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Growth and Yield of Rice (*Oryza sativa* L.) as Influenced by Integrated Nitrogen Management Practices

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ABSTRACT

A field experiment was carried out for two consecutive years (2014-15 and 2015-16) on sandy clay loam soils at Regional Agricultural Research Station, Chintapalli, Visakhapatnam district, Andhra Pradesh to study the effect of integrated nitrogen management practices on growth and yield of rice. The experiment was laid out in randomized block design replicated thrice. The research results revealed that supply of 100% recommended dose of nitrogen through fertilizer and green manure *in-situ* has recorded significantly superior growth characters of *viz.*, plant height(cm), total number tillers m^{-2} and drymatter accumulation and yield attributes like number of panicles m^{-2}, number of grains $panicle^{-1}$ and filled grains $panicle^{-1}$, yield and economics. The next best treatments were the supply of 100% recommended dose of nitrogen through fertilizer + FYM @ 5 t ha^{-1} (T_4) and 125% recommended dose of nitrogen through fertilizer + FYM @ 5 t ha^{-1}.

Key words: *Economics, Growth, High altitude region, Integrated nitrogen, Rice, Yield.*

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. Nutrient management especially that of nitrogen is very essential to achieve higher yields with reduced cost. Integrated nitrogen recommendation to rice is emphasized for increasing the productivity. Rice is the principal rainy season crop grown under rainfed condition in high altitude tribal zone of Andhra Pradesh. Identifying viable integrated nitrogen management package to rice for high altitude tribal region of Andhra Pradesh is fairly necessary. Hence, the present study was taken up to investigate the response of rice crop to sources of nitrogen and their integration.

MATERIALS AND METHODS

A field experiment was conducted at Regional Agricultural Research Station, Chintapalli Visakhapatnam district, 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 during *kharif* 2014-15 and 2015-16. The soil of the experimental field was sandy clay loam in texture, slightly acidic in reaction (p^H- 6.3), low in organic carbon (0.33) and low in available nitrogen (180.6 kg ha^{-1}) and high in available phosphorus (25.63 kg ha^{-1}) and potassium (332.5 kg ha^{-1}). The weekly mean maximum temperature during the cropping period ranged from 24.0 to 31.2°C and 26.7 to 38.2°C during 2014-15 and 2015-16 and mean minimum temperature ranged from 19.0 to 22.4°C and 16.1 to 22.7°C during two years of study. A total amount of 943.4 mm rainfall was received in 64 rainy days during the crop growth period of 2014-15 and 1214.0 mm in 70 rainy days during 2015-16. The experiment was laid out in randomized block design with three replications. The treatments comprised of seven integrated nitrogen management practices *viz.,* T_1) 100% recommended dose of nitrogen (RDN) through fertilizer (FN_{100}), T_2) 125% recommended dose of nitrogen (RDN) through fertilizer (FN_{125}), T_3) 150% recommended dose of nitrogen (RDN) through fertilizer (FN_{150}), T_4) 100% RDN through fertilizer + FYM @ 5 t ha^{-1} (FN_{100} + FYM N_{25}), T_5) 125% RDN through fertilizer + FYM @ 5 t ha^{-1} (FN_{125} + FYM N_{25}), T_6) 100%

RDN through fertilizer + BGA @10 kg ha^{-1} (FN_{100}+BGA) and T_7) 100% RDN through fertilizer + Green manure *in-situ* (FN_{100} + GM). The recommended dose of nitrogen for rice in high altitude tribal region is 80 kg N ha^{-1}. Three organic manures on equal nitrogen basis were applied to respective treatments. Farm yard manure was added to the soil and thoroughly incorporated, 15 days prior to transplanting of rice crop. Blue green alga was applied in rice field at the rate of 10 kg ha^{-1} 10 days after transplanting. Sunhemp (*Crotalaria juncea*) was sown @25 kg ha^{-1} before rice crop and incorporated at 50 days after sowing and decomposed for 15 days. The test variety of rice was MTU 1075 (Pushyami) and spacing of 20 X 10 cm was adopted. Different growth parameters at various stages and yield were recorded and statistically analysed following the analysis of variance for randomised block design as suggested by Panse and Sukhatme (1978).

