemical Properties of Soil

The pH Value. The integrated nutrient management approach brought about a little influence of the treatments on soil pH (Tables 3 and 4). pH value of the soil showed an increasing trend towards sub-surface layer. Data showed that integration of organic and inorganic fertilizer treatments resulted higher pH value over control and recommended fertilizer treatments. Among treatments, T_5 recorded the highest pH followed by T_4 and T_3 after rice and was at par with each other. Higher in soil pH might be due to the application of organic material which help in deactivation of Al^{3+} and concomitant release of basic cations that contributed in raising the pH values (8). No significant variation of pH values was observed after niger.

Organic Carbon. Significant increase in the organic carbon content was recorded after rice and niger crops in treatments where FYM had been applied along with NPK fertilizers (Tables 3 and 4). Among intergrated treatments, the highest value was recorded in the treatment T_4 (50% NPK + 50% N FYM). This

Table 4. Effect of integrated nutrient management on chemical properties of soil after harvest of niger.

Treatments	Niger							
	pH		Organic Carbon (%)		CEC [cmol (p^+)/ kg]		Base saturation (%)	
	0—15 cm	15—30 cm	0—15 cm	15—30 cm	0—15 cm	15—30 cm	0—15 cm	15—30 cm
T_1 : Control	4.81	5.04	0.46	0.44	4.64	4.98	37.59	38.26
T_2 : 100% NPK	4.88	5.08	0.56	0.54	5.00	5.04	38.63	38.95
T_3 : Biofertilizer based INM package	5.03	5.11	0.66	0.63	5.10	5.12	39.48	40.28
T_4 : 50% NPK + 50% N FYM	4.97	5.22	0.85	0.80	5.27	5.28	39.86	40.47
T_5 : 75% NPK + 25% N FYM	5.11	5.22	0.80	0.73	5.15	5.19	40.70	41.05
T_6 : 50% NPK + 50% N FYM + PK (less present in FYM)	4.90	5.20	0.72	0.68	5.20	5.20	39.34	43.47
T_7 : 75% NPK + 25% N FYM + PK (less present in FYM)	4.89	5.10	0.64	0.61	5.15	5.20	38.82	39.70
CD 0.05	NS	NS	0.12	0.11	0.14	0.09	NS	NS

increase might be due to addition of organic manure, which stimulated the growth and activity of microorganisma, and also due to better root growth (9). The effect was further enhanced by the addition of NPK fertilizers resulting in the improvement in root and shoot growth and thus higher production of biomass might have increased the organic carbon content (10).

Cation Exchange Capacity. Application of different integrated treatments brought a significant variation in cation exchange capacity of the soil (Tables 3 and 4). After rice, in surface layer, T_4 (50% NPK + 50% N FYM) exhibited the significantly highest content of the CEC compared to other treatments. On the other hand, after niger, all the integrated treatments (T_4, T_5, T_6 and T_7) were at par with each other in the layer of soil. This increase in CEC could be attributed to the improvement in the organic carbon content of the soil and also due to formation of humus as a result of decomposition of organic matter which might have increased the surface area and developed more negative charge due to dissociation of H^+ ion from functional groups. Such an increase was also reported by Basumatary and Talukdar (11).

Base Saturation. Different integrated nutrient management treatments had no significant effect on per cent base saturation (Tables 3 and 4). Though non-significant, the integrated treatments showed higher per cent base saturation as compared to control and recommended dose of fertilizer. This might probably be due to addition of FYM, which on decomposition released different proportion of Ca, Mg, Na and Na and K to the exchange sites and thus contributed to the higher base saturation. Irrespective of all treatments, at each depth for both the seasons, T_5 (75% recommended dose of inorganic fertilizer + 25% N FYM) exhibited the highest per cent base saturation.

The overall results thus show that integrated treatments involving both inorganic fertilizers and farm yard manure had pronounced influence in improving soil physical-chemical properties in Inceptisol of Assam.

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