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Integrated nutrient management in transplanted rice(*Oryza sativa* L.)

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ABSTRACT

A field experiment was conducted during the rainy season on heavy black clayey soils for 13 years (1995-2007) at Vyara, Gujarat to the study effect of integrated nutrient management on transplanted rice (*Oryza sativa*) productivity. The experiment was comprised of 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 remained at 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 were not affected, except organic carbon and available P status of soil. The highest net return was reported with inorganic fertilizer than INM treatments. Similar trend was observed in BCR value also.

Key words : Transplanted rice, Pressmud, FYM, NPK uptake, INM

INTRODUCTION

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 45 million ha and contributing 84 million tonnes grain production (Government of India, New Delhi, 2005). Cultivation of high yielding dwarf varieties responsive to fertilizer and irrigation in intensive cropping after green revolution with continuous and excess use of inorganic fertilizer alone has depleted the inherent soil fertility and soil health leading to deficiency of important plant nutrients. It will also encourage environmental pollution and degrade the quality of the produce. 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) has an important role, which improves efficiency substantially to maintain a high level of productivity and rice production (Prasad *et al*., 1995). Organics supply nutrients at the peak period of absorption, but also provides micro nutrients and modifies soil- physical behavior as well as increase the efficiency of applied nutrients (Pandey *et al*., 2007) and there by productivity of crops. Farm yard manure (FYM) is being used as major source of organic manure in field crops and role of it in crop production cannot be over looked, in addition to supplying all essential plant nutrients it increases activities of bacteria or 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 has advocated as good organic manure for use in field crops (Kumawat and Jat, 2005). Keeping this in view, a field experiment has been 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-394 650 to study the effect of integrated nutrient management on transplanted rice. The soil sample for initial soil quality has done before *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@5 t/ha + Recommended dose of fertilizer (RDF, 80:30:0 kg NPK/ha), (ii) Pressmud @ 10 t/ha + RDF, (iii) Pressmud@ 15 t/ha +RDF, (iv) pressmud @ 20 t/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 as basal. Twenty two to twenty six days old 2-3 seedlings of early maturing (90-100 days duration) rice variety 'GR-3' were transplanted in puddled field at a spacing of 20 cm x 15 cm during July and harvested in

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October 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 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

The results obtained from the present investigation as well as relevant discussion have been presented under following heads:

Growth and yield components:

None of the growth and yield parameters has significantly influenced by the treatments (Table 1). However, maximum plant height was observed with integrated nutrient treatment than without organic treatment (T_6). The enhancement in growth with increase in fertility was owing to rapid conversion of synthesized photosynthates into protein to form more protoplasm, thus increasing the number and size of cell, which might have increased the plant height. The growth has 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 at par with that of pressmud @ 15 t/ha +RDF(T_3) in 2000 and 2005 and with FYM @ 10 t/ha + RDF(T_5) in 1995. The grain yield in paddy in pooled of 13 years showed that treatment T_4 (pressmud @ 20 t/ha + RDF) reported significantly highest yield (5.36 t/ha) which remained statistically at par with treatment T_5 (FYM 10 t/ha + RDF). The treatment without organic (T_6 only RDF) gave lower grain yield, which remained at 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 improve soil physico-chemical and biological properties by providing essential food to microbes (Sutaliya and Singh, 2005). Increased activity of heterotrophic bacteria and fungi in soil, in turn increase the activity of soil enzymes responsible for the conversion of unavailable form of nutrients to available form (Singh *et al.*, 2006) which reflect ultimately on the yield of rice. Similar result was also reported by Pandey and Tripathi (1993), Salik Ram and Sanjay (1999) and 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 highest paddy grain yield. 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 might be due to its nature of providing balanced supply of all the essential nutrients, which synchronize with crop needs, uptake and thus result in significantly higher grain yield over inorganic fertilizers (Ghosh, 2007). Prasad and Prasad (1995) 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

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
S.E.±	0.54	6	0.16	0.045	0.078			
CD(P=0.05)	NS	NS	NS	0.125	0.217			

NS = Non significant

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
S.E.±	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
C.D.(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
S.E.±	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
C.D.(P=0.05)	0.131	0.660	NS	NS	NS	0.699	0.293	NS	NS	NS	NS	NS	NS	0.217

