Journal of Academia and Industrial Research (JAIR)
Volume 4, Issue 2 July 2015

ISSN: 2278-5213

RESEARCH ARTICLE

Effect of Graded Nutrient Levels on Yield, Economics, Nutrient Uptake and Post-harvest Soil Fertility Status of Aerobic Rice

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Abstract

A field experiment was conducted at the dry land farm of S.V. Agricultural College, Tirupati during *kharif* 2011 and 2012 to identify the optimum nutrient requirement of aerobic rice. The study was laid out in a randomized block design, replicated four times with five treatments proposed with various percentages of recommended dose of nutrients namely N_1:75%, N_2:100%, N_3:125%, N_4:150% and N_5:175%. The data recorded on various parameters of rice, gross and net returns per hectare were computed considering the existing market price of inputs and outputs. Among all the treatments, N_5 has resulted in the highest yield, economic returns, N, P and K uptake and post-harvest available nutrient status of soil. But, it was comparable with N_4 and all of them were at their lowest with N_1.

Keywords: *kharif*, randomized block design, treatments, economic returns, nutrient status.

Introduction

The traditional flooded rice requires 3000-5000 L of water to produce just one kg of rice; the water is also lost through percolation and evaporation. Tuong and Bouman (2003) estimated that approximately 22 million hectares of irrigated rice in south and south-east Asia will suffer from "Economic Water Scarcity" (Prohibitively high water prices for agriculture) by 2025 and 10.4 million hectares in northern and central India will probably experience physical water scarcity by that time. Aerobic rice is that which is grown on non-puddled and non-flooded soil, just like maize, wheat and upland rice, but with higher inputs such as supplementary irrigation and fertilizers (Bouman, 2001). The quantity of irrigation saved in aerobic rice is about 40-50% compared to lowland transplanted rice cultivation (Castaneda *et al.,* 2002). Nutrient management is an inevitable component of any fertilizer management programme and particularly it is more so, for the aerobic rice crop. Hence, to develop an optimum nutrient management package for aerobic rice, a field experiment was conducted at the dry land farm of S.V. Agricultural College, Tirupati during *kharif* 2011 and 2012 to identify the optimum nutrient requirement of aerobic rice.

Materials and methods

Experimental design: Field experiments were conducted during *kharif* 2011 and 2012 at the dry land farm of Acharya N.G. Ranga Agricultural University, S.V. Agricultural College, Tirupati. Soil of the experimental field was sandy clay loam in texture, neutral pH (7.4), low in organic carbon (0.37%) and available nitrogen (168 kg ha^{-1}), medium in available phosphorus (18.95 kg ha^{-1}) and available potassium (238.15 kg ha^{-1}).

In *kharif* season, the experiment was laid out in randomized block design with four replications and five treatments. The experiment consisted of five treatments comprising of different graded nutrient management practices namely N_1-75%, N_2:100%, N_3:125%, N_4:150% and N_5:175%. The 100% recommended dose of fertilizer was 80-40-40 kg N, P_2O_5 and K_2O ha^{-1}. Entire quantities of P_2O_5 and K_2O were applied basally at the time of sowing while nitrogen was applied in three equal splits at sowing, tillering and panicle initiation stages as per the treatments. The sources of N, P_2O_5 and K_2O were urea, single super phosphate and muriate of potash, respectively and the variety of rice was Sravani (NLR-33359). The data recorded on various parameters of rice, gross and net returns per hectare were computed considering the existing market price of inputs and outputs. Benefit-cost ratio was worked out for different treatments by dividing the gross returns by corresponding cost of cultivation. The uptake of N, P and K in kg ha^{-1} was calculated by multiplying the nutrient content with the respective dry matter production. Immediately after the harvest of rice crop, soil samples were collected from the individual plots of the treatments and analyzed for available nitrogen (Subbiah and Asija, 1956), available phosphorus (Olsen *et al.,* 1954) and available potassium (Jackson, 1973). The data recorded on various parameters of rice during the course of investigation were statistically analyzed using variance for randomized block design (Panse and Sukhatme, 1985).

Results and discussion

Grain yield and straw yield of aerobic rice differed significantly due to graded nutrient levels (Table 1).

Table 1. Grain and straw yield (kg ha^{-1}) of aerobic rice as influenced by graded nutrient levels (Pooled data of 2 years).

Treatments	*Kharif* 2011 and 2012	
	Grain yield	Straw Yield
N_1 - 75% RDN	2540	4195
N_2 - 100% RDN	3107	5143
N_3 - 125% RDN	3642	6157
N_4 - 150% RDN	4106	7167
N_5 - 175% RDN	4232	5933
SEm ±	135.9	233.3
CD (P=0.05)	450	772

Table 2. Nutrient uptake (kg ha^{-1}) of aerobic rice as influenced by graded nutrient levels (Pooled data of 2 years).

