Indian Journal of Agronomy **56** (3): 228–231 (September 2011)

Effect of integrated nitrogen management on yield, quality and nutrient uptake of rice (*Oryza sativa*) under different dates of planting

S.K. CHAUDHARY*, J.P. SINGH AND S. JHA

Rajendra Agricultural University, Pusa, Samastipur, Bihar, 848 125

Received: March, 2011

ABSTRACT

A field experiment was conducted during 2006 and 2007 rainy season on a silty loam soil at Pusa, Bihar to study the effect of inorganic fertilizer in combination with organic sources, *viz.* vermicompost, poultry manure, FYM and green manuring under four dates of transplanting (5, 15, 25 July and 4 August) on rice (*Oryza sativa* L.). Rice 'Rajendra Suwasani' recorded significantly higher values of yield attributes (panicles/m^2, panicle length, grains/panicle, panicle weight, 1000-grains weight), yields and nutrient accumulation under integrated source of nutrients than inorganic fertilizer alone. Maximum grain yield (4.12 t/ha) was with 75% recommended dose of nitrogen (RDN) + 25% N from *dhaincha* (*Sesbania aculata* L.) and it was 14.8 and 26.1% higher over 100 and 75% RDN, respectively. There was significant reduction in yield attributes, yields and nutrient uptake due to delayed transplanting. Transplanting on 5 July recorded 13.6 and 25.3% higher grain yield than transplanting on 25 July and 4 August, respectively.

Key words: Date of planting, Integrated nutrient management, NPK uptake, rice

Rice is the staple food of the country. Rice production constitutes the major economic activity and a key source of livelihood for the rural households of the north Bihar plain, where growing rice during the *kharif* season is a physio graphic compulsion. Time of transplanting and nutrient management is the two key inputs, which play major role in enhancing the yield and quality of aromatic rice. Transplanting date assumes significance, especially in quality rice, because of its thermo sensitivity during flowering and grain filling stages resulting in high spikelet sterility besides influencing the quality parameters (Singh *et al*., 2005). For realizing the inherited yield potentials of high yielding rice variety, recourse must be taken to the application of manures and fertilizers. In recent years, there has been increasing recognition of the importance of organics as a source of plant nutrients due to growing ecological concern and depleting inherent soil fertility leading to multiple deficiencies of essential plant nutrients. The results of long-term fertilizer experiments have emphasized that sustainability can only be maintained by integration of inorganic and organic sources of nutrients. Organic sources of plant nutrients offer the twin benefits of increase in organic matter content and improvement in physical, chemical and microbiological properties of soil while meeting a part of nutrients need of crops (Chettri and Bandhopadhya, 2005). Keeping this in view, the present study was undertaken to evaluate the performance of various sources of organics in combination with inorganic sources under different dates of planting for quality rice.

***Corresponding author Email:** skcrau@gmail.com

MATERIALS AND METHODS

The field experiment was conducted for 2 consecutive years (2006 and 2007) during rainy season at research farm of Rajendra Agricultural University, Pusa (Bihar). The soil was silty loam, low in organic carbon (0.43%), available N (178 kg/ha) and available P (21.4 kg/ha) and medium in available K (179 kg/ha) with alkaline (pH 8.3) in reaction. The experiment was laid out in a split-plot design by keeping the dates of transplanting in main-plots, *viz.* 5, 15 and 25 July and 4 August every year; and seven combinations of organic and inorganic sources of nutrients, were allotted to sub-plots, *viz.* 100% RDN, 75% RDN, 75% RDN + 25% RDN from vermicompost, 75% RDN + 25% RDN from FYM, 75% RDN + 25% RDN from poultry manure and 75% RDN + 25% RDN from *dhaincha*. All the treatments were replicated thrice.

Nitrogen content was estimated in these organic sources on dry-weight basis and their quantities required to substitute a specified amount of N as per treatment were calculated. All organics were applied to supply 25 kg N/ha to the specific treatments based on their moisture content and N content. *Dhaincha* was grown in separate plot for 48 days and was incorporated 7 days before transplanting along with other organic sources. Recommended dose of fertilizersfor the rice was for 100 kg N, 21.5 kg P and 25 kg K/ha. The whole quantity of P and K and half of N along with 25 kg $ZnSO_4$/ha were applied basal to rice crop, and the remaining amount of N was top dressed in two equal splits at tillering and panicle-initiation stage. 25 days old seedlings of rice 'Rajendra Suwasani' were transplanted at 20 cm × 15 cm spacing as per the specific date of transplanting. All improved packages of practices were followed to raise the crop. Yield components and the grain and straw yields were recorded at harvest and the data were statistically analysed. Plant NPK uptake were also estimated.

