Integrated Nutrient Management in Transplanted Rice (*Oryza sativa* L.)

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Abstract

A[1] field experiment was conducted during the rainy season on heavy black clayey soils for 13 years (1995-2007) at Vyara, to study effect of integrated nutrient management on transplanted rice (*Oryza sativa*) productivity. The experiment was conducted with various quantity of pressmud (5,10,15,20t/ha); farmyard manure-FYM (10 t/ha) along with recommended dose of fertilizer(RDF) and without organics(only RDF). The rice grain and straw yield was significantly higher with integrated nutrient application (pressmud @ 20 t/ha + RDF), which remain on par with pressmud @ 15 t/ha + RDF or FYM@ 10 t/ha + RDF. The growth and yield attributing characters as well as soil and plant analysis results has not affected, except organic carbon and available P status of soil. The highest net return was with inorganic fertilizer than INM treatments. Similar trend was observed in BCR value.

Among the cereals, rice (*oryza sativa* L.) is the major source of calories for 40 per cent of the world population. In India, it cultivated on 44 million ha and contributing 99 million tonnes grain production (Government of India, New Delhi, 2009). Cultivation of high yielding dwarf varieties responsive to fertilizer and irrigation in intensive cropping after green revolution with continuous 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 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). Sharma (2002) reported increased yield and nutrient use efficiency in rice with organics. Organics supply nutrients at the peak period of absorption, and also provide micro nutrients and modify soil- physical behavior as well as increase the efficiency of applied nutrients (Pandey *et al*.,2007). Farmyard manure (FYM) is being used as major source of organic manure in field crops as it supplies all essential plant nutrients and increases activities of microbes in soil (Sutaliya and Singh, 2005). Limited availability of FYM is however an important constraints in its uses as source of nutrients. Sharma *et al.*, (2006) reported 5-6 million tonnes annual pressmud production from sugar industries. Pressmud is being advocated as good organic manure for use in field crops (Kumawat and Jat, 2005). Keeping this in view a field experiment has conducted to find out effect of integrated nutrient management on transplanted rice productivity.

Materials and Methods

A field experiment was conducted for 13 years (1995-2007) during *kharif* season at Regional Rice Research Station, Navsari Agricultural University, Vyara to study the effect of integrated nutrient management on productivity of transplanted rice. The soil sample for initial soil quality was done prior to *kharif* 2005. The soil was deep heavy black clayey; Neutral (pH 7.3); non-saline ($Ec_{2.5}$ 0.23 ds/m); low in organic carbon (0.43%); medium in available phosphorus (48 kg P/ha) and high in potassium (275 kg K/ha). The experiment was laid out in randomized block design with 6 treatments and four replications. The six treatments were (i) Pressmud @ 5t/ha + Recommended dose of fertilizer (RDF; 80:30:0 kg NPK/ha); (ii) Pressmud @ 10t/ha + RDF; (iii) Pressmud@ 15 t/ha +RDF; (iv) pressmud @ 20t/ha + RDF (v) Farm yard manure (FYM) @ 10 t/ha + RDF (vi) RDF alone. Pressmud and FYM were incorporated a week before transplanting of rice seedlings. Recommended dose of fertilizer (RDF) were applied as whole amount of P (30 kg/ha) as basal through DAP, where as N (80 kg/ha) was applied in 3 split *viz*., 40 per cent basal, 40 per cent at active tillering and 20 per cent at panicle-initiation stage to all the treatments through ammonium sulphate. Quantity of N fertilizer in basal dose was adjusted after deducting N available from DAP applied in basal Twenty two to twenty six days old 2-3 seedlings of early maturing (90-100 days duration) rice variety 'GR-3' was transplanted in puddled field at a spacing of 20 x 15 cm during July and harvested in October during all the years. All other agronomical as well as plant protection measures were taken as per recommended schedule of practices. Growth, yield components and grain

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and straw yields were recorded at harvest for all the years and the data were statistically analyzed. The soil and plant analysis as per standard procedure were carried out for last three years experiment

Results and Discussion

Growth and Yield components: None of the growth and yield parameters was significantly influenced by the treatments (Table 1). However, maximum plant height was observed with integrated nutrient treatment than without organic treatment (T_6). The growth was mainly influenced by nitrogen fertilization and all the treatments received similar quantity of chemical nitrogen. This make initial N availability from fertilizer nitrogen encouraged better primary growth; while slow release of nutrients after decomposition of organics (FYM and pressmud) sustaining the growth which could have no effect on initial plant growth. Therefore, there was no significant difference in growth and yield components.

