EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON RICE PRODUCTIVITY, PROFITABILITY AND SOIL FERTILITY

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ABSTRACT

A field experiment was conducted at experimental farm, annamalai university, annamalai nagar during 2012 and 2013 to study the effect of integrated nutrient management on rice productivity, profitability and soil fertility in eastern Himalayan region on a sandy loam soil. The experiment was laid out in ramdomized block design with 16 treatments with 3 replications. Among the organic sources, poultry manure (2.5 t ha^{-1}) was found to be most profitable in terms of productivity, profitability and sustaining soil fertility. The crop receiving 2.5 t poultry manure ha^{-1} along with 75 kg N +16.5 kg P + 31.3 kg K ha^{-1} improved yield attributes and yield (6.03 t ha^{-1}) as well as nutrient uptake and crop profitability (₹.366.28 /ha/day) over other treatments. The same treatment recorded significant improvement in soil organic carbon, nitrogen, phosphorus and potassium status of soil after harvest of the crop. The highest benefit: cost ratio (2.76) and returns (₹.47616 ha^{-1}) were recorded with 5 t Sesbenia green manure ha^{-1} + 75 kg N +16.5 kg P + 31.3 kg K ha^{-1} and 2.5 t poultry manure ha^{-1} + 125% CDF, respectively over other treatments. The lowest net returns (₹. 11508 ha^{-1}) and B: C ratios (1.66) were recorded under 5t Sesbenia green manure ha^{-1}.

Key words: Economics, organic manures, inorganic fertilizers, nutrient uptake, rice, yield.

INTRODUCTION

Among the cereals, rice *(Oryza sativa* L.) is the major source of calories for 40 % of the world population. In India, rice is cultivated on 44 million ha and contributing 104.32 million tonnes grain production with productivity of 2.37 t ha^{-1}.Cultivation of high yielding dwarf varieties responsive to fertilizer and excess use of inorganic fertilizers has depleted the inherent soil fertility. The decline or stagnation in yield has been attributed to nutrient mining and reduced use of organics (John *et al*. 2001). Several long-term experiments conducted all over India indicated a decrease in rice productivity due to continuous use of chemical fertilizers. Integrated nutrient management (INM) aims to improve soil health and sustain high level of productivity and production (Prasad et al, 1995). Singh and Kumar (2014) reported increased yield and nutrient use efficiency in rice with organics. Organic supply of nutrients at the peak period of absorption also provide micro nutrients and modify soil-physical behavior as well as increase the efficiency of applied nutrients (Pandey et al., 2007). The combined use of organic and inorganic fertilizers has been reported not only to meet the nutrients need of the crop but also has been fund to sustain large scale productivity goals (Yadav and Meena 2014) Crop fertilization refers to fertilizer application according to the crop demands, while soil fertilization is targeted to replenish its fertility level. So, the present investigation "integrated nutrient management on rice productivity, profitability and soil fertility" was undertaken to meet the urgent need of the farmers of eastern Himalayan Region.

