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Influence of integrated nutrient management practices on dry matter production, yield and NPK uptake of transplanted rice (*Oryza sativa*)

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Abstract: A field investigation was carried out during *Rabi* season (Pishanam rice) of 2012-2013 at wetland of Central Farm, Agricultural College and Research Institute, TNAU, Killikulam, to study the effect of integrated nutrient management practices on dry matter production, yield and NPK uptake of transplanted rice. The treatments were laid out in a Randomized Block Design and replicated thrice using the rice variety ADT(R) 45. Among the different integrated nutrient management practices, application of GLM @ 6.25 t ha^{-1} + Azophosmet + 100 % NPK registered significantly the highest (P<0.01) dry matter production at all the stages (Active tillering; 1690, flowering; 9100 and harvest;14490 kg ha^{-1}). The grain yield was increased, when GLM was integrated with 100 % NPK application (6030 kg ha^{-1}). The grain yield was further increased, when Azophosmet was applied through seed and soil application along with GLM and 100 % NPK (6617 kg ha^{-1}). However, it was on par with application of FYM + Azophosmet + 100 % NPK. The same trend was noticed in straw yield also. The uptake of N, P and K nutrients by rice crop at harvest stages (95.6, 37.7 and 118 kg ha^{-1}) of crop growth was remarkably increased by the application of GLM + Azophosmet + 100 % NPK. Among the various nutrient management practices, application of GLM + Azophosmet + 100 % NPK registered superior growth indicators due to the effective utilization of various nutrients and subsequent accumulation of more assimilates which inturn led to improved vegetative growth and higher yield of transplanted rice.

Keywords: Azophosmet, Farmyard manure, Greenleaf manure, Nutrient uptake, Transplanted rice

INTRODUCTION

Rice is one of the most important food grains produced and consumed all over the world. Global rice demand is expected to rise from 439 million tonnes in 2010 to 496 million tonnes in 2020 and further increase to 553 million tonnes in 2035 (FAO, 2013). This shows an overall increase of 26 per cent in the next 25 years, thus global rice yields must raise much faster. Among the rice growing countries, India has the largest area (44 million hectares) and it is the second largest producer (131 million tonnes) of rice next to China (197 million tonnes). The rice productivity in India is 2.98 t/ha, while the world average is 4.25 t/ha (IRRI, 2011). To meet the food requirement of the growing population, the rice production has to be enhanced with good management practices with shrinking availability of land and water resources condition.

The increasing demand for rice grain production has to be achieved by using an integration of organic and inorganic fertilizer to maintain the sustainability in crop production (Datta and Singh, 2010). Probably, there will be no universally best integrated nutrient management practice. Thus more efforts are needed to identify the improved nutrient management strategy for a particular target environment. Appropriate combinations of organic and inorganic nutrient sources enhance the use efficiency of nutrients and ultimately increased the growth and yield attributes of rice. Hence, the present study was initiated to study the integrated nutrient management practices on dry matter production, yield and NPK uptake of transplanted rice.

MATERIALS AND METHODS

A field investigation was carried out during rabi season (Pishanam rice) of 2012-2013 at wetland (field number 37a of ‘B’ block) of Central Farm, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Killikulam (8°46' N latitude and 77°42' E longitude at an altitude of 40 m above MSL). Experimental field soil was sandy clay loam in texture (Robinson’s International pipette method; Piper (1966) with slightly alkaline in reaction (pH 7.6) and electrical conductivity of soil was 0.32 dSm^{-1}. The fertility status of soil was low in available N (252 kg ha^{-1}) (Alkaline permanganate method; Subbiah and Asija, 1956), and with medium levels of available P_2O_5 (19 kg ha^{-1}) (Olsen method; Olsen *et al*., 1954) and K_2O (246 kg ha^{-1}) (Neutral normal ammonium acetate extract; Stanford and English, 1949) content. The soil was of medium status in organic carbon content

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(0.55%) (Walkley and Black method; Walkley and Black, 1934).

