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Research Paper

Effect of nutrient sources and transplanting date on aromatic rice (*Oryza sativa*) under mid hills of north eastern India

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ABSTRACT

A field experiment was conducted during *kharif* seasons of 2009 and 2010 to find out the effect of dates of transplanting and nutrient sources on productivity, nutrient uptake and economics of aromatic rice (*Oryza sativa* L.) in lowland condition. The results showed that 16 July transplanted aromatic rice performed better in terms of yield, yield attributing characters and total uptake of N, P and K with different nutrient management practices. Pooled results indicated that integrated application of 50% recommended dose (RD) of NPK through inorganic + 50% RDNP through FYM and rockphosphate recorded highest average grain yield (4.68 t/ha), which was 118% higher than grain yield under control (2.14 t/ha). Available N, P and K and nitrogen use efficiency were found maximum with the application of 50% RDNPK through inorganic + 50% RDNP through FYM and rockphosphate in 16 July transplanted aromatic rice crop. The soil organic carbon (SOC) was enhanced by 11.8% with the application of 100% RDNP through FYM and rockphosphate compared to initial value. Soil microbial biomass carbon (SMBC) was also found maximum under 100% RDNP through FYM and rockphosphate followed by 50% RDNPK through inorganic + 50% RDNP through FYM and rockphosphate. Average net returns (₹21,324) was found maximum in 50% RDNPK through inorganic + 50% RDNP through FYM and rockphosphate treatment, whereas benefit: cost ratio (1.94) was the highest with the application of 100% RDNPK through inorganic sources of nutrient.

Key words: Aromatic rice, Nitrogen use efficiency, Nutrient management, Productivity, Soil health, Transplanting date

Rice is the principal food crop of the north-eastern region of India, occupying an area of about 3.5 m ha with an average productivity of 1.78 t/ha, which is much below the National average. The region is still deficit of about 1.77 million tonnes of rice. The reason for such low productivity is the non-adoption of high yielding varieties and poor agronomic practices. There is a good scope for promoting aromatic rice varieties in the region. Availability of high yielding aromatic rice varieties in the region are very low and the aromatic varieties introduced from other parts of the country are not showing promising results. Indian Council of Agricultural Research (ICAR) Research Complex for NEH Region, Umiam has developed a new aromatic rice variety 'Megha AR-2' (RCPL 1-160) suitable for the mid altitude condition. The optimum sowing time of any field crop depends on the environmental conditions required for good growth and development. Sowing dates can be manipulated to avoid the periods of greatest risk from insect pests, weeds and diseases and hence improved yields of the crop (Harper, 1983). Usually, yield declines when planting is delayed beyond the optimum time. Transplanting of rice in the optimum period of time is critical to achieve high grain yield. However, optimum rice planting dates are regional and vary with location and genotypes (Bruns and Abbas, 2006). Yoshida (1981) reported that rice plants require a particular temperature for its phenological affairs such as panicle initiation, flowering, panicle exertions from flag leaf sheath and maturity and these are very much influenced by planting dates during rainy season. Planting rice after the optimum dates can result in higher disease and insect pest incidence, tropical storm-related lodging and possible cold damage during heading and the grain filling period resulting in low yields (Groth and Lee, 2003). Chemical fertilizer offers

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nutrients which are readily soluble in soil solution and thereby instantly available to plants. Nutrient availability from organic sources is due to microbial action and improved physico-chemical condition of soil (Sarkar*et al.,* 2004). Organic sources offer more balanced nutrition to the plants, especially micronutrients which positively affect number of tillers in plants and improve reproductive performance (Miller, 2007).

Hence, the present work has been undertaken to find out suitable date of transplanting and nutrient management practices for the newly released aromatic rice variety for the mid hills of north-east India.

