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Studies on rice productivity, nitrogen uptake and nitrogen balance in wet seeded rice under integrated nitrogen management practices

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ABSTRACT

A field experiment was conducted during *Rabi* season (Oct. – Jan.) of 2001-02 at wetland of Central farm, Agricultural College and Research Institute, TNAU, Killikulam (8º 48' N 77º42' E and 40m AMSL) to study the rice productivity, N uptake and N balance in wet seeded rice under integrated nitrogen management. The experiment was laid out in randomized block design replicated thrice. Eight integrated nitrogen management practices viz., presowing of *Sesbania* @ 50 kg ha^{-1} and *in situ* incorporation at 45 DAS + 150 kg N ha^{-1}, presowing of *Sesbania* @ 75 kg ha^{-1} and *in situ* incorporation at 45 DAS + 112.5 kg N ha^{-1}, intercropping of *Sesbania* in rice @ 25 kg ha^{-1} and *in situ* incorporation at 40 DAS + 150 kg N ha^{-1} , intercropping of *Sesbania* in rice @ 75 kg and *in situ* incorporation at 40 DAS + 112.5 kg N ha^{-1}, GLM @ 6.25 t ha^{-1} + 150 kg N ha^{-1}, GLM @ 9.38 t ha^{-1} + 112.5 kg N ha^{-1}, FYM @ 12.5 t ha^{-1} + 150 kg N ha^{-1}, FYM @ 18.75 t ha^{-1} + 112.5 kg N ha^{-1} and two levels of inorganic N alone i.e., 150, 112.5 kg ha^{-1} and control (no manure) was adopted. The treatment receiving FYM @ 12.5 t ha^{-1} + 150 kg N ha^{-1} registered significantly the higher grain yield (5538 kg ha^{-1}) straw yield (8693 kg ha^{-1}) and N uptake (154.24 kg ha^{-1}). Application of inorganic N @ 150 kg ha^{-1} alone recorded the lower amount of grain (4382 kg ha^{-1}) and straw (7373 kg ha^{-1}) yield and N uptake (140.45 kg ha^{-1}). The actual post harvest fertility status of the soil also clearly indicated that, integrated application FYM @ 12.5 t ha^{-1} + 150 kg N ha^{-1} recorded highest amount of available N (251.26 kg ha^{-1}), where as in control plot the available N was very low (112.26 kg ha^{-1}). A positive net gain of N over than initial soil status was also recorded in all the integrated nitrogen management practices but in control the report was in negative.

Key words : Wet seeded rice, Integrated nitrogen management, Grain and Straw yield, N uptake, N balance.

INTRODUCTION

Indian agriculture had witnessed a gradual transformation from subsistence farming of early fifties to the present intensive agriculture especially in better-endowed region. Nutrient imbalance is one of the major abiotic constraints limiting productivity of rice. At the same time, in view of increasing nutrient demand, escalating prices of inorganic fertilizer and their possible degradation of cultivable soil health and hazardous to environment, warrants the need for judicious use of chemical fertilizer (Fauci and Dick, 1994; Fageria, 1994). There is immense need to exploit the alternate source of nutrients viz., organic manure, use of legumes in crop rotation and bio fertilizer to sustain the productivity with more environment friendly nutrient management system (Fageria and Baligar, 1997; Collins *et al.*, 1992).

The supplementary and complementary use of organic manures improves the physical, chemical and biological properties of soil and also improves the use efficiency of applied N fertilizer as well as other inputs (Wander *et al.*, 1994; Kalyanasundaram, *et. al*, 1997). According to Pramnik and Mahapatra (1997) and Devi *et al.*, (1999) integrated use of urea and organic N fertilizer is helpful in maintaining higher concentration of soil NH_4- N for long period and realizing higher grain yield and N uptake in lowland rice. Therefore, to study the effect of integrated nitrogen management on rice productivity, N uptake and N balance, an field investigation was carried out by application of organic manures by different sources at different levels along with different levels of inorganic fertilizers to wet seeded (drum seeding) *Rabi* (*Pishanam* season) rice grown in southern parts of Tamil Nadu.