The treatments were laid out in a Randomized Block Design and replicated thrice. The treatment were Farmyard manure (FYM) @ 12.5 t ha^{-1} + 100 % N and P, FYM @ 12.5 t ha^{-1} + 75 % N and P, Green leaf manure (GLM) @ 6.25 t ha^{-1} + 100 % N and P, GLM @ 6.25 t ha^{-1} + 75 % N and P, FYM @ 12.5 t ha^{-1} + Azophosmet + 100 % N and P, FYM @ 12.5 t ha^{-1} + Azophosmet +75 % N and P, FYM @ 12.5 t ha^{-1} + Azophosmet, GLM @ 6.25 t ha^{-1} + Azophosmet + 100 % N and P, GLM @ 6.25 t ha^{-1} + Azophosmet +75 % N and P, GLM @ 6.25 t ha^{-1} + Azophosmet, FYM @ 12.5 t ha^{-1}, GLM @ 6.25 t ha^{-1}, Azophosmet and 100 % N and P.

The recommended dose of fertilizer (RDF) to rice crop was 150:50:50 kg NPK ha^{-1}.The nitrogen and phosphorus were applied at 75 % and 100 % levels to the respective treatments and potassium was applied at recommended dose. The recommended dose of K was applied for all the treatments except Farmyard manure, Green leaf manure, Azophosmet, FYM + Azophosmet and GLM + Azophosmet treatments. Azophosmet was applied through seed treatment @ 600 g ha^{-1} and soil application @ 2 kg ha^{-1} before transplanting. Nitrogen, phosphorus and potassium were applied as urea, single super phosphate and muriate of potash respectively. Twenty five per cent of nitrogen, fifty per cent of potassium and full dose of phosphorus were applied as a basal dressing at the time of planting. The remaining K was applied at panicle initiation stage and N was applied in three equal splits at active tillering, panicle initiation and heading stages. The required amount of FYM and GLM (*Glyricidia maculata*) leaves were applied and incorporated in the respective plots before 15 days of transplanting. Soil application of Azophosmet @ 2 kg ha^{-1} were mixed with well decomposed FYM and applied before transplanting to the respective plots. The plot size is 5× 4 m.

The rice variety used for trial was ADT (R) 45; with the spacing of 25 × 25 cm, and harvesting was done at 105^{th} day for all the treatments. Uptake of nitrogen, phosphorus and potassium by rice plants at tillering, flowering and harvest stages was estimated respectively by Microkjeldahl method (Humphries, 1956), triple acid extract method (Jackson, 1973) and flame photometer (Jackson, 1973).

RESULTS AND DISCUSSION

Dry matter production: The dry matter production of transplanted rice varied significantly (P<0.01) and ranged from 900 to 1690 kg ha^{-1}, 4900 to 9100 kg ha^{-1} and 7800 to 14490 kg ha^{-1} at active tillering, flowering and at harvest stages respectively (Table 1). Among the different integrated nutrient management practices adopted, application of GLM @ 6.25 t ha^{-1} + Azophosmet + 100 % NPK (150:50:50 kg NPK ha^{-1}) registered significantly(P<0.01) the highest production of dry matter at all the stages (fig 1). It recorded the highest dry matter production of 14,490 kg ha^{-1}, which was on par with application of FYM + Azophosmet + 100 % NPK (14,100 kg ha^{-1}). This might have due to increased availability of major nutrients (N, P, K) through chemical fertilizer and mineralized nutrient from organics to transplanted rice throughout the cropping period. This leads to enhancement of proficient growth and development of rice through highest uptake and utilization of the nutrients. These results are in conformity with the findings of Sujathamma and Reddy (2004) found that application of 100 per cent N through fertilizers recorded higher grain yield of 5.2 t ha^{-1} which was comparable with 25 per cent N through green manure and 75 per cent fertilizers N (5.16 t ha^{-1}) and also with 25 per cent N through FYM and 75 per cent N through fertilizers (5.14 t ha^{-1}) in respect of rice grain yield.

