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Performance of Rice with Varied Crop Establishment and Nutrient Management Methods

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ABSTRACT

The experiment was conducted at Agricultural College Farm, Naira with eight treatments comprising of two different methods of establishment in rice as main plots and four different sources of nutrients both organic and in-organic sources as sub plots. The experiment was conducted in Split plot Design with three replications for two years during *kharif* 2017-18 and 2018-19. The two main plots (Wet seeding and Transplanting) did not differ either for growth or yield of rice. Among subplots, the maximum plant height, drymatter accumulation, number of tillers m^{-2}, nitrogen uptake and economics were recorded with 100% RDF which was on a par with 75 % RDF + 25 % RDF through green manure crop (Sunhemp). Significantly higher grain yield was recorded with 75 **%** RDF + 25**%** RDF through green manure crop **(**6166 $kgha^{-1}$) which was at par with 100**%** RDF **(**5926 $kgha^{-1}$**)** and 75**%** RDF + 25**%** RDF through FYM (5683$kgha^{-1}$).

Key words: *Crop establishment techniques, Green manures, Nutrient Management and Rice.*

Rice (*Oryza sativa* L.) is an important cereal crop of India and it is the staple food for most of the Indians and occupies a significant position in the agricultural economy of the country. In India, it is cultivated in an area of 43.86 M ha with a production of 105.80 million tonnes and productivity of 2.7 t ha^{-1}. In Andhra Pradesh, it is grown in an area of 38.09 L ha with a production of 11.56 M t and productivity of 2.9 t ha^{-1} (Anonymous, 2014). However, the productivity of rice in India is very low as compared to other rice growing countries like Australia (10.1 t ha^{-1}), USA (7.5 t ha^{-1}), Russia (5.2 t ha^{-1}) and China (4.3 t ha^{-1}). Rice being a valuable and important food crop it is necessary to reduce the use of chemical fertilizers by following management strategies like combined use of organic and inorganic sources of nutrients. Hence, proper blending of chemical fertilizers with organic manures not only improves soil health but also helps to maximize the sustainable production. The philosophy in Integrated Nutrient Management (INM) system is to maintain soil fertility, sustaining agricultural productivity and improving farmer's profitability through judicious and efficient use of mineral fertilizers to the extent possible. This INM system aims at sustainable crop production levels with minimum deleterious effect of chemical fertilizers on soil health and least disturbance to the rice ecosystems.

MATERIAL AND MEHTODS

The experiment was carried out in field nos.16 (block – C) and 11 (block -'E') of Agricultural College Farm, Naira during *kharif* 2017-18 and 2018-19, respectively. The trial was conducted with rice variety, Vijetha (MTU 1001) having two main plot treatments with different methods of establishment in rice and four sub plot treatments with different organic and in-organic sources of nutrients. The experiment was conducted in Split plot Design with three replications.

The treatments comprised of main plots M_1: Wet seeded rice (Drum seeding method), M_2: Transplanting and subplots S_1**:** 100**%** RDF **(**Chemical fertilizers**)**, S_2**:** 75**%** RDF + 25**%** RDF through FYM, S_3**:** 75**%** RDF + 25**%** RDF through green manure crop **(**Sunhemp**)** and S_4**:** 50**%** RDF + 25**%** RDF through FYM + 25**%** RDF through green manure crop **(**Sunhemp**).** The experimental soil was sandy loam in texture, slightly alkaline in reaction, non saline, low in available nitrogen, low in organic carbon, high in available phosphorus and medium in potassium. The application of nutrients was done with fertilizer recommendations as per the treatments. 100% RDF with chemical sources was applied with 120:60: 50 Kg NPK ha^{-1}, 25 % RDF was applied with 6.67 tonnes of FYM ha^{-1} and 25% of RDF was applied with 7.14 tonnes of green manure crop (Sunhemp).

RESULTS AND DISCUSSION

All the growth parameters *viz.*, Plant height, drymatter and tillers/m^2 at harvest were not influenced by the crop establishment methods during 2017-18 and 2018-19 and also in pooled analysis. The interaction between the crop establishment methods was non-significant during both the years (Table 1).

