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Effect of green manuring and biofertilizers on rice production

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ABSTRACT

A field experiment was conducted to evaluate the various components of integrated plant nutrient system on transplanted rice in plateau region of Jharkhand during wet seasons of 2006 to 2008. Combined application of 50% of recommended dose through chemical fertilizers and 25 % N through farmyard manure along with in situ green manuring and blue green algae improved growth and yield attributing characters resulted in an increase in yield of rice variety Lalat (19.3%) as compared to that of recommended fertilizer dose. Increase in nutrient uptake (21.4, 29.0 and 16.9 % of N, P and K, respectively) and improvement of the soil physico-chemical properties like organic carbon (0.34 to 0.44%), available N (220.3 to 254.0 kg ha^{-1}), P (21.2 to 25.8 kg ha^{-1}) and K status (153.0 to 159.0 kg ha^{-1}) were also recorded. The maximum net return (Rs 22160 ha^{-1}) and benefit-cost ratio of 2.23 were also noted under the combined nutrient application.

Key words : *rice, integrated nutrient management, green manuring, biofertilizers, nutrient uptake*

Agriculture in Jharkhand is mainly characterized by rice- fallow cropping system due to very low in irrigation potential. Production of rice in Jharkhand is 34.2 lakh tons with average productivity of 2.0 t ha^{-1} and area under rice is 16.8 lakh ha. The productivity of rice in Jharkhand is less as compared to the national average (2.2 t ha^{-1}). Soils of the plateau zone of the state mostly are deficient in available N, P, K and organic matter (Agarwal *et al*., 2010). The maintenance soil organic matter in optimum level is essential to retain soil fertility for sustaining crop productivity. Though this region receives abundant rainfall (1400 mm), low soil fertility status and poor nutrient management practices result low yield. In this context, integrated nutrient management system can play a vital role in balancing the soil fertility and plant nutrient supply to an optimum level through the judicious and efficient use of chemical fertilizers, green manure, FYM and biofertilizers leading to an ecofriendly approach and economically viable solution for this problem. The use of green manure, FYM or biofertilizer not only helps in supplementing requirement but also improves soil physical, chemical and biological properties (Yadav *et al*., 2009). Hence, the present investigation was carried out with the objective to study the performance of rice under different integrated nutrient management practice and to evaluate the effect of different INM practices on soil properties, yield and profitability.

MATERIALS AND METHODS

A field experiment was conducted during wet seasons from 2006 to 2008 at the research farm, Birsa Agricultural University, Ranchi. The soil was sandy loam in texture, low in available N, P and K with acidic pH of 6.1. Seven treatment combinations were adopted to find out the effective integrated nutrient management for increasing and sustaining the rice productivity. The seven treatments comprised of control (no NPK), 100% recommended dose (RDF) through chemical fertilizers, 50% NPK (RDF) + 50% N through farmyard manure (FYM), 50% RDF + 25% N FYM + green manuring with sannhemp (GM), 50% RDF +25% N FYM + GM + blue green algae (BGA), 50% N FYM + GM + BGA, 50% N FYM +GM + BGA + phosphate solubilizing bacteria (PSB) were laid out in randomized block design with 3 replications. FYM was applied as per treatment and incorporated at 15 days before transplanting (DBT) of rice. Sunnhemp (*Crotalaria juncea*) as green

manure (45 days old) was incorporated in situ at 15 DBT. The recommended dose of NPK (100:50:30) were applied through urea, single super phosphate and muriate of potash, respectively. Half amount of N as urea and full dose of P and K were applied as basal and the remaining N was applied in two equal splits at tillering and panicle initiation stages. The recommended agronomic practices including need based plant protection measures were followed to harvest maximum yield.

Data on leaf area at 60 days after transplanting, plant height, no. of tillers m^{-2}, grain and straw yield and yield attributing characters at harvest were recorded. Grain and straw were analyzed for N, P and K concentration during the year of experimentation following the standard procedures (Jackson, 1973). After completion of 3 years of experimentation, composite soil samples collected from the surface soil (0-15 cm) were analyzed for pH, organic carbon, available N, P and K following standard procedures.