Treatments	*Kharif* 2011 and 2012		
	Nitrogen	Phosphorus	Potassium
N_1 - 75% RDN	64.5	16.2	81.9
N_2 - 100% RDN	74.7	18.4	95.2
N_3 - 125% RDN	85.2	20.5	108.8
N_4 - 150% RDN	95.5	23.8	122.8
N_5 - 175% RDN	98.3	24.8	126.6
SEm ±	2.9	0.6	3.8
CD (P=0.05)	9.6	2.05	12.6

The highest grain and straw yield of rice was recorded with N_5 (175% precommended dose of nutrients), which was however, comparable with that under N_4 (150% recommended dose of nutrients) and distinctly superior to N_3 (125% recommended dose of nutrients) and N_2 (100% recommended dose of nutrients). The lowest grain and straw yield were recorded with N_1 (75% recommended dose of nutrients), which was significantly lesser than with the other nutrient levels tried (Table 1). The higher grain and straw yield obtained was due to the favorable influence of steady, consistent and adequate availability of nutrients during the required stages of crop growth, favoring the production of photosynthates coupled with better partitioning to the sink, under higher level of nutrition. These results are in conformity with those of Maheswari *et al.* (2008) and Malla Reddy *et al.* (2012).

Nutrient uptake: Nutrient uptake of aerobic rice estimated at harvest was significantly influenced by graded nutrient levels. Nutrient uptake was found increased progressively with increasing levels of nutrients. The highest nitrogen, phosphorus and potassium uptake was recorded with N_5 (175% recommended dose of nutrients), which were however, on par with N_4 (150% recommended dose of nutrients) and significantly superior than with N_3 (125% recommended dose of nutrients) and N_2 (100% recommended dose of nutrients) (Table 2). The higher level of nutrient supply is conducive for extensive root proliferation, to explore a greater volume of soil and absorb larger quantities of nutrients often tend to correlate positively with dry matter production and concentration of nutrients in the plant under higher level of nutrient supply. Similar results were also reported earlier by Jadhav and Dahiphale (2005) and Pasha *et al.* (2013).

The lowest nutrient uptake was recorded with N_1 (75% recommended dose of nutrients), which was significantly lesser than other nutrient levels tried.

Economics

Net returns: Net returns from aerobic rice were significantly influenced by graded nutrient levels with similar trend during both the years of study. The net returns recorded with N_5 (175% recommended dose of nutrients) was superior compared to all other treatments, followed by N_4 (150% recommended dose of nutrients), N_3 (125% recommended dose of nutrients) and N_2 (100% recommended dose of nutrients) in order of decrease. The net returns recorded with N_1 (75% recommended dose of nutrients) was significantly lowest among all the treatments (Table 3). These findings are in accordance with those of Aruna *et al.* (2012).

Benefit cost ratio: Benefit cost ratio of rice under aerobic culture differed significantly with graded levels of nutrient. N_5 (175% recommended dose of nutrients) showed its superiority in recording of benefit cost ratio followed by N_4 (150% recommended dose of nutrients), N_3 (125% recommended dose of nutrients) and N_2 (100% recommended dose of nutrients). The lowest benefit cost ratio was recorded with N_1 (75% recommended dose of nutrients). These results are in accordance with the findings of Yadav *et al.* (2008) and Murthy (2010).

Post-harvest soil fertility status: Post-harvest soil available nutrient status (N, P_2O_5 and K_2O) after the harvest of aerobic rice was significantly influenced by graded nutrient level. The highest post-harvest soil available nutrients was noticed with N_5 (175% recommended dose of nutrients), which was comparable with N_4 (150% recommended dose of nutrients).

Table 3. Economics of aerobic rice as influenced by graded nutrient levels (Pooled data of 2 years).

Treatments	*Kharif* 2011 and 2012	
	Net returns (ha^{-1})	B:C ratio
N_1 - 75% RDN	17815	2.20
N_2 - 100% RDN	24125	2.60
N_3 - 125% RDN	37785	2.90
N_4 - 150% RDN	34280	2.95
N_5 - 175% RDN	36634	3.20
SEm ±	1579	0.065
CD (P=0.05)	5229	0.2

Table 4. Post-harvest soil available N, P_2O_5 and K_2O (kg ha^{-1}) of aerobic rice as influenced by graded nutrient levels (Pooled data of 2 years).

Treatments	*Kharif* 2011 and 2012		
	Nitrogen	Phosphorus	Potassium
N_1 - 75% RDN	136.9	19.2	161.2
N_2 - 100% RDN	151.7	23.0	177.3
N_3 - 125% RDN	166.0	26.4	192.8
N_4 - 150% RDN	179.9	29.7	207.5
N_5 - 175% RDN	185.2	30.15	211.1
SEm ±	4.11	0.95	4.34
CD (P=0.05)	13.4	3.1	14.2

The next best treatment was N_3 (125% recommended dose of nutrients), which was significantly higher than with N_2 (100% recommended dose of nutrients) (Table 4). The above trend might be due to considerable quantities of nutrients might have left in the soil after meeting maximum requirement of the crop. Similar results were also reported by Pandey *et al.* (2000) and Kishor *et al.* (2008). The lowest post-harvest soil available nutrient status was noticed with N_1 (75% recommended dose of nutrients).

Conclusion

The two years of study revealed that highest grain yield, economic returns, nutrient uptake and post-harvest soil fertility status could be obtained with application of 175% recommended dose of fertilizer to aerobic rice. However, fertilizer dose can be reduced up to 150% of recommended dose of fertilizer without reduction in the grain yield, net returns and B: C ratio, nutrient uptake and post-harvest soil fertility status of soil.

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