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Growth and Yield of Direct Seeded Rice as Influenced by Integrated Nutrient Management Practices

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ABSTRACT

A field experiment was conducted during *kharif* for two consecutive years (2015-2016 and 2016-2017) on sandy clay loam soil of Agricultural College Farm, Bapatla. The experiment was laid out in a randomized block design with thirteen INM treatments replicated thrice. The results indicate that all the characters studied were significantly higher with application of 100% RDN through inorganic fertilizer (T_1). However it was on par with that of application of 50% RDN+ 50 % Green manure (T_{12}) and 50% RDN + 50% Poultry manure (T_6) during both the years of study.

Key words: *Rice, INM, FYM.*

Rice (*Oryza sativa* L.) is staple food for more than half of the global population in about 40 countries and more than 65 per cent of the population in India. In India, it is grown in an area of 43.49 M ha with a total production of 104.40 M t and a productivity of 2400 kg ha^{-1} (CMIE, 2015-16). In Andhra Pradesh, rice is grown in an area of 2.16 M ha with annual production of 7.48 M t and productivity of 3465 kg ha^{-1} (CMIE, 2015-16). In Andhra Pradesh, direct seeded rice is grown in an area of 4.0 lakh ha (Commissioner and Director of Agriculture, 2015-16), which is gaining momentum among the farmers of Krishna agro climatic zone of A.P. by taking the advantage of early rains received before release of canal water and makes it feasible to rise a second crop early which increases the farmers income.

In coastal districts of AP reduced profit for transplanted rice is due to scarcity of irrigation water and high cost of labour. Hence, direct seeded rice has gained popularity due to its less labour and water needs. Increased use of inorganic fertilizers leads to soil and water pollution. To reduce the pollution, use of organic manures to supplement total recommended levels of nutrients is an option.

Nitrogen, an essential primary nutrient which promotes the growth and development influences the availability of other nutrients. It deserves a special status among the major nutrients and is the "mineral of life" for rice crop. It is the most critical input that limits rice productivity in irrigated ecosystem. It takes about 1 kg of nitrogen to produce 15 to 20 kg of grain, but the efficiency of nitrogen use in India is very low (Hegde and Sudhakar Babu, 2001).

Although the use of fertilizers promises to increase the productivity, the indiscriminate and imbalanced use of fertilizers affect the productivity, soil health and environment. Hence, the focus of agriculture is to evolve ecologically sound nutrient management practices. Integrated nutrient management is the best option to achieve this goal. The farmers use several organic sources with varying levels of nutrients (Khush, 2004). Therefore, it is necessary to evaluate the different sources of organic manures for standardizing the recommendation to farmers. Hence, the present trial was conducted for two consecutive years.

MATERIAL AND METHODS

An experiment was conducted at Agricultural College Farm, Bapatla situated at 15^0 54' N latitude and 80^0 25' E longitude, at an altitude of 5.49 m above the mean sea level and is about 8 km away from the Bay of Bengal. The chemical analysis of soil showed that the soil is sandy clay loam in texture and low in available N (214, 254 kg ha^{-1}), medium in P (39, 34 kg ha^{-1}) and high in OC (0.73, 0.87) and K (472,513 kg ha^{-1}) during 2015-16 and 2016-17 respectively. The average maximum and minimum temperatures during the rice crop growth period were 32.1 °C and 22.1 °C during 2015-16 and 32.7 °C and 21.9 °C during 2016-17, respectively. The mean relative humidity was 77.8% and 72.3% during both the years. A total rainfall of 660.5 mm and 575.2 mm was received during 2015-16 & 2016-17 in 30 and 26 rainy days, respectively. The experiment was laid out during *kharif* in a randomized block design with thirteen treatments and replicated thrice during both the years of study. The treatments consisted of different combinations of nitrogen i.e. T_1 :100 % RDN, T_2 :75% RDN + 25% Farmyard manure (FYM), T_3 :50% RDN + 50% FYM, T_4 :25% RDN + 75% FYM, T_5 :75% RDN + 25% Poultry manure (PM), T_6 :50% RDN + 50% PM, T_7

:25% RDN + 75% PM, T_8 :75% RDN + 25% Vermicompost(VC), T_9 :50% RDN + 50% VC, T_{10} :25% RDN + 75% VC, T_{11} :75% RDN + 25% Green manure(GM), T_{12} :50% RDN + 50% GM and T_{13} :25% RDN + 75% GM. The experiment was repeated during 2nd year in another field.