RESULTS AND DISCUSSION

Data on growth parameters like leaf area index (LAI), plant height and effective tillers m^{-2} indicated significant effect of different treatments (Table 1). Application of 50% NPK through chemical fertilizers along with 25% N through FYM, green manuring and blue green algae recorded the highest plant height (81.48 cm) with effective tillers m^{-2} (382.63) and LAI (4.92) which was at par with 100% NPK (RDF) and 50% N FYM + GM + BGA but significantly superior to control and completely inorganically (100% NPK (RDF)) and organically fertilized (50% N FYM+GM+BGA+PSB) plots. The combined use of organic and inorganic sources of plant nutrients in varying proportions resulted better growth of the plants. This could be due to integration of biofertilizer and organic manures along with chemical fertilizers resulted in better mineralization of plant nutrients and copping better with the plant demand (Thakur and Kanwar, 1994).

Maximum panicle length (23 cm) and more number of grains $panicle^{-1}$ (113) were noted in 50% RDF + 25% N FYM + GM + BGA which was found significantly higher than that under control and completely chemically fertilized plot but remained at par with 25% N FYM + 50% RDF + GM, 50% N FYM + GM + BGA and 50% N FYM + GM + BGA + PSB. Data related to test weight showed non significant variation among the different treatments. The higher value of yield attributes in plot supplied with 50% NPK through chemical fertilizers with green manure, FYM and biofertilizer could be due to higher availability of nutrient and modifying soil environment for better retention of nutrient and water during the critical crop growth stages (Dass *et al*., 2009).

The highest grain (4.33 t ha^{-1}) and straw yield (5.99 t ha^{-1}) were observed in 50% RDF +25% N FYM + GM + blue green algae (BGA) treatment which

Table 1. Effect of integrated plant nutrient management on growth parameters and yield of rice (Pooled mean of 3 years)

Treatment	Leaf Area Index at 60 DAT	Plant height at harvest (cm)	Effective tillers m^{-2} at harvest	Panicle length (cm)	Number of grains $panicle^{-1}$	1000 grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
Control	2.16	69	220	18	58	21	1.84	2.77
100% NPK (RDF)	4.66	93	345	21	95	22	3.63	5.05
50% N FYM + 50% RDF	4.49	94	342	22	97	23	3.75	5.09
25% N FYM + 50% RDF + GM	4.78	95	368	23	106	23	4.04	5.68
50% RDF+25% N FYM+GM+BGA	4.92	91	383	23	113	23	4.33	5.99
50% N FYM + GM + BGA	4.11	97	375	23	102	22	3.80	4.98
50% N FYM +GM + BGA + PSB	4.35	89	340	23	104	22	3.95	5.22
CD (P = 0.05)	0.36	6.4	15.8	1.1	5.8	NS	0.56	0.81

RDF: Recommended fertilizer dose (100 kg N, 50 kg P_2O_5 and 30 kg K_2O ha^{-1}), FYM: Farmyard manure, GM: Green manuring through sannhemp, BGA: Blue green algae, PSB: Phosphate solubilizing bacteria and DAT: Days after transplanting

followed the similar trend of yield attributing characters. This might be due to easy and continuous availability of plant nutrients throughout the growing period resulting improvement in physical, chemical and biological properties of soil. Integrated application of organic and inorganic sources of nutrient in improving the yield of rice was reported by Mondal *et al*. (2004) and Sarwad *et al.* (2005), .

Table 2. Effect of integrated plant nutrient management on nutrient uptake by rice

Treatment	Nutrient uptake (kg ha^{-1})		
	N	P	K
Control	33.18	11.95	39.94
100% NPK (RDF)	72.16	24.55	80.60
50% N FYM + 50% RDF	84.36	27.59	88.43
25% N FYM + 50% RDF+GM	82.58	24.26	87.8
50% RDF+25% N FYM+GM+BGA	87.60	31.67	94.20
50% N FYM + GM + BGA	71.73	23.21	77.93
50% N FYM+GM+BGA+PSB	76.4	25.13	76.52
CD (P = 0.05)	10.73	2.76	8.77

RDF: Recommended fertilizer dose (100 kg N, 50 kg P_2O_5 and 30 kg K_2O ha^{-1}), FYM: Farmyard manure, GM: Green manuring through sannhemp, BGA: Blue green algae, PSB: Phosphate solubilizing bacteria and DAT: Days after transplanting

The highest N uptake (87.6 kg ha^{-1}), P uptake (31.67 kg ha^{-1}) and K uptake (94.20 kg ha^{-1}) were noted in 50% RDF +25% N FYM + GM + blue green algae (BGA) treatment which was at par with 50% NPK (RDF) + 50% N through farmyard manure (FYM), 50% RDF + 25% N FYM + green manuring with sannhemp (GM) and 50% N FYM +GM + BGA + phosphate solubilizing bacteria (PSB), but significantly superior to control, 100% recommended dose (RDF) through chemical fertilizers and 50% N FYM + GM + BGA indicating better utilization of applied nutrients under the combined application of inorganic and organic source of plant nutrients (Table 2). These findings are in agreement with the findings of Mondal and Chettri (1998).

