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Response of Machine Transplanted Rice to Different Levels of Nutrients Under Coastal Irrigated Ecosystem

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Abstract

Field experiments were conducted during *Kharif*, 2014 and 2015 seasons in deltaic alluvial soils at Andhra Pradesh Rice Research Institute, Maruteru to study the optimum doses of nitrogen, phosphorus and potassium for enhancing the productivity of rice under machine planted conditions. The treatments mainly comprise of combination 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}). There was significant response to the increased levels of NPK treatments over lower dosages. Significantly higher number of tillers and higher no. of panicles/m^2 was observed with 120-60-60 kg NPK ha^{-1} and which is significantly superior to lower and higher dosage levels of NPK. The data pertaining to panicle weight and test weight indicated that there was no significant difference due to different levels of NPK. 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. 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 in turn results in higher grain and straw yields.

Key Words: Machine transplanting, level of nutrients, grain yield

Introduction

Rice 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 use and nutrient use as well as benefit: cost ratio (Moorthy and Saha, 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 no. of tillers/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.

Material and Methods

Field experiments were conducted at Andhra Pradesh Rice Research Institute & Regional Agricultural Research Station, Maruteru, West Godavari district, Andhra Pradesh during *Kharif*, 2014 and *Kharif*, 2015 seasons under coastal irrigated ecosystem in deltaic alluvial soils. 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 MTU 1064 (Amara) is a cross between PLA 1100 (Bhadava Mahsuri) X MTU 1010 (Cottondora Sannalu) and known for non-lodging, tolerance to submergence, low shattering, resistance to BPH and BLB and suitable for low lying areas of Krishna, Godavari delta region.

Results and Discussion

The number of tillers/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/m2 did not significantly differed among the levels of nutrients. The lowest number of tillers/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/m2 was found to be significant across different levels of nutrients. Highest number of panicles/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/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 & 2). 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 in turn results in even distribution of source to sink ratio of dry matter accumulation. The data on 1000 grain weight (Test weight) 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 3). 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 3). Increase in graded levels of fertilizer dose of N, P & 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 N 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 3). 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 1: Yield attributes and yield of rice as influenced by fertilizer levels in machine planting during *Kharif*, 2014

Treatment		Number of Tillers/m^2	Number of Panicles/m^2	Panicle Weight (g)	Test Weight (g)	Grain Yield (kg ha^{-1})	Straw Yield (kg/ha)
T_1	90-60-60 NPK kg ha^{-1}	362	242	3.21	19.0	4957	5593
T_2	90-60-90 NPK kg ha^{-1}	371	248	3.00	18.2	5201	5645
T_3	90-90-60 NPK kg ha^{-1}	383	254	3.15	19.4	5492	5750
T_4	90-90-90 NPK kg ha^{-1}	407	256	3.16	19.4	5708	6033
T_5	120-60-60 NPK kg ha^{-1}	418	262	3.48	19.8	6338	6861
T_6	120-60-90 NPK kg ha^{-1}	426	284	3.20	19.8	6800	7046
T_7	120-90-60 NPK kg ha^{-1}	435	277	3.22	19.9	6765	7004
T_8	120-90-90 NPK kg ha^{-1}	442	282	3.04	19.6	6875	7306

T_9	150-60-60 NPK kg ha^{-1}	443	264	3.11	19.8	6969	7527
T_{10}	150-60-90 NPK kg ha^{-1}	439	280	3.06	19.9	6878	7805
T_{11}	150-90-60 NPK kg ha^{-1}	436	243	3.10	19.9	6528	7360
T_{12}	150-90-90 NPK kg ha^{-1}	433	232	3.58	19.7	6318	7146
	SE (m$\pm$)	12.8	10	0.20	0.33	927	1224
	CD (0.05)	NS	NS	NS	NS	316	417
	CV (%)	5.32	4.20	9.89	2.93	8.78	10.74

Table 2: Yield attributes and yield of rice as influenced by fertilizer levels in machine planting during *Kharif*, 2015

Treatment		Number of Tillers/m^2	Number of Panicles/m^2	Panicle Weight (g)	Test Weight (g)	Grain Yield (kg ha^{-1})	Straw Yield (kg/ha)
T_1	90-60-60 NPK kg ha^{-1}	305	289	3.35	18.1	4892	6105
T_2	90-60-90 NPK kg ha^{-1}	312	207	3.22	18.5	4525	5484
T_3	90-90-60 NPK kg ha^{-1}	362	254	3.11	18.7	4880	5733
T_4	90-90-90 NPK kg ha^{-1}	345	218	3.20	18.6	5228	6036
T_5	120-60-60 NPK kg ha^{-1}	374	224	3.52	18.8	5571	6495
T_6	120-60-90 NPK kg ha^{-1}	355	238	3.19	18.6	5517	6746
T_7	120-90-60 NPK kg ha^{-1}	324	261	3.30	19.4	5972	7116
T_8	120-90-90 NPK kg ha^{-1}	360	231	3.03	19.2	5806	6971
T_9	150-60-60 NPK kg ha^{-1}	361	204	3.06	18.9	5679	7049
T_{10}	150-60-90 NPK kg ha^{-1}	339	214	3.00	18.7	5683	7141
T_{11}	150-90-60 NPK kg ha^{-1}	327	237	3.06	18.8	5594	7182
T_{12}	150-90-90 NPK kg ha^{-1}	319	226	4.14	18.7	5853	7243
	SE(m$\pm$)	13.2	15.7	0.23	0.2	225	209
	CD (0.05)	39	46	NS	NS	663	618
	CV (%)	6.70	11.70	12.21	2.00	7.20	5.50

Table 3: Mean grain yield and straw yield of rice as influenced by fertilizer levels in machine planting

	Treatment 2014	Grain Yield (kg/ha)			Straw Yield (kg/ha)		
		2015	Mean	2014	2015	Mean	
T_1	90-60-60 NPK kg ha^{-1}	4957	4892	4925	5593	6105	5849
T_2	90-60-90 NPK kg ha^{-1}	5201	4525	4863	5645	5484	5565
T_3	90-90-60 NPK kg ha^{-1}	5492	4880	5186	5750	5733	5742
T_4	90-90-90 NPK kg ha^{-1}	5708	5228	5468	6033	6036	6035
T_5	120-60-60 NPK kg ha^{-1}	6338	5571	5955	6861	6495	6678
T_6	120-60-90 NPK kg ha^{-1}	6800	5517	6159	7046	6746	6896
T_7	120-90-60 NPK kg ha^{-1}	6765	5972	6369	7004	7116	7060
T_8	120-90-90 NPK kg ha^{-1}	6875	5806	6341	7306	6971	7139
T_9	150-60-60 NPK kg ha^{-1}	6969	5679	6324	7527	7049	7288
T_{10}	150-60-90 NPK kg ha^{-1}	6878	5683	6281	7805	7141	7473
T_{11}	150-90-60 NPK kg ha^{-1}	6528	5594	6061	7360	7182	7271
T_{12}	150-90-90 NPK kg ha^{-1}	6318	5853	6086	7146	7243	7195
	SE (m$\pm$)	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