Grain and straw yield: The grain yield of transplanted rice differed significantly(P<0.01) due to different integrated nutrient management practices (Table 1). The grain yield was increased, when organic manure was integrated with 100 % NPK application. Among the organic manure integration, application of GLM along with 100 % NPK recorded highest grain yield of 6030 kg ha^{-1}, which was on par with application of FYM + 100 % NPK (5853 kg ha^{-1}). The grain yield was further increased, when Azophosmet was applied through seed and soil application along with organic manure like GLM / FYM and 100 % NPK. An integrated application of GLM + Azophosmet + 100 % NPK recorded highest grain yield of 6617 kg ha^{-1}, which was on par with application of or FYM along with 100 % NPK and the biofertilizer Azophosmet recorded the highest grain yield of 6523 kg ha^{-1} respectively. . The rice grain yield increase due to Azophosmet application along with GLM / FYM + 100 % NPK over combined application of organic manure (GLM / FYM) and 100 % NPK were 9.7 and 11.4 per cent respectively. The yield increase due to organic manures (GLM / FYM) plus Azophosmet along with 100 % NPK application over 100 % NPK application alone were 21.9 and 20.1 per cent respectively. Rayees Shah (2014) reported the maximum rice grain yield (63 and 67 q per hectare was obtained with the integration of NPK 50% RDF + Neem cake @2.5 tonnes ha-1 + FYM @5 tonnes ha-1+Azotobacter+PSB @ 5kg ha^{-1}.

Integrated nutrient management also influenced the straw yield of transplanted rice (Table 1). The straw yield was increased, when Azophosmet was applied through seed and soil application along with organic manure like GLM / FYM and 100 % NPK. Application of GLM or FYM along with 100 % NPK and the biofertilizer Azophosmet significantly (P<0.01) recorded the highest straw yield of 7623 and 7360 kg ha^{-1} respectively and they were on par. They were 10.3 and 9.2 percent significantly (P<0.01) superior to application of GLM / FYM plus 100 % NPK (6913 and

Table 1. Influence of INM practices on dry matter production, grain yield and straw yield of transplanted rice.

Treatment	Dry matter production (kg ha^{-1})			Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
	Tillering	Flowering	Harvest		
FYM +100 % N and P	1500	8020	12760	5853	6743
FYM +75 % N and P	1350	7150	11320	5175	5970
GLM +100 % N and P	1540	8375	13175	6030	6913
GLM +75 % N and P	1400	7650	12090	5513	6390
FYM + Azophosmet +100 % N and P	1650	8950	14100	6523	7360
FYM + Azophosmet +75 % N and P	1410	7750	12230	5598	6430
FYM + Azophosmet	1070	5800	9250	4243	4840
GLM + Azophosmet +100 % N and P	1690	9100	14490	6617	7623
GLM + Azophosmet +75 % N and P	1450	7950	12500	5767	6580
GLM + Azophosmet	1100	6100	9650	4413	5056
FYM alone	1010	5470	8680	3987	4540
GLM alone	1050	5650	8900	4073	4667
Azophosmet alone	900	4900	7800	3563	4093
100 % N and P	1390	7500	11800	5430	6227
SEd	42	222	367	167	193
CD=(0.05)	86	456	754	343	397

6743 kg ha^{-1}) respectively.

Higher organic matter content would have favourably influenced the grain and straw yield of rice. The beneficial effect in respect of grain and straw yield of rice was more prominent, when 50% N was substituted through farmyard manure which may be attributed to nutrient supply or also as a result of better utilization of applied nutrients through improved micro-environmental conditions, especially the activities of soil micro-organisms involved in nutrient transformation and fixation (Powar and Mehta, 1997). Kandeshwari *et al.* (2012) recorded the highest rice grain and straw yield was obtained with application of 75% inorganic N + 12.5% N through FYM + 12.5% N through well decomposed poultry manure