Plant height was significantly affected by fertilizer treatments (both organic and inorganic

Table 1. Plant height (cm), Drymatter accumulation (kg ha^{-1}), Total number of tillers m^{-2} at harvest and Grain yield (kg ha^{-1}) of rice as influenced by crop stand establishment and nutrient management during *kharif* 2017-18, 2018-19 and pooled.

Treatments	2017-18				2018-19				Pooled data			
	Plant height	DMP	Tillers m^{-2}	Grain yield	Plant height	DMP	Tillers m^{-2}	Grain yield	Plant height	DMP	Tillers m^{-2}	Grain yield
kharif : Rice												
M_1 (Wet seeding)	103	12654	454	5627	101	11749	437	5217	102	12202	446	5421
M_2 (Transplanting)	114	12992	469	5971	106	12083	445	5565	110	12537	457	5768
SEm ±	2.6	350	8.1	136	1.96	188	7.9	211	2.9	452.12	7.35	17
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	8.3	9.4	6.1	8.1	6.5	5.4	6.2	13.5	9.5	12.6	5.6	10.7
Fertilizer treatments (Organic and in-organic sources)												
S_1 (100% RDF through chemical fertilizers)	115	13435	480	5926	104	12421	456	5527	110	12928	468	5726
S_2 (75% RDF + 25% RDF through FYM)	104	12506	453	5683	100	11879	430	5359	102	12193	442	5521
S_3 (75% RDF + 25% RDF through green manure crop)	108	13130	481	6166	111	12419	457	5586	110	12774	469	5876
S_4 (50% RDF+ 25% RDF through FYM + 25%RDF through green manure crop)	104	12221	432	5421	99.1	10946	422	5091	101	11583	427	5256
SEm ±	2.26	264	12	170	2.55	471	9.06	116	2.2	265	10.2	121.2
CD (P=0.05)	7	814	36.9	525	7.87	1390	27.9	359	6.7	817	31.5	373.4
CV (%)	5.1	5.04	6.35	7.19	6.02	9.69	5.02	5.29	5.07	5.25	5.54	5.3
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 2. Nitrogen uptake (kg ha^{-1}) of rice as influenced by crop stand establishment and nutrient management during *kharif* 2017-18, 2018-19 and pooled data.

Treatments	2017-18	2018-19	Pooled data
kharif : Rice			
M_1 (Wet seeding)	99.31	91.39	95.35
M_2 (Transplanting)	107.21	99.62	103.41
SEm ±	3.63	3.01	3.27
CD (P=0.05)	NS	NS	NS
CV (%)	12.19	10.94	11.4
Fertilizer treatments (Organic and in-organic sources)			
S_1 (100% RDF through chemical fertilizers)	108.85	100.75	104.8
S_2 (75% RDF + 25% RDF through FYM)	100.18	92.57	96.37
S_3 (75% RDF + 25% RDF through green manure crop)	111.92	99.76	105.84
S_4 (50% RDF+ 25% RDF through FYM + 25%RDF through green manure crop)	92.09	88.93	90.51
SEm ±	4.56	2.89	3.16
CD (P=0.05)	14.07	8.91	9.74
CV (%)	10.83	7.41	7.79
Interaction	NS	NS	NS

sources) during both the years and also in pooled analysis. At harvest, the crop attained maximum plant height in the treatment where it was supplied with more amount of nutrients. Among fertilizer treatments, 100% RDF (S_1) was on a par with 75 % RDF + 25 % RDF through green manure crop (Sunhemp) (S_3) and plant height recorded was significantly lower when the nutrients were applied through 75**%** RDF + 25**%** RDF through FYM (S_2) and 50 % RDF + 25 % RDF through FYM + 25 % RDF through green manure crop (Sunhemp) (S_4). This might be due to availability of less nutrients through FYM in both the treatments. These results are in accordance with Singh *et al* (2006). Increase in level of nitrogen application might have increased nitrogen availability to the crop which might have enhanced cell division and cell elongation resulting in taller plants. Such a favourable effect of nitrogen on increase in plant height of rice has also been reported by (Bhanuprakash *et al*.,2013).