NS = Non significant

inorganic fertilizers treatment (RDF only). It was the highest with treatment in which pressmud was applied @ 20 t/ha along with RDF (Rs. 23780). However, benefits of organics applied have been inherent in soil health improvement, which 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 numerical higher uptake value of N.P.K. than only RDF treatment in grain straw and total uptake (Table 3), however result were non significant. This might be due to the realization of higher yield with organic sources. As application of FYM might have modified the physical condition of the soil and helped in its absorption and translocation from the soil. Such results are obvious, as application of fertilizer in combination with organic manures 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 Fig.1, 2 and 3 showed built up of organic carbon,

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
S.E.±	1.30	1.85	0.23	0.43	0.25	2.16
C.D.(P=0.05)	NS	NS	NS	NS	NS	NS

NS = Non significant

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 initial. It was also observed that available K_2O status of soil reduced (11 kg/ha) in only RDF treatment than initial. It has indicated that organic manure improves organic carbon status of

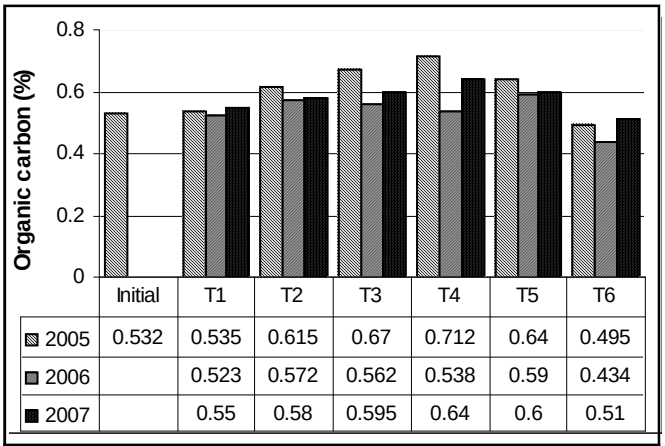

Fig. 1: Effect of different treatments on organic carbon content in soil after harvest of the crop

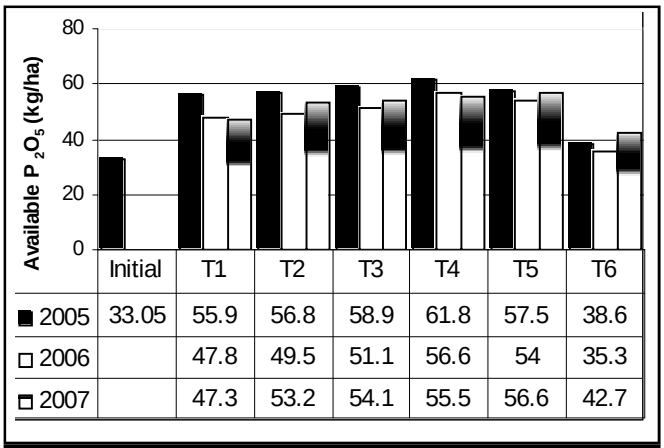

Fig. 2 : Effect of different treatments on available P_2O_5 content in soil after harvest of the crop

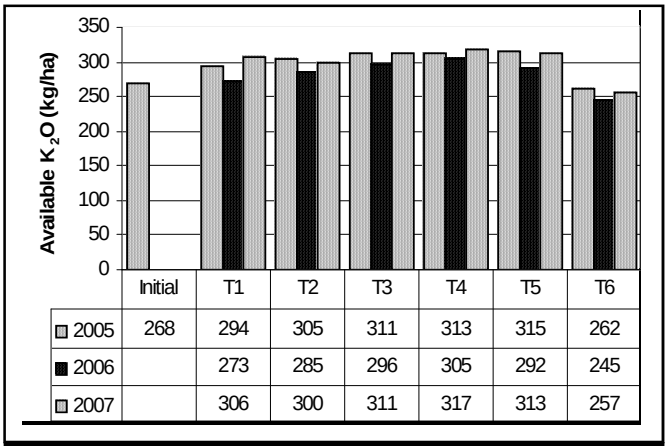

Fig. 3 : Effect of different treatments on available k_2O content in soil after harvest of the crop

soil, which has most important component of soil. 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 as microbial activity convent unavailable plant nutrients in to available from (Singh *et al.*, 2006; Yadav *et al.*,2005;Pandey *et al.*,2007).

It is concluded that integrated nutrient management improve rice yield, as proper decomposition of organic matter supply available plant nutrient directly to plants and created favorable soil environment, altimetly increased the nutrient capacity of soil for longer time, which resulted in better growth, yield attributes and altimetly grain and straw yield.

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