

Original Research Article

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Influence of Integrated Nitrogen Management on Nitrogen Uptake and Soil Fertility Status in Rice-based Cropping Systems of High Altitude Region of Andhra Pradesh

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ABSTRACT

Field studies were conducted for two consecutive years (2014-15 and 2015-16) in sandy clay loam soils of Regional Agricultural Research Station, Chintapalli of Andhra Pradesh to study the nitrogen uptake and soil fertility changes in rice-based cropping systems under various nitrogen management practices employed to rice. The first season (*kharif*) experiment was laid out in randomized block design replicated thrice comprising seven nitrogen management practices to rice viz., T₁) FN₁₀₀; T₂) FN₁₂₅; T₃) FN₁₅₀; T₄) FN₁₀₀+FYM₂₅; T₅) FN₁₂₅+FYM₂₅; T₆) FN₁₀₀+BGA and T₇) FN₁₀₀+GM. Each of the treatment plots of *kharif* was subdivided into six plots during *rabi* to accommodate three crops viz., wheat, rajmash and mustard crops with two fertilizer schedules (F₁-50% RDF and F₂-100% RDF) in split plot design. From the two years study, it is indicated that the nitrogen uptake by *rabi* crops under the residual influence of N management practices to *kharif* rice was higher with wheat crop and the residual effect of different N management practices significantly influenced the post-harvest soil available nitrogen, phosphorus and potassium after *rabi* crops during both the years of study. The highest soil available nitrogen, phosphorus and potassium after *rabi* crops were registered with the residual effect of N supplied to *kharif* rice through FN₁₀₀ + GM during both the years of study. Among the three *rabi* crops rajmash left the soil fertility status at higher level than mustard and wheat, which in turn maintained clear disparity between them in rice-based cropping system in high altitude region of Andhra Pradesh.

Keywords

Rice based cropping system, Integrated N management, Nitrogen uptake, Soil fertility

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Introduction

The emerging food grain demand of 300 million tonnes by 2030 (IFPRI, 2012) to meet the requirement of burgeoning population depicts an important challenge in the present agricultural scenario. Green revolution of the 1960's that sustained for over 3 decades got jeopardized, and the future increase of food supplies must come primarily from crop

intensification and enhanced productivity rather than through area expansion alone. Green revolution technologies involving greater use of synthetic agrochemicals combined with nutrient-responsive, high yielding varieties of crops have boosted up the output in most of the cases. However in the process of attaining higher level of agricultural productivity to match the demands of burgeoning population, we have inadvertently

ignored the detrimental effect to the natural resource base and environment.

Food security in terms of production totals is meaningless if the agricultural resource base that produces the gains itself is threatened. There are several reasons for decreasing trend in productivity, the major being the drastic decline in soil fertility, particularly in areas where fertilizers are being used in increasing quantities year after year, without adequate supplementation of organic matter. The gravity of environmental degradation has drawn the attention of the scientists and planners towards finding out ecologically sound, viable and sustainable farm technologies, keeping in view of the needs of the future generations.

Adoption of a cropping system by the farmers depends upon the economic returns and labour costs. Farmers of high altitude tribal region of Andhra Pradesh have been adopting varying rice-based cropping systems, only based on traditional knowledge and neither the component crops of rice based cropping systems nor the nutrient management practices adopted by them are eco-friendly and scientific enough to sustain the productivity and soil health. To fulfill the demand of cereal, pulses and oilseeds of ever increasing population, inclusion of oilseeds and pulses in rice based cropping sequence was found more beneficial than cereal alone (Kumar *et al.*, 2008).

Rice is the principal rainy season crop grown under rice-fallows in high altitude tribal zone of Andhra Pradesh. The existing mono cropping of rice is becoming less remunerative and the need therefore, is to intensify agricultural production through increasing the cropping intensity that can be achieved through rice-based cropping system, as the rice being the main crop of the zone. The information on performance of different rice-

based cropping systems with regard to stability, profitability and productivity are lacking. Identifying a suitable cropping system with rice as principal component crop and developing a sound viable nitrogen management package for high altitude tribal region of Andhra Pradesh is fairly necessary. Hence, the present study was carried out to study the performance of productivity and economics of rice-based cropping system.

Materials and Methods

Field experiments were conducted at Regional Agricultural Research Station, Chintapalli farm of Acharya N.G. Ranga Agricultural University, Andhra Pradesh for two years from July 2014 to April 2016 which is geographically situated at 17.6°N latitude, 82.3°E longitude and at an altitude of 839.0 m above the mean sea level in the high altitude and tribal zone of Andhra Pradesh. The soil of the experimental plot was sandy clay loam in texture, slightly acidic in reaction (pH 6.3), low in organic carbon (0.33%) and available nitrogen (180.6 kg ha⁻¹), medium in available phosphorus (25.63 kg ha⁻¹) and high in available potassium (332.5 kg ha⁻¹). Average annual rainfall of the region is 1211.0 mm.