RESULTS AND DISCUSSION

Growth parameters

Growth parameters like plant height (cm), number of tillers m^{-2} and drymatter production were significantly influenced by integrated nitrogen management practices during both the years of study (Table 1).

The tallest plants of rice *viz*., 87.7 cm and 106.6 cm during 2014 and 2015, respectively were recorded with the combined supply of 100% recommended dose of nitrogen (RDN) through fertilizer along with green manure *in-situ*, which were however, comparable with those received with 100% RDN through fertilizer + FYM @ 5 t ha^{-1} (85.3 cm and 103.3 cm) and 125% RDN through fertilizer + FYM @ 5 t ha^{-1} (82.3 cm and 103.2 cm) during two years (2014-15 & 2015-16) of study, but significantly superior to 100% RDN through fertilizer + BGA @ 10 kg ha^{-1}. The shortest plants (72.6 cm and 94.7 cm in 2014 and 2015, respectively) of rice were associated with 100% RDN through fertilizer which were significantly shorter than any other N management practice. Combined application of organic and inorganic source of nutrients to rice crop might have increased nitrogen availability which might have enhanced cell division and cell elongation resulting in taller plants. Similar results were also reported by Anu Lavanya and Ganapathy, 2011; Revathi *et al*., 2014 and Manjunath *et al.,* 2016.

The highest numbers of tillers m^{-2} (386.3 and 407.7 during 2014 and 2015) were recorded with FN_{100}+GM, which were however, on a par with FN_{100}+FYM_{25} and FN_{125}+FYM_{25}. Significantly the lowest number of tillers (m^{-2}) was recorded with 100% RDN through fertilizer. The highest number of tillers with the supply of integrated supply of nitrogen might be attributed due to ready availability of comfortable level of instantly usable nitrogen by rice crop along with green manure, which would have created favourable environment of nitrogen nutrition in the rhizo-ecosystem of rice crop. Similar results were reported by Radha Kuamari and Srinivasulu Reddy (2011), Santhoshkumar *et al*. (2014) and Sowjanya *et al*. (2017).

As it was noticed with plant height and number of tillers, the drymatter accumulation was also the highest (13493 kg ha^{-1} and 13627 kg ha^{-1} during two years of study) with 100% RDN through fertilizer + green manuring *in-situ* (FN_{100}+GM). The treatments T_4 and T_5 were distinctly superior to 125% RDN through fertilizer (FN_{125}) and 150% recommended dose of nitrogen through fertilizer (FN_{150}). Application of green manure *in situ* /FYM @ 5 t ha^{-1} along with RDF accounted to significantly higher dry matter production over the other treatments may be attributed that combined application of inorganic fertiliser and organic manure could have helped in balanced availability of nutrients till harvesting time. Similar findings of higher dry matter accumulation with application of green manuring, FYM was reported by Balaji Naik and Yakadri (2004), Anchal Dass *et al*. (2009) and Jagdish Kumar *et al.* (2010).

Yield attributes

The number of productive tillers m^{-2}, total number of grains panicle^{-1} and filled grains panicle^{-1} were significantly influenced by integrated nitrogen management practices (Table 2). The maximum number of productive tillers (221.3 and 267.0), higher number of grains panicle^{-1} (224.5 and 286.1) and highest number of filled grains panicle^{-1} (193.8 and 255.2) were recorded with the supply of 100% RDN through fertilizer + green manure *in-situ* during both the years of study, which was superior to all other treatments, but was however, comparable with 100% RDN through fertilizer + FYM @ 5 t ha^{-1} and 125% recommended dose of nitrogen through fertilizer + FYM @ 5 t ha^{-1}, but significantly superior to 100% RDN through fertilizer + BGA @ 10 kg ha^{-1}. The treatments T_4 and T_5 were superior to 125% RDN through fertilizer and 150% RDN through fertilizer. The ha^{-}