MATERIALS AND METHODS

The field experiment was conducted 2012 and 2013 using paddy as test crop. The experimental site was located between 25.45^0 N latitude 93.53^0E longitudes with a mean altitude of 295 m above mean sea level. Temperature and relative humidity during the experiment ranged from 15.6^0C to 32.6^0C and 81% to 85%, respectively. The experiment was conducted in randomized block design in three replications with 16 treatments. The treatments consisted of different sources of organic manures and inorganic fertilizer viz., T_1 , 5 t *Sesbenia* green manure ha^{-1}, T_2 , 5t *Sesbenia* green manure ha^{-1}+ 75% CDF(chemical fertilizers dose), T_3, 5t *Sesbenia* green manure ha^{-1} + 100% CDF, T_4, 5t *Sesbenia* green manure ha^{-1} + 125% CDF FYM (5t ha^{-1}), T5, 5t FYM ha^{-1} , T6, 5t FYM ha^{-1} + 75% CDF, T7, 5t FYM ha^{-1} + 100% CDF, T_8, 5t FYM ha^{-1} + 125% CDF, T9 , 1t Vermicompost ha^{-1}, T_{10}, 1t Vermicompost ha^{-1} + 75% CDF, T_{11} ,1t Vermicompost ha^{-1} + 100% CDF, T_{12} , 1t Vermicompost ha^{-1} + 125% CDF, T_{13} ,2.5 t Poultry manure ha^{-1}, T_{14} ,2.5 t Poultry manure ha^{-1} + 75% CDF, T_{15},2.5 t Poultry manure ha^{-1}+ 100% CDF, T_{16}, 2.5 t Poultry manure ha^{-1}+ 125% CDF. The chemical dose of fertilizers used by the farmers in paddy was 60 kg N + 13.1 Kg P + 25.0 kg ha^{-1}. The percent N, P and K content of *Sesbenia* green manure, FYM, Vermicompost and poultry manure were 0.7-0.5-0.6, 0.50 - 0.29-

0.61, 1.20-0.65-0.80 and 1.52- 0.820.87%, respectively. Organic manures were applied before 15 days of transplanting. The soil fertility dynamics under various treatments were estimated by soil analysis of composite soil sample from each plot before transplanting and after harvesting of crop. The soil of the experimental site was sandy loam, acidic in reaction with pH 5.4, medium in organic carbon 6.7g kg^{-1}, deficient in nitrogen (156 kg ha^{-1}) moderate in phosphorus (22 kg ha^{-1}) and low in potassium (60 kg ha^{-1}). The experimental site comes under sub humid region where monsoon normally starts by the middle of April and extends up to September. The annual rainfall during crop growing was 1047.5 mm in 2010 and 1235.1 mm during 2013 which was less than annual average rainfall 1570 mm. The crop variety IET-16313 was transplanted when sufficient rain was received. The crop was harvested at maturity, dried in the sun and weighed for yield. Observations on yield and yield attributes viz. plant height, effective tillers, length of panicle were recorded. Economics was worked out by taking into account the cost of inputs and income obtained from produce (grain and straw yield). Minimum support price (Fixed by Government of India) of rice was ₹. 10800 t^{-1}. The N P and K uptake by the crop and available N P and K content of soil after two years of the experimentation was estimated with standard procedures (Jackson, 1973). Crop profitability (₹./ha/ day)=Net returns (₹.ha^{-1}) ÷ number of days field occupied.

RESULTS AND DISCUSSION

Growth and yield

Various sources of organic manure and inorganic fertilizers influenced positively the growth and yield of paddy (Table 1). The crop receiving higher amount of nutrients through organic or inorganic sources recorded higher growth and yield. Among the nutrient management practices, the crop receiving 2.5 t poultry manure ha^{-1} + 125% CDF (75 + 16.5 + 31.3 kg N P and K ha^{-1}) recorded the taller plants (112.27cm), higher effective tillers (14.60), panicle length (24.93cm), grain yield (6.03t ha^{-1}) and straw yield (9.41t ha^{-1}) closely followed by the 2.5 t poultry manure ha^{-1} + 100% CDF (60 +13.1 + 25 kg N, P and K ha^{-1} and 5t FYM ha^{-1} along with 125% CDF (75 + 16.5+ 31.3 kg N P and K ha^{-1}. The lowest growth and yield of paddy was found with application of organic manures alone as compared to integrated nutrient management practices. However, among the organic sources, addition of vermicompost (1t ha^{-1}) produced higher crop growth and grain yield closely followed by 2.5 t poultry manures ha^{-1} and 5t FYM ha^{-1}. This might be due to better and timely nutrient availability to the crop from the vermicompost as compared to other sources of organic manure. This is in conformity with the findings of Singh and Kumar (2014). The higher yield with increasing levels of fertilizers might be due to higher amount of nutrients added to soil Yadav and Meena, (2014) reported similar results. The favorable effect of integrated nutrient management through both inorganic fertilizers and organic manures on higher crop growth and yield was also reported by Kumar *et al.* (2008) and Savina Ahmed *et al.* (2014).

