Internat. J. Agric. Sci. Vol.3 No.2 June, 2007 : 70-74

Influence of integrated nitrogen management practices on yield attributes, yield and harvest index of wet seeded rice

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ABSTRACT

To study the influence of integrated nitrogen management practices on rice yield attributes, yield and harvest index of wet seeded rice, a field investigation was carried out 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). Total of eleven treatments were planned out in randomized block design and replicated thrice. Eight integrated nitrogen management practices viz., four organic manure sources with two levels (100 % and 150 % recommended dose) in combination (100 % organic manures + 100 % inorganic N level and 150 % organic manures + 75 % inorganic N level) with two levels of inorganic nitrogen (100 % and 75 % recommended level) serially, 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 three levels of inorganic N alone i.e., 150, 112.5 and 0 kg ha^{-1} (control) was adopted. The treatment receiving FYM @ 12.5 t ha^{-1} (100 %) + 150 kg N ha^{-1} (100 %) registered significantly the higher number of tillers (545 m^{-2}), number of productive tillers (526 m^{-2}), number of filled grains panicle^{-1}(94.30), test weight (22.2 g),grain yield (5538 kg ha^{-1}) and straw yield (8693kg ha^{-1}) however, there is no difference was observed in harvest index among the N management practices.

Key words : Wet seeded rice, Integrated nitrogen management, Organic sources, Yield attributes, Yield.

INTRODUCTION

Rice feeds more than half the people in the world, but not well and not for much longer. According to the United Nations the demand is expected to rise by a further 38 per cent within 30 years (Thiyagarajan, 2002). The situation calls for profound improvements in the rice packages of practices such as integrate crop management, integrated soil fertility management and the applicability of various sustainable farming technologies are crucial in attaining this goal (Uphoff, 2003). Nitrogen is the predominant nutrient required in the largest amount by crop and especially rice. But nitrogen in soil solution is rapidly lost from the rooting zone through leaching or loss to the atmosphere through a process called denitrification (Balasubramanian and Veerabadran, 1997; Basumatary and Talukdar, 1998). The escalating prices of chemical inputs and it's dangerous to environment urged the scientists to develop alternative remedy practices such as integrated nitrogen management for reducing the nitrate pollution and to improve the rice yield in sustained manner (Fageria and Baligar, 1997). Bulky organic manure with any sources definitely improves the rice productivity (Jose Mathew *et al*.,1993) and the integrated use of organic and inorganic nitrogen can make contribution to increasing and sustaining rice production and reduce the nitrogen loss from the rice ecosystem (Dhane *et al.*,1995). Therefore, to study the influence of integrated nitrogen management practices on rice yield attributes, rice yield and harvest index a field experiment was conducted in wet seeded (drum seeding) rice in *Rabi (Pishanam)* season rice grown in southern parts of Tamil Nadu.

MATERIALS AND METHODS

A field experiment was carried out 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 soil was of medium status in organic carbon content (0.52 %). With reference to the fertility status of the experimental site, 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 eleven treatments comprises, eight integrated N management (four organic manure sources with two levels (100 % and 150 % recommended dose) in combination (100 % organic manures + 100 % inorganic N level and

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150 % organic manures + 75 % inorganic N level) with two levels of inorganic nitrogen (100 % and 75 % recommended level) and two inorganic N and one control) were imposed in randomized 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 sowed 52 days before sowing and trampled seven days before drum seeding. In intercropping *Sesbania* incorporation treatment the *Sesbania* seeds were sowed along with drum seeding and *in situ* incorporated as per date schedule (40 DAS). The rice variety used for trial was ADT –43, the required quantity of seeds (80 kg ha^{-1}) 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. The total number and productive tillers were counted from four quadrate points (0.25 m^2) placed at random in the net plot area and expressed in number m^{-2} at harvest stage.

RESULTS AND DISCUSSION

Number of tillers m^{-2}

Significant variations were noticed in the tillers production m^{-2} due to different nitrogen management practices (Table 1). The total number of tillers per m^2 at harvest stage ranged from 462 to 545 and was favourably influenced by the integrated N management. Among the different integrated N management tried, application of FYM @ 12.5 t ha^{-1} + 150 kg N ha^{-1} recorded (545 m^{-2}) significantly the higher number of tiller, which was 8.4, 11.0 and 15.3 % higher than the 100 and 75 % inorganic N alone and control, respectively. This finding is in accordance with Jayabal *et al.* (1999). This might be due to beneficial effect of farmyard manure in improving favourable rice ecosystems and applied fertilizer use efficiency. 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}). Because the supply of required nutrients through organic and inorganic sources facilitated the balance nutrition to the crop which resulted improved number of

Table 1 : Yield attributes of wet seeded rice as influenced by different integrated N management practices.

Treatments	Number of tillers m^{-2}	Number of Productive tillers m^{-2}	Number of grains panicle^{-1}	Test weight (g)
T_1	541	511	97.50	22.0
T_2	513	468	92.03	20.9
T_3	531	503	96.59	22.0
T_4	504	468	91.12	20.7
T_5	527	491	95.76	21.8
T_6	499	460	90.57	20.5
T_7	545	526	100.23	22.2
T_8	517	472	92.94	21.1
T_9	499	449	87.48	20.3
T_{10}	485	437	83.43	19.1
T_{11}	462	387	74.72	18.1
SEd	12.95	11.75	2.29	0.53
CD(p = 0.05)	27.01	24.52	4.78	1.10

tillers per m^2.

