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Effect of integrated nitrogen management on yield and quality of rice

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ABSTRACT

A field experiment was conducted during Kharif 2011 and 2012 on sandy clay loam soil at Regional Agricultural Research Station, Chintapalli, Andhra Pradesh to find out the effect of sources of nitrogen and planting methods on productivity and quality of rice. The experiment consisted of twenty treatment combinations involving two methods of planting, direct seeding and transplanting and two rice varieties, BPT 8024 and MTU 2077 as main treatments and the sub-plot treatments consisted of five nitrogen management practices viz N_1 (no nitrogen), N_2 (100% recommended nitrogen through fertilizer), N_3 (100% recommended nitrogen through FYM), N_4 (50% recommended nitrogen through fertilizer with 50% recommended nitrogen through FYM) and N_5 (100% recommended nitrogen through fertilizer with 25% recommended nitrogen through FYM). The results indicated that neither the two planting methods nor the two varieties had any significant effect on the growth as well as quality parameters of rice. Among the different nitrogen management practices N_5 (100% recommended nitrogen through fertilizer with 25% recommended nitrogen through FYM) resulted in the highest 1000-grain weight, grain and straw yield and nutrient uptake of rice crop. Quality parameters like head rice recovery, volume/expansion ratio, protein content and amylase content were the highest with N_5 (100% recommended nitrogen through fertilizer with 25% recommended nitrogen through FYM) which was however comparable with N_5 (100% recommended nitrogen through fertilizer with 25% recommended nitrogen through FYM) and N_2 (100% recommended nitrogen through fertilizer) but distinctly superior to N_3 (100% recommended nitrogen through FYM).

Keywords: Rice; yield; quality; nitrogen source; varieties; planting methods; nutrient uptake

INTRODUCTION

Nutrient dynamics especially of nitrogen differ largely among the methods of planting as well as water availability to rice. Integrated nutrient supply concept involving both organic and inorganic sources based on their availability and cost effectiveness is well adopted and judicious combination of these two sources has been found to mutually reinforce the efficiency of both the sources resulting in higher productivity and soil fertility. Application of FYM at 10 ton/ha in combination with inorganic fertilizers increased the grain yield of rice (Dixit and Gupta 2000). The quantitative performance of rice under varied methods of reduced water supply has to be thoroughly understood in order to develop a sound nutrient management strategy for a given method of planting.

As water is likely to become a scarce and costly commodity for rice production in future agronomic strategies should therefore be worked out to decrease water use. Different methods of planting of lowland rice on puddle soil are being widely adopted with varying levels of success. However the best method of planting in terms of productivity and profitability differs with the agro-ecological situations. Transplanting practice conventionally accepted by the farmers has become costlier and at times is constrained by labour availability. Further the practice also witnessed planting of over age seedlings late in the season owing to delayed monsoon and undependable release of water into the irrigation canals. Direct sowing of sprouted seeds on puddle soil either by broadcasting or drilling is the nearest to surmount the difficulties of transplanting method provided land levelling, weed menace and adequate as well as timely availability of water do not constrain. In the light of the above context this study was planned to find out the performance of rice varieties under direct seeding and transplanting and to know the effect of nitrogen sources on productivity and quality of rice.

MATERIAL and METHODS

The field experiment was conducted during Kharif 2012 and 2013 at Regional Agricultural Research Station, Chintapalli, Visakhapatnam district, AP. The experimental site was sandy clay loam in texture, low in organic carbon (0.41) and available nitrogen (219 kg/ha), medium in available phosphorus (16.5 kg/ha) and high in available potassium (383 kg/ha). The experiment consisted of twenty treatment combinations with two varieties, BPT 8024 (V_1) and MTU 2077 (V_2) and two planting methods direct seeding (M_1) and transplanting (M_2) as main plot treatments and nitrogen management practices as sub-plot treatments. Sub-plot treatments consisted of five nitrogen management practices viz N_1 (no nitrogen), N_2 (100% recommended nitrogen through fertilizer), N_3 (100% recommended nitrogen through FYM), N_4 (50% recommended nitrogen through fertilizer with 50% recommended nitrogen through FYM) and N_5 (100% recommended nitrogen through fertilizer with 25% recommended nitrogen through FYM) in split plot design with three replications.