The pre germinated rice seeds were sown @ 80 kg ha^{-1} in solid rows at 20 cm spacing between two rows in a puddeled and levelled moist soil. To maintain uniform plant population, thinning of seedlings and gap filling was done at 10 DAS. Organic manures viz., farmyard manure, poultry manure, vermicompost were applied as per the treatments fifteen days before sowing and green manure was sown 45 days before sowing and incorporated. The inorganic nitrogen (120 kg N ha^{-1}) was applied through urea and uniform application of phosphorous (60 kg P_2O_5 ha^{-1}) and potassium (40 kg K_2O ha^{-1}) were applied through single superphosphate and muriate of potash, respectively. Entire quantity of phosphorus and potassium and one third of the N were applied as basal at the time of sowing. Remaining inorganic N was applied in two equal splits at active tillering stage and panicle initiation stages. The data on plant height, total number of tillers m^{-2} drymatter production, yield attributes viz., No. of panicles m^{-2}, panicle length, No. of grains panicle, test weight, grain yield, straw yield were analysed by adopting Panse and Sukhatme (1978) standard procedures.

RESULTS AND DISCUSSION

Growth parameters

The results revealed that the growth parameters (Table.1) *viz.,* plant height, total No of tiller m^{-2} and drymatter production at maturity were significantly affected by INM practices during the two years of study. Significantly taller plants (73.5, 76.7 cm) were recorded with the application of recommended dose of inorganic fertilizer 100% RDN (T_1), which was on par with the treatments 50% RDN+50% GM (T_{12}) and 50% RDN+50% PM (T_6) during both the years, which might be due to quick release of nutrients and more availability of nitrogen. Nitrogen is associated with increase in protoplasm, cell division and cell enlargement resulting in taller plants (Tisdale *et al*., 1985). The treatment that received recommended dose of inorganic fertilizers 100% RDN (T_1) recorded significantly the maximum number of tillers (358, 384) which was closely followed by the treatments 50% RDN+50% GM (T_{12}) and 50% RDN+50% PM (T_6) during both the years. Among the organic sources, better performance of poultry manure might be due to the involvement of certain growth promoting substances which might have also accelerated the number of tillers. These results are in consonance with the findings of Prabhakaran (2000), Miller (2007) and Budhar *et al*., (1991). Maximum drymatter accumulation (12846 kg ha^{-1}, 13984 kg ha^{-1}) was observed with the application of recommended dose of inorganic fertiliser100% RDN (T_1) but proved significantly superior to the rest of the treatments during both years of study. Among different organic manures, 50% RDN+50% GM (T_{12}) and 50% RDN+50% PM (T_6) registered maximum drymatter accumulation. Increased drymatter accumulation in poultry manure (50%) and green manure (50%) treated plots might be attributed due to the continuous slow release of nutrients which have enabled extension of the leaf area duration thereby providing an opportunity time for plants to increase the photosynthetic rate which in turn, could have led to higher accumulation of drymatter. Similar results were obtained by Amanullah *et al.,* (2006), Suvarna Latha and Sankara Rao (2001) and Altaf Hussain *et al*., (2012).

Yield attributes

Highest number of panicles m^{-2}, panicle length (cm), total number of grains $panicle^{-1}$ and test weight (g/1000 grains) were (Table 2) recorded with the treatment T_1 (100% RDN) which was statistically on a par with 50% RDN+50% GM (T_{12}) and 50% RDN+50% PM (T_6), but proved significantly superior to rest of the treatments. Significantly lowest number of all the yield attributes was recorded with 25% RDN+75% FYM (T_4) which was on par with 25% RDN+75% VC (T_{10}) during both the years of study. 100% RDN (T_1) recorded the maximum number of panicles m^{-2} (346, 377), which was statistically on a par with 50% RDN+50% GM (T_{12}) and 50% RD1N+50% PM (T_6), This might be due to quick release of nutrients from the inorganic sources compared to organics. Among the organic manures, better performance of T_{12} i.e. 50% RDN+50% GM might be due to increased availability of nitrogen with 50% N applied through green manure and remaining 50% through urea.