MATERIALS AND METHODS

A field experiment was conducted at the lowland agronomy farm of ICAR Research Complex for NEH Region, Umiam, Meghalaya, India ($25^0$30'N latitude, $91^0$51'E longitude and 980 m msl) during rainy season (June to November) of 2009 and 2010. Soil samples were collected from the surface layer (0-15 cm) before treatment applications. The experimental field had pH 4.97, high in organic carbon (1.62%), low in available nitrogen (214.7 kg/ha) and phosphorus (7.21 kg P/ha) and medium in potassium (173.3 kg K/ha). The soil was sandy loam in texture. The experimental site (Umiam) is under a subtropical type of climate. The two years mean minimum and maximum temperature ranges from 12.1 to 20.5 and from 24.8 to 28.7°C, respectively, with a mean total rainfall of 1,774 mm received during the cropping season. The experiment was laid out in a split plot design with treatment combinations of three dates of transplanting *viz*., 6, 16 and 26^{th} July in main plot and five nutrient management practices *viz.*, control, 100% recommended dose (RD) of NPK (80: 26.2 : 33.3 kg/ha) through inorganic fertilizers (RDNPK), 50% RDNPK through inorganic fertilizers, 50% RDNPK through inorganic fertilizers + 50% RDNP through FYM and rockphosphate and 100% RDNP through FYM and rockphosphate in sub-plots. FYM contained 0.62% N, 0.15% P and 0.43% K and rockphosphate contained 7.9% P. Organic manures were applied on the basis of N-equivalent and phosphorus requirement was supplemented through rockphosphate. The combinations were replicated thrice. Thirty days old seedlings were transplanted with three seedlings per hill at a spacing of 20 cm × 15 cm. Entire dose of phosphorus (26.2 kg P/ha as single super phosphate) and potassium (33.3 kg K/ha as murate of potash) were applied as basal and incorporated into the soil uniformly in all treatments before transplanting. Fertilizer N in the form of urea was applied in three equal splits *i.e.*, $1/3^{rd}$ as basal, $1/3^{rd}$ at tillering, and $1/3^{rd}$ at panicle initiation stage (PI stage). Well decomposed FYM and rock phosphate were applied about 15 days before transplanting and incorporated during field preparation. Two hand weedings were given at 20 and 45 days after transplanting (DAT). All other recommended cultural practices for achieving maximum grain yield were followed.

Panicles from $1m^2$ were counted to determine the number of panicles/m^2. Plants were separated into straw and panicles. Panicles were threshed manually and filled spikelets were separated from unfilled spikelet by submerging them in tap water. Grain yield and straw yield were determined from net plot area within each plot and grain yield was adjusted to a moisture content of 0.14 g H_2O/g fresh weight. Formula for nitrogen use efficiency (NUE) used was (Yield of treated plot–yield of control plot)/Nitrogen applied (kg/ha). The field data obtained were pooled for two years and statistically analyzed using the F-test (Gomez and Gomez, 1984). Test of significance of the treatment differences was done on the basis of the t-test. The significant differences between treatment means were compared with the critical difference (CD) at a 5% level of probability (P=0.05). The difference between two treatment means which were higher than the respective CD values were considered as significant. No meaningful interactions were observed.

RESULTS AND DISCUSSION

Yield attributes

Different dates of transplanting of rice *viz*., 6, 16 and 26 July were found statistically different in terms of number of tillers/m^2, where 16 July transplanting recorded significantly higher number of tillers/m^2 than 6 and 26 July transplanting (Table 1). There was no significant effect of date of transplanting on panicles/m^2, filled grains/panicle, panicle length and test weight. However, 16 July transplanting produced comparatively higher number of panicles/m^2, filled grains/panicle, panicle length and test weight. Among the nutrient management practices, the integrated application of 50% RDNPK + 50% RDNP through FYM and rockphosphate produced maximum numbers of tillers/m^2, panicles/m^2, filled grains/panicle and panicle length which were at par with 100% RDNPK through inorganic and 100% RDNP through FYM and rockphosphate and found statistically superior to control. Further, 50% RDNPK through inorganic produced significantly higher number of tillers/m^2, panicles/m^2, filled grains/panicle and panicle length compared to control but remained statistically inferior to integrated application of 50% RDNPK + 50% RDNP through FYM and rockphosphate. Noorbakhshian (2003) reported that the delay in transplanting resulted reduced grain yield. Mirza *et al*. (2010) reported increase in number of tillers in rice plants due to integrated application of organic and inorganic. According to them more number of tillers per square meter might be due to the more availability of nitrogen, which plays a vital role in cell division.