Table 1: Growth parameters of rice as influenced by integrated nitrogen management practices during *kharif* 2014 and 2015

	Treatments	2014-15			2015-16		
		Plant height at harvest (cm)	No. of tillers m^{-2}	Drymatter production at harvest (kg ha^{-1})	Plant height at harvest (cm)	No. of tillers m^{-2}	Drymatter production at harvest (kg ha^{-1})
T_1	FN_{100}	72.6	312.5	9322	94.7	315.7	10827
T_2	FN_{125}	80.3	350.0	9666	97.3	354.5	12206
T_3	FN_{150}	78.9	347.5	9500	95.5	351.6	11493
T_4	FN_{100} + FYM N_{25}	85.3	385.3	11480	103.3	400.8	13370
T_5	FN_{125} + FYM N_{25}	82.3	382.2	11141	103.2	399.7	13113
T_6	FN_{100}+BGA	81.3	357.7	10693	102.4	386.1	12473
T_7	FN_{100} + GM	87.7	386.3	13493	106.6	407.7	13627
	SEm±	2.00	11.3	559.7	2.30	11.8	563.4
	CD (P = 0.05)	6.22	34.7	1724.9	7.17	36.61	1736.1
	CV(%)	5.74	5.43	9.0	5.69	5.50	7.84

Table 2: Yield parameters of rice as influenced by integrated nitrogen management practices during *kharif* 2014 and 2015

	Treatments	2014-15			2015-16		
		Plant height at harvest (cm)	No. of tillers m^{-2}	Drymatter production at harvest (kg ha^{-1})	Plant height at harvest (cm)	No. of tillers m^{-2}	Drymatter production at harvest (kg ha^{-1})
T_1	FN_{100}	191.3	160.1	138.3	209.7	221.3	194.1
T_2	FN_{125}	200.0	181.9	153.9	238.0	250.3	213.5
T_3	FN_{150}	192.0	182.6	146.3	222.8	251.6	191.5
T_4	FN_{100} + FYM N_{25}	220.3	213.3	175.4	256.3	268.5	250.0
T_5	FN_{125} + FYM N_{25}	211.7	200.2	174.3	247.3	259.4	217.3
T_6	FN_{100}+BGA	205.3	183.4	163.5	232.7	257.9	218.7
T_7	FN_{100} + GM	221.3	224.5	193.8	267.0	286.1	255.2
	SEm±	6.61	9.69	6.47	9.40	12.4	10.11
	CD (P = 0.05)	20.39	28.8	19.95	28.98	36.8	31.15
	CV(%)	5.56	8.73	6.85	6.81	8.36	7.95

Table 3 : Yield and economics of rice as influenced by integrated nitrogen management practices during *kharif* 2014 and 2015

	Treatments	Grain yield (kg ha^{-1})	straw yield (kg ha^{-1})	Gross returns (Rs ha^{-1})	Net returns (Rs ha^{-1})	B:C Ratio	Grain yield (kg ha^{-1})	straw yield (kg ha^{-1})	Gross returns (Rs ha^{-1})	Net returns (Rs ha^{-1})	B:C Ratio
T_1	FN_{100}	4378	4744	69537	29948	1.76	4620	6007	74680	35091	1.88
T_2	FN_{125}	4436	5086	70327	30624	1.77	5200	6690	76800	43097	2.09
T_3	FN_{150}	4452	4948	70547	30731	1.77	5020	6387	80280	37691	1.89
T_4	FN_{100} + FYM N_{25}	5048	5344	78649	35060	1.80	6100	7080	95400	51811	2.19
T_5	FN_{125} + FYM N_{25}	4969	5172	77574	33871	1.78	5950	7033	93300	49597	2.13
T_6	FN_{100} + BGA	4890	5129	76508	33918	1.80	5740	6727	90027	50544	2.27
T_7	FN_{100} + GM	5290	5772	81945	41756	2.04	6127	7270	95773	55584	2.38
	SEm±	203.46	148.6	-	-	-	257.9	228.0	-	-	-
	CD (P = 0.05)	626.90	458.0	-	-	-	794.6	702.8	-	-	-
	CV(%)	7.37	5.98	-	-	-	8.06	6.64	-	-	-

