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Research Paper

Effect of establishment methods on aromatic rice (*Oryza sativa*) genotypes in lower Gangetic plains of West Bengal

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ABSTRACT

A field experiment was conducted at Jaguli, Nadia, West Bengal, India, during the rainy (*kharif)* season of 2016, to study the response of four aromatic (*Oryza sativa* L.) rice genotypes ('Gobindabhog', 'Radhunipagal', 'Tulaipanji' and 'Kalonunia') under 3 establishment methods [conventional planting, drum seeding and modified system of rice intensification (SRI)].The plants raised under modified SRI showed the maximum plant height at harvesting (136.7 cm), tiller production (298/m^2) at 63 days after transplanting (DAT), and dry-matter production at 33 DAT (194 g/m^2/day) and 63 DAT (444 g/m^2/day). Conventional planting resulted in the highest grain yield (2.24 t/ha), head rice recovery (HRR) (55.2%) and net income (₹32,593/ha), which were greater over the modified SRI (2.09 t/ha, 53.5% and ₹30,901/ha) and drum seeding method (2.0 t/ha, 53.2% and ₹32,192/ha). 'Gobindabhog' had the highest grain yield (2.35 t/ha), HRR (56.5%), net income (₹39,754/ha) and benefit: cost (B:C) ratio (2.13) compared to the other genotypes; but 'Kalonunia' might be tried as a second option in New Alluvial Zone of West Bengal.

***Key words*:** Aromatic rice, Cultivar, Establishment method, Growth, Quality, Yield

The state of West Bengal has precious wealth of genetic diversity in aromatic rice (Shobharani and Krishnaiah, 2001). Among such non-basmati type scented rices, 'Gobindabhog', 'Tulaipanji', 'Kalonunia', 'Radhunipagal', 'Badshabhog', 'Kataribhog', etc. are popular in domestic market owing to their different end-uses like cooked table rice, pulse-mixed rice (*bhog*), dessert (*payesh)*, *pulao*, *biryani*. It is estimated that such scented rices occupy about 0.1 million ha land in West Bengal during the rainy (*kharif*) season (Adhikary *et al*., 2011). The cultivation of some potential scented rices have been promoted in recent times owing to recommendation for export of Gobindabhog and Tulaipanji rice by Parliament of India in 2011 (Rajya Sabha, 2011).

Manual transplanting in puddled condition is a routine method of rice cultivation in West Bengal.Transplanted puddled rice require large amount of water, labour and other resources (Babu *et al*., 2014), which are becoming increasingly scarce and expensive. In the context, alternative approaches like direct seeding of pre-germinated (sprouted) paddy seeds in the main field by drum seeder, or system of rice intensification (SRI) may be tested for sustaining the productivity of transplanted rice with reduction of labour cost and water (Sato and Uphoff, 2007). The present study was undertaken to find out the appropriate crop establishment method(s) for better growth, yield, quality and economics of potential traditional aromatic rice cultivars during rainy (*kharif*) season in New Alluvial Zone of West Bengal.

A field experiment was conducted at the Instructional Farm (22°93' N, 88°53' E and 9.75 m altitude) of the Bidhan Chandra KrishiViswavidyalaya (BCKV), Jaguli, Nadia, West Bengal, India during the rainy (*kharif)* season of 2016. The soil of the field was clay-loam (Order inceptisols), neutral in reaction (*p*H 7.0), low in organic carbon (0.53%), available nitrogen (200.9 kg/ha), phosphorus (37.5 kg/ha) and potassium (180.2 kg/ha). The experiment was laid out in a split-plot design with 3 replications, which consisted of 3 crop-establishment methods (C_1, Conventional planting; C_2, direct seeding by drum seeder; C_3, modified SRI) in main plots and 4 traditional aromatic rice cultivars (V_1, 'Gobindabhog', V_2, 'Radhunipagal', V_3, 'Tulaipanji', V_4, 'Kalonunia') in subplots. Pre-germinated seeds of 4 rice genotypes were sown in the experimental