Significantly higher panicle length (16.2, 16.9 cm) was observed in the treatment, T_1 (100% RDN) which was statistically on a par with 50% RDN+50% GM (T_{12}) and 50% RDN+50% PM (T_6), but proved significantly superior to rest of the treatments during both the years of experimentation. Significantly higher number of grains $panicle^{-1}$ (125, 127) was recorded with the treatment that received recommended dose of inorganic fertilizer 100% RDN (T_1), which was statistically on a par with 50% RDN+50% GM (T_{12}) and 50% RDN+50% PM (T_6) but proved significantly superior to the rest of the treatments. Similar trend was followed during both years of research. Maximum number of total grains $panicle^{-1}$ with the application of

Table1: Plant height (cm), Total number of tillers m^{-2} and Drymatter production at maturity (kg ha^{-1}) of rice at maturity during *kharif* as influenced by integrated nutrient management practices

Treatments	2015-16			2016-17		
	Plant height (cm)	Total number of tillers m^{-2}	Drymatter production (kg ha^{-1})	Plant height (cm)	Total number of tillers m^{-2}	Drymatter production (kg ha^{-1})
T_1: 100% RDN	73.5	358.2	12846	76.7	384.1	13984
T_2: 75% RDN+25% FYM	71.6	325.3	11764	72.1	375.4	12040
T_3: 50% RDN+50% FYM	70.9	333.2	11500	69.9	378.0	11622
T_4: 25% RDN+75% FYM	69.5	318.4	10247	67.9	372.6	11547
T_5: 75% RDN+25% PM	71.3	343.6	12776	70.8	368.3	11922
T_6: 50% RDN+50% PM	72.6	351.0	12811	74.6	381.4	13218
T_7: 25% RDN+75% PM	70.6	338.7	11524	72.9	372.7	11842
T_8: 75% RDN+25% VC	71.0	334.0	12827	70.8	364.7	11991
T_9: 50% RDN+50% VC	71.2	335.2	11609	71.3	372.9	12024
T_{10}: 25% RDN+75% VC	70.1	315.1	10611	69.5	373.4	12680
T_{11}: 75% RDN+25% GM	71.6	325.2	11756	70.9	374.3	12773
T_{12}: 50% RDN+50% GM	72.5	348.3	12811	75.5	379.7	13287
T_{13}: 25% RDN+75% GM	71.6	319.8	12773	70.5	368.2	11689
SEm±	0.71	3.14	229.1	1.12	1.86	204.3
CD (P=0.05)	1.6	11.4	688	3	3.7	611
CV(%)	2.8	6	5.3	4.2	3.8	5

Table 2: Number of panicles m^{-2}, Panicle length (cm), Total number of grains $panicle^{-1}$ and Test weight (g/1000 grains) of rice during *kharif* as influenced by integrated nutrient management practices

Treatments	2015-16				2016-17			
	Number of panicles m^{-2}	Panicle length (cm)	Total number of grains $panicle^{-1}$	Test weight (g/1000 grains)	Number of panicles m^{-2}	Panicle length (cm)	Total number of grains $panicle^{-1}$	Test weight (g/1000 grains)
T_1	346.9	16.2	125.8	20.3	377	16.9	127.1	23.3
T_2	326.4	14.8	109.3	17.0	369.7	15.3	117.4	19.7
T_3	324.8	14.4	106.0	18.7	370.3	14.6	113.7	19.7
T_4	311.7	14.1	101.5	16.0	343.3	14.2	105.4	18.0
T_5	333.6	15.4	121.0	18.0	361.1	15.6	110.9	21.0
T_6	339.9	15.6	124.6	19.7	372.4	16.6	123.9	23.0
T_7	335.2	15.2	121.7	18.3	362.8	15.6	109.7	20.7
T_8	328.3	14.5	102.0	17.7	355.2	15.4	108.5	20.7
T_9	328.0	14.4	105.3	18.0	361.6	15.7	110.7	22.7
T_{10}	310.2	14.2	102.7	16.3	347.2	14.6	107.5	19.3
T_{11}	324.4	15.1	120.3	18.0	369.1	15.5	110.2	22.0
T_{12}	335.6	16.0	123.5	19.3	375.6	16.8	125.5	22.6
T_{13}	309.1	15.3	121.8	18.3	360.2	15.5	110.7	21.0
SEm±	4.87	0.34	0.92	0.44	1.15	0.14	1.22	0.66
CD (P=0.05)	11.3	0.6	2.7	1.3	3.4	0.4	3.5	1.1
CV(%)	4.2	5.1	4	7	0.9	2.4	3.1	9.9

RDN: Recommended dose of Nitrogen;
FYM: Farmyard Manure;
PM: Poultry manure
VC: Vermicompost;
GM: Green manure

Table3: Grain yield (kg ha^{-1}), Straw yield (kg ha^{-1}) and Harvest index (%) of rice during *kharif* as influenced by integrated nutrient management practices