Nitrogen uptake: The nitrogen uptake of transplanted rice under integrated nutrient management was estimated at active tillering, flowering and at harvest stages (Table 2). United application of GLM + Azophosmet + 100 % NPK significantly ($P<0.01$) influenced the higher N uptake at all the stages, The highest nitrogen uptake of 95.6 kg ha^{-1} at harvest stage was observed with the application of GLM + Azophosmet + 100 % NPK, which was on par with application of FYM + Azophosmet +100 % NPK (91.7 kg ha^{-1}) and were superior over others. The increase in N uptake with these treatments was 22.7 and 17.7 per cent respectively over application of 100 % NPK alone. This result put up the usefulness of integrated use of organic manure and inorganic manures, which is helpful in maintaining higher concentration of soil NH_4-N for longer period and recording higher N uptake of rice. Kabat *et al.* (2006) Observed that increase in inorganic sources of nitrogen, the rice crop responded positively in terms of grain yield and other yield attributes. The highest grain yield, straw yield, panicles and filled grains panicle^{-1} of rice were recorded when nitrogen was supplied in 100% through inorganic form. Singh *et al.* (2006) also reported the rice-straw compost @ 6 t/ha inoculated with Azotobacter + phosphous solublizing bacteria (PSB) along with NPK registered significantly higher plant height, leaf-area

Table 2. Nutrient (N, P & K) uptake of transplanted rice under INM practices.

Treatment	N uptake (kg ha^{-1})			P uptake (kg ha^{-1})			K uptake (kg ha^{-1})		
	AT	FL	HA	AT	FL	HA	AT	FL	HA
FYM +100 % N and P	31.5	68.3	85.5	3.1	21.7	34.5	11.1	65.3	103.9
FYM +75 % N and P	28.4	61.0	73.6	2.8	18.0	29.4	9.60	57.2	90.6
GLM +100 % N and P	32.3	70.4	88.3	3.4	20.9	32.9	10.8	68.3	107.5
GLM +75 % N and P	29.4	64.4	81.0	3.1	20.1	32.6	10.6	61.8	97.7
FYM + Azophosmet +100 % N and P	36.3	75.2	91.7	3.6	22.4	36.7	11.1	73.1	115.2
FYM + Azophosmet +75 % N and P	29.6	65.1	80.7	3.1	19.5	30.6	9.90	62.8	99.1
FYM + Azophosmet	23.5	48.6	60.1	2.3	14.5	25.0	7.80	46.1	73.5
GLM + Azophosmet +100 % N and P	37.2	77.4	95.6	3.7	25.5	37.7	11.9	74.4	118.5
GLM + Azophosmet +75 % N and P	31.9	67.7	83.8	3.2	19.9	31.3	9.70	64.6	101.6
GLM + Azophosmet	24.2	51.2	62.7	2.4	15.3	26.1	7.80	48.7	77.0
FYM alone	20.2	46.0	57.3	2.2	13.6	22.6	6.90	42.9	68.1
GLM alone	22.1	47.5	59.6	2.3	14.1	22.3	7.50	44.1	69.4
Azophosmet alone	18.9	41.2	50.7	1.9	12.2	21.1	6.40	38.0	60.4
100 % N and P	30.6	63.8	77.9	2.9	18.8	30.7	9.40	60.5	95.1
SEd	0.9	1.9	2.4	0.1	0.6	0.9	0.3	1.9	2.9
CD = (0.05)	1.9	3.4	4.9	0.2	1.2	1.9	0.6	3.8	6.0