RESULTS AND DISCUSSION

Yield and yield attributes

Different schedules of nutrient management had a significant effect on yield attributes, viz. panicles/m^2, panicle length, panicle weight, grains/panicle, spikelet sterility, and test weight. Among the nutrient combinations, application of 75% RDN in combination with *dhaincha*, poultry manure or vermicompost except FYM, being on par, recorded significantly maximum panicles/m^2 than other nutrient management practices (Table 1). The magnitude of increase due to 75% RDN along with *dhaincha* over 100% RDN and 75% RDN was 7 and 16%, respectively. The values of panicle length, grains/panicle, panicle weight and 1000-grain weight were significantly higher with 75% RDN + *dhaincha* than 75 and 100% RDN, but it was comparable with other sources of organics except FYM treatment. Thus, integrated use of organics and inorganics recorded significantly more values of yield attributes compared to inorganics alone. It could be ascribed to the slow release of nutrients after decomposition ensuring continued availability compared with inorganic fertilizer alone. Moreover, organics, besides supplying macro and micronutrient, have also solubilizing effect on native soil nutrients due to the action of organic acids produced during decomposition (Pandey *et al.,* 2007 and Tripathi *et al.,* 2009).

Effect of Inorganic fertilizer on grain and straw yields of rice was significant and increased with increasing level of N from 75 to 100%.This has been due to additive enrichment and enhanced nutrient availability. Integrated use of 75% RDN along with *dhaincha* recorded significantly higher grains and straw yields of rice. The treatment, however, exhibited statistical parity with other combination of organics with 75% RDN except FYM. Amongst the different organics, *dhaincha* proved superior, perhaps because of its fast decomposition and solubilizing effect on native soil nutrient which led to better availability of nutrients besides improving the soil environment (Singh, 2006). Besides N, *dhaincha* add appreciable amount of P, K, Ca, Mg, S and micronutrients to the soil. Performance of nutrient treatments in terms of grains and straw yields followed the order of 75% RDN + *dhaincha* > 75% RDN + poultry manure > 75% RDN + vermicompost > 100%

Table 1. Yield attributes and yield and economics of production of rice as affected by date of transplanting and nitrogen sources (pooled data of 2 years)

Treatment	Panicles/ m^2	Panicle length (cm)	Panicle weight (g)	Grains/ panicle	Unfilled spikelet (%)	Test weight of grain (g)	Grain yield (t/ha)	Straw yield (t/ha)	B : C ratio
Date of planting									
5 July	268	24.0	2.08	93	15.03	21.0	4.11	5.71	1.06
15 July	263	23.9	2.03	89	15.11	21.0	4.06	5.66	1.03
25 July	248	23.8	1.94	83	16.01	20.8	3.68	5.19	0.87
4 August	236	23.7	1.88	78	16.68	20.6	3.32	4.68	0.70
SEm±	4.6	0.4	0.02	2.0	0.02	0.25	0.09	0.13	0.04
CD (P=0.05)	14.0	NS	0.07	6.0	0.62	NS	0.29	0.39	0.11
Nitrogen management									
100% RDN	254	23.76	1.96	84	16.11	21.0	3.66	5.16	1.04
75% RDN	230	22.88	1.91	76	17.83	19.8	3.31	4.68	0.77
75% RDN + 25% N Vermicompost	261	24.03	2.0	88	14.98	21.2	3.89	5.45	0.82
75% RDN + 25% N FYM	247	23.37	1.98	82	15.17	20.7	3.73	5.22	0.84
75% RDN + 25% N Poultry manure	262	24.30	2.03	90	15.09	21.3	4.04	5.64	0.99
75% RDN + 25% N *Dhaincha*	266	24.69	2.04	94	15.08	21.3	4.12	5.71	1.03
SEm±	4.2	0.4	0.03	2.5	0.33	0.29	0.12	0.17	0.05
CD (P=0.05)	12.0	1.07	0.09	7.0	0.93	0.83	0.34	0.45	0.14

RDN: Recommended dose of nitrogen

RDN > 75% RDN + FYM > 75% RDN.

Significant effect of transplanting date was observed on grain yield and yield attributes. Early planting on 5 July significantly increased panicles/m^2, panicle weight, grains/ panicle over the 25 July, and 4 August while remaining at par with 15 July transplanting. Panicle length and test weight remain unaffected. Sterility (%) was significantly higher under August 4 planting and gradually declined in the successive early planting (Singh *et al,* 2005). Significantly higher grain yield (4.11 t/ha) was recorded at July 5 planting, being on par with 15 July planting. Reduction in grains yield was of the order of 1.6, 13.6 and 25.3%, respectively under 15 July, 25 July and 4 August planting compared with 5 July planting. The decreasing trend in delayed planting might be associated with significantly lower number of panicles/m^2 and grains/panicle along with non-significant decreasing trend in test weight. This may be attributed to the thermosensitivity of the high yielding varieties of rice at flowering and grain filling stages (Singh *et al.,* 2005 and Nayak *et al.,* 2003).