Yields

The grain yield of aromatic rice was significantly higher with 16 July transplanting (3.91 t/ha) compared to 26 July (3.76 t/ha) and 6 July transplanting (Table 2). Integrated application of organic manures along with inorganic fertilizer had significant effect on yield of rice. Among the various nutrient sources, 50% RDNPK through inorganic + 50% RDNP through FYM and rockphosphate, registered the highest grain yield (4.68 t/ha) compared to control, 50% RDNPK through inorganic alone, 100% RDNP through FYM and rockphosphate as well as 100% RDNPK through inorganic only. This significant response might be due to the enhanced nutrient availability to the crop by the application of organic manures in combination with inorganic fertilizers. The application of 50% RDNPK through inorganic alone, 100% RDNP through FYM and rockphosphate and 100% RDNPK through inorganic only registered statistically similar grain yields with each other and remained significantly superior to control. Straw yield and harvest index were not influenced by different dates of transplanting, though the 16 July transplanting recorded higher straw yield and harvest index. Different nutrient sources have shown significant influence on straw yield and harvest index of rice. Higher straw yield and harvest index were observed with 50% RDNPK through inorganic + 50% RDNP through FYM and rockphosphate and found significantly superior to 50% RDNPK through inorganic

Table 1. Effect of nutrient sources and dates of transplanting on growth and yield parameters of rice

Treatment	Tillers/m^2	Panicles/m^2	Filled grains/ panicle	Panicle length (cm)	Test weight (g)
Date of transplanting					
6 July	234.5	213.8	107.3	25.5	31.0
16 July	248.4	217.1	110.1	25.7	31.7
26 July	232.8	214.9	108.0	25.5	31.2
SEm±	2.78	8.51	2.25	0.28	0.60
CD (P=0.05)	10.86	NS	NS	NS	NS
Nutrient sources					
50% RDNPK through inorganic + 50% RDNP through FYM and RP	262.9	242.0	117.6	26.3	32.3
100% RDNPK through inorganic	256.1	227.0	115.6	25.9	31.3
50% RDNPK through inorganic	229.8	208.3	105.5	25.4	30.4
100% RDNP through FYM and RP	247.2	224.1	112.5	26.1	31.5
Control	197.0	173.7	91.0	24.2	29.8
SEm±	5.86	5.84	2.82	0.30	0.58
CD (P=0.05)	17.11	17.08	8.32	0.88	NS

Table 2. Effect of nutrient sources and dates of transplanting on grain and straw yield, harvest index and economics

Treatment	Grain yield (t/ha)	Straw yield (t/ha)	Harvest index (%)	Net returns (×10^3₹/ha)	B:C ratio
Date of transplanting					
6 July	3.57	4.97	41.0	12.25	1.53
16 July	3.91	5.12	42.8	15.70	1.67
26 July	3.76	5.07	41.9	14.15	1.61
SEm±	0.050	0.105	0.27	-	-
CD (P=0.05)	0.197	NS	1.06	-	-
Nutrient sources					
50% RDNPK through inorganic + 50% RDNP through FYM and RP	4.68	5.49	46.0	21.32	1.84
100% RDNPK through inorganic	4.35	5.39	44.7	21.13	1.94
50% RDNPK through inorganic	3.28	4.80	40.6	11.82	1.57
100% RDNP through FYM and RP	4.28	5.33	44.5	14.17	1.50
control	2.14	4.22	33.7	1.77	1.09
SEm±	0.047	0.071	0.44	-	-
CD (P=0.05)	0.140	0.206	1.29	-	-

alone and control and at par with 100% RDNPK through inorganic alone and 100% RDNP through FYM and rockphosphate. Improved physico-chemical characteristics of the soil due to integrated application of FYM and inorganic fertilizer possibly resulted in better nutrients availability than others that produced higher biomass and grain yield. Siavoshi *et al*. (2011) also reported maximum grain yield of rice with integrated application of chemical fertilizer and organic manure.

Economics

Among the date of transplanting, 16 July produced maximum net returns than other dates of transplanting. Benefit cost ratio was also recorded maximum in 16 July transplanting (Table 2). The higher returns in 16 July transplanting was due to significantly higher grain yield compared to other dates of transplanting. The net returns were recorded maximum with 50% RDNPK through inorganic + 50% RDNP through FYM and rockphosphate followed by 100% RDNPK through inorganic alone. These results are in conformity with the findings of Virda and Mehta (2010).

