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Response of rice varieties to different establishment methods under system of aerobic rice production

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ABSTRACT

A field investigation on response of rice varieties to different establishment methods under system of aerobic rice production was carried out at Orissa University of Agriculture and Technology, Bhubaneswar during wet season of 2012. Among the varieties, aerobic rice Pyari, proved superior with higher yield of grain and straw, and net return compared to other two varieties. With regards to methods of establishment, the yield of grain and straw and net returns were higher under aerobic transplanting with crop geometry of 20 cm x 20 cm. It also recorded higher values of yield attributing characters, leaf area index, nutrient uptake and field water use efficiency.

Key words: *aerobic rice, spot seeding method, aerobic transplanting*

Aerobic rice culture is an emerging technology designed to enhance water productivity in rice production needing less water compared to low land rice. The crop is grown like other upland irrigated dry crops. The soil thus, remains aerated throughout its growing season compared to anaerobic flooded condition. Lafittee *et al*. (2002) termed this system of rice cultivation with provision of irrigation as aerobic rice. Many low land high yielding varieties are not well suited for such aerobic system of cultivation (Lafittee *et al*., 2002), and since the manipulation of genetic behavior adaptable to aerobic condition is a long term strategy, testing of available high yielding varieties under such ecosystem becomes imperative. Further, crop establishment methods differ markedly and are highly dependent on soil moisture regime. As the aerobic rice concept targets upland with irrigation supplement to rainfall, and low land having insufficient water to support flooded rice, the present study was undertaken during wet season.

The experiment was conducted during wet season of 2012 at Orissa University of Agriculture and Technology, Bhubaneswar on sandy loam soil. Crop received a total of 967.9 mm rain in 77 rainy days. The soil of the experimental field contained 0.39% organic carbon, 5.90 pH (1:2.5 soil and water ratio) and 215, 24 and 88 kg available N, P and K ha^{-1}, respectively. The experiment was laid out in a split plot design with four replications having main plots comprising of varieties Jyotirmayee, Naveen and Pyari, and five sub plots such as direct seeding in 20 cm apart rows, spot seeding at 20 cm x 20 spacing, spot seeding method (25 cm x 25 cm), aerobic transplanting (20 cm x 20 cm) and aerobic transplanting (25 cm x 25 cm). A well pulverized seed bed was prepared for all the treatments. In direct seeding treatment *i.e.* direct seeding in 20 cm apart rows, the seeds were sown manually in lines directly in 20 cm apart rows. In case of spot seeding (spot seeding at 20 cm x 20 spacing and spot seeding method (25 cm x 25 cm), 2-3 seeds $hill^{-1}$ were dibbled manually. In aerobic transplanting, the field was prepared thoroughly without puddling operation but irrigation was provided one day before transplanting for easier planting operation. One seedling of twelve day old at two leaf stage was transplanted under aerobic transplanting (20 cm x 20 cm) and aerobic transplanting (25 cm x 25 cm) treatments. Crop was irrigated during the growth period as a supplement to rainfall and was fertilized with a uniform dose of 80-17-33 kg N, P and K ha^{-1}. All P and K along with 25% N and FYM @ 5 t ha^{-1} were applied as basal and remaining N was applied in two

splits *i.e* 50 % at tillering and 25% at PI stage. Water requirement and field water use efficiency was worked out as per standard methods.

Study revealed that variety Naveen and Pyari produced significantly the tallest plant (110 cm, 108 cm, respectively) as compared to Jyotirmayee (91cm).The difference in height between Pyari and Naveen was at part. Plant height due to methods of establishment also did not differ significantly. However, at harvest, plants were the taller (107 cm) when seeded directly in 20 cm apart rows as compared to other methods of establishment. Such variation in plant height can be attributed to inner plant competition towards solar radiation that arises due to genetic makeup and establishment environment. Leaf area index (LAI) at 50% flowering was higher in the aerobic variety Pyari (5.37) compared to Jyotirmayee (4.69) and Naveen (5.25). Bouman *et al.* (2006) also reported low leaf area index in lowland variety JD 305 compared to aerobic variety HD 502. Among the methods of planting, aerobic transplanting with 20 cm x 20 cm spacing recorded highest leaf area index (5.29) at 50% flowering over direct seeding treatment (4.72) but with other methods it remained statistically at par.