Increase in plant height might also be due to the reason that decrease in the soil pH due to the formation of organic and inorganic acids as a result of green manure decomposition and more CO_2 might have been formed increasing the metabolic activity of the root system which might have enhanced the cell division and cell elongation resulting in taller plants. The results obtained in present study are in close agreement with the report by Elshouny *et al*., 2008 and Sarwar *et al.,* 2009.

The drymatter accumulation obtained at harvest was significantly influenced by fertilizer treatments. Among the various fertilizer treatments, it was noticed that 75**%** RDF + 25**%** RDF through green manure crop **(S_3)** had significant effect on increasing drymatter accumulation which was at par with 100**%** RDF and found significantly superior to application of 75**%** RDF + 25**%** RDF through FYM and the lowest drymatter accumulation was observed in 50**%** RDF + 25**%** RDF through FYM + 25**%** RDF through green manure crop. The treatment 50**%** RDF + 25**%** RDF through FYM + 25**%** RDF through green manure crop was significantly lower than all the other treatments where 50% of organic sources may not supply the required amount of nutrients to the crop.

Drymatter accumulation is the result of increase in growth parameters as reported by Mankotia and Shekhar (2007). This might have facilitated better uptake and accumulation of nutrients for better growth of rice and consequently increased drymatter production by increasing the fertilizer efficiency as well as soil fertility by promoting soil microbial activities by narrowing down C: N ratio, readily and slow available nutrients coinciding with the time of requirement of the crop. These results are in agreement with Islam *et al*., (2013).

The data pertaining to total number of tillers m^{-2} sampled at maturity are presented in (Table 1). Fertilizer treatments significantly influenced the number of tillers during both the years of study and in

Table 3. Economics of rice as influenced by crop stand establishment and nutrient management during *kharif* 2017-18, 2018-19 and pooled data.

Treatments	2017-18				2018-19				Pooled data			
	Cost of cultivation Rs ha^{-1}	Gross returns Rs ha^{-1}	Net returns Rs ha^{-1}	Return per rupee investment	Cost of cultivation Rs ha^{-1}	Gross returns Rs ha^{-1}	Net returns Rs ha^{-1}	Return per rupee investment	Cost of cultivation Rs ha^{-1}	Gross returns Rs ha^{-1}	Net returns Rs ha^{-1}	Return per rupee investment
kharif : Rice												
M_1 (Wet seeding)	31676	98504	66828	2.12	36931	102971	66040	1.79	34303	100737	66434	1.96
M_2 (Transplanting)	36831	103970	67139	1.83	40156	110063	69907	1.75	38493	107016	68523	1.79
SEm ±	0.059	1659	1659	0.04	0.059	1458	1458	0.03	0.059	1556	1556	0.039
CD (P=0.05)	0.71	NS	NS	0.26	0.36	NS	NS	NS	0.036	NS	NS	NS
CV (%)	0.01	5.6	8.6	7.5	0.01	4.7	7.4	6.7	0.01	5.2	8	7.2
Fertilizer treatments (Organic and in-organic sources)												
S_1 (100% RDF through chemical fertilizers)	32822	103930	71107	2.18	37112	108800	71688	1.93	34967	106365	71397	2.06
S_2 (75% RDF + 25% RDF through FYM)	35503	99201	63698	1.81	39793	105963	66170	1.66	37648	102582	64934	1.74
S_3 (75% RDF + 25% RDF through green manure crop)	33003	107457	74454	2.27	37293	110651	73357	1.97	35148	109054	73905	2.12
S_4 (50% RDF+ 25% RDF through FYM + 25% RDF through green manure crop)	35684	94359	58675	1.65	39974	100653	60679	1.52	37829	97506	59677	1.59
SEm ±	0.083	1370	1370	0.04	0.083	1580	1580	0.04	0.083	1043	1043	0.028
CD (P=0.05)	0.51	4220	4220	0.12	0.25	4869	4869	0.13	0.26	3214	3214	0.08
CV (%)	0.01	3.3	5	5	0.01	3.6	5.7	5.7	0.01	2.5	3.8	3.7
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