The *experiment* was laid out in randomized block design with three replications for rice crop in *kharif* season. There were seven treatments comprising of different manurial practices for rice crop in *kharif* season *viz.*, T₁-100% recommended dose of nitrogen (RDN) through fertilizer (FN₁₀₀), T₂-125% RDN through fertilizer (FN₁₂₅), T₃-150% RDN through fertilizer (FN₁₅₀), T₄-100% RDN through fertilizer + FYM @ 5 t ha⁻¹ (FN₁₀₀ + FYM N₂₅), T₅-125% RDN through fertilizer + FYM @ 5 t ha⁻¹ (FN₁₂₅ + FYM N₂₅), T₆-100% RDN through fertilizer + BGA @ 10 kg ha⁻¹ (FN₁₀₀+BGA) and T₇-100% RDN through fertilizer + Green manure in-situ (FN₁₀₀ + GM). The recommended dose of nitrogen for

rice is 80 kg N ha⁻¹. There were seven main plot treatments and six sub plot treatments for *rabi* crops laid out in split plot design with three replications. Treatments (7) applied to rice crop during *kharif* season are the main plots during *rabi*. Sub plot treatments were 6 (3 different crops with 2 levels of NPK) viz., wheat, rajmash and mustard with 50% of the recommended dose (F₁) of the respective crop and 100% of the recommended dose (F₂) of the respective crop. The test variety of rice was MTU 1075 (Pushyami) and varieties of wheat, rajmash and mustard were Sagarika, CTPL Red and Varuna, respectively.

All the manures and fertilizers were applied to all the test crops as per the treatments. The recommended dose of fertilizers was applied to the treatmental plots of crops *i.e.*, for rice (80-60-50 Kg N-P-K ha⁻¹), wheat (120-60-40 Kg N-P-K ha⁻¹), Rajmash (100-60-20 Kg N-P-K ha⁻¹) and mustard (40-30-40 Kg N-P-K ha⁻¹) crops.

Entire quantity of P₂O₅ and K₂O was applied as a basal dose for *rabi* crops. For rice, nitrogen was applied in three equal spits *i.e.* one third as basal, one third at 30 days after transplanting and the remaining one third at panicle initiation stage. The sources of N, P and K were urea, single super phosphate and muriate of potash, respectively. Nitrogen uptake of *rabi* crops and soil fertility status of the cropping system were recorded and computed after the harvest of the crops.

The data recorded on various parameters of all the four crops of the cropping system were statistically analysed following the analysis of variance as suggested by Panse and Sukhatme (1978). Wherever the treatmental difference were found significant ('F' test), critical difference was worked out at 0.05 probability level and the values were furnished. Treatmental differences that were non-significant were denoted by "NS".

Results and Discussion

Nitrogen uptake (kg ha⁻¹) by *rabi* crops at harvest

The uptake of nitrogen (Table 1) of *rabi* crops was influenced by the residual effect of integrated N management practices to *kharif* rice and fertilizer schedules applied to the succeeding *rabi* crops during both the years of study (Table 1). However, the interactions between N management practices to *kharif* rice and *rabi* crops with their fertilizer schedules found to be non-significant during both the years. Different N management practices to *kharif* rice significantly increased the nitrogen uptake of *rabi* crops during both the years of investigation. The highest N uptake (75.3 and 77.5 kg ha⁻¹) was noticed with FN₁₀₀ + GM which was significantly superior to all other N management practices to *kharif* rice, during both the years of study. The highest N uptake was attributed to higher biomass yield of wheat due to slow and prolonged availability of nutrient to crop. The combined application of organic and inorganic source of nutrient might have improved soil environment, encouraged root proliferation and root surface absorption zone, which in turn, drew more water and nutrients. These results were in conformity with Niru Kumari *et al.*, 2013. The increased nitrogen uptake might be due to increased availability of nutrients which in turn, might have aided in higher yield and N uptake. The present results are in close conformity with the findings of Sesha Saila Sree Pande (2001), Sharma and Sharma (2002) and Ramesh Babu (2012). Fertilizer schedules adopted to *rabi* crops also showed similar response in uptake of nitrogen during both the years of experimentation. The fertilizer schedule with 100% RDF enhanced the N uptake of *rabi* crops than 50% recommended dose of fertilizers to the respective crops during two years of investigation.

