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Response of rice varieties to forms of urea and levels of N in rice-zero till maize cropping system

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ABSTRACT

A field experiment was conducted to evaluate the performance of rice varieties of different duration in relation to levels of N and forms of urea during wet seasons of 2006-07 and 2007-08 on sandy clay loam soils of Rajedranagar, Hyderabad. Results indicated that the long duration variety BPT-5204 out yielded other two varieties, M-7 (medium) and Tellahamsa (short) in terms of growth, dry matter production, per day productivity, grain yield and straw yield. Increasing levels of nitrogen from 75% recommended dose of nitrogen (RDN) i.e. 100kg N ha^{-1} to 125% RDN brought significant improvement in growth parameters, yield attributes and grain yields irrespective of the rice varieties.

Key words: *rice, response, N levels, zero till, maize, cropping system*

Rice plays a seminal role in food security of India. The total domestic demand for rice is estimated to be 113.3 million tonnes and 28-29 percent yield enhancement is required to achieve 2.65 t ha^{-1} average yield for the year 2021-2022 (Kumar *et. al*., 2009). It is very clear that there is no scope for area expansion under rice cultivation. In these circumstances, there is need to improve the utilization of external inputs in rice cultivation. Urea is the most widely used source of N fertilizer in India, however N use efficiency is relatively low (20-30 per cent) in wet land condition due to rapid hydrolysis, voltalization and mineralization. Increased nitrogen use efficiency in cereal is unlikely unless system approach is implemented with best agriculture practices to manage fertilizer nitrogen through the amount, form and matching cultivar to profitable utilize the applied resources. Of late, the rice fallow pulse cropping system in Andhra Pradesh, southern India has been replaced by rice-zero till maize system. Dry season zero-till maize is thermo sensitive at tasseling stage and affected by higher temperature of > 36^{0}C which cause pollen drying and barrenness. Therefore, there is a need to identify a rice variety which permits early harvest and allow timely raising of sequential dry season maize to escape high temperature during tasseling stage. There is also a need to workout a package of variety, amount and form of N to realize higher rice yield with early duration rice cultivars. Hence, the present study was undertaken to study the response of rice varieties to the dynamics of applied nitrogen forms, post soil fertility and associated microbes in the rice-zero till maize system.

MATERIAL AND METHODS

An experiment was conducted at College of Agriculture, Rajendranagar, Hyderabad, Andhra Pradesh during wet seasons of 2006-07 and 2007-08. The soil was sandy clay loam in texture with medium organic carbon content (0.60), low available nitrogen (235 kg ha^{-1}) and medium available phosphorus (20.2 kg ha^{-1}) and potassium (271 kg ha^{-1}) content with slight alkalinity (pH 8.0). The experiment was laid in split-split plot design with three replicates. The main treatments consisted of three rice varieties, Tellahamsa (short duration of 120 days), Early Samba (medium duration of 135 days) and BPT-5204 (long duration of 150 days). The sub treatments consisted of three levels of nitrogen, 75, 100 and 125% of recommended dose of nitrogen (RDN) *i.e.* 100 kg ha^{-1} and sub-sub treatments consisted of two forms of urea, prilled urea (PU) and granular urea

(GU). Recommended dose of 60 P_2O_5 and 40 K_2O kg ha^{-1} was applied uniformly at the time of last puddling. Nitrogen as per the treatment, was applied in three equal splits *i.e.* basal (at the time of transplanting), active tillering and at panicle initiation stage. The sources of N, P_2O_5 and K_2O were urea, single super phosphate and muriate of potash, respectively. Initial and final available nitrogen, phosphorus and potassium in the soil were estimated by prescribed standard methods and total microbial population at the time of flowering and after rice harvest was estimated by following the standard dilution plate technique (Allen 1957).

RESULTS AND DISCUSSION

The effect of varieties was significant on grain yield in both the years. Long duration rice variety (BPT-5204) recorded 19.7, 35.9, 42.6, 24.0 and 52.8, 80.5, 156.4, 54.5 per cent more grain yield, straw yield, net returns and B:C ratio over M-7 and Tellahamsa, respectively (Table 2). It was favourable for the long duration varieties to assimilate and translocate maximum amount of photosynthates from source to sink resulting in higher percentage of filled grains as compared to medium and short duration varieties. Such varieties have more vigour and inheritance of superior growth and yield attributing characteristics (Table 1) and higher grain and straw yield. Hence, rice grain yield and straw yield of BPT 5204 was superior to M-7 and Tellahamsa. Singh *et al*. (1998), Reddy and Kumar (1999) and Navin Kumar and Rajendra Prasad (2004) also reported similar results. Eventhough, rice varieties reached physiological maturity and harvesting at different times, the temperatures at the time of expected tasseling stage of the sequential maize crop after three rice varieties was below 36^0C which can permit successful sequential zero till maize. Thus in case of early onset of monsoon and sufficient inflows into water bodies, rice variety of any duration can be planted in the existing rice zero till maize systems as harvesting of all the varieties falling within recommended time of sowing of dry season maize (1st week of October to 2nd fortnight of December). Level of nitrogen or forms of urea did not effect the duration of rice varieties.