lowest number of productive tillers m^{-2}, total number of grains panicle^{-1} and filled grains panicle^{-1} were recorded with 100% RDN through fertilizer alone during two years (2014-15 and 2015-16) of study.

Increased number of panicles m^{-2} recorded with integration of nutrients through organic and inorganic source could be attributed to better nutrient availability, supported longer panicles with more spikelets *i.e.,* total number of grains panicle^{-1}, might have supported photosynthesis during later stages of crop and better translocation of photosynthates to grain for adequate filling. A few other researchers also reported the similar results (Sunitha and Raju, 2004, Srilaxmi *et al*., 2005, Prasada Rao *et al*., 2011. and Ramana *et al*., 2012).

Grain and straw yield

Grain and straw yield of rice was significantly influenced by integrated nitrogen management practices during two years of experimentation (Table 3). The highest grain yield (5290 kg ha^{-1} and 6127 kg ha^{-1}) and straw yield (5772 kg ha^{-1} and 7270 kg ha^{-1}) were recorded with FN_{100} + GM during 2014-15 and 2015-16, which was however comparable to FN_{100} + FYM_{25}, FN_{125} + FYM_{25}, but significantly superior to FN_{100} + BGA. However, application of 125% RDN and 150% RDN through fertilizer did not show any disparity among them in producing grain and straw yields. The lowest grain and straw yields were recorded with 100% RDN through fertilizer, which was significantly lower than all N management practices tried.

The increased yield due to the combined application of organic and inorganic sources of nitrogen supplementation might be due to the improvement in soil physical properties, water holding capacity and better nutrient use efficiency for a longer time for crop growth period. These results are in agreement with Aruna and Shaik Mohammed (2011). The increase in straw yield with the treatments that received combination of organic and inorganic nitrogen nutrition might be due to better growth reflected in these treatments in terms of plant height, drymatter accumulation and tillering. These results are in conformity with those reported by Sudhakar *et al*. (2006), Yogeshwar Singh *et al*. (2006)

Economics

The highest gross return (Rs.81945 ha^{-1} and Rs. 95773 ha^{-1}), net return (Rs.41756 and Rs.55584 ha^{-1}) and B:C ratio (2.04 and 2.38) were realized with the combined application of 100% RDN through fertilizer + green manure *in-situ* (FN_{100}+GM) during 2014-15 and 2015-16. Supply of FN_{100}+FYM_{25} and FN_{125}+FYM_{25} was next best treatments and superior to FN_{125} and FN_{150}. The lowest gross returns (Rs.69537 ha^{-1} and Rs.74680 ha^{-1}) and net return (Rs.29948 ha^{-1} and Rs.35091 ha^{-1}) were recorded with the application of 100% RDN through fertilizer (FN_{100}).

Among the integrated N management practices, application of FN_{100} + GM attained significantly higher economic returns (Gross return, Net return and B:C ratio) during both the years owing to higher grain yield and in turn higher gross and net returns in this treatment. The beneficial effect of green manure and FYM in improving the net returns and B:C ratio was also reported by Balaji Naik and Yakadri (2004) and Vikas Gupta *et al*. (2006).

Conclusion:

Rice crop performed well with the combined use of 100% recommended dose of nitrogen through fertilizer and green manure *in-situ* with respect to growth, yield and economic returns. Combination of 100% RDN through fertilizer + FYM_{25} and 125% RDN through fertilizer + FYM_{25} were next best treatments in realizing the higher yields.

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