NPK uptake

The NPK uptake differed significantly due to different treatments. Nutrient uptake being a function of dry matter production and partly due to increase in its concentration, 75% RDN + *dhaincha* treatment gave more total dry mat-

Table 2. Nutrient uptake by rice as affected by different date of transplanting and nitrogen sources (pooled data of 2 years)

Treatment	Nitrogen uptake (kg/ha)			Phosphorus uptake (kg/ha)			Potassium uptake (kg/ha)		
	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
Date of planting									
5 July	62.0	25.5	87.5	11.5	4.5	15.9	18.8	138.4	157.2
15 July	61.3	25.8	87.1	11.4	4.4	15.8	18.7	137.0	155.7
25 July	55.3	23.2	78.5	10.7	4.2	14.7	16.6	124.6	141.1
4 August	49.8	20.4	70.2	9.6	3.6	13.2	14.6	111.6	126.2
SEm±	1.3	1.01	-	0.38	0.16	-	0.79	2.81	-
CD (P=0.05)	4.1	2.9	-	1.1	0.5	-	2.3	8.6	-
Nitrogen management									
100% RDN	55.1	22.7	77.8	10.6	3.9	14.6	16.5	125.4	141.8
75% RDN	48.1	19.2	67.3	8.8	3.4	12.2	14.2	111.3	125.6
75% RDN + 25% N Vermicompost	59.1	24.5	83.6	11.2	4.3	15.4	17.8	131.2	149.1
75% RDN + 25% N FYM	56.3	22.5	78.8	10.7	4.0	14.7	16.8	124.8	141.6
75% RDN + 25% N Poultry manure	62.1	26.5	88.6	11.6	4.5	16.1	19.0	136.9	155.9
75% RDN + 25% N *Dhaincha*	63.1	26.8	89.9	12.3	4.6	16.8	19.4	137.6	156.9
SEm±	1.6	1.4		0.5	0.2		1.03	3.3	
CD (P=0.05)	4.6	3.4		1.3	0.5		2.8	9.4	

Table 3. Grain quality of rice as influenced by different date of transplanting and nitrogen sources (pooled data of 2 years)

Treatment	Milling (%)	Head rice recovery (%)	Kernel length (cm)	L/B ratio	Amylose content (%)	Gel consistency (mm)	Volume expansion ratio
Date of planting							
5 July	71.2	44.2	7.1	3.9	24.96	60.84	4.98
15 July	71.0	43.8	7.1	3.9	24.20	62.49	5.14
25 July	71.1	42.1	7.1	3.9	23.94	63.39	5.09
4 August	71.0	41.9	7.1	3.9	23.39	63.98	5.11
SEm±	0.73	0.36	0.06	0.04	0.37	1.3	0.04
CD (P=0.05)	NS	NS	NS	NS	1.07	NS	NS
Nitrogen management							
100% RDN	71.2	43.3	7.1	3.9	24.02	62.91	5.14
75% RDN	71.2	42.7	7.1	3.9	23.94	61.76	5.11
75% RDN + 25% N vermicompost	70.9	43.6	7.1	3.9	24.33	62.81	5.15
75% RDN + 25% N FYM	71.1	42.9	7.1	3.9	24.48	63.0	5.04
75% RDN + 25% N Poultry manure	70.9	42.8	7.1	3.9	24.02	62.70	5.05
75% RDN + 25% N *dhaincha*	71.0	42.9	7.1	3.9	24.15	62.92	4.99
SEm±	0.77	0.34	0.06	0.05	0.38	1.2	0.05
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS

ter, registered significantly higher uptake of NPK. This may due to the sufficient and continued availability of N from Inorganic and organic source, that eventually led to higher N uptake (Dixit and Gupta, 2000). CO_2 produced during mineralization of organic sources play role in solubilization of native P. Higher K uptake might be due to better soil condition and reduced K fixation. Similar result has been reported by Bhoite (2005). Planting on 5 July recorded significantly higher NPK uptake over 25 July and 4 August, owing to enhanced growth leading to increased rate of grain filling, higher test weight, more number of grains/panicle, and grain and straw yields.

Quality

The milling percentage, head rice recovery, kernel length L/B ratio, alkali spreading value, volume expansion ratio and gel consistency were analysed and found to be statistically on par due to dates of transplanting and nitrogen management. Only the amylose content (AC) was significantly influenced by the dates of transplanting and decreasing trend was observed in the amylose content with the late planting. The minimum amylose content was found in late planted crop.

Economics

Amongst the different dates of planting of quality rice, higher mean benefit:cost ratio of 1.06 was recorded under 5 July planting, followed by 15 July (1.03). This showed that 5 and 15 July planting of rice is more effective in realizing higher benefit:cost ratio. These were on par and statistically superior over 25 July and 4 August planting (Table 1). In nitrogen management practices, 100% RDN and 75% RDN + 25% N from *dhaincha* gave maximum benefit:cost ratio of 1.04 and 1.03, respectively. Singh *et al.,* 2006b have also observed that green manuring to rice were economically viable.

The present study indicated that the combined application of 75% RDN together with organics played a significant role in increasing the grain yield of rice. Transplanting in the first fortnight of July resulted in maximum grain yield.

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