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RESEARCH ARTICLE

INFLUENCE OF LEVELS AND TIME OF NITROGEN APPLICATION ON YIELD, NUTRIENT UPTAKE AND SOIL FERTILITY STATUS IN MACHINE TRANSPLANTED RICE (*ORYZA SATIVA* L.).

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ABSTRACT

A field experiment was conducted at Agriculture Research Instiitute (ARI), Rajendranagar, Hyderabad, Telangana on a clay loam soil during the *kharif* seasons of 2014 and 2015 to study the "Influence of levels and time of nitrogen application on yield, nutrient uptake and soil fertility status in machine transplanted rice (*Oryza sativa* L.)". Experiment was carried out in a split plot design with three nitrogen levels viz. 120, 160 and 200 kg N ha^{-1}in main plot treatments and three split schedules viz.2 equal splits at active tillering (AT) and panicle initiation (PI), 3 equal splits at initial tillering (IT), active tillering (AT) and panicle initiation (PI) and 4 equal splits at initial tillering (IT), active tillering (AT), tillering (T) and panicle initiation(PI) as sub plot treatments with three replications using the long duration variety BPT 5204. Application of 200 kg N ha^{-1} gave significantly highest grain yield (6,119 kg ha^{-1}) over application of 120 kg N ha^{-1} and was at par with application of 160 kg N ha^{-1}. Uptake of NPK was highest with application of 200 kg N ha^{-1} and it decreased with decreasing nitrogen levels. Three equal split applications recorded maximum grain (6,028 kg ha^{-1}) yield and NPK uptake. Soil post-harvest pH and EC were not affected by nitrogen levels and time of application. With increasing nitrogen levels, available nitrogen increased while available phosphorus decreased and no effect on potassium.

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INTRODUCTION

Rice (Oryza sativa L.) is the most important staple food for more than half of the world's population. In Asia, more than two billion people are meeting 60-70 per cent of their energy requirement from rice and its derived products, a major source of dietary protein for most people in tropical Asia (Juliano, 1993). In Telangana state of India, rice is the principal food crop cultivated throughout the state. The crop is cultivated in an area of about 2.01 m ha with an annual production of 6.62 mt and productivity of 3.29 t ha^{-1} (Statistical Year Book, 2015). Among nutrients, nitrogen is the most important limiting element in rice growth and it is required in large amount for achieving higher productivity (Jayanthi *et al*., 2007). Additionally, rice production has heavy system losses of nitrogen when applied as inorganic sources in puddled field (Fillery *et al*., 1984).

Yield increase in magnitude of 70-80% of field rice could be obtained by the application of nitrogen fertilizer (IFC, 1982).In low land rice ecosystems in wet season, usually nitrogen use efficiency is approximately 30-40% (Ramakrishan *et al*., 2007) and rest of 60-70% being lost by way of denitrification, ammonium volatilization, leaching, runoff and immobilization. Therefore, nitrogen use efficiency need to be increased through its appropriate level and split application at transplanting, tillering and panicle initiation stages to produce highest paddy yield (Bacon, 1980). Due to prolonged duration of vegetative time in machine transplanted rice, these loses may become more if same nitrogen scheduling is in practice for machine transplanted rice as that of conventional rice systems. The rice plant behavior will vary with nitrogen schedules and these losses will be minimized by adjusting scheduling of nitrogen. Hence the present field investigation was carried out to evaluate the effect of nitrogen levels and split schedules on yield, nutrient uptake and soil post-harvest characteristics.