MATERIALS AND METHODS

A field investigation was conducted during *Rabi* season (*Pisahnam* rice) of 2001 -2002 at the wetlands (field number 48 b of 'B' block) of Central farm, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Killikulam (8° 48'N latitude, 77°42' E longitude and 40 m above mean sea level). The soil of the experimental field was moderately deep and sandy clay in texture, with slightly alkaline in reaction (pH 7.6). The fertility status of the soil was low in available nitrogen (172 kg ha^{-1}), high in available phosphorus (24 kg ha^{-1}) and medium in available potassium (176 kg ha^{-1}). The soil was medium status in organic carbon content (0.52 %). The treatments were imposed in randomized

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block design and replicated thrice. The treatments were: T_1 - presowing of *Sesbania* @ 50 kg ha^{-1} and *in situ* incorporation at 45 DAS + 150 kg N ha^{-1}, T_2 - presowing of *Sesbania* @ 75 kg ha^{-1} and *in situ* incorporation at 45 DAS + 112.5 kg N ha^{-1}, T_3 - intercropping of *Sesbania* in rice @ 25 kg ha^{-1} and *in situ* incorporation at 40 DAS + 150 kg N ha^{-1}, T_4 - intercropping of *Sesbania* in rice @ 75 kg ha^{-1} and *in situ* incorporation at 40 DAS + 112.5 kg N ha^{-1}, T_5 - GLM @ 6.25 t ha^{-1} + 150 kg N ha^{-1}, T_6 - GLM @ 9.38 t ha^{-1} + 112.5 kg N ha^{-1}, T_7 - FYM @ 12.5 t ha^{-1} + 150 kg N ha^{-1}, T_8 - FYM @ 18.75 t ha^{-1} + 112.5 kg N ha^{-1}, T_9- 100 per cent recommended N (150 kg ha^{-1}), T_{10} – 75 per cent recommended N (112.5 kg ha^{-1}), and T_{11} – control (no manure) was adopted.

The inorganic sources of N were applied in the form of urea (46 % N) as three splits viz., 75 Kg, 37.5 Kg, and 37.5 kg N for 100 per cent recommended dose plot and 56.25 kg, 28.13 kg and 28.13 kg N for 75 per cent recommended dose plot, respectively at 20, 40 and 60 DAS. The required amounts of FYM, GLM was applied and trampled seven days before drum seeding and for presowing *Sesbania* incorporation the required quantity seeds were sown 52 days before rice sowing and was trampled seven days before drum seeding. In intercropping *Sesbania* incorporation treatment the *Sesbania* seeds were sown along with drum seeding and *in situ* incorporated as per date schedule (40 DAS). The rice variety used was ADT –43, the seeds were sown in the puddled and levelled field using the drum seeder developed by TNAU with the row spacing of 22.5 cm and harvesting was done at 105 days after drum sowing. Soil samples before the planting and after harvesting were taken and analyzed for organic carbon (Walkley and Black, 1934), available nitrogen (Subbiah and Asija, 1956). Nitrogen uptake by the rice plant and nitrogen contribution from different organic manures was estimated by Microkjeldahl methods suggested by Humphries (1956). To work out the N balance sheet, initial status of soil available N, nutrients added through organic manures and inorganic fertilizer, plant uptake and available soil N after rice was taken in to the account.