Table.1 Nitrogen uptake (kg ha⁻¹) by *rabi* crops at harvest as influenced by integrated nitrogen management practices during 2014-15 and 2015-16

Treatments		2014-15				2015-16			
Treatments imposed to <i>kharif</i> rice (Main plots)		Wheat	Rajmash	Mustard	Mean	Wheat	Rajmash	Mustard	Mean
T ₁	FN ₁₀₀	112.2	47.5	45.0	68.2	117.2	45.6	39.6	67.5
T ₂	FN ₁₂₅	116.2	46.2	45.9	69.4	115.3	47.0	43.7	68.7
T ₃	FN ₁₅₀	113.1	48.5	44.2	68.6	113.6	47.3	42.2	67.7
T ₄	FN ₁₀₀ + FYM N ₂₅	120.1	48.9	40.4	69.8	111.2	48.5	44.5	68.1
T ₅	FN ₁₂₅ + FYM N ₂₅	113.3	49.3	47.7	70.1	119.7	45.9	49.2	71.6
T ₆	FN ₁₀₀ +BGA	118.2	47.2	45.1	70.2	111.6	46.6	46.2	68.1
T ₇	FN ₁₀₀ + GM	121.5	52.7	51.7	75.3	125.3	54.5	52.8	77.5
	Mean	116.4	48.6	45.7		116.2	47.9	45.4	
	SEm±	0.84				1.51			
	CD (P = 0.05)	2.61				4.68			
	CV (%)	5.67				8.42			
Treatments given to <i>rabi</i> crops (sub plots)									
F ₁	50% RDF	108.4	42.3	39.0	63.2	111.2	42.9	37.7	63.9
F ₂	100% RDF	124.0	53.6	50.1	75.9	122.7	55.0	50.7	76.1
	SEm±	1.48				3.52			
	CD (P = 0.05)	4.22				10.0			
	CV (%)	7.33				11.4			

Table.2 Post harvest soil N (kg ha⁻¹) status as influenced by integrated N management practices and fertilizer schedules during *rabi* 2014-15 and 2015-16

Treatments		2014-15				2015-16			
Treatments imposed to <i>kharif</i> rice (Main plots)		Wheat	Rajmash	Mustard	Mean	Wheat	Rajmash	Mustard	Mean
T ₁	FN ₁₀₀	125.1	284.7	139.8	183.2	139.9	125.3	178.2	147.8
T ₂	FN ₁₂₅	127.3	280.1	138.0	181.8	182.3	190.6	194.3	189.1
T ₃	FN ₁₅₀	128.8	283.2	138.5	183.5	161.1	162.0	148.0	157.0
T ₄	FN ₁₀₀ + FYM N ₂₅	126.2	261.0	138.0	175.1	172.9	212.7	221.6	202.4
T ₅	FN ₁₂₅ + FYM N ₂₅	128.4	294.9	137.3	186.9	147.8	149.4	215.6	170.9
T ₆	FN ₁₀₀ +BGA	124.0	271.7	139.3	178.3	202.8	127.7	163.0	164.5
T ₇	FN ₁₀₀ + GM	131.7	295.0	141.1	189.3	189.1	193.0	225.2	202.4
Mean		127.4	281.5	138.9		170.8	165.8	192.3	
SEm±		1.23				1.96			
CD (P = 0.05)		3.80				6.0			
CV (%)		5.62				5.33			
Treatments given to <i>rabi</i> crops (sub plots)									
F ₁	50% RDF	120.3	271.4	126.2	172.7	167.4	163.7	180.7	170.6
F ₂	100% RDF	132.7	283.9	151.6	189.4	188.9	172.5	193.4	184.9
SEm±		2.58				7.4			
CD (P = 0.05)		7.35				21.0			
CV (%)		6.90				13.5			

Interaction

	SEm±	CD (P = 0.05)		SEm±	CD (P = 0.05)
S at M	5.17	14.7	S at M	14.8	42.0
M at S	4.78	9.62	M at S	13.4	26.8

Table.3 Post harvest soil P₂O₅ (kg ha⁻¹) status crops as influenced by integrated N management practices and fertilizer schedules during *rabi* 2014-15 and 2015-16