*Grain and straw yield :*The application of pressmud @ 20 t/ha along with recommended dose of fertilizer, RDF (T_4) gave the highest grain yield (Table 2) which was on par with that of pressmud @ 15 t/ha +RDF (T_3) in 2000 and 2005 and with or FYM @ 10 t/ha + RDF (T_5) in 1995. Pooled data of 13 years showed that treatment T_4 (pressmud @ 20 t/ha + RDF) gave the highest yield (5.36 t/ha) which remain statistically on part with treatment T_5 (FYM 10 t/ha + RDF). The treatment without organic (T_6 only RDF) had lower grain yield, which remain on par with pressmud @ 5 t/ha +RDF (T_1) and pressmud @ 10 t/ha +RDF (T_2). This might be due to improvement in nutrient supply with more organics, which improves soil physico-chemical and biological properties by providing essential food to microbes (Sutaliya and Singh,2005) It also increased the activity of soil enzymes responsible for the conversion of unavailable form of nutrients to available form (Singh *et al.*,2006). Similar results were also reported by Pandey and Tripathi (1993); Salik and Shah (1999); Surekha (2007). Out of 13 years result only 3 years (1995,2000 and 2007) were significant, during all the three years, treatment with higher dose of pressmud @ 20 t/ha along with RDF (T_4) resulted in the highest paddy grain yield while only RDF application treatment (T_6) gave lower yield. The trend of straw yield was almost identical to that of grain yield (Table 2). Relatively higher yield with sufficient quantity of organics is due to its nature of providing balanced supply of all the essential nutrients, which synchronizes with crop needs, uptake and thus result in significantly higher grain yield over inorganic fertilizers (Ghosh,2007). Prasad (1985) also observed higher rice yields due to combined application of green manure and fertilizer N than fertilizer N alone.

Economics: The cost of cultivation increased with increase in quantity of organics (Table 1). Owing to the various treatments, the cost of cultivation was lower for only inorganic fertilizers treatment (RDF only). It was the highest with treatment in which pressmud was applied @ 20 t/ha along with RDF (Rs. 23780). Net return reported with organics indicated loss of Rs. 1683 to Rs. 3596 as campered to only RDF. However, benefits of organics applied have been inherent in soil health improvement, which are not calculated in terms of money. The gross income received under various treatments revealed that pressmud application @ 15 and 20 t/ha have almost similar and higher gross income as compare to other remaining treatments. Owing to the production and comparatively lower cost the net return were the highest under only RDF treatment (T_6) and lowest with higher dose of pressmud @ 20 t/ha, while all other treatments recorded almost similar net return value. The B:C ratio of only inorganic fertilizer level(T_6) was higher than other treatments. Pandey *et al.* (2007) also reported similar results.

Nutrient Uptake : The pooled result of nutrient uptake indicated that application of organics along with RDF gave numerically higher uptake value of N.P.K. than only RDF treatment in grain, straw and total uptake (Table 3). However result were not significant. This might be due to the realization of higher yield with organic sources. Application of FYM might have modified the physical condition of the soil and helped in absorption and translocation of nutrients from the soil. Such results are obvious, as application of fertilizer in combination with organic manures is known to improve various physico-chemical properties resulting in enhanced nutrient absorption or uptake. These findings confirm those of Singh(2006) and Pandey *et al.* (2007).

Fertility status of soil: The Figure-1,2,a nd 3 showed built up of organic carbon, available P_2O_5 and K_2O content in soil in all the treatments except in treatment T_6 (only RDF). Higher values of soil nutrient status were observed with higher rate of pressmud or FYM application. Increase in soil organic carbon was 0.2 to 0.11%, available P_2O_5 was 14.25 to 23.54 kg/ha, available K_2O was 32 to 49 kg/ha than the initial value. It was also observe that available K_2O status of soil reduced (11 kg/ha) in only RDF treatment. It is indicated that organic manure improves organic carbon status of soil, which is the most important component of soil.

