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Response of Rice (*Oryza Sativa* L.) to Different Nutrient Levels under Machine Planted Conditions

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Abstract: *Experiments were conducted during Kharif, 2014 and 2015 seasons under field conditions in deltaic alluvial soils at Andhra Pradesh Rice Research Institute, Maruteru to study yield potentiality of rice under machine planted conditions in response to major nutrients. Three levels of nitrogen (90, 120 and 150 kg N ha^{-1}), two levels of phosphorus (60 and 90 kg P_2O_5 ha^{-1}) and two levels of Potassium (60 and 90 kg K_2O ha^{-1}) were taken for field experimentation with graded combinations. Significant response was observed with increased levels of N, P and K combination treatments over lower dosages. Significantly higher number of tillers and higher number of panicles/m^2 were observed with 120-60-60 kg NPK ha^{-1} and which was significantly superior to lower and higher dosage levels of N, P and K fertilizers. Data pertaining to panicle weight/plant and test weight indicated that there was no significant difference among the treatments due to different levels of N, P and K. The mean data on grain and straw yields of machine planted rice revealed that, significantly higher grain yield of 6369 kg ha^{-1} was recorded with 120-90-60 kg NPK ha^{-1} followed by 120-90-90 kg NPK ha^{-1} (6341 kg ha^{-1}) which is superior over lower doses of N, P and K levels and on par grain yields were registered with higher doses of N, P and K levels. Where as in case of mean straw yields, significantly higher straw yields of 7473 kg ha^{-1} were registered with 150-60-90 kg NPK ha^{-1} followed by 150-60-60 kg NPK ha^{-1} (7288 kg ha^{-1}) which is on par with 120-90-60 kg NPK ha^{-1} (7060 kg ha^{-1}) and 120-90-90 kg NPK ha^{-1} (7139 kg ha^{-1}). This clearly shows that with increase of graded doses of N, P and K there is improvement in grain and straw yield to a dose of 120-90-60 kg NPK ha^{-1} during both the seasons beyond which there is not much significant yield improvement. Hence response to different levels of N, P and K under machine planted rice responded well and produced more number of productive tillers which inturn results in higher grain and straw yields.*

Keywords: *Machine transplanting, levels of nutrients, grain yield and mean data*

1. Introduction

Rice (*Oryza Sativa* L.) is cultivated in diverse ecosystems spread over 43.97 million ha in India with a production of 104.32 million tonnes of milled rice with average productivity of 2372 kg ha^{-1} (G.O.I., 2013). In Andhra Pradesh, rice is grown in an area of 41.9 lakh ha with an annual production of 97.46 lakh tones and a productivity of 2930 kg ha^{-1} (Ministry of Agriculture, 2014-15). Method of stand establishment influences the performance of rice through its effect on growth and development. Although, transplanting has been reported to be the best establishment method (Singh *et al.,* 1997), some alternatives like direct seeding, SRI cultivation and

Machine transplanting are being explored to reduce cost of cultivation on account of high labour and water requirement.

The age old traditional manual transplanting method is laborious and expensive. Off late, due to delay in release of canal water, plantings of rice are delayed beyond August resulting in poor yields as critical stages like flowering and fertilization coincide with low temperatures and cloudy weather. Further, with the present day situations, constraints in timely availability of labour accompanied with unfavorable weather conditions and increased labour wages particularly during peak periods, Kharif transplanting had become difficult. This emphasizes the need for better alternative method for transplanting which has advantage of saving labour cost of raising, pulling and transplanting the seedlings. Machine transplanting of rice is found to be as an alternative technique to transplanting in irrigated and rainfed low lands, since it saves labour, time and energy as well as minimizes drudgery besides efficient water and nutrient use as well as B:C ratio (Moorthy and Sanjoy, 2002).

In Godavari delta machine planting is becoming more popular due to increased labour cost in raising nursery, pulling and planting. It is observed that more number of tillers per m^2 are produced in machine planting with planting of relatively younger seedlings at wider spacing. But all the tillers produced are not becoming productive due to less conversion ratio, and even the grain filling is poor in tertiary tillers which ultimately causing the reduction of grain yield. This may be attributed due to inadequate nutrition. Nutrient management provides an approach for feeding the plants with nutrients as and when required. Hence, the present experimentation was carried out to find out the optimum fertilizer doses of NPK for enhancing the productivity of machine planted rice.

2. Material and Methods

Field experiments were conducted at Andhra Pradesh Rice Research Institute, Maruteru, Andhra Pradesh during *Kharif*, 2014 and *Kharif,* 2015 seasons under coastal irrigated ecosystem in deltaic alluvial soils. The method of planting is machine planting (8 row paddy transplanter) with definite spacing of 30 cm x 12 cm at 3-5 cm depth of palnting. Tray nurseries are raised for machine planting to attain the age of 12 days seedlings. The experiment was laid out in factorial Randomized Block Design and replicated thrice. The treatments combinations consists of three levels of nitrogen (90, 120 and 150 kg N ha^{-1}), two levels of phosphorus (60 and 90 kg P_2O_5 ha^{-1}) and two levels of Potassium (60 and 90 kg K_2O ha^{-1}). The experimental soil was clay loam in texture, slightly alkaline in reaction, low in organic carbon (0.43%) and available nitrogen (188 kg ha^{-1}), medium in available phosphorus (34.4 kg ha^{-1}) and high in available potassium (225.4 kg ha^{-1}). The test rice variety is MTU 1064 (Amara) is known for its non-lodging, tolerance to submergence, low shattering characters, resistance to BPH and BLB and suitable for low lying areas of Krishna, Godavari delta region.