RESULTS AND DISCUSSION

Grain Yield

The grain yield of wet seeded rice differed significantly due to different N management practices. The highest grain yield (5538 kg ha^{-1}) was recorded in treatment receiving FYM @12.5 t ha^{-1} + 100 per cent recommended N, which was 73 and 26 per cent higher than control (3178 kg ha^{-1}) and 100 per cent N alone (4382 kg ha^{-1}). However this was at par with presowing of *Sesbania* @ 50 kg ha^{-1} and *in situ* incorporation at 45 DAS + 150 kg N ha^{-1} (5442 kg ha^{-1}), intercropping of *Sesbania* in rice @ 25 kg ha^{-1} and *in situ* incorporation at 40 DAS + 150 kg N ha^{-1} (5393 kg ha^{-1}), T_5 - GLM @ 6.25 t ha^{-1} + 150 kg N ha^{-1} (5297 kg ha^{-1}). It might be due to maintaining the higher concentration of available nitrogen for a longer period and realizing higher grain yield. Mondal *et al*. (2003) also obtained the similar results. Because integrated use of organic and inorganic nitrogen sources are effective in arresting the deterioration in productivity under intensive farming and more over organic manures has the essential plant and other growth promoting substances like enzymes and hormones, while no synthetic fertilizer can supply all together.

Table 1 : Influence of different integrated N management practices on wet seeded rice grain and straw yield and N uptake at harvest stage.

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Nitrogen uptake(kg ha^{-1})
T_1	5442	8615	152.99
T_2	4960	7684	142.96
T_3	5393	8560	151.73
T_4	4864	7528	142.93
T_5	5297	8382	147.97
T_6	4720	7451	141.70
T_7	5538	8693	154.24
T_8	5056	7839	144.21
T_9	4382	7373	140.45
T_{10}	4045	7140	129.16
T_{11}	3178	6054	90.29
SEd	119.8	194.1	3.50
CD (p =0.05)	249.9	405.0	7.30

Straw yield

Straw yield of wet seeded rice under different integrated nitrogen management practices varied significantly than inorganic nutrients alone and absolute control. Among the different integrated N management tried, application of FYM @ 12.5 t ha^{-1} with 100 per cent recommended N (150 kg ha^{-1}) showed superiority (8693 kg ha^{-1}) over the 100 per cent recommended inorganic N alone (7373 kg ha^{-1}) and absolute control (6054 kg ha^{-1}). Similar results were reported earlier by Kandasamy and Ramasamy (1998). But it was comparable with other integrated nitrogen treatments viz., presowing of *Sesbania* @ 50 kg ha^{-1} and *in situ* incorporation at 45 DAS + 150 kg N ha^{-1}, intercropping of *Sesbania* in rice @ 25 kg ha^{-1} and *in situ* incorporation at 40 DAS + 150 kg N ha^{-1}, T_5 - GLM @ 6.25 t ha^{-1} + 150 kg N. Because combined use of organic manures and inorganic N fertilizer help in maintaining the nutrient stability throughout cropping period, correcting the marginal deficiencies of secondary and micronutrients and hence enhanced the more and vigorous vegetative growth of wet drum seeded rice. Integrated application of organic manures and inorganic fertilizers would have improved the nitrogen availability and other nutrients by mineralization process and hence there was an improvement in growth and development of rice.

Nitrogen Uptake

Uptake of nitrogen by wet seeded rice under different N management practices was estimated at harvest stage (Table 1). United application of FYM @12.5 t ha^{-1} with 100 per cent-recommended N significantly influenced the higher N uptake, which accounts 154.24 kg N ha^{-1}. This uptake was 9.82 %, 10.68 % and 14.72 % higher than 100 per cent inorganic N, 75 per cent inorganic N and absolute control, respectively. However integrated N management through FYM and 100 % inorganic N was comparable with other integrated nitrogen management practices, which includes presowing of *Sesbania* @ 50 kg ha^{-1} and *in situ* incorporation at 45 DAS + 150 kg N ha^{-1} (152.99 kg ha^{-1}), intercropping of *Sesbania* in rice @ 25 kg ha^{-1} and *in situ* incorporation at 40 DAS + 150 kg N ha^{-1}(151.73 kg ha^{-1}), T_5 - GLM @ 6.25 t ha^{-1} + 150 kg N ha^{-1} (147.97 kg ha^{-1}). These results put up the usefulness of organic manure in rice cultivation as estimated by many authors like (Rathore *et al*. (1995) and Singh *et al*. (1997) and stated that uptake of nitrogen by rice increased significantly with application of organic manures viz., FYM, *Sesbania* as pre sowing crop as well as intercrop and *in situ incorporation* at 45 DAS and green leaf manure. Because organic manures restore humus status of the soil ecosystem to holds its fertility and productivity. Integrated use of urea and organic N fertilizer is helpful in maintaining higher concentration of soil $Nh_4^{\pm}$ N for longer period and realizing higher N uptake.