Table 1: Effect of different sources of organic manures and inorganic fertilizers on growth and yield of rice

Treatments	Plant height (cm)	No of tillers	Length of panicle (cm)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
5t *Sasbenia* green manure ha^{-1}	93.03	13.0	17.03	2.23	4.02
5t *Sasbenia* green manure ha^{-1}) + 75% CDF	107.40	13.6	22.00	4.07	7.12
Sasbenia green manure (5t/ha) + 100% CDF	110.33	13.9	23.20	4.43	7.45
5t *Sasbenia* green manure ha^{-1}) + 125% CDF	114.50	14.1	23.73	4.93	7.89
5 t FYM ha^{-1}	93.30	12.4	16.20	3.07	5.52
5 t FYM ha^{-1} + 75% CDF	103.50	13.5	17.37	4.63	7.88
5 t FYM ha^{-1} + 100% CDF	106.27	14.0	22.07	4.90	8.18
5 t FYM ha^{-1} + 125% CDF	110.37	14.3	23.23	5.37	8.59
1 t Vermi compost ha^{-1}	93.70	13.3	17.37	4.33	7.37
1 t Vermi compost ha^{-1}+ 75% CDF	104.63	14.0	22.93	4.83	7.73
1 t Vermi compost ha^{-1}+ 100% CDF	105.03	14.3	23.97	5.17	8.11
1 t Vermi compost ha^{-1}+ 125% CDF	110.30	14.5	24.75	5.53	8.69
2.5t Poultry manure ha^{-1}	92.47	12.7	17.27	3.87	6.57
2.5t Poultry manure ha^{-1}+ 75% CDF	107.47	13.7	23.67	5.33	8.53
2.5t Poultry manure ha^{-1}+ 100% CDF	110.40	14.5	24.63	5.60	8.85
2.5t Poultry manure ha^{-1}+ 125% CDF	112.27	14.6	24.93	6.03	9.41
SEm ±	2.15	0.5	0.48	0.09	0.15
CD (P=0.05)	6.24	1.3	1.40	0.25	0.43

Table 2: Effect of different sources of organic manure and inorganic fertilizer on nitrogen, phosphorous and potassium uptake (kg ha^{-1}) by rice grain and straw

Treatments	Nitrogen		Phosphorous		Potassium	
	Grain	straw	Grain	straw	Grain	straw
5t *Sasbenia* green manure ha^{-1}	17.8	20.1	6.4	4.0	8.9	54.2
5t *Sasbenia* green manure ha^{-1}) + 75% CDF	36.6	36.3	12.2	7.8	17.0	96.7
Sasbenia green manure (5t/ha) + 100% CDF	44.3	38.7	13.7	8.9	19.0	102.0
5t *Sasbenia* green manure ha^{-1}) + 125% CDF	54.2	41.8	15.7	10.2	21.7	108.9
5 t FYM ha^{-1}	24.5	27.6	8.8	5.5	12.2	74.5
5 t FYM ha^{-1} + 75% CDF	41.7	40.1	13.9	8.6	19.4	107.1
5 t FYM ha^{-1} + 100% CDF	49.0	42.5	15.1	9.8	21.0	112.1
5 t FYM ha^{-1} + 125% CDF	59.0	45.5	17.1	11.1	23.6	118.5
1 t Vermi compost ha^{-1}	34.6	36.8	12.5	7.3	17.3	99.4
1 t Vermi compost ha^{-1}+ 75% CDF	43.5	39.44	14.5	8.5	20.3	105.1
1 t Vermi compost ha^{-1}+ 100% CDF	51.6	42.1	16.0	9.7	22.2	111.1
1 t Vermi compost ha^{-1}+ 125% CDF	60.8	46.0	17.7	11.3	24.35	119.8
2.5t Poultry manure ha^{-1}	30.9	32.8	11.2	6.5	15.47	88.7
2.5t Poultry manure ha^{-1}+ 75% CDF	48.0	43.5	16.0	9.3	22.40	116.0
2.5t Poultry manure ha^{-1}+ 100% CDF	56.0	46.0	17.3	10.6	24.08	121.2
2.5t Poultry manure ha^{-1}+ 125% CDF	66.3	49.8	19.3	12.2	26.55	129.8
SEm ±	0.8	0.7	0.3	0.2	0.37	2.0
CD (P=0.05)	2.4	2.2	0.8	0.5	1.06	5.8