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field at a spacing of 20 cm × 20 cm with the help of drum seeder; while 12 days and 24 days old seedlings @ 2–3/hill were transplanted manually at the same spacing in the main field under modified SRI and conventional system respectively. A uniform nutrient dose comprising farmyard manure (FYM) @ 5 t/ha and inorganic fertilizers @ 40 : 20 : 20 (N: P_2O_5: K_2O) kg/ha were given in all the experimental plots. Two hand-weedings were done at 20 and 40 days after transplanting (DAT) in conventional and modified SRI plots, while at 30 and 50 days after sowing (DAS) in drum-seeding plots. Irrigation was given in drum seeding and conventional plots at shallow depth (2–5 cm) whenever required based on south-west monsoon rainfall and crop age, while the soil of SRI plots was kept moist through rainfall and light irrigation during the entire cropping period. The growth attributes of scented rice like plant height, tillering habit, dry-matter (DM) production at different stages were noted, while yield components and grain yield were determined at maturity. The grain-quality parameters like head-rice recovery (Rice milling unit, Satake make, Japan), gelatinization temperature by alkali digestibility test (Little *et al.,* 1958) and aroma (Nagaraju *et al*., 1991) were determined at Aromatic Rice Laboratory of BCKV, and the economics of cultivation was calculated as per local rates. The data obtained in the study were analyzed using 'Analysis of Variance' technique (ANOVA) following standard statistical procedures (Gomez and Gomez, 1984).

The plants grown under modified SRI exhibited the maximum plant height at maturity and produced the highest number of tillers/m^2 at 75 DAS (Table 1). It could be explained by the fact that planting of 12-day-old younger seedlings under modified SRI method favoured the tillering habit of all 4 varieties compared to the crop raised with 24-day-aged seedlings under conventional planting (C_1) and with the pre-germinated seeds by drum-seeding method (C_2) in lowland condition during the rainy (*kharif*) season. Similar finding was also reported by Duttarganvi *et al.* (2016), wherein SRI resulted in greater number of tillers/m^2 than mechanical and normal transplanting at Hyderabad, India. Although the variation in tiller number/unit area among 4 genotypes was found significant at 75 DAS only, 'Gobindabhog' produced the maximum number of tillers/m^2 throughout the cropping period. The crop raised under modified SRI (C_3) accumulated the highest dry matter (DM) in unit area at 33 DAT and 63 DAT, being at par with conventional planting (C_1) at respective stages. Although no significant variation in DM yield was noted among the cultivars at 45 DAS, 'Gobindabhog' recorded the maximum DM yield at 75 DAS, while 'Tulaipanji' the lowest value (383 g/m^2) in the study.

The maximum panicles/m^2 were noted with modified SRI, being at par with conventional manual planting method, which was significantly greater over direct sowing in main field by drum seeder. The filled grains/panicle were not significantly influenced by 3 rice-establishment methods adopted in the investigation. 'Gobindabhog' recorded the highest number of panicles in 1 m^2 area, while

Table 1. Effect of crop establishment method and genotype on growth attributes and yield of traditional aromatic rice of West Bengal during rainy (*kharif)* season

Treatment	Plant height at harvest (cm)	Tillers/m^2		Dry matter accumulation (g/m^2)		Panicles/m^2	Filled grains/panicle	1,000-grain weight (g)	Grain yield (t/ha)
		45 DAS	75 DAS	45 DAS	75 DAS				
Establishment method									
C_1, Conventional planting	120.4	235	285	189	433	282	108.8	12.46	2.24
C_2, Direct seeding by drum seeder	130.5	251	267	182	357	248	106.3	11.95	2.01
C_3, Modified SRI	136.7	243	298	194	444	285	102.6	11.97	2.09
SEm±	1.64	7.2	5.2	1.5	3.9	4.5	2.14	0.08	0.04
CD (P=0.05)	6.59	NS	21.1	5.9	15.8	18.0	NS	0.32	0.16
Genotype									
V_1, Gobindabhog	125.5	253	300	189	442	283	115.4	10.17	2.35
V_2, Radhunipagal	135.7	234	274	187	386	270	111.8	10.03	2.02
V_3, Tulaipanji	119.7	241	283	187	383	260	92.7	15.22	1.89
V_4, Kalonunia	135.6	243	276	189	434	274	103.8	13.08	2.18
SEm±	1.52	7.1	6.4	1.9	11.3	4.9	1.88	0.13	0.05
CD (P=0.05)	4.54	NS	18.4	NS	33.9	14.5	5.62	0.40	0.14

***** 45, 75 and 105 DAS for drum seeding are equivalent to 21, 51 and 81 DAT for conventional planting and 33, 63 and 93 DAT for modified SRI