Table 1: Effect of different treatments on growth and economics of paddy

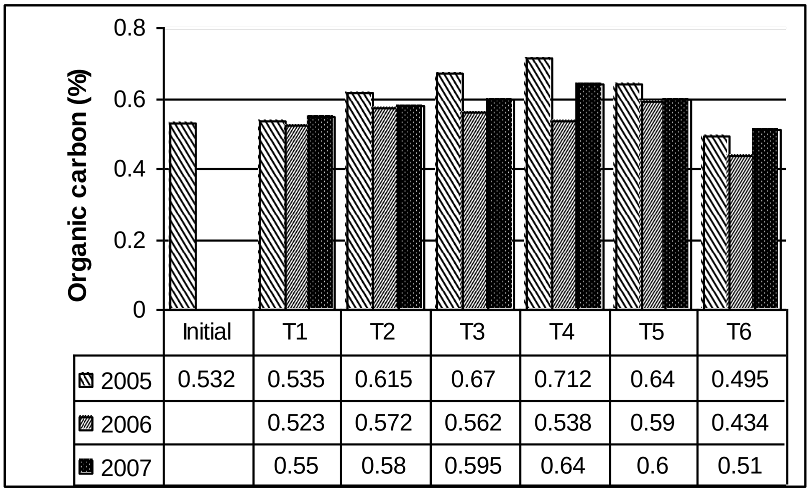
Treatments	Plant height (cm)	Number of Effective tiller (per m^2)	Panicle length (cm)	Pooled yield paddy (x 10^3 kg/ha)		Cost of cultivation (x 10^3 Rs./ha)	Net income (x 10^3 Rs./ha)	BCR
				Grain	Straw			
T_1	100	329	23.69	5.041	5.695	19.48	20.76	1:1.07
T_2	100	326	23.41	5.102	5.749	21.05	19.11	1:0.91
T_3	100	331	23.59	5.214	5.838	22.66	19.66	1:0.87
T_4	100	330	23.77	5.358	5.952	23.78	18.84	1:0.79
T_5	101	327	23.75	5.246	5.787	20.98	19.91	1:0.95
T_6	99	327	23.27	5.069	5.597	17.78	22.44	1:1.26
SEm±	0.54	6	0.16	0.045	0.078			
CD(P=0.05)	NS	NS	NS	0.125	0.217			

Table 3: Effect of different treatments on NPK uptake (kg/ha) by of paddy

Treatments	N		P		K	
	Grain	Total	Grain	Total	Grain	Total
T_1	45.13	70.81	5.42	8.94	9.48	80.22
T_2	45.86	69.31	5.44	9.07	9.67	81.97
T_3	45.85	74.18	6.01	9.72	10.36	81.21
T_4	48.76	73.30	6.16	9.94	10.45	79.21
T_5	47.21	69.94	5.51	9.01	9.48	78.81
T_6	45.21	68.29	5.66	9.18	9.63	76.04
SEm±	1.30	1.85	0.23	0.43	0.25	2.16
CD(P=0.05)	NS	NS	NS	NS	NS	NS

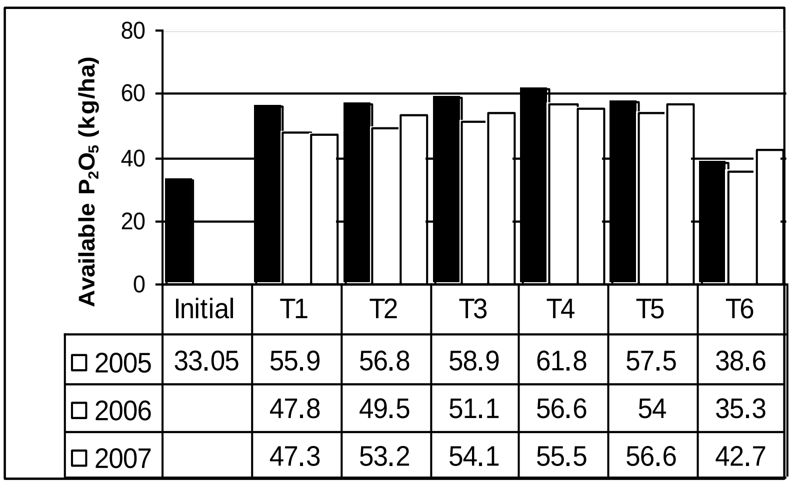
Table 2: Effect of different treatments on grain and straw yield of paddy (t/ha)