Nutrient uptake

The effect of organic manures and chemical fertilizers was significant on the uptake of N, P and K by the crop (Table 2). The highest uptake of these nutrients was recorded in the treatment combination 125% CDF and 2.5t poultry manure ha^{-1} closely followed by 125% CDF + 1t vermicompost ha^{-1} and 125% CDF + 5t FYM ha^{-1}. This might be ascribed to greater dry matter production as well as nutrient concentration with combined use of organic and inorganic fertilizers. Better performance under these treatments might also be due to favorable soil environment, which encouraged better root proliferation and ensured higher nutrient uptake.

These results corroborate with the findings of Sabina Ahmed *et al.* (2014). The organic manures recorded comparatively lower uptake of N, P and K as compared to integration of organic manures with inorganic fertilizers. This might be due to slow mineralization of organic manures as they could not supply the nutrient to the crop timely as well as higher yield of the crop with the integration of organic and inorganic sources of nutrients.

Table 3: Effect of different sources of organic manure and inorganic fertilizers on economics of rice

Treatment	Gross return (₹.ha^{-1})	Net return (₹. ha^{-1})	B: C ratio	Crop profitability (₹. ha/day)
5t *Sasbenia* green manure ha^{-1}	28908	11508	1.66	88.52
5t *Sasbenia* green manure ha^{-1}) + 75% CDF	52500	31899	2.55	245.38
Sasbenia green manure (5t/ha) + 100% CDF	56784	35116	2.62	270.12
5t *Sasbenia* green manure ha^{-1}) + 125% CDF	62712	39977	2.76	307.52
5 t FYM ha^{-1}	39780	17380	1.78	133.69
5 t FYM ha^{-1} + 75% CDF	59460	34924	2.42	268.65
5 t FYM ha^{-1} + 100% CDF	62736	36068	2.35	277.45
5 t FYM ha^{-1} + 125% CDF	68304	39504	2.37	303.88
1 t Vermi compost ha^{-1}	55608	28208	2.03	216.98
1 t Vermi compost ha^{-1}+ 75% CDF	61440	31906	2.08	245.43
1 t Vermi compost ha^{-1}+ 100% CDF	65568	33900	2.07	260.77
1 t Vermi compost ha^{-1}+ 125% CDF	70152	36350	2.08	279.62
2.5t Poultry manure ha^{-1}	49680	27280	2.22	209.85
2.5t Poultry manure ha^{-1}+ 75% CDF	67800	43264	2.76	332.80
2.5t Poultry manure ha^{-1}+ 100% CDF	71100	44432	2.67	341.78
2.5t Poultry manure ha^{-1}+ 125% CDF	76416	47616	2.65	366.28

DHAINSA @₹.1/-; FYM@₹.2/- V.C @₹.8/-PM@₹.2/-; 60-30-30NPKIC UREA: 123 KG @ RS. ₹./= 1230; SSP =2437/-MOP =601/- TOTAL₹=4268/-