All the growth and yield parameters were found maximum with 125% RDN (25% higher N than recommended nitrogen; 120 kg ha^{-1}) resulting in significantly higher grain and straw yield of all the three varieties (Table 1). Continuous cropping and N losses in lowland rice and lower microbial activity (Table 4) warrant higher RDN level to any rice variety irrespective of the duration from the present study. Advantage of higher levels of N over lower levels of N was reported by Amarjit *et al*. (1995), Abdul Rasheed Wani *et al*. (1999) and Mahato *et al.* (2007)

Table 1. Yield attributes of rice as influenced by varieties, levels and forms of Nitrogen

Treatments	2006 – 07			2007 – 08		
	Panicle length (cm)	Number of filled grains panicle^{-1}	Test weight (g)	Panicle length (cm)	Number of filled grains panicle^{-1}	Test weight (g)
Rice Varieties						
Tellahamsa	18.04	66.44	23.61	18.60	67.55	23.71
Early Samba	19.39	136.44	21.5	19.80	138.45	20.65
Samba Mahsuri	20.78	157.47	18.35	21.18	159.06	18.45
CD (P<0.05)	0.97	13.18	1.91	0.92	17.80	2.01
N levels						
75% RDN	17.77	93.60	20.43	18.21	8.03	20.20
100% RDN	19.37	120.06	21.17	19.81	121.22	20.93
125% RDN	21.08	146.70	21.91	21.56	148.53	21.68
CD (P<0.05)	0.30	11.08	0.41	0.56	11.76	0.45
Forms of Urea						
Prilled Urea	18.83	108.64	20.90	19.32	110.05	20.67
Granular Urea	19.97	131.60	21.44	20.40	133.32	21.21
CD (P<0.05)	0.23	6.37	0.34	0.31	6.66	0.28

Note: Interaction non significant, RDN - recommended dose of nitrogen

Table 2. Rice grain and straw yield, net returns and B:C ratio of rice as influenced by varieties, levels and forms of Nitrogen

Treatments	2006 – 07				2007 – 08			
	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Net returns (₹ ha^{-1})	B:C Ratio	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Net returns (₹ ha^{-1})	B:C Ratio
Rice Varieties								
Tellahamsa	3.70	4.13	8,752	1.44	3.83	4.22	12,929	1.64
Early Samba	4.78	5.55	17,220	1.87	4.84	5.55	21,759	2.07
Samba Mahsuri	5.70	7.53	24,843	2.25	5.81	7.55	30,742	2.51
CD (P<0.05)	0.43	0.91			0.81	1.27		
N levels								
75% RDN	4.48	5.45	15,335	1.79	4.55	5.40	19,735	1.99
100% RDN	4.73	5.73	16,966	1.86	4.86	5.79	22,098	2.09
125% RDN	4.97	6.03	18,515	1.92	5.07	6.03	23,597	2.14
CD (P<0.05)	0.19	0.16			0.17	0.18		
Forms of urea								
Prilled urea	4.63	5.64	16,188	1.82	4.70	5.67	20,710	2.02
Granular urea	4.82	5.83	17,689	1.89	4.96	5.87	22,910	2.13
CD (P<0.05)	0.13	0.12			0.12	0.17		

Note: Interaction non significant

Application of nitrogen through granular urea increased rice yield by 4.9 per cent over prilled urea (Table 2) and left soil with high nitrogen status (Table 3). Complete and slow transformation of N in granular urea and relatively large size and weight of granular urea made them to reach the reduced zone releasing positively charged NH^+_4 ions. This made nitrogen to remain stable and available for long period, prevented its loss and made available to crop for long period and prevented losses. This also reduced excess availability of the nitrogen in the soil and to the crop at the time of N application and its deficiency before next split application. Complementary nature of N with P and K availability resulted in higher uptake of N, P and K leading to better vegetative, reproductive, yield attributes and higher grain and straw yield. Granular urea was superior over prilled urea, irrespective of rice variety and RDN levels. Beneficial effect of granular urea over prilled urea was reported by Shivay *et al*., 2000.