Treatments		2014-15				2015-16			
Treatments imposed to <i>kharif</i> to rice (Main plots)		Wheat	Rajmash	Mustard	Mean	Wheat	Rajmash	Mustard	Mean
T ₁	FN ₁₀₀	13.7	13.9	18.4	15.3	20.4	25.3	25.9	23.9
T ₂	FN ₁₂₅	13.9	15.4	18.6	16.0	23.7	25.0	26.9	25.2
T ₃	FN ₁₅₀	12.7	18.3	18.5	16.5	22.7	23.0	26.8	24.2
T ₄	FN ₁₀₀ + FYM N ₂₅	13.8	13.3	18.8	15.3	22.0	23.3	28.5	24.6
T ₅	FN ₁₂₅ + FYM N ₂₅	14.9	15.4	18.5	16.3	24.9	25.2	26.3	25.5
T ₆	FN ₁₀₀ +BGA	14.3	13.0	16.9	14.7	21.7	23.0	25.6	23.4
T ₇	FN ₁₀₀ + GM	14.8	18.7	18.8	17.4	24.2	27.3	28.7	26.7
	Mean	14.0	15.4	18.4		22.8	24.6	27.0	
	SEm±	0.55				0.71			
	CD (P = 0.05)	NS				NS			
Treatments given to <i>rabi</i> crops (sub plots)									
F ₁	50% RDF	13.3	13.4	15.9		21.3	23.2	25.3	
F ₂	100% RDF	15.6	14.4	20.6		25.0	24.0	29.3	
	SEm±	0.73				1.12			
	CD (P = 0.05)	2.09				3.18			
	CV (%)	16.0				15.6			

Table.4 Post harvest soil K₂O (kg ha⁻¹) status as influenced by integrated N management practices and fertilizer schedules during *rabi* 2014-15 and 2015-16

Treatments		2014-15				2015-16			
Treatments imposed to <i>kharif</i> rice (Main plots)		Wheat	Rajmash	Mustard	Mean	Wheat	Rajmash	Mustard	Mean
T ₁	FN ₁₀₀	157.5	146.0	153.9	152.5	164.2	175.2	160.5	166.6
T ₂	FN ₁₂₅	152.5	152.5	153.2	152.7	159.5	159.2	159.9	159.5
T ₃	FN ₁₅₀	156.4	165.5	150.4	157.4	163.1	172.2	157.0	164.1
T ₄	FN ₁₀₀ + FYM N ₂₅	157.9	132.9	154.1	148.3	164.6	139.5	160.8	155.0
T ₅	FN ₁₂₅ + FYM N ₂₅	156.1	151.9	153.3	153.8	162.7	158.6	159.9	160.4
T ₆	FN ₁₀₀ +BGA	160.2	148.1	152.2	153.5	166.8	154.7	158.9	160.1
T ₇	FN ₁₀₀ + GM	160.5	168.5	155.5	161.5	167.2	152.7	163.5	161.1
	Mean	157.3	152.2	153.2		164.0	158.9	160.1	
	SEm±	2.38				2.19			
	CD (P = 0.05)	7.36				6.77			
	CV (%)	6.01				5.29			
Treatments given to <i>rabi</i> crops (sub plots)									
F ₁	50% RDF	146.5	139.2	151.4	145.7	153.1	145.9	158.1	152.3
F ₂	100% RDF	168.8	150.2	156.2	158.4	175.5	156.8	163.5	165.2
	SEm±	3.17				3.10			
	CD (P = 0.05)	9.02				8.81			
	CV (%)	7.12				6.67			

The increased N uptake may be attributed to increased availability of nutrients with 100% RDF which might have leads to higher uptake of nitrogen. Similar observations were also reported by Raghavaiah (1999) and Patel *et al.*, (2010).

Post-harvest soil fertility status in rice based cropping system (N, P₂O₅ and K₂O) (kg ha⁻¹)

The status of available soil N, P₂O₅ and K₂O were significantly influenced in rice-based

cropping system under different N management practices to *kharif* rice and fertilizer schedules given to succeeding *rabi* crops during both the years of study. However, the interactions between N management practices and fertilizer schedules to *rabi* crops were found to be non-significant, except soil available N which was significantly influenced during both the years of study (Table 2 to 4). The interaction between integrated N management practices to preceding rice and *rabi* crops with their fertilizer schedules found to be significant.

Application of 100% RDN through fertilizer + green manuring *in-situ* to rice and 100% RDF to succeeding crops was significantly superior than other N management practices.

Among different N management practices to rice 100% RDN through fertilizer + green manuring *in-situ* significantly influenced the available N, P and K status in soil over all other levels during both the years of study. Application of green manuring *in-situ* in combination with 100% RDN through fertilizer had significant residual effect in increasing the available nutrient status than the 100% RDN applied alone in both the years. The increased available N, P and K in the soil might be due to enhanced native and applied nutrients. These results were in close conformity with the findings of Raju and Reddy *et al.*, (2000) and Patro *et al.*, (2005).

In respect of fertilizer schedules adopted viz., 50% and 100% RDF to *rabi* crops, application of 100% RDF proved significantly superior in increasing the available N, P and K over 50% RDF during both the years of experimentation. This might be due to more availability of nutrients with 100% RDF treatment. These results agreed with the findings of Kedar Prasad *et al.*, (2005).

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