'Tulaipanji' had the lowest value at maturity. However, 4 traditional aromatic rice cultivars could be arranged with regard to filled grains/panicle as 'Gobindabhog' > 'Radhunipagal' > 'Kalonunia' > 'Tulaipanji' (Table 1). Conventional planting with 24-day-old rice seedlings in the main field (C_1) resulted in the maximum test weight of grains, which was significantly greater over modified SRI and drum seeding method. Test weight, being a genetical character, differed significantly among 4 scented rice landraces with a range between 10.17 g 'Radhunipagal' and 15.22 g 'Tulaipanji' in our study.

Conventional planting resulted in the highest grain yield (2.24 t/ha), being at par with modified SRI (2.09 t/ha), but significantly greater over drum-seeding method (2.01 t/ha). Among 4 aromatic rice landraces, 'Gobindabhog' yielded highest, which was 0.17, 0.33, and 0.46 t/ha greater over 'Kalonunia', 'Radhunipagal', and 'Tulaipanji' respectively. Saha *et al*. (2017) also reported that, conventional transplanting of aromatic rice (cv. 'Pusa Sugandha') recorded the highest grain yield being at par with SRI, but significantly greater over aerobic rice at New Delhi, India.

The aromatic rice plants raised under conventional transplanting system (C_1) resulted in maximum HRR, which was significantly greater than both modified SRI and drum seeding method (Table 2). However, Prathiksha *et al*. (2017) reported that, crop-establishment methods could not influence the hulling, milling and head-rice recovery of rice (cv. 'BPT 5204') in Telengana, India. 'Gobindabhog' had the highest head-rice yield (56.5%), closely followed by 'Radhunipagal', while 'Tulaipanji' recorded the lowest HRR in the study. No significant variation was found in alkali-spreading value (ASV) and intensity of aroma among the 3 crop-establishment methods during wet (*kharif)* season. Three aromatic rice genotypes 'Radhunipagal', 'Kalonunia' and 'Gobindabhog' recorded >4.0 alkali value, so they might be categorized to intermediate gelatinization temperature (GT); while 'Tulaipanji' belonged to high-intermediate or intermediate GT (ASV 3.7). With regard to aroma in milled rice, 4 traditional aromatic rice cultivars could be arranged as: 'Kalonunia' (score 2.2) > 'Radhunipagal' (score 2.1) > 'Gobindabhog' (score 1.8) > 'Tulaipanji' (score 1.7).

Although the common cost of cultivation was same (₹26,826/ha) for all 3 crop- establishment methods, but total cost of production varied among the methods due to the cost of seeds, expenses related to preparation and management of wet nursery, direct sowing or transplanting in main field, irrigation, etc. The total cost of cultivation for raising traditional aromatic rice was estimated as ₹37,691, ₹31,914 and ₹36,204/ha under conventional planting, modified SRI and drum-seeding method respectively. Conventional planting method (C_1) recorded the maximum net return (₹32,593/ha) which was ₹401/ha and ₹1,692/ha greater over drum seeding and modified SRI, respectively. On the contrary, Duttarganvi *et al.* (2016) reported that, SRI recorded 93.2 and 45.8% higher net income over normal and mechanical transplanting, respectively, at Hyderabad, India. The crop raised by drum-seeding method (C_2) recorded the highest benefit: cost (B:C) ratio (1.93) owing to non-requirement of costs related to preparation and management of wet nursery along with transplanting of seedlings in the main field compared to the

Table 2. Effect of crop-establishment method and genotype on grain quality and economics of traditional aromatic rice of West Bengal during rainy (*kharif*) season

Treatment	Head rice recovery (%)	Alkali value (score)	Aroma (score)	Cost of cultivation (₹/ha)	Gross return (₹/ha)	Net income (₹/ha)	Benefit: cost ratio
Establishment method							
C_1, Conventional planting	55.5	4.4	2.0	37,691	70,284	32,593	1.86
C_2, Direct seeding by drum seeder	53.2	4.4	2.1	31,914	64,106	32,192	2.01
C_3, Modified SRI	53.5	4.0	1.9	36,204	67,105	30,901	1.85
SEm±	0.19	0.19	0.06				
CD (P=0.05)	0.78	NS	NS				
Genotype							
V_1, Gobindabhog	56.5	4.3	1.8	35,113	74,866	39,753	2.14
V_2, Radhunipagal	56.0	4.7	2.1	35,113	60,242	25,130	1.72
V_3, Tulaipanji	51.4	3.7	1.7	35,563	68,891	33,328	1.94
V_4, Kalonunia	52.4	4.4	2.2	35,289	64,660	29,371	1.84
SEm ±	0.62	0.15	0.06				
CD (P=0.05)	1.87	0.44	0.18				