Total N, P and K uptake

The total uptake of N was recorded significantly higher in 16 July transplanting compared to 6 and 26 July (Table 3). However, transplanting dates did not show any significant influence on P and K uptake of rice. Among the nutrient management practices, the N, P and K uptake with 50% RDNPK through inorganic + 50% RDNP through FYM and rockphosphate was significantly higher than all other sources. This might be due to initial quick availability of nutrients from inorganic, and later from organic source leading to an overall higher nutrient uptake (Das and Sinha, 2004). The N, P and K uptake with 100% RDNPK through inorganic was the next highest which was statistically similar to100% RDNP through FYM and rockphosphate but remained superior to 50% RDNPK through inorganic alone and control. Pandey *et al.* (2001) reported that combined used of organic and inorganic fertilizers found significantly better than inorganic fertilizers alone for grain and straw N uptake.

Table 3. Effect of nutrient sources and date of transplanting on total N, P and K uptake by rice

Treatment	Nutrient uptake (kg/ha)		
	N	P	K
Date of transplanting			
6 July	87.5	15.8	98.2
16 July	93.9	17.8	103.3
26 July	91.3	16.8	102.0
SEm±	1.20	0.40	1.92
CD (P=0.05)	4.70	NS	NS
Nutrient sources			
50% RDNPK through inorganic + 50% RDNP through FYM and RP	113.2	22.6	120.7
100% RDNPK through inorganic	102.8	19.4	111.9
50% RDNPK through inorganic	81.3	13.3	94.5
100% RDNP through FYM and RP	101.6	19.2	111.2
control	55.7	9.6	67.4
SEm±	1.08	0.49	1.31
CD (P=0.05)	3.14	1.43	3.82

Soil fertility and nitrogen use efficiency

Different dates of transplanting did not show any significant effect on soil fertility in terms of pH, organic carbon, available N, P, K and SMBC (Table 4). However, various nutrient sources had significant effect on soil parameters. Significantly higher pH (5.17), available N (261.5 kg/ha), available P (23.1 kg/ha) and available K (252.3 kg/ha) were recorded with 50% RDNPK through inorganic + 50% RDNP through FYM and rockphosphate over control and 50% RDNPK through inorganic alone. Increase in available N and P might be due to the direct addition of N through FYM and improved microbial activities, which might have converted organically bound N to inorganic forms. Increase in P availability might be due to the fact that organic materials form a cover on sesquioxides and thus reduce the phosphate fixing capacity of the soil and increased phosphorus solubilization for the native soil pool. The benefit of using organic manure like FYM was due to release of aliphatic and aromatic hydroxy acids and humates that leads to higher availability of nutrients. The rockphosphate further adds to the P pool of soil. The results corroborate with the similar findings of Das and Sinha (2004). In terms of soil organic carbon, there was no significant effect of nutrient sources though 100% RDNP through FYM and rockphosphate recorded relatively higher organic carbon content (1.82%). Soil microbial biomass carbon (SMBC) was recorded significantly higher with 100% RDNP through FYM and RP (215.1 µg g^{-1} soil) followed by 50% RDNPK through inorganic + 50% RDNP through FYM and RP (199.2 µg g^{-1} soil). Nitrogen use efficiency (NUE) was recorded maximum with 16 July followed by 26 and 6 July transplanted crop, which were statistically non-significant (Table 4). Among the nutrient sources, significantly highest NUE was recorded with 50% RDNPK through inorganic + 50% RDNP through FYM and rockphosphate followed by 100% RDNPK through inorganic aloneand 50% RDNPK through inorganic + 50% RDNP through FYM and RP. The lowest NUE was recorded with 50% RDNPK through inorganic alone.The results corroborate the findings of Satyanarayana *et al*. (2002).

