

Evaluation of rice (*Oryza sativa*) under double transplanting in rainfed lowland rice ecosystem of Asom

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ABSTRACT

A field experiment was conducted during the rainy (*kharif*) season of 2011 and 2012 at Gerua, Hajo, Asom to assess the performance of high-yielding varieties of rice (*Oryza sativa* L.) under double-transplanting method in rainfed lowland rice ecosystem of lower Brahmaputra Valley of Asom. The experiment consists of 10 treatment combinations, viz. 2 plant stand establishment methods (normal transplanting and double transplanting) in main plots and 5 rice varieties 'Ranjit', 'Swarna', 'Swarna Sub 1', 'Sabita' and 'Pooja' in subplots. Double transplanting recorded significantly increase in grain yield by 9.4% over normal transplanting. The increase in grain yield was owing to increase in number of panicles/unit area, number of grains/panicle, grain filling percentage and 1,000-grain weight. Among the rice varieties 'Swarna' recorded significantly higher grain yield of 6.16 t/ha followed by 'Ranjit' (5.67 t/ha) and 'Swarna Sub 1' (5.65 t/ha). Under double transplanting, 'Swarna' recorded the highest benefit cost ratio of 2.03 and least production cost of ₹5.03/kg of grain, while 'Sabita' recorded lowest benefit: cost ratio of 1.10 due to lowest yield (4.20 t/ha) and poor market price.

Key words: Double transplanting, Economics, Rice, Secondary nursery, Yield

Double transplanting is a crop-establishment system for rice cultivation in shallow lowland areas where farmers transplant rice seedlings twice, first on secondary nursery, and then the main field. This system of rice cultivation is prevalent in certain tracts of rainfed lowland areas of Chhattishgarh, Tamil Nadu, Maharashtra, Uttar Pradesh, Bihar, West Bengal and Asom. In Asom, it is popularly known as *Ballan* system but farmers also transplant very old seedlings to avoid high water level in shallow lowland. In this method, seeds are first thickly sown in the primary nursery and then 3 to 4 weeks old seedlings are transplanted in bunches (4–5 number) with closer spacing (7–10 cm apart) in a secondary nursery. Subsequently after 3 to 4 weeks, rice seedlings from secondary nursery are uprooted and clones are transplanted in the main field (Das, 2006). The need of double transplanting arises in situations where the main field is not ready due to delay in onset of monsoon or due to continuous stagnation of flood water in shallow lowlands. However, in case of dry season rice, this practice helps in increasing the cropping intensity

by obviating the problem of late vacation of main field or in avoiding the problem of seedlings establishment in cold period (Singh *et al.*, 2003). An agronomic way of preventing the reduction of *boro* (summer) rice yield that results from delayed planting may be the adoption of double transplanting. The ill-effect of aged seedlings can be overcome by transplanting seedlings from primary to secondary nursery (Sarma *et al.*, 2010). Simultaneously, this practice helps in producing healthy and taller seedlings that can easily overcome the adverse situation like high water depth at the time of transplanting (Rautaray, 2007; Ashim *et al.*, 2010). Ziagun (2000) also reported yield advantage with double transplanting in rice. An information on rice yield and economics due to double transplanting is meager, especially for promising high-yielding rice varieties in rainfed lowland rice ecosystem of Lower Brahmaputra Valley zone of Asom. Keeping above facts in view, the present study was carried out to assess the performance of some promising high-yielding varieties of rice under double transplanting situation during the rainy (*kharif*) season in rainfed lowland rice ecosystem.

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MATERIALS AND METHODS

A field experiment was conducted during the rainy (*kharif*) season of 2011 and 2012 at the research farm of Regional Rainfed Lowland Rice Research Station, Gerua,

Hajo, Asom, located at 28° 14' 59" N, 91° 33' 44" E and at an altitude of 49 m above mean sea-level and characterized by subtropical monsoon climate with annual average rainfall 1,500 mm. The maximum rainfall occurs in lower Bhrmaputra Valley during April–September keeps water stagnation in lowlying areas during early crop-growth period. The soil was clay loam, having pH 6.2, high in organic carbon (0.85%), medium in available nitrogen (290 kg/ha), high in available P₂O₅ (37 kg/ha) and medium in available potash (320 kg/ha). The field experiment was carried out in split-plot design with 3 replications. The experiment consists of 10 treatment combinations, viz. 2 plant-stand establishment methods (normal transplanting and double transplanting) in main plots and 5 rice varieties 'Ranjit', 'Swarna', 'Swarna Sub 1', 'Sabita' and 'Pooja' in subplots. Rice seedlings were raised in primary nursery in the end of May every year for both systems of plant stand establishment. After 28 days, seedlings from primary nursery were uprooted and closely transplanted (10 cm × 10 cm) in bunches of 4 to 5 seedlings/hill in the secondary nursery for double transplanting. The seedlings from secondary and normal nursery were up rooted at age of 28 and 56 days, respectively, and transplanted in the

main field with 2 to 3 seedlings or clones or hill at a spacing of 20 cm × 15 cm in 23 July during both the years. The crop was fertilized with recommended dose of 60–30–30 kg N, P and K/ha. Half of the dose of N and K and full dose of P were applied basal, while remaining N and K were top-dressed in 2 equal splits—at tillering and panicle-initiation stage. Need-based plant-protection measures were taken during the crop-growth period. The crop received 418.2 mm and 365.3 mm of rainfall during the first and second year respectively. Data were recorded at different crop-growth stages and statistically analysed. Economics were calculated for both systems of cop establishment based on prevailing minimum support price of rice and labour wages/man-day.