Among rice varieties, Tellahamsa being of short duration got less time to assimilate entire quantity of nutrients applied from extraneous sources which left higher soil available N, P and K after its harvest (Table 3). On the other hand, BPT-5204 a long duration variety had enough time to uptake and assimilate nutrients and hence left the soil with lower fertility status. Among the N levels and sources tried, 125% RDN and granular urea recorded higher available N status in soil. The increase in available N might be due to increased and steady mineralization of N at 125 per cent RDN and in the form of granular urea, respectively

Table 3. Available N, P and K (Kg ha^{-1}) after harvest of rice as influenced by varieties, levels and forms of Nitrogen

Treatments	2006 – 07			2007 – 08		
	N	P	K	N	P	K
Rice Varieties						
Tellahamsa	243.48	32.8	274.04	244.84	34.30	276.44
Early Samba	223.88	23.09	221.25	225.24	24.19	222.53
Samba Mahsuri	202.47	13.66	177.91	203.85	14.64	178.86
CD (P<0.05)	4.15	1.56	5.12	5.99	1.34	6.21
N levels						
75% RDN	218.02	24.80	231.98	218.72	26.25	233.43
100% RDN	223.35	23.23	224.62	224.45	24.34	225.71
125% RDN	228.46	21.59	216.59	230.746	22.53	218.68
CD (P<0.05)	3.50	1.06	2.57	2.93	1.10	3.19
Forms of urea						
Prilled urea	222.20	24.10	225.93	223.56	25.49	227.49
Granular urea	224.35	22.31	222.87	225.72	23.26	224.39
CD (P<0.05)	2.02	0.67	2.11	1.96	0.78	2.73

Note: Interaction non significant, Initial Soil Status N : 235.0 kg N ha^{-1}, P_2O_5 - 20.2 kg ha^{-1}, K_2O - 271.0 kg ha^{-1}

Table 4. Microbial population at flowering and after rice harvest as influenced by varieties, levels and forms of Nitrogen

Treatments	2006 - 07		2007 – 08	
	Microbial population at the time of flowering (No.x 10^6 cfu g^{-1} soil)	Microbial population after rice harvest (No.x 10^6 cfu g^{-1} soil)	Microbial population at the time of flowering (No.x 10^6 cfu g^{-1} soil)	Microbial population after rice harvest (No.x 10^6 cfu g^{-1} soil)
Rice Varieties				
Tellahamsa	27.21	18.19	27.31	18.27
Early Samba	27.20	18.30	27.49	18.33
Samba Mahsuri	27.38	18.31	27.54	18.38
CD (P<0.05)	NS	NS	NS	NS
N levels				
75% RDN	25.83	16.74	25.95	16.80
100% RDN	27.90	18.77	28.02	18.80
125% RDN	28.06	19.29	28.37	19.38
CD (P<0.05)	1.73	1.48	1.30	1.22
Forms of Urea				
Prilled Urea	25.78	16.54	25.91	16.58
Granular Urea	28.75	20.00	28.98	20.08
CD (P<0.05)	1.03	1.19	1.35	1.16

Note: Interaction non significant, RDN - recommended dose of nitrogen

(Table 3). Whereas, the total available P and K recorded in the soil was higher with prilled urea and at lower level of N (75 per cent RDN). Lower N level and prilled urea form might have favoured less utilization of available P and K leading to higher P and K status of soil and similar results were reported by Mahajan and Tripathi (1992), Patel *et al*. (1997), Navin Kumar and Rajendra Prasad (2004).

Microbial population was not significantly affected by rice varieties. Application of higher levels of N *i.e*., 125 and 100% RDN favoured higher microbial activity compared to lower level of N (75% RDN) due to release of higher nitrate and ammonical nitrogen and medium organic matter available for growth and multiplication of microbes (Table 4). Also use of granular form of urea also registered higher microbial population compared to prilled forms. This might be due to the slow release pattern and steady mineralization characteristics of granular forms which synchronized with the demand of the crop. Furthermore, the NH_4-N concentration was not too high at a given time, consequent to adsorption by clay complex and becoming substrate to microbes. Application of granular form was not toxic to the microbial population in the soil and the same was reported by Deniel *et al*. (1999). Based on the results, it may be concluded that, among the urea forms, granular urea proved better than prilled urea. Short duration rice varieties left the soil with high nutrient status when compared to long duration variety and microbial status was not effected by the varieties. Higher RDN levels and granular form of urea improved soil N status and higher microbial activity.

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