3. Results and Discussion

The number of tillers per m2 had differed significantly with the levels of nutrients at all the stages. Significantly higher number of tillers (374) was registered with 120-60-60 kg NPK ha-1 and which is significantly superior to lower and higher dosage levels of NPK during Kharif, 2015 season (Table 2). Where as in case of Kharif, 2014 season number of tillers per m2 did not significantly differed among the levels of nutrients. The lowest number of tillers per m2 was recorded in the treatment that received lower doses of NPK at all the stages of crop growth which might be due to inadequate supply of nutrients. Increasing nitrogen levels will improve tiller number in rice and the same was also reported by Rajput and Warsi (1992) and Madhav et al. (1996).

Number of panicles per m2 was found to be significant across different levels of nutrients. Highest number of panicles per m2 (289) was observed with 120-60-60 kg NPK ha-1 during Kharif, 2015 which were significantly superior over lower and higher NPK levels. During Kharif, 2014 season number of panicles per m2 shows non-significant results (Table 1). Increase in panicles with increase in nutrient doses 120-90-90 kg NPK

ha-1 but over and above doses produced profuse tillering which lead to competition among them resulting in lesser tillers produced lesser number of panicles. This was in conformity with the results of Jadhav et al., 2004.

The data pertaining to panicle weight (g) during both Kharif, 2014 and 2015 seasons did not showed significant results (Table 1). But with the increase of levels of NPK there is proportional improvement in panicle weight was observed. This might be due to increased levels of nitrogen increased the photosynthetic efficiency of plant which inturn results in even distribution of source to sink ratio of dry matter accumulation. The data on test weight (1000 grains weight in grams) indicated that there was no significant difference due to different levels of NPK. Test weight is mostly a genetically fixed factor by the individual variety and not much influenced by levels of NPK and further interaction effect had no significant effect on test weight as reported by Rahman et. al., (2007) and Swarna et. al., (2014).

During Kharif, 2014 revealed that, highest grain yield of 6969 kg ha-1 was recorded with application of 150-60-60 kg NPK ha-1 compared to other treatments followed by 150-60-90 kg NPK ha-1 (6878 kg ha-1) which are superior to lower doses of NPK but on par with medium doses of NPK (Table 2). During Kharif, 2015 season highest grain yield of 5972 kg ha-1 was recorded with application of 120-90-60 kg NPK ha-1 which was on par with 150-90-90 kg NPK ha-1 (5853 kg ha-1) and significantly superior to other treatments (Table 2). Increase in graded levels of fertilizer dose of N, P and K beyond recommended dose of 90-60-60 kg NPK ha-1 there is a significant response up to 120-90-60 kg NPK ha-1, beyond that there is not much significant yield increase was observed.

The data revealed that the application of nitrogen at graded levels significantly improved straw yield but, such significant effect was not observed with graded levels of phosphorus and potassium and their combinations. The results of the present study showed that increase in levels of nitrogen significantly increased the straw yield of rice. The treatment which received 150-60-90 kg NPK ha-1 recorded higher grain straw yield of 7805 kg ha-1 during Kharif, 2014 and the treatment 150-90-90 kg NPK ha-1 registered higher grain yield of 7243 kg ha-1 during Kharif 2015 and found significantly superior over different levels of NPK combinations. Addition of graded levels of phosphorus and potassium did not show any significant result on straw yield but higher straw yields were observed with higher doses of phosphorus and potassium. Increase in dose of Nitrogen increased the straw yield and these findings are in agreement with that of Gangaiah B and Rajendra Prasad (1999).

The mean data on grain and straw yields of machine planted rice revealed that, significantly higher grain yield of 6369 kg ha-1 was recorded with 120-90-60 kg NPK ha-1 followed by 120-90-90 kg NPK ha-1 (6341 kg ha-1) which is superior over lower doses of NPK levels and on par grain yields were registered with higher doses of NPK levels (Table 2). Where as in case of straw yields, significantly higher straw yields of 7473 kg ha-1 were registered with 150-60-90 kg NPK ha-1 followed by 150-60-60 kg NPK ha-1 (7288 kg ha-1) which is on par with 120-90-60 kg NPK ha-1 (7060 kg ha-1) and 120-90-90 kg NPK ha-1 (7139 kg ha-1). This clearly shows that with the increase of graded doses of NPK there is a improvement in grain and straw yield to a dose of 120-90-60 kg NPK ha-1 beyond which there is not much significant yield improvement. Hence response to different levels of NPK machine planted rice responded well and produced more number of productive tillers which inturn results in higher grain and straw yields.