Soil fertility

The organic carbon, available nitrogen, phosphorus and potassium status of soil after harvest of the crop increased due to application of 125 % CDF or through integrated application of inorganic fertilizers and organic manure. The plot receiving 2.5 t poultry manure ha^{-1} + 125% CDF registered highest available organic carbon, N, P and K status in the soil. The application of organic manures along with inorganic fertilizers (Table-4) increased soil organic carbon (7.8-9.4 g kg^{-1}) nitrogen (166.6-203.0 kg ha^{-1}), phosphorus (23.3-32.6 kg ha^{-1}) and potassium (61.092.3 kg ha^{-1}). Addition of inorganic fertilizers along with organic manures helps in mineralization which resulted in rapid conversion of organically bound forms of nutrients to organic forms, however, it was observed that crop receiving same source of organic manures along with different levels of inorganic fertilizers did not vary significantly in respect of organic carbon content of soil. Such favorable effect of integrated nutrient management on increasing the available N, P and K content in soil were noticed by Kumar *et al.* (2008).

Economics

The results showed that the gross return and net return (₹. 76416/- and ₹. 47616/-) were markedly higher with 125% CDF + 2.5 t poultry manure ha^{-1} closely followed by 100% CDF + 2.5 t poultry manure ha^{-1} and 75 % CDF + 2.5 t poultry manure ha^{-1} (Table 3). However, higher benefit cost ratio (2.76) was recorded with 125% CDF + 5 t *Sasbenia* green manure ha^{-1} and 75% CDF + 2.5 t poultry manure ha^{-1} The highest crop profitability (' 366.28/- /day/ha) was recorded with 125% CDF + 2.5 t of poultry manure ha^{-1}. This trend in economic return is mainly due to the treatment effect on the grain and stover yield of rice.

Table 4: Status of organic carbon, available N, P_2O_5 and K_2O in post harvest soil

Treatments	O.carbon (g kg^{-1})	Available N (kg ha^{-1})	Available P_2O_5 (kg ha^{-1})	Available K_2O (kg ha^{-1})
5t *Sasbenia* green manure ha^{-1}	7.8	166.6	23.3	61.0
5t *Sasbenia* green manure ha^{-1}) + 75% CDF	7.9	181.6	28.1	74.0
Sasbenia green manure (5t/ha) + 100% CDF	8.1	193.3	28.4	78.6
5t *Sasbenia* green manure ha^{-1}) + 125% CDF	8.8	198.7	29.0	80.0
5 t FYM ha^{-1}	8.1	182.0	25.7	81.6
5 t FYM ha^{-1} + 75% CDF	8.6	188.6	26.8	73.8
5 t FYM ha^{-1} + 100% CDF	8.9	198.1	27.7	78.5
5 t FYM ha^{-1} + 125% CDF	9.0	202.3	28.1	80.5
1 t Vermi compost ha^{-1}	7.9	185.0	23.5	80.6
1 t Vermi compost ha^{-1}+ 75% CDF	8.2	192.3	24.7	82.6
1 t Vermi compost ha^{-1}+ 100% CDF	8.5	198.0	25.3	86.5
1 t Vermi compost ha^{-1}+ 125% CDF	8.2	202.5	26.6	90.0
2.5t Poultry manure ha^{-1}	7.7	183.5	25.6	79.6
2.5t Poultry manure ha^{-1}+ 75% CDF	8.9	192.6	28.8	88.3
2.5t Poultry manure ha^{-1}+ 100% CDF	9.2	197.3	31.00	90.3
2.5t Poultry manure ha^{-1}+ 125% CDF	9.4	203.0	32.0	92.3
SEm±	0.2	2.35	0.59	0.9
CD	0.6	6.82	1.71	2.7

From the study, it can be concluded that application of 75 kg N +16.5 kg P + 31.3 kg K ha^{-1} + 2.5 t poultry manure ha^{-1} was found to be most effective for sustainable rice production, profitability and soil fertility. However, incorporation of 5 t *Sesbenia* green manure ha^{-1} + 75 Kg N +16.5 Kg P + 31.3 kg K ha^{-1} may be opted for getting higher benefit: cost ratio.

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