Yield attributing characters varied with variety and variety Pyari recorded significantly higher ear bearing tiller (EBT) of 405 m^{-2}, panicle length (24.7cm) and no. of filled grains $panicle^{-1}$(104) over variety Jyotirmayee. Similar significant difference among the varieties under aerobic condition has also been reported by Lampayan *et al.* (2011).With regards to methods of establishment, aerobic transplanting at 20 cm x 20 cm recorded significantly more EBT (409 m^{-2}) over direct seeding in rows and spot seeding (spot seeding method 25 cm x 25 cm). Similarly, it also produced significantly the longest panicle (24.8 cm) with higher number of grains (108) over direct seeding in 20 cm apart rows, spot seeding at 20 cm x 20 spacing and spot seeding method (25 cm x 25 cm). Highest total uptake of nitrogen and phosphorus was associated with Naveen while in case of Pyari, higher Potash uptake was noticed. Similar cultivar based nutrient accumulation has also been reported by *Katsura et al* (2010). Among the methods of establishment, the treatment aerobic transplanting (20 cm x 20 cm) harvested more of N and P while removal of K was marginally higher in treatment spot seeding at 20 cm x 20 spacing. Minimum removal of nutrient was noticed with treatment direct seeding in 20 cm apart rows. Similar result was also reported by Yadav *et al*, (2009).

Significantly the highest grain yield was recorded with aerobic variety Pyari (4.55 t ha^{-1}) closely followed by Naveen (4.45 t ha^{-1}). Both the varieties showed significant yield advantage of 16.4 and 13.8%, respectively over the variety Jyotirmayee (3.91 t ha^{-1}). Veeresh *et al.* (2008) also reported higher grain yield with aerobic rice MAS 26 compared to lowland varieties. Among the varieties, both Naveen and Pyari recorded higher straw yield (7.6 t ha^{-1}) than that of Jyotirmayee (6.73 t ha^{-1}). The harvest index remained unaffected due to the varieties.

Table 1. Yield attributing characters as affected by variety and methods of establishment under SARP

Variety	Plant height (cm)	EBT m^{-2}	Panicle length (cm)	Filled grain $panicle^{-1}$	Unfilled grain $panicle^{-1}$	1000 grain weight (g)	WR (cm)	FWUE (kg/ha-cm)
Jyotirmayee	91	372	22.2	97	29.5	22.9	51.2	76.4
Naveen	110	394	23.5	101	27.0	21.2	66.1	72.7
Pyari	108	405	24.7	104	25.0	22.0	65.6	74.8
CD(P<0.05)	9	20	0.90	4	1.05	0.71	-	-
Method of establishment								
DS 20 cm R to R	107	369	22.2	89	30.0	21.2	55.4	64.2
SS (20 cm x 20 cm)	103	401	23.5	103	27.0	21.9	55.5	75.8
SS (25 cm x 25 cm)	100	380	22.9	99	30.2	22.1	55.6	69.1
ATP (20 cm x 20cm)	104	409	24.8	108	24.7	22.5	61.4	86.8
ATP (25 cm x 25cm)	102	394	24.1	106	24.0	22.6	60.8	75.7
CD(P<0.05)	NS	23	0.99	4	1.45	0.97	-	-