Analysis of Physico-chemical properties of soil after 3 years of experimentation clearly indicated the effect of different treatment combinations on soil chemical properties (Table 3). The application of 50% NPK, 25% N through FYM, green manure and blue green algae increased the organic carbon, available N, P and K of soil. The highest value of organic carbon (0.44%), available N (254.0 kg ha^{-1}), available P (25.8 kg ha^{-1}) and available K (159.0 kg ha^{-1}) was recorded in 50% RDF +25% N FYM + GM + blue green algae (BGA) treatment. The soil pH under different treatments did not show significant variations. Available N, P and K content of soil increased in all the treated plots received nutrients through inorganic or combined sources as compared to their initial status. Improvement in soil physico-chemical properties might be due to direct application of organic manures along with chemical fertilizers and increased growth of the plant resulted in higher root biomass and its recycling. Similar effect of integrated nutrient management on soil properties was reported earlier by Sharma *et al*. (1985).

The highest net return (Rs 22,160) was recorded under the integrated application of 50% NPK,

Table 3. Soil physico-chemical properties after 3 years of experimentation.

Treatment	pH	Organic carbon (%)	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})
Control	6.2	0.29	188.4	17.8	138.0
100% NPK (RDF)	6.1	0.34	220.3	21.2	153.0
50% N FYM + 50% RDF	6.2	0.38	234.4	24.0	158.0
25% N FYM + 50% RDF + GM	6.3	0.42	240.3	22.0	157.0
50% RDF + 25% N FYM + GM + BGA	6.1	0.44	254.0	25.8	159.0
50% N FYM + GM + BGA	6.2	0.41	229.4	21.4	156.0
50% N FYM + GM + BGA + PSB	6.2	0.40	202.3	23.0	156.0
Initial	6.15	0.32	200.0	20.0	154.0

RDF: Recommended fertilizer dose (100 kg N, 50 kg P_2O_5 and 30 kg K_2O ha^{-1}), FYM: Farmyard manure, GM: Green manuring through sannhemp, BGA: Blue green algae, PSB: Phosphate solubilizing bacteria and DAT: Days after transplanting

Table 4. Effect of integrated plant nutrient management on economic return of rice 2006-2008

Treatment	Economic return (Rs ha^{-1})			
	Cost of cultivation	Gross return	Net return	B:C ratio
Control	13500	17474	3974	1.29
100% NPK (RDF)	16096	34105	18009	2.11
50% N FYM + 50% RDF	18798	34579	15782	1.83
25% N FYM + 50% RDF + GM	17748	37596	19848	2.11
50% RDF+25% N FYM+GM+BGA	17948	40108	22160	2.23
50% N FYM + GM + BGA	18650	34646	15996	1.85
50% N FYM +GM + BGA + PSB	18731	36130	17398	1.90

RDF: Recommended fertilizer dose (100 kg N, 50 kg P_2O_5 and 30 kg K_2O ha^{-1}), FYM: Farmyard manure, GM: Green manuring through sannhemp, BGA: Blue green algae, PSB: Phosphate solubilizing bacteria and DAT: Days after transplanting

25% N through FYM, green manure and blue green algae followed by the treatment 25% N FYM + 50% RDF + GM (Rs 19,848) (Table 4). All the integrated nutrient management treatment combinations recorded higher net returns over control (Rs 3,974). Benefit- cost ratio found maximum of 2.23 under 50% RDF+25% N FYM+GM+BGA showed the superiority of INM over control, completely organically or chemically fertilized plots.

From the above results, it could be concluded that integrated use of chemical fertilizer (50% RDF), FYM (25% N), green manure and blue green algae resulted in maximum yield and better N, P and K uptake. There was a build up in organic carbon and available N, P and K status of soil under the combined application of organic and inorganic sources of plant nutrients along with biofertilizers. Thus, the combined use of organic as well as inorganic source of plant nutrients could be a sustainable option for optimizing the yield of transplanted rice.

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