Treatments	2015-16			2016-17		
	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index (%)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index (%)
T_1: 100% RDN	5242	6496	45	5508	6749	45
T_2: 75% RDN+25% FYM	4113	5495	43	4067	5274	44
T_3: 50% RDN+50% FYM	4327	5565	44	4331	5609	43
T_4: 25% RDN+75% FYM	3105	4206	43	3509	4950	42
T_5: 75% RDN+25% PM	4573	5805	44	4591	5979	44
T_6: 50% RDN+50% PM	5153	6464	44	5281	6553	45
T_7: 25% RDN+75% PM	3914	5258	43	4562	5958	43
T_8: 75% RDN+25% VC	4893	6214	44	4434	5972	43
T_9: 50% RDN+50% VC	4412	5730	44	4534	5794	44
T_{10}: 25% RDN+75% VC	3286	4434	43	3459	4630	43
T_{11}: 75% RDN+25% GM	3814	4850	44	4907	6264	44
T_{12}: 50% RDN+50% GM	5185	6317	44	5286	6592	45
T_{13}: 25% RDN+75% GM	4384	5830	43	4740	5958	44
SEm±	87.4	254.1	0.6	123.1	133.4	0.4
CD (P=0.05)	289	661	1	371	400	1
CV(%)	8.5	7.7	5.1	6.4	8.3	4.9

RDN: Recommended dose of Nitrogen;
FYM: Farmyard Manure; GM: Green manure
PM: Poultry manure VC: Vermicompost;

inorganic fertilizers (100% RDN i.e. T_1) might be due to better nutrition especially quick and adequacy of nitrogen probably favoured the cellular activities during panicle formation and development that might have led to increased number of grains panicle^{-1} (Yadav and Yadav, 2015). During both the years of study, significantly highest test weight (20.3g, 23.3g) was recorded with the treatment that received recommended dose of inorganic fertilizer 100% RDN (T_1), which was statistically on a par with 50% RDN+50% GM (T_{12}) and 50% RDN+50% PM (T_6) treatments but, proved significantly superior to rest of the treatments. This might be due to increased translocation of more carbohydrates from source to sink, hence better filling of grains and bold seeds were obtained. These results are in conformity with the findings of Bandyopadhyay and Puste (2002).

Grain and Straw yield

During both the years significantly higher yields were recorded with the recommended dose of inorganic fertilizer 100% RDN (T_1) i.e. 5242 kg ha^{-1}and 5507 kg ha^{-1} during 1st and 2nd years respectively, which was statistically on a par with 50% RDN+50% GM (T_{12}) and 50% RDN+50% PM (T_6) i.e. 5185 kg ha^{-1}, 6952 kg ha^{-1} and 5153 kg ha^{-1}, 6553 kg ha^{-1} respectively but proved significantly superior to the rest of the treatments under test (Table 2). Rice is relatively leafy in its early stages and adequate supply of nitrogen improves the photosynthetic rate and better nutrient uptake and ultimately the grain yield (Ramesh babu, 2012 and Padmaja, 2014)

Perusal of the data on straw yield (Table 2) revealed that the straw yield also followed almost similar trend as that of grain yield during both the years of study. Significantly highest straw yield (6496 kg ha^{-1} and 6749 kg ha^{-1} during 1st and 2nd year respectively) was recorded with 100% RDN (T_1), which was statistically on a par with the treatments 50% RDN+50% GM (T_{12}) and 50% RDN+50% PM (T_6) but proved significantly superior to rest of the treatments. This might be due to stimulated vegetative growth as evidenced through higher plant height, tiller production and drymatter accumulation (Table 1) on account of adequate and prolonged supply of essential nutrients received during each split application, greater availability of nutrients in soil, improved soil environment and higher root penetration leading to better absorption of moisture and nutrients (Urkurkar *et al*., 2010).

Harvest index (Table 2) was maximum with 100% RDN (T_1) (44.7 and 45.0 during 1st and 2nd year, respectively) which was statistically on a par with

50% RDN+50% GM (T_{12}) and 50% RDN+50% PM (T_6) but proved significantly superior to the rest of the treatments. This might be due to the positive response to the higher availability of nitrogen and grain yields which could be ascribed to overall improvement in crop growth enabling the plant to absorb more quantity of nutrients, increased photosynthetic activity and accumulating them in sink. These findings are in close accordance with those of Singh *et al.,* (2006).

CONCLUSION

Based on the above results, it can be concluded that the field studies conducted for two consecutive years clearly indicated that the application of 100% RDN through inorganic fertilizer was remained on par with combined application of inorganic and organic sources i.e green manure and poultry manure (@ 50% each) and these treatments had a significant influence in increasing growth, yield attributes, grain and straw yield of direct wet sown rice.

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