The recommended doses of 100 kg nitrogen, 60 kg P_2O_5 and 40 kg K_2O/ha were applied through urea, single super phosphate and muriate of potash respectively. Entire P_2O_5 and K_2O were applied basally to all the treatments duly taking into consideration the phosphorus and potassium content of the organic manure. Nitrogen was applied in 3 split doses of 50 basal and 25 per cent each at active tillering and panicle initiation stages.

Quality parameters like head rice recovery (%) was estimated by head rice of 2/3rd separated after milling, weighed and the head rice recovery was calculated by using the following formula:

$$\text{Head rice recovery (\%)} = \frac{\text{Weight of the head rice recovery}}{\text{Weight of whole rice x 100}} \times 100$$

For determining the volume/ expansion ratio the standard method of Vergheese (1950) and later modified by Murthy (1965) was followed. The volume/ expansion ratio was estimated using the following formula:

$$\text{Volume/expansion ratio} = \frac{\text{Volume of cooked rice (ml)}}{\text{Volume of uncooked rice (ml)}}$$

Grain protein content estimated by Microkjeldhol method (Anon 1980) was computed by multiplying the factor 5.95 and expressed as percentage:

Protein content = Total N content in grain (%) x 5.95

Grain amylase content was estimated as per the procedure described by Sadasivam and Manikam (1992) and expressed as percentage. The method of alkali test was used to indicate gelatinization temperature of rice grain proposed by Little et al (1958).

RESULTS and DISCUSSION

Yield: The results of the present study indicate that planting methods and rice varieties did not exhibit significant variations in the grain and straw yields and harvest index of rice (Table 1). However transplanted rice recorded higher grain yield over direct seeded rice. Similarly the variety MTU 2077 recorded increased grain yield over the variety BPT 8024. Grain and straw yields of rice in response to nitrogen sources manifested significant differences though their interaction effect was found non-significant. The highest grain yield (4967 kg/ ha), straw yield (5359 kg/ha) and harvest index (48.1) of rice were obtained with N_5 which was on a par with N_4 but significantly superior to N_3. The per cent increase in grain yield was 101.7, 96.3, 90.6 and 52.6 due to N_4, N_3, N_1 and N_2 respectively over control. Nitrogen being the constituent of protoplasm adequate supply ensures cell division and cell enlargement exerting a positive cognizant on the growth as well as yield attributing characters. Comfortable level of plant N nutrition manifested increased growth stature and augmented the yield structure thus resulting in higher yield of rice. The superior performance of rice under the influence of integrated nutrient management as observed in the present findings is in agreement with Budhar and Palaniappan (1997) and Sampath Kumar and Sankara Reddy (2010).

Nitrogen uptake: Data pertaining to the uptake of nitrogen by rice crop were not significantly influenced by both the planting methods and varieties. N_5 was distinctive in recording the highest nitrogen uptake (99.6 kg/ha) which exhibited conspicuous superiority over N_4, N_2 and N_3. Nitrogen uptake by rice crop in response to N sources were exhibited in the descending order of N_4, N_5, N_2, N_3 and N_1.

A proper blend of both organic and inorganic sources of N at required combination results in a conducive environment of N nutrition in the rhizosphere for lowland rice. Inorganic nitrogen released immediately after the application fulfils the initial N requirement of the crop while the organic N mineralizes gradually at a steady rate catering the later requirement thus assuming continuous N supply throughout the growth period. Such situation promotes adequate N absorption by the crop at different stages.

Quality Parameters: Head rice recovery (%) and volume/expansion ratio were not significantly influenced by both the planting methods and varieties and their interaction with the nitrogen sources. However nitrogen sources were found to significant influence the volume/expansion ratio (Table 2). Among the nitrogen sources the highest head rice recovery (68.4%) was noticed with the combined application of N_5 which was on a par with N_4 and N_2 but distinctly superior to N_3.

N_5 recorded significantly higher volume/expansion ratio compared to rest of the treatments which was at a par with that of N_4, N_3 and N_2.

The data pertaining to protein and amylase content of rice reveal that significant differences were only due to nitrogen sources and the influence of planting methods and varieties and their interaction with nitrogen sources on the protein content was found to be non-significant. The highest protein and amylase content was noticed with the N_5 which was comparable to N_4 but exhibited conspicuous supermacy to N_2 and N_3.