Method of establishment was found to exert noticeable influence on crop yield and the method aerobic transplanting with spacing of 20 cm x 20 cm recorded significantly the highest grain yield (5.33 t ha^{-1}). Lowest yield was observed in case of direct seeding (3.56 t ha^{-1}).The harvest index was significantly highest in aerobic transplanting (20 cm x 20 cm) than all other treatments. Sridhara *et al*. (2011) reported that although the crop plants have ability to modify and adapt to the environment in which they grow, planting geometry has significant influence on growth and yield of aerobic rice. Square transplanting with 20 cm x 20 cm spacing might have provided the environment with continuous availability of nutrients, higher carbohydrate synthesis and its translocation to the yield attributing points as reported by Sonjui *et al* (1990). Further, Wells and Faw (1978) observed that dense population due to decreased light interception and CO_2 accumulation limits the rice yield. This might be the cause of low yield obtained under direct seeding in rows. Further, among the direct seeding methods, sowing of seeds through dibbling (spot seeding method- average of spot seeding at 20 cm x 20 spacing and spot seeding method 25 cm x 25 cm) showed its superiority with respect to grain yield (4.03 t ha^{-1}) over direct seeding in rows by a margin of 13.2%. However, when the comparison was made between direct seeded and aerobically transplanted rice, the yield advantage (average of aerobic transplanting 20 cm x 20 cm & aerobic transplanting 25 cm x 25 cm) was to the tune of 39.2 and 23.0 %, over direct seeding in 20 cm apart rows and average of spot seeding at 20 cm x 20 spacing and spot seeding method (25 cm x 25 cm) respectively. The straw yield was also the highest in aerobic transplanting with a spacing of 20 cm x 20 cm (7.60 t ha^{-1}) and lowest in direct seeding with 20 cm row spacing (6.66 t ha^{-1}). Similar trend has also been reported by Jagtap *et al* (2012). As aerobic transplanting resembles SRI except in soil condition and water regime, it could harness the advantage of more space and sunlight. Interaction between variety and methods was insignificant and indicates that method of establishment was variety neutral.

Table 2. Yield of grain and straw, HI economics and nutrient uptake as affected by variety and methods of establishment.

Variety	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index	LAI	Cost of cultivation (x 10^3 ₹ ha^{-1})	Net return (x 10^3 ₹ ha^{-1})	Total nutrient uptake, kg ha^1		
							N	P_2O_5	K_2O
Jyotirmayee	3.91	6.73	36.7	4.69	29.0	19.3	63.72	14.05	114.56
Naveen	4.45	7.60	36.9	5.25	31.2	23.8	72.32	15.78	132.21
Pyari	4.55	7.60	37.4	5.37	31.8	24.3	71.57	15.27	137.69
CD(P<0.05)	0.41	0.69	NS	0.42	0.97	4.68			
Method of establishment									
D S (20 cm R to R)	3.56	6.66	34.8	4.72	28.0	16.5	55.90	12.38	115.63
SS (20 cm x 20 cm)	4.21	7.37	36.4	5.25	32.6	20.0	72.01	14.67	134.08
SS (25 cm x 25 cm)	3.84	7.19	34.8	5.11	31.1	16.8	64.49	13.29	129.55
ATP (20 cm x 20cm)	5.33	7.60	41.3	5.29	31.9	32.7	85.74	18.73	133.63
ATP (25 cm x 25 cm)	4.58	7.30	38.6	5.14	29.9	26.4	78.00	15.93	126.71
CD(P<0.05)	0.50	0.71	3.95	0.43	1.08	5.14			

The cost of cultivation was the lowest (₹ 28,000/-) under direct seeding. It increased by 16.4, 11.1, 13.9 and 6.8 % in spot seeding (20 cm x 20 cm), spot seeding (25 cm x 25 cm), aerobic transplanting (20 cm x 20 cm) and aerobic planting (25 cm x 25 cm), respectively. Variety Pyari gave highest net return (₹ 24,300/-) Economic indices further indicated that aerobic transplanting with spacing 20 cm x 20 cm recorded the highest net returns of ₹ 32,700/-. Water requirement was the highest and almost identical with Naveen (66.1 cm) and Pyari (65.6 cm) while Jyotirmayee recorded the highest field water use efficiency (76.4 kg ha-cm). Among the methods water requirement (61.4 cm) and field water use efficiency (86.8 kg ha-cm) was the highest with treatment aerobic transplanting (20 cm x 20 cm).

Based on one year study, it may be concluded that aerobic rice variety Pyari is superior to high yielding varieties Naveen and Jyotirmayee, and aerobic transplanting (20 cm x 20 cm) is better than other methods of establishment under system of aerobic rice production (SARP).

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