Table 4. Effect of nutrient sources and date of transplanting on post-harvest pH, soil organic carbon, available N, P and K, SMBC and nitrogen use efficiency (NUE)

Treatment	pH	Soil organic carbon (%)	Available nutrients (kg/ha)			SMBC ($\mu g\ g^{-1}$ soil)	NUE (kg grain/kg N applied)
			N	P	K		
Date of transplanting							
6 July	5.09	1.65	237.5	18.9	236.3	166.1	18.5
16 July	5.10	1.64	238.9	22.1	226.2	169.4	21.1
26 July	5.07	1.77	238.5	20.8	234.9	167.7	20.5
SEm±	0.02	0.05	1.17	0.41	2.98	1.30	0.98
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS
Nutrient sources							
50% RDNPK through inorganic + 50% RDNP through FYM and RP	5.17	1.77	261.5	23.1	252.3	199.2	32.0
100% RDNPK through inorganic	5.13	1.77	251.9	21.7	244.8	171.0	27.5
50% RDNPK through inorganic	5.05	1.70	219.2	18.2	217.3	161.3	14.5
100% RDNP through FYM and RP	5.08	1.81	252.2	22.3	248.1	215.1	26.5
control	4.99	1.55	210.6	17.9	204.9	100.2	
SEm±	0.02	0.09	1.32	0.75	4.80	4.95	0.81
CD (P=0.05)	0.06	NS	3.91	2.22	14.02	14.70	2.39
Initial	4.97	1.62	214.7	16.5	208.0	104.7	

Thus, it could be concluded that optimum transplanting date for achieving higher yield of newly released aromatic variety ‘Megha AR-2’ at mid altitude of Meghalaya is 16 July. Application of 50% recommended dose of NPK through fertilizers and remaining 50% RDNP through FYM and RP is a recommendable option for higher rice productivity and income.

REFERENCES

Bruns, H.A. and Abbas, H.K. 2006. Planting date effect on Bt and non-Bt corn in the mid-south USA. *Agronomy Journal* **98**: 100–06.

Das, T. and Sinha, A.C. 2004. Effect of organic materials and levels of nitrogen on yield attributes and yield of rice (*Oryza sativa* L.) under Terai region of West Bengal. *Environment and Ecology* **22**(2): 362–65.

Groth, D.E. and Lee, F.N. 2003. Rice disease. (In:) Rice: Origin, history, technology and production. C.W. Smith and R.H. Dilday (Ed.) John Wiley and Sons, Hoboken, New Jersey. pp. 413–16.

Gomez, K.A. and Gomez, A.A. 1984. Statistical Procedures for Agricultural Research, 2nd Edn.Wiley, New York.

Harper, F.1983. Principles of arable crop production. Canada, London, U.K.

Miller, H.B. 2007. Poultry litter induces tillering in rice. *Journal of Sustainable Agriculture* **31**: 1–12.

Mirza, Hasanuzzaman, K.U., Ahamed, N.M., Rahmatullah, N., Akhetar, K.N. and Rahman, M.J. 2010. Plant growth characters and productivity of wetland rice (*Oryza sativa* L.) as affected by application of different manures. *Emirates Journal of Food and Agriculture* **22**(1): 46–58.

Noorbakhshian, S.G. 2003. Effect of seed rate, planting date in nursery and transplanting date on yield and yield components of rice (Koohrang cultivar). *Iranian Journal of Crop Science* **5**(4): 261–72.

Pandey, N., Upadhyay, S.K., Joshi, B.S. and Tripathi, R.S. 2001. Integrated use of organic manures and inorganic fertilizers for the cultivation of low land rice in vertisol. *Indian Journal of Agricultural Research* **35**(2): 112–14.

Sarkar, M.A.R., Pramanik, M.Y.A., Faruk, G.M. and Ali, M.Y. 2004. Effects of green manures and levels of nitrogen on some growth attributes of transplant aman rice. *Pakistan Journal of Biological Sciences* **7**: 739–42.

Satyanarayana, V., Varaprasad, P.V., Murthy, V.R.K. and Boote, K.J. 2002. Influence of integrated use of farm yard manure and inorganic fertilizers on yield and yield components of irrigated lowland rice. *Journal of Plant Nutrition* **25**(10): 2081–90.

Siavoshi, M., Nasiri, A. and Laware, S.L. 2011. Effect of organic fertilizer on growth and yield components in rice (*Oryza sativa* L.). *Journal of Agricultural Sciences* **3**(3): 217–23.

Virdia, H.M. and Mehta, H.D. 2010. Integrated nutrient management in transplanted rice (*Oryza sativa* L). *International Journal of Agricultural Sciences* **5**(1): 295–99.

Yoshida, S. 1981. Fundamentals of rice crop science. International Rice Research Institute, Los Banos, Laguna, Pilippines, pp. 94–110.