AT - Active tillering; FL - Flowering; HA - Harvest

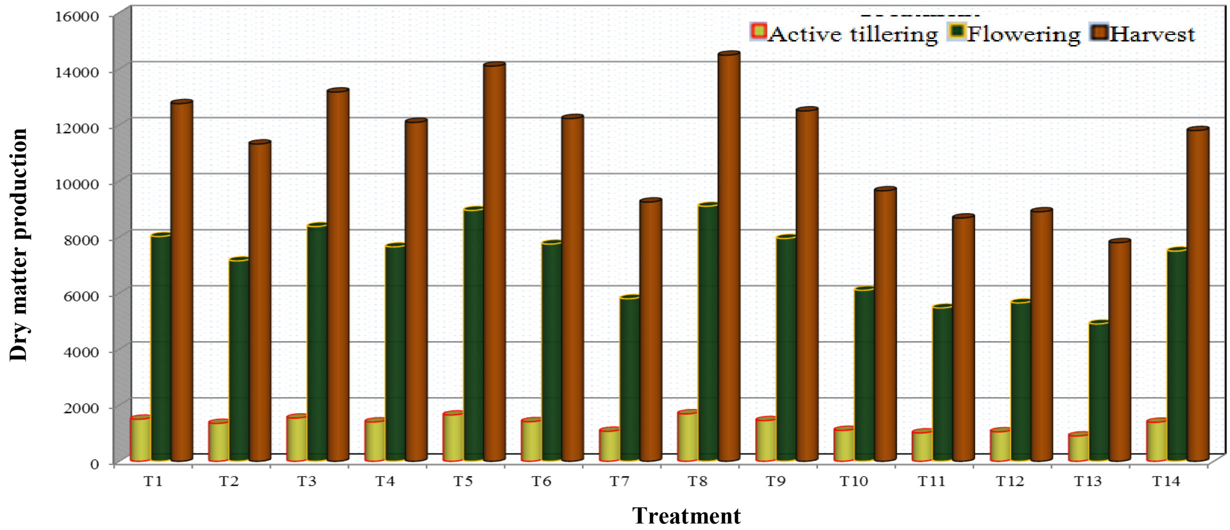

Fig.1. *Effect of integrated nutrient management on dry matter production (kg ha^{-1}) of rice.*

index and yield attributes (panicles, panicle length, grains/panicle and test weight), and gave 21.17% increase in grain and 15.36% in straw yields compared with NPK (120 kg N, 60 kg P_2O_5, 60 kg K_2O/ha). The organic manures were found to reduce N losses and conserve soil N by forming organo-mineral complex, maintained supply of N to rice plant and increased total N uptake (Pandey *et al.,* 2001).

Phosphorus uptake: The P uptake of transplanted rice varied significantly ($P<0.01$) due to different integrated nutrient management practices (Table 2). Integrated application of GLM + Azophosmet + 100 % NPK significantly ($P<0.01$) recorded the higher P uptake of transplanted rice. At harvest stage, it recorded 37.7 kg P ha^{-1}, which was on par with application of FYM + Azophosmet + 100 % NPK (36.7 kg ha^{-1}). The increase in P uptake with these treatments was in the tune of 22.8 and 19.5 per cent compared to application of 100 % NPK alone.

Enhanced P uptake with judicious application of organic manures and inorganic fertilizers might be due to a combination of factors that enhance P availability in soils. These include production of organic acids through decomposition of organic matter and subsequent releases of phosphate ions, formation of phospho -humic complexes and isomorphic replacement of phosphate ions by humate ions and also by synergistic effect existing between N and P due to application of organic manures. Such effects on soil P and plant uptake were also reported by Subbiah *et al.* (2000). Satheesh and Balasubramanian (2003) inferred that application of farmyard manure at 10 t ha^{-1} in combination with neem cake at 3.0 t ha^{-1} found to be equally effective for getting higher rice grain yield (5.6 t ha^{-1}) and improved NPK uptake (163.9, 52.4, 133.4 kg NPK ha^{-1}) when compared to chemical N fertilizers application.

Potassium uptake: The K uptake of transplanted rice significantly varied due to different integrated nutrient management practices. At harvest stage, higher potassium uptake was noticed with combined application of GLM + Azophosmet + 100 % NPK (118.5 kg ha^{-1}), which was on par with application of FYM + Azophosmet + 100 % NPK (115.2 kg ha^{-1}). These hike in K uptake were 24.6 and 21.1 percent compared to application of 100 % NPK alone. Increased K uptake with organically treated plots might be due to the priming effect of FYM/Green Leaf Manures on the decomposition-related release of organic acids that solubilize native K in soil. In addition, higher magnitude of increases in K uptake by conjunctive use of organic manures and inorganic fertilizers showed that organic manures presumably play key role in enhancing the use efficiency of applied fertilizer as well as inherent nutrient availability in the soil. This was also documented earlier by Bhagavathi Ammal and Muthiah (1995) and Singh *et al.* (2001).

Conclusion

From the experimental results, it could be concluded that incorporation of GLM @ 6.25 t ha^{-1} at basal, application of Azophosmet through seed treatment @ 600 g ha^{-1} and soil application @ 2 kg ha^{-1}, and recommended dose of 150:50:50 kg NPK ha^{-1} could be considered as a better option for achieving higher productivity of ADT (R) 45 rice under transplanted condition.

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