Treatment	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Pooled
							Grain yield							
T_1	3.691	4.647	4.872	6.271	5.175	6.068	6.752	5.149	4.808	4.637	4.743	4.102	4.615	5.041
T_2	3.835	4.767	4.743	6.303	5.340	5.919	7.130	5.620	4.743	4.530	4.743	3.996	4.658	5.102
T_3	3.910	4.885	4.530	6.624	5.004	6.229	7.276	5.620	4.808	4.615	4.850	4.273	5.171	5.214
T_4	4.250	4.833	4.701	6.656	5.444	6.410	7.489	5.449	4.872	5.021	4.872	4.316	5.342	5.358
T_5	4.156	4.767	4.551	6.752	5.575	5.993	7.692	5.385	4.786	4.722	4.808	4.295	4.722	5.246
T_6	4.060	4.592	4.423	6.218	5.224	5.780	6.923	5.427	4.786	4.893	4.765	4.295	4.508	5.069
SEm±	0.025	0.112	0.131	0.161	0.258	0.105	0.155	0.235	0.153	0.146	0.083	0.177	0.173	0.045
CD(P=0.05)	76	NS	NS	NS	NS	317	NS	NS	NS	NS	NS	NS	0.523	0.125
							Straw yield							
T_1	4.679	5.812	6.838	6.410	4.914	8.974	6.688	5.342	4.722	5.342	4.914	4.487	4.914	5.695
T_2	4.607	6.068	6.838	6.517	4.914	9.081	6.688	5.128	4.914	5.555	5.021	4.701	4.701	5.749
T_3	4.783	6.389	6.624	6.517	4.701	9.515	6.923	5.341	4.914	5.555	4.914	4.273	5.342	5.838
T_4	5.064	6.261	6.838	6.923	4.914	10.256	6.944	5.555	4.914	5.555	4.914	4.102	5.128	5.952
T_5	5.000	5.555	6.410	7.008	5.128	9.615	6.923	5.342	4.701	5.555	5.021	4.060	4.914	5.787
T_6	4.786	5.213	6.196	6.453	4.701	9.508	6.196	5.342	5.128	5.342	5.128	4.273	4.487	5.597
SEm±	0.043	0.218	0.729	0.177	0.351	0.232	0.097	0.196	0.237	0.255	0.137	0.253	0.281	0.078
CD(P=0.05)	0.131	0.660	NS	NS	NS	0.699	0.293	NS	NS	NS	NS	NS	NS	0.217



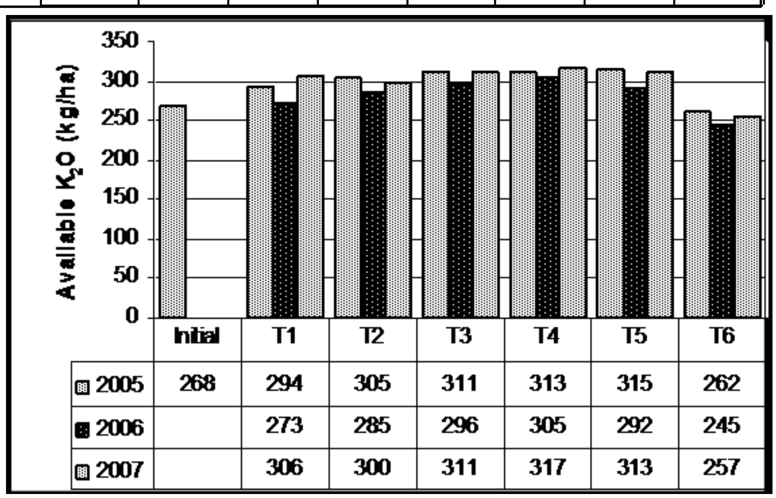
	Initial	T1	T2	T3	T4	T5	T6
2005	0.532	0.535	0.615	0.67	0.712	0.64	0.495
2006		0.523	0.572	0.562	0.538	0.59	0.434
2007		0.55	0.58	0.595	0.64	0.6	0.51

Fig. 1 Effect of different treatments on organic carbon content in soil after harvest of the crop



	Initial	T1	T2	T3	T4	T5	T6
□ 2005	33.05	55.9	56.8	58.9	61.8	57.5	38.6
□ 2006		47.8	49.5	51.1	56.6	54	35.3
□ 2007		47.3	53.2	54.1	55.5	56.6	42.7

Fig. 2 Effect of different treatments on available P_2O_5 content in soil after harvest of the crop



	Initial	T1	T2	T3	T4	T5	T6
2005	268	294	305	311	313	315	262
2006		273	285	296	305	292	245
2007		306	300	311	317	313	257

Fig. 3 Effect of different treatments on available K_2O content in soil after harvest of the crop

Organic carbon will help to increase microbial population in the soil and there by biological activity of soil increase which improve availability of plant nutrients (Singh et al., 2006; Yadav et al.,2005;Pandey et al.,2007).

It is concluded that integrated nutrient management improved rice grain and straw yield.

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