Intensity of aroma (score): 1, mild; 2, medium; and 3, strong, Price of grain: 'Gobindabhog' (₹25/kg), 'Radhunipagal' (₹22/kg), 'Tulaipanji' (₹28/kg), 'Kalonunia' (₹22/kg), Price of straw: 'Gobindabhog', 'Radhunipagal', 'Tulaipanji' and 'Kalonunia' (₹2.50/kg)

other 2 planting systems (C_1 and C_3) in the investigation. Based on net income and B: C ratio, 4 aromatic rice landraces tested in the study could be arranged as: 'Gobindabhog' > 'Tulaipanji' > 'Kalonunia' > 'Radhunipagal'.

Thus, it could be concluded that conventional planting of traditional scented rice resulted in the highest grain yield, maximum head rice recovery and greater net income compared to modified SRI and drum seeding during the rainy (*kharif)* season. Among the 4 aromatic rice genotypes, 'Gobindabhog' performed best with the highest grain yield, HRR and net income, but 'Kalonunia' might be a second option owing to its medium yield potentiality and slightly better medium aroma in New Alluvial Zone of West Bengal.

REFERENCES

Adhikary, B., bhowmick, M.K., Haldar, A. and De, S. 2011. Cultivation of aromatic rice in West Bengal during *aman* season (in Bengali). *Saar Samachar* **49**(2): 33–39.

Babu, S., Singh, R., Avasthe, R.K., Yadav, G.S. and Chettri, T.K. 2014. Production potential, economics and energetics of (*Oryza sativa* L.) genotypes different methods of production in organic management conditions of Sikkim Himalayas. *Indian Journal of Agronomy* **59**(4): 602–606.

Duttarganvi, S., Kumar, R.M., Desai, B.K., Pujari, B.T., Tirupataiah, K., Koppalkar, B.G., Umesh, M.R., Naik, M.K. and Reddy, K.L. 2016. Influence of establishment methods, irrigation water levels and weed-management practices on growth and yield of rice (*Oryza sativa*). *Indian Journal of Agronomy* **61**(2): 174–178.

Gomez, K.A. and Gomez, A.A. 1984. *Statistical Procedures for Agricultural Research*. John Willey & Sons, Singapore.

Little, R.R., Hidder, G.B. and Dawson, E.H. 1958. Differential effect of dilute alkali on 25 varieties of milled white rice. *Cereal Chemistry* **35**: 111–126.

Nagaraju, M., Mohanty, K.K., Chaudhury, D. and Gangadharan, C. 1991. A simple screening technique to detect scent in rice. *Oryza* **28**: 109–110.

Prathiksha, Jaya, Mallareddy, G., Rao, M., Madhukar, P., Chandrashaker, K. and Padmaja, B. 2017. Energy consumption, economics, yield and quality of rice (*Oryza sativa* L.) in different crop establishment methods. *Oryza.* **54**(1): 37–43.

Rajya Sabha. 2011. *98th Report on Export of Foodgrains*: *Premium Non-Basmati Rice & Wheat*. Standing Committee on Commerce, Parliament of India, New Delhi.

Saha, S, Singh, Y.V. Kumar, D. and Gaind, S. 2017. Growth and profitability of aromatic rice under production techniques and nitrogen management. *Research Journal of Agricultural Sciences* **8**(1) : 8–14.

Sato, S. and Uphoff, N. 2007. A review of on-farm evaluation of system of rice intensification (SRI) methods in eastern Indonesia (In) *CAB Reviews*. Commonwealth Agricultural Bureau International, Wallingford, the UK. pp. 67–68.

Shobha Rani, N. and Krishnaiah, K. 2001. Current status of and future prospect for improvement of aromatic rice in India. (In:) *Speciality Rices of the World- Breeding, Production and Marketing,* pp.49–78. Duffy, R. (Ed.). Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi, India.