MATERIALS AND METHODS

The experiment was conducted during *kharif* season of 2014 and 2015 at the Rice Section experimental site of the Agricultural Research Institute (ARI), Rajendranagar, Hyderabad located at 17°32' N latitude, 78° 40' E longitude and at an altitude of 542.3 m above mean sea level. The soil was clay loam in texture, moderately alkaline in reaction (pH = 8.1), organic carbon (1.37%) and electrical conductivity (1.42 dsm^{-1}) with low available nitrogen (229 and 231 kg ha^{-1}), high available phosphorus (39.4 and 42.6 kg ha^{-1}) and potassium (531 and 535 kg ha^{-1}) in 2014 and 2015 respectively. The experiment was laid out in a split plot design where main plot treatments consisted of three N levels: N_1=120, N_2=160 and N_3=200 kg ha^{-1} and sub plot treatments were split schedules: S_1= 3 equal splits at basal (B), active tillering (AT) and panicle initiation (PI), S_2= 4 equal splits at basal (B), initial tillering (IT), active tillering (AT) and panicle initiation (PI) and S_3= 5 equal splits at basal (B), initial tillering (IT), active tillering (AT), tillering (T) and panicle initiation (PI) with three replications. Nitrogen was applied in the form of urea whereas 60 kg P_2O_5 kg ha^{-1} as single super phosphate (SSP) and potassium @ 40 kg K_2O ha^{-1} as muriate of potash (MOP) were applied to all the treatments uniformly as basal. The long duration (150 days) variety BPT 5204 was used in the experiment and was machine transplanted on 23rd June and 11th July in 2014 and 2015respectively using 15 days old seedlings spaced at 30 x 16 cm in individual plots of size 7.2 m x 3.0 m.

RESULTS AND DISCUSSION

Grain yield

Maximum grain yield (6,119 kg ha^{-1}) was obtained with 200 kg N ha^{-1} and was comparable to 160 kg N ha^{-1} (5,992 kg ha^{-1}), both were significantly higher as compared to 120 kg N ha^{-1} (5,707 kg ha^{-1}). Similar results were obtained by Khalifa (2012), Babu *et al*. (2013). Split schedules significantly affected the grain yield where application of nitrogen in 4 equal splits gave maximum grain yield (6,028 kg ha^{-1}) and was significantly higher as compared to 3 and 5 equal splits which yielded 5,875 and 5,914 kg ha^{-1} respectively, both being at par. These results are in conformity with the findings of Chaudhary *et al*. (2013) and Tari and Amiri (2015). Interaction effect between nitrogen levels and split schedules on grain yield was found to be non-significant (Table 1).

Straw yield: Straw yield increased linearly and significantly with increasing N levels where 200 kg N ha^{-1} recorded maximum (8,597 kg ha^{-1}), then followed by 160 (8,017 kg ha^{-1}) and least with 120 kg N ha^{-1} (7,596 kg ha^{-1}). Similar findings were made by Kumar *et al*. (2013). With respect to split schedules, maximum straw yield (8,184 kg ha^{-1}) was recorded with 3 equal splits and was statistically similar to 4 equal splits (8,102 kg ha^{-1}). However, both 3 and 4 equal split applications recorded significantly higher straw yield as compared to 2 equal split which recorded 7,924 kg ha^{-1}. Interaction effect between N levels and split schedules on straw yield was found to be non-significant (Table 1).

Nutrient (NPK) uptake: Highest total nitrogen uptake (144.2 kg ha^{-1}) was recorded with application rate of 200 kg N ha^{-1} then followed by 60 kg N ha^{-1} (134.8 kg ha^{-1}). The higher nitrogen uptake with 200 kg N ha^{-1} may have directly related

Table 1. Grain yield as influenced by levels and time of nitrogen application in machine transplanted rice

Treatments		Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
Nitrogen levels (kg ha^{-1})			
N_1 – 120		5,707	7,596
N_2 – 160		5,992	8,017
N_3 – 200		6,119	8,597
SEM±		49	102
CD (p=0.05)		137	284
Split schedules			
S_1 - 3 equal split at B, AT & PI		5,875	7,924
S_2 - 4 equal split at B, IT, AT & PI		6,028	8,184
S_3 - 5 equal split at B, IT, AT, T & PI		5,914	8,102
SEM±		38	39
CD (p=0.05)		82	84
N x S	SEM±	65	67
	CD (p=0.05)	NS	NS
S x N	SEM±	73	116
	CD (p=0.05)	NS	NS