Number of productive tillers m^{-2}

Among the different N management practices followed the number of productive tillers varied significantly and ranged between 387 to 526 m^{-2}. Application FYM @ 100 % level with 100 % recommended NPK (FYM @12.5 t ha^{-1} + 150 kg N ha^{-1}) registered significantly the highest number 526 m^{-2} and was comparable with other integrated N management which involves (100 % level with 100 % N) viz., presowing of *Sesbania* @ 50 kg ha^{-1} and *in situ* incorporation at 45 DAS + 150 kg N ha^{-1} (511 m^{-2}), intercropping of *Sesbania* in rice @ 25 kg ha^{-1} and *in situ* incorporation at 40 DAS + 150 kg N ha^{-1}(503 m^{-2}), T_5 - GLM @ 6.25 t ha^{-1} + 150 kg N ha^{-1} (491 m^{-2}). However this was significantly varied with integrated N management which involves 150 % recommended level of organic plus 75 % level of inorganic N, inorganic N alone and control. This might have increased availability of nitrogen to wet seeded rice which leads to enhancement of number of productive tillers m^{-2} significantly and reduces the unproductive tillers. These results are in conformity with well documented evidence of effectiveness of organic manure uses in rice was observed by Singh and Verma (1999).

Number of grains panicle^{-1}

The nitrogen management practices adopted through different sources of organic manures in two levels and integrated with two levels of fertilizer varied significantly on number of grain panicle^{-1} (Table 1). Integrated N management which involves, FYM @ 12.5 t ha^{-1} with 100 per cent-recommended N (150 kg ha^{-1}) significantly influenced the higher number of grains panicle^{-1} which accounts 100.23 grains panicle^{-1}. This grain number was significantly higher about 12.72 %, 16.76 % and 25.45 % higher than 100 per cent and 75 per cent inorganic N alone and absolute control, respectively. This result is in concordance with the observation made by Kuppusamy *et al*. (1991). By integrated N management which involves FYM along with inorganic N would have improved the nitrogen availability and other nutrient by mineralization process and hence there was an improvement in growth as well as higher number of grains panicle^{-1}. But this treatment would have failed to distinct with other integrated N management which involves 100 % organic manure (irrespective of sources) united with 100 % inorganic N, however this significantly out dated integrated N management of 150 % organic sources with all the sources combined with 75 % inorganic N.

Test weight

Test weight of wet seeded rice under different N management practices varied significantly (Table 1). United application of FYM @12.5 t ha^{-1} with 100 percent-recommended N significantly influenced the higher test weight (22.2 g) than inorganic N alone and control. However integrated N management through FYM and 100 % inorganic N was comparable with other integrated nitrogen management practices, which involves irrespective of the organic sources at 100 % level integrated with 100 % recommended inorganic N. This result high lights the usefulness of organic manure in rice cultivation. 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 and consequently higher the test weight.

Grain Yield

The grain yield of wet seeded rice differed significantly due to different N management practices (Table 2). 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.

Straw yield

Straw yield of wet seeded rice under different integrated nitrogen management practices varied significantly than inorganic nutrients alone and absolute control (Table 2). Among the different integrated N management tried, application of FYM @ 12.5 t ha^{-1} with 100 percent 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

Table 2 : Influence of integrated N management practices on wet seeded rice grain and straw yield and harvest index.

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest Index
T_1	5442	8615	0.386
T_2	4960	7684	0.375
T_3	5393	8560	0.384
T_4	4864	7528	0.374
T_5	5297	8382	0.383
T_6	4720	7451	0.373
T_7	5538	8693	0.389
T_8	5056	7839	0.377
T_9	4382	7373	0.371
T_{10}	4045	7140	0.361
T_{11}	3178	6054	0.342
SEd	119.8	194.1	0.078
CD (p =0.05)	249.9	405.0	NS

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.

Harvest Index

The harvest index in rice, varied numerically from 0.342 to 0.389 (Table 2). Integrated N management which involves different organic sources in two levels and integrated with two levels of inorganic N failed to increase harvest index significantly than inorganic N alone and control. However integrated application of FYM @12.5 t ha^{-1} with 100 per cent recommended N, registered the highest harvest index value (0.389) and the lowest harvest index value was notices in the control plot, which accounts 0.342. This indicates that there was no difference between economic yield and biological yield and the ratio between economic and biological yield was similar in all the nitrogen management practices.

It may be concluded that, integrated N management practices, which involves FYM @12.5t ha^{-1} + 150 kg N ha^{-1} found superior than other integrated N management practices. However other organic sources with 100 % level + 100 % recommended inorganic N viz., presowing of *Sesbania* @ 50 kg ha^{-1} and *in situ* incorporation at 45 DAS + 150 kg N ha^{-1}, intercropping of *Sesbania* with rice @ 25 kg ha^{-1} and *in situ* incorporation at 40 DAS + 150 kg N ha^{-1} and GLM (*Glyricidia*) @ 6.25 t ha^{-1} + 150 kg N ha^{-1} found as substitute form of integrated N management for wet seeded rice (ADT – 43) during *Rabi* (*Pishanam)* season which predominantly practiced in the southern parts of Tamil Nadu. Hence the farmer may adopt any one of the organic sources at 100 % recommended level in combined with 100 % inorganic N based on availability of organic manure within his domain.

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Received : August, 2006; Accepted : January, 2007