Nitrogen Balance Sheet

The actual fertility status of the soil after the harvest of wet seeded rice (Table 2) clearly indicats that, united application of FYM @12.5 t ha^{-1} with 100 per cent recommended N, registered the highest amount of post harvest soil available N, which accounts 251.26 kg ha^{-1}.

Table 2 : Nitrogen balance sheet of soil in wet drum seeded rice under integrated nitrogen management**

Treatments	Initial soil N status (kg ha^{-1})	Added N through organic and inorganic (kg ha^{-1})	N uptake (kg ha^{-1})	Expected balance in soil {(A+B)- C}	Actual soil fertility status	Apparent gain (E-D) or loss (D-E)	Net gain (E-A) or loss (A-E)
	(A)	(B)	(C)	(D)	(E)	(F)	G
T_1	172.0	192.0	152.99	211.01	242.51	31.50	70.51
T_2	172.0	173.5	142.96	202.54	232.32	29.78	60.32
T_3	172.0	181.0	151.73	201.27	241.66	40.39	69.66
T_4	172.0	151.5	142.93	180.57	231.16	50.59	59.16
T_5	172.0	180.0	147.97	204.03	239.65	35.62	67.65
T_6	172.0	151.5	141.70	181.8	228.82	47.02	56.82
T_7	172.0	206.0	154.24	223.76	251.26	27.50	79.26
T_8	172.0	196.5	144.21	224.29	238.62	14.33	66.62
T_9	172.0	150.0	140.45	181.55	186.21	4.66	14.21
T_{10}	172.0	112.5	129.16	155.34	175.26	19.92	3.26
T_{11}	172.0	0	90.29	81.71	112.26	30.55	-59.74

** - The data were not analyzed statistically except N uptake

Whereas in control (unmanured plot) treatment the available N was very low (112.26 kg ha^{-1}) when compared to other integrated N management. These findings confirm those of Raju and Reddy (2000) and Jeyaselvin Inbaraj (1995). The net gain over initial N status was also higher in integrated application of FYM @12.5 t ha^{-1} with 100 per cent N, which recorded 79.26 kg N ha^{-1} higher than that of pre planting soil N values (172 kg ha^{-1}), but in control treatment the net gain was in negative side (- 59. 74 kg N ha^{-1}) from the initial N values. The residual soil N status was maintained with nutrient management practices involving the application of both organic and inorganic N sources for rice. Though such nutrient supply practices enabled greater uptake of nutrients by rice, the balance of N after rice harvest was higher in all integrated N management. This could mean that, the immediate crop requirement of nitrogen was met from the inorganic sources and later requirement with mineralized nitrogen from the organic sources, which maintained or enhanced the soil N status. With judicious application of organic matter, the leaching of nutrients subjected to chemical fertilizer application could be reduced and moreover united application of organic and inorganic nitrogen can sustain soil fertility and yield.

It may be concluded from this field experiment that integrated nitrogen management, which involves judicious application of FYM @12.5 t ha^{-1} with 100 per cent-recommended nitrogen (150 kg ha^{-1}) found superior than other integrated N management, however, in the condition of non availability of FYM, the farmer may adopt *Sesbania* green manure either as pre sown crop or intercrop at 100 % recommended level and *in situ* incorporation at 45/ 40 DAS with 150 kg N or due non availability of *Sesbania* seeds the farmer may opt GLM (*Glyricidia* @ 6.25 t ha^{-1} + 150 kg N ha^{-1} may give higher grain yield of drum seeded rice (ADT –43) during *Rabi* (*Pishanam)* season in the southern parts of Tamil Nadu.

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