to the higher grain and straw yield obtained at that N level (Table 2). Panday *et al*. (2007) also observed higher uptake with 200 kg N ha^{-1}. The lowest total nitrogen uptake (122.8 kg ha^{-1}) was recorded with application of 120 kg N ha^{-1}.Regarding split schedules, 4 equal splits recorded maximum uptake (136.4 kg ha^{-1}) and was at par with 5 equal splits (134.2 kg ha^{-1}). Both 4 and 5 equal split applications registered significantly higher nitrogen uptake as compared to 3 equal split applications (129.8 kg ha^{-1}). Similar findings were made by Chaudhry *et al*. (2013) and Tari and Amiri (2015). Maximum phosphorus uptake (35.0 kg ha^{-1}) was recorded with the application of 200 kg N ha^{-1} and was comparable to application of 160 kg N ha^{-1} (30.5 kg ha^{-1}) but significantly higher than application of 120 kg N ha^{-1} (27.5 kg ha^{-1}). Similar finding was made by Paruna *et al.* (2016) and Srivastava *et al.* (2014). In terms of split schedules, 4 equal splits of nitrogen recorded maximum (35.6 kg ha^{-1}) phosphorus uptake and was at par with 5 equal splits (32.8 kg ha^{-1}) however, both recorded significantly higher phosphorus uptake as compared to 3 equal splits (26.5 kg ha^{-1}).

Maximum potassium uptake (141.2 kg ha^{-1}) was recorded with application of 200 kg N $ha^{-1}$and was at par with 160 kg N ha^{-1} (137.5 kg ha^{-1}) however, both recorded significantly higher potassium uptake as compared to 120 kg N ha^{-1} (130.8 kg ha^{-1}). Ganga Devi *et al.* (2012) findings were similar to those observed. Split schedules of nitrogen did not significantly influence the potassium uptake. The effects of right dose and right time of nitrogen application might have stimulated more vegetative growth and increased activity of roots which in turn increased the uptake of phosphorus and potassium. Majumdar *et al*. (2005) explained that nitrogen had a complimentary effect on availability of other nutrient especially P and K, thus enhanced uptake of N resulted in enhancement in the uptake of P and K. Interaction effect between N levels and split schedules on nitrogen uptake was found to be non-significant (Table 2).

Post-harvest soil characteristics

The soil chemical properties like pH and electrical conductivity (EC) after harvest were not significantly change due to application of different levels of nitrogen and split schedules. Similar finding was made by Srivastava *et al* (2014). Similarly, organic carbon (OC) after harvest was not affected by different nitrogen levels and split schedules (Table 3). Soil post-harvest available nitrogen varied from initial values.

Table 2. Total NPK uptake as influenced by levels and time of nitrogen application in machine transplanted rice

Treatments		Nutrient uptake (kg ha^{-1})		
		N	P	K
Nitrogen levels (kg ha^{-1})				
N_1 – 120		122.8	27.5	130.8
N_2 – 160		134.8	30.5	137.5
N_3 – 200		144.2	35.0	141.2
SEM±		2.7	1.6	1.7
CD (p=0.05)		7.5	5.0	4.4
Split schedules				
S_1 - 3 equal split at B, AT & PI		129.8	26.5	134.5
S_2 - 4 equal split at B, IT, AT & PI		136.4	35.6	139.2
S_3 - 5 equal split at B, IT, AT, T & PI		134.2	32.8	135.9
SEM±		1.5	1.7	2.75
CD (p=0.05)		3.3	5.2	NS
N x S	SEM±	2.6	0.4	4.6
	CD (p=0.05)	NS	NS	NS
S x N	SEM±	3.5	0.5	3.9
	CD (p=0.05)	NS	NS	NS

Table 2. Post harvest soil chemical reaction and available nitrogen, phosphorus and potassium as influenced by levels and time of nitrogen application in machine transplanted tice