The increase in grain yield with application of nitrogen could be attributed to increase in photosynthesis since nitrogen is the constituent of Chlorophyll, which inturn, might have resulted in accumulation of photosynthates in vegetative portion of plants and ultimately enhanced the plant growth, attributes and grain yield Jhansi lakshmi bai et al 2013 and Swarna et al (2014). The positive response to the higher levels of nutrients and grain yields could be ascribed to overall improvement in crop growth enabling the plant to absorb more quantity of photosynthates and accumulating them in sink. These findings are in close accordance with those reported by Singh and Jain (2000) and Aruna and Reddy (2011).

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TABLE I: Yield Attributes Of Rice As Influenced By Fertilizer Levels In Machine Planting During *Kharif* Season

Treatment details		Number of Tillers per m2			Number of Panicles per m2			Panicle Weight (g)			Test Weight (g)		
		2014	**2015**	**Mean**	**2014**	**2015**	**Mean**	**2014**	**2015**	**Mean**	**2014**	**2015**	**Mean**
T_1	90-60-60 kg NPK ha^{-1}	362	305	**334**	242	289	**266**	3.21	3.35	**3.28**	19.0	18.1	**18.6**
T_2	90-60-90 kg NPK ha^{-1}	371	312	**342**	248	207	**228**	3.00	3.22	**3.11**	18.2	18.5	**18.4**
T_3	90-90-60 kg NPK ha^{-1}	383	362	**373**	254	254	**254**	3.15	3.11	**3.13**	19.4	18.7	**19.1**
T_4	90-90-90 kg NPK ha^{-1}	407	345	**376**	256	218	**237**	3.16	3.20	**3.18**	19.4	18.6	**19.0**
T_5	120-60-60 kg NPK ha^{-1}	418	374	**396**	262	224	**243**	3.48	3.52	**3.50**	19.8	18.8	**19.3**
T_6	120-60-90 kg NPK ha^{-1}	426	355	**391**	284	238	**261**	3.20	3.19	**3.20**	19.8	18.6	**19.2**
T_7	120-90-60 kg NPK ha^{-1}	435	324	**380**	277	261	**269**	3.22	3.30	**3.26**	19.9	19.4	**19.7**
T_8	120-90-90 kg NPK ha^{-1}	442	360	**401**	282	231	**257**	3.04	3.03	**3.04**	19.6	19.2	**19.4**
T_9	150-60-60 kg NPK ha^{-1}	443	361	**402**	264	204	**234**	3.11	3.06	**3.09**	19.8	18.9	**19.4**
T_{10}	150-60-90 kg NPK ha^{-1}	439	339	**389**	280	214	**247**	3.06	3.00	**3.03**	19.9	18.7	**19.3**
T_{11}	150-90-60 kg NPK ha^{-1}	436	327	**382**	243	237	**240**	3.10	3.06	**3.08**	19.9	18.8	**19.4**
T_{12}	150-90-90 kg NPK ha^{-1}	433	319	**376**	232	226	**229**	3.58	4.14	**3.86**	19.7	18.7	**19.2**
	SE(m±)	12.8	13.2		10	15.7		0.20	0.23		0.33	0.2	
	CD (0.05)	NS	39		NS	46		NS	NS		NS	NS	
	CV (%)	5.32	6.70		4.20	11.70		9.89	12.21		2.93	2.00	

TABLE II: Mean Grain Yield And Straw Yield Of Rice As Influenced By Fertilizer Levels In Machine Planting

Treatment details		Grain Yield (kg ha^{-1})			Straw Yield (kg ha^{-1})		
		2014	**2015**	**Mean**	**2014**	**2015**	**Mean**
T_1	90-60-60 kg NPK ha^{-1}	4957	4892	**4925**	5593	6105	**5849**
T_2	90-60-90 kg NPK ha^{-1}	5201	4525	**4863**	5645	5484	**5565**
T_3	90-90-60 kg NPK ha^{-1}	5492	4880	**5186**	5750	5733	**5742**
T_4	90-90-90 kg NPK ha^{-1}	5708	5228	**5468**	6033	6036	**6035**
T_5	120-60-60 kg NPK ha^{-1}	6338	5571	**5955**	6861	6495	**6678**
T_6	120-60-90 kg NPK ha^{-1}	6800	5517	**6159**	7046	6746	**6896**
T_7	120-90-60 kg NPK ha^{-1}	6765	5972	**6369**	7004	7116	**7060**
T_8	120-90-90 kg NPK ha^{-1}	6875	5806	**6341**	7306	6971	**7139**
T_9	150-60-60 kg NPK ha^{-1}	6969	5679	**6324**	7527	7049	**7288**
T_{10}	150-60-90 kg NPK ha^{-1}	6878	5683	**6281**	7805	7141	**7473**
T_{11}	150-90-60 kg NPK ha^{-1}	6528	5594	**6061**	7360	7182	**7271**
T_{12}	150-90-90 kg NPK ha^{-1}	6318	5853	**6086**	7146	7243	**7195**
	SE(m+)	316	225	**208**	417	209	**250**
	CD (0.05)	927	663	**616**	1224	618	**739**
	CV (%)	8.78	7.20	**5.85**	10.74	5.50	**6.27**