pooled data. At harvest, significantly lower number of tillers were recorded by 50 **%** RDF + 25**%** RDF through FYM + 25**%** RDF through green manure than with all the other treatments. Similar results were observed during both the years and in pooled data. Maximum tiller production might be due to liberal and constant supply of nutrients from inorganic as well as organic sources in the presence of sufficient levels of primary nutrients, synchronizing with peak physiological requirement of rice crop. Tiller production, being a vegetative attribute demands liberal supply of all nutrients which might have been provided due to combined application of chemical fertilizers along with slow and steady decomposition of sunhemp (green manure) in the soil. Similar findings were also reported by Aruna *et al*., (2012).

Grain yield of rice during *kharif* was unaffected by different crop establishment techniques during both the years of study and the same was reflected in pooled data also. These results are in accordance with similar observations made by Ali *et al*., (2006). The interaction effect of crop establishment techniques and fertilizer treatments of rice also failed to influence the grain yield of succeeding rice during both the years of study (Table 1).

Fertilizer treatments both organic and inorganic sources were found to show considerable influence on grain yield of rice during the two years of study. Significantly higher grain yield was recorded with treatment 75 **%** RDF + 25**%** RDF through green manure crop which was at par with 100**%** RDF and 75**%** RDF + 25**%** RDF through FYM. In the two treatments S_2 and S_3 where 25% of organic sources were used, these supplied sufficient amount of nutrients along with 75 % chemical fertilizers which were significantly at par with 100% RDF as was reported by Aruna and Reddy (2012). The lowest grain yield was observed when applied with 50**%** RDF + 25**%** RDF through FYM + 25**%** RDF through green manure crop applied during both the years of study and in pooled data.

At harvest, during both years, significant uptake of nitrogen was recorded (Table 2) by S_1 -100**%** RDF and S_3- 75**%** RDF + 25**%** RDF through green manure crop which were at par and lowest was recorded in S_2 -75**%** RDF + 25**%** RDF through FYM and S_4 - 50**%** RDF + 25**%** RDF through FYM + 25**%** RDF through green manure crop. The interaction was found to be non-significant. Similar results were also reported by Sowmya *et al*., (2011). Nitrogen is very important nutrient in utilization of absorbed light energy and photosynthetic carbon metabolism in many physiological and biochemical activities of plant as reported by Huang *et al*., (2004).

Both growth parameters and yield parameters have great influence on yield of the crop and inturn depend on the nutrient availability of the crop. Greater availability of nutrients and metabolites for growth and development of reproductive structures might have ultimately led to realization of higher productivity of individual plant. The increased availability of nutrients and photosynthates might have enhanced the yield attributes as was reported by many workers Parihar (2004), Kumar *et al*. (2016), Kandeshwari and Thavaprakash (2016), Pal *et al*. (2016).

The results of cost of cultivation, gross returns, net returns and returns per rupee invested were presented in table 3. Among the two crop establishment methods there is no significant variation in the economic parameters studied and also there was no interaction effect between method of establishment and fertilizer treatments.

Among fertilizer treatments, significant highest gross and net returns and returns per rupee invested were recorded with 75 % RDF + 25 % RDF through green manure crop which was at par with 100% RDF and lowest was recorded with the treatments 75**%** RDF + 25**%** RDF through FYM followed by 50 % RDF + 25 % RDF through FYM + 25 % RDF through green manure crop during both the years of study and in pooled data. The differences among subplots are clear due to difference in cost of cultivation and grain yield.

CONCLUSION

Based on the observations made on growth parameters, grain yield, nitrogen uptake and economics, it can be recommended to apply 75 % RDF + 25 % RDF through green manure crop and 75**%** RDF + 25**%** RDF through FYM as they were comparable with 100% RDF through chemical fertilizers. For increasing the soil fertility and sustainability 25% of organic sources have to be applied along with inorganic sources for Rice in North Coastal Zone of Andhra Pradesh.

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