Treatments		pH	EC (dsm^{-1})	OC (%)	Soil available (kg ha^{-1})		
					N	P_2O_5	K_2O
Nitrogen levels (kg ha^{-1})							
N_1– 120		8.12	1.48	1.34	215.7	30.1	531.3
N_2– 160		8.16	1.45	1.39	226.8	29.1	531.9
N_3– 200		8.16	1.46	1.36	242.7	27.9	531.9
SEM±		0.03	0.05	0.08	2.7	0.6	1.5
CD (p=0.05)		NS	NS	NS	7.5	1.7	NS
Split schedules							
S_1 - 3 equal split at B, AT & PI		8.13	1.48	1.36	231.7	29.5	531.9
S_2 - 4 equal split at B, IT, AT & PI		8.16	1.47	1.37	228.8	28.9	532.4
S_3 - 5 equal split at B, IT, AT, T & PI		8.15	1.44	1.36	224.7	28.7	530.8
SEM±		0.03	0.04	0.03	1.6	0.3	2.4
CD (p=0.05)		NS	NS	NS	3.4	0.7	NS
N x S	SEM±	0.05	0.07	0.05	2.7	0.6	4.2
	CD (p=0.05)	NS	NS	NS	NS	NS	NS
S x N	SEM±	0.05	0.08	0.08	3.5	0.8	3.7
	CD (p=0.05)	NS	NS	NS	NS	NS	NS
Initial soil values		8.11	1.39	1.31	230.0	42.0	533.0

Application of 120 kg N ha^{-1} recorded significantly lower (215.7 kg ha^{-1}) available nitrogen as compared to initial value (230.0 kg ha^{-1}) and it was also significantly lower as compared to the application of 160 and 200 kg N ha^{-1} (226.8 and 242.7 kg ha^{-1} respectively). Application of 160 kg N ha^{-1}recorded closest soil available nitrogen as compared to initial value, while application of 200 kg N ha^{-1} recorded significantly higher soil available nitrogen after harvest. Similar findings were obtained by Tejeswara Rao *et al* (2012), Paruna *et al* (2016) and Srivastava *et al* (2014). Application of nitrogen in 3 equal split at active tillering and panicle initiation recorded significantly highest soil available nitrogen after harvest and was significantly higher as compared to 4 and 5 equal splits. Higher soil available nitrogen after harvest with 3 equal splits might be due to higher proportion of nitrogen applied in less number of splits causing higher fixation (Table 3). Soil available phosphorus after harvest reduced at all nitrogen levels as compared to initial value. Among nitrogen levels, application of 120 kg N ha^{-1} recorded highest soil available phosphorus (30.1 kg ha^{-1}) after harvest as compared to 200 kg N ha^{-1} (29.1 kg ha^{-1}) and was as at par with 160 kg N ha^{-1} (27.9 kg ha^{-1}).Increased in nitrogen application rates had complimentary effect on phosphorus uptake. These results are in conformity with those observed by Tejeswara Rao *et al* (2014). Regarding split schedules, 3 equal splits at active tillering and panicle initiation recorded highest soil available phosphorus and was at par with 4 equal splits but significantly higher than 5 equal splits. Soil available potassium after harvest was not significantly different from initial value and also among the different nitrogen levels and split schedules (Table 3).

Conclusion

The study on Influence of levels and time of nitrogen application on yield, nutrient uptake and soil fertility status in machine transplanted rice revealed that grain yield, nitrogen, phosphorus and potassium uptake and soil available nitrogen were highest with application of 200 kg N ha^{-1} and was at par with application of 160 kg N ha^{-1} except for nitrogen uptake and soil available nitrogen. Four equal split application of nitrogen recorded highest grain yield, nitrogen, phosphorus and potassium uptake. Three equal split application of nitrogen recorded highest soil available nitrogen and phosphorus and was on par with 4 equal splits application. Soil pH, EC, OC and available potassium were not significantly affected by levels and time of nitrogen application.

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