Gelatinization temperature score of rice was significantly influenced by the planting methods only. The score was significantly higher under direct sown rice than transplanted rice (Table 2).

Table 1. Yield and nitrogen uptake in rice as affected by planting methods, varieties and sources of nitrogen

Treatment uptake	Grain yield (kg/ha)	Straw yield (kg/ha)	Harvest index (%)	Nitrogen (kg/ha)
Planting method (M)				
M_1- direct seeding	4165	4779	46.5	82.7
M_2- transplanting	4212	4674	47.4	82.9
SEm±	121.2	133.2	0.48	0.74
$CD_{0.05}$	NS	NS	NS	NS
Variety (V)				
V_1- BPT 8024	3924	4762	46.9	82.7
V_2- MTU 2077	4363	4690	46.2	82.9
SEm±	169.6	63.9	0.66	0.48
$CD_{0.05}$	NS	NS	NS	NS
Nitrogen sources (N)				
N_1	2462	3226	43.5	57.0
N_2	4695	5321	47.3	87.0
N_3	3758	4450	45.9	75.1
N_4	4835	5276	47.8	95.3
N_5	4967	5359	48.1	99.6
SEm±	162.1	173.2	0.99	1.04
$CD_{0.05}$	317.8	339.6	1.95	2.0
Interaction	NS	NS	NS	NS
CV (%)	9.6	9.0	5.3	3.1

N_1: no nitrogen, N_2: 100% recommended nitrogen through fertilizer, N_3: 100% recommended nitrogen through FYM, N_4: 50% recommended nitrogen through fertilizer with 50% recommended nitrogen through FYM, N_5: 100% recommended nitrogen through fertilizer with 25% recommended nitrogen through FYM

The complimentary effect of organic and inorganic sources exhibited positive effect on head rice recovery, protein content and amylase content which was due to increase in the protein content of brown rice and a decrease in chaffy spikelets. The protein bodies functioned as a binder occupying the space between unpacked

Table 2. Quality parameters of rice as affected by planting methods, varieties and sources of nitrogen

Treatment	Head rice recovery (%)	Volume/ expansion ratio	Protein content (%)	Amylase content (%)	Gelatinization temperature score
Planting method (M)					
M_1- direct seeding	66.0	3.3	7.4	21.1	2.9
M_2- transplanting	66.7	3.3	7.4	21.2	2.8
SEm±	0.83	0.06	0.06	0.1	0.01
$CD_{0.05}$	NS	NS	NS	NS	0.1
Variety (V)					
V_1-BPT 8024	66.3	3.4	7.5	21.19	2.8
V_2-MTU 2077	66.4	3.3	7.4	21.12	2.8
SEm±	0.50	0.05	0.07	0.08	0.03
$CD_{0.05}$	NS	NS	NS	NS	NS
Nitrogen source (N)					
N_1	62.7	3.2	7.0	19.2	2.7
N_2	66.7	3.3	7.4	21.7	2.8
N_3	66.2	3.3	7.2	20.8	2.8
N_4	67.6	3.3	7.7	21.7	2.9
N_5	68.4	3.5	7.9	22.2	2.9
SEm±	0.94	0.10	0.12	0.18	0.05
$CD_{0.05}$	1.8	0.2	0.2	0.35	NS
Interaction	NS	NS	NS	NS	NS
CV (%)	3.5	7.5	4.2	2.1	4.5

N_1: no nitrogen, N_2: 100% recommended nitrogen through fertilizer, N_3: 100% recommended nitrogen through FYM, N_4: 50% recommended nitrogen through fertilizer with 50% recommended nitrogen through FYM, N_5: 100% recommended nitrogen through fertilizer with 25% recommended nitrogen through FYM

starch granules which resulted in increased resistance of rice grain to breakage during milling (Sakada Jongkaewwattana et al 1993) and the similar results were obtained in the present investigations. Increased protein synthesis under the influence of nitrogen supply N_5 might be due to continuous availability of nitrogen to the crop besides increased absorption and assimilation by the plants. Higher protein content with integrated N use encountered in the findings of Dixit and Gupta (2000) and similar results of quality parameters reported by Chaudhary et al (2011) are in agreement with the present investigations.

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