RESULTS AND DISCUSSION

Seedling vigour

Seedlings obtained from secondary nursery under double transplanting had more shoot length, root length and volume than seedlings obtained from conventional nursery; it may be due to less competition between plants in secondary nursery (Table 1). Nutrient availability may also contribute to obtain vigour seedlings from secondary

Table 1. Seedling vigour under different stand-establishment methods in rainfed lowland situations (pooled data of 2 year)

Variety	Double transplanting			Normal transplanting		
	Shoot length (cm)	Root length (cm)	Fresh volume of 10 seedling (cm ³)	Shoot length (cm)	Root length (cm)	Fresh volume of 10 seedling (cm ³)
'Ranjit'	62.6	22.5	21.2	42.5	12.4	14.2
'Swarna Sub 1'	50.5	23.8	17.4	40.2	12.6	13.6
'Sabita'	72.5	25.2	22.2	47.8	14.2	14.4
'Swarna'	49.4	26.8	16.6	38.8	12.8	13.4
'Pooja'	57.7	24.6	18.2	39.2	11.4	13.6

Table 2. Influence of stand-establishment method and variety on growth parameters of rice under rainfed lowland (pooled data of 2 years)

Treatment	Plant height (cm)	50% flowering (days)	Panicle length (cm)	Panicle weight (g)	Spikelet fertility (%)	Tillers/hill
<i>Method of stand establishment</i>						
Double transplanting	133.8	139.5	24.7	3.1	82.2	12.6
Normal transplanting	127.8	133.3	23.6	2.8	78.9	10.9
SEm±	1.27	0.85	0.24	0.06	0.82	0.52
CD (P=0.05)	3.45	2.32	0.66	0.17	2.2	1.43
<i>Variety</i>						
'Ranjit'	137.0	134.1	25.2	3.16	82.7	11.2
'Sabita'	177.5	148.7	24.2	2.73	77.5	9.8
'Pooja'	107.7	143.7	23.1	2.37	78.1	13.7
'Swarna'	117.7	126.4	24.2	3.47	83.6	11.5
'Swarna Sub 1'	114.1	129.0	23.8	3.10	81.4	12.1
SEm±	0.99	0.51	0.20	0.04	1.04	0.74
CD (P=0.05)	2.98	1.53	0.61	0.14	3.11	2.23

nursery. Rautaray (2007) also recorded thicker culm and better food reserve with double transplanted seedlings than normal seedlings. The better health of seedlings under double transplanting leads to quick establishment in main field and early production of effective nodal and basal tillers.

Growth attributes

Plant height, tillers/hill and days to 50% flowering were significantly influenced by stand-establishment methods and rice varieties (Table 2). Double transplanting resulted in higher plant height and tillers/hill than normal one. Among the varieties, 'Sabita' recorded highest plant height followed by 'Ranjit'. Days to 50% flowering increased under double transplanting by 6 days. This was due to time required for seedling establishment in the second nursery. Double transplanting also recorded significantly higher panicle length and panicle dry weight over normal transplanting.

Yield attributes and yields

Panicles/unit area, filled grains/panicle and 1,000-

weight of grains were significantly more under double transplanting than normal transplanting (Table 3). Grain yield, straw yield and harvest index were significantly influenced by stand-establishment methods. Under double transplanting there was 9.4% and 4.2% increase in grain and straw yield over normal transplanting. The increase in grain yield was owing to higher number of panicles/unit area, more filled grains/panicle and better 1,000-grain weight than normal transplanting. These yield attributes might be influenced by better seedling health. These results were fully confirm the findings of Ashim *et al.* (2010) and Ghosh (2006).

Among the rice varieties, 'Swarna' recorded the maximum grain yield of 6.16 t/ha owing to higher number of panicles/unit area and more grains/panicle followed by 'Ranjit' and 'Swarna Sub 1'. The lowest yield under 'Sabita' was due to poor number of panicles in spite of highest 1,000-grain weight. Variety 'Pooja' recorded grain yield of 4.52 t/ha due to poor number of filled grains/panicle (98.3) in spite of high number of panicles per unit area.

Table 3. Influenced of stand-establishment method and variety yield attributes and yields of rice under rainfed lowland (pooled data of 2 year)

Treatment	Panicles/ m ²	Grains/ panicle	1,000-grain weight (g)	Straw yield (t/ha)	Grain yield (t/ha)	Harvest index (%)
<i>Method of stand establishment</i>						
Double transplanting	298.0	128.7	22.8	6.4	5.5	45.8
Normal transplanting	279.6	121.1	22.2	6.2	5.0	44.6
SEM±	4.82	1.25	0.17	0.06	0.08	0.20
CD (P=0.05)	13.11	3.40	0.47	0.17	0.23	0.55
<i>Variety</i>						
'Ranjit'	288.3	138.1	19.58	6.48	5.67	46.6
'Sabita'	241.5	106.2	31.62	6.98	4.20	37.5
'Pooja'	309.5	98.3	19.88	5.45	4.52	45.2
'Swarna'	313.4	144.9	21.55	6.33	6.16	49.2
'Swarna sub 1'	291.3	136.8	19.80	6.20	5.65	47.6
SEM±	4.00	1.20	0.11	0.07	0.08	0.35
CD (P=0.05)	12.00	3.60	0.33	0.22	0.24	1.05

Table 4. Influence of stand-establishment method and variety on economics of rice under rainfed lowland (pooled data of 2 years)

Treatment	Gross returns (× 10 ³ ₹/ha)	Net returns (×10 ³ ₹/ha)	Production cost (₹/kg grain)	Benefit: cost ratio
<i>Stand-establishment method</i>				
Double transplanting	54.5	22.5	6.0	1.7
Normal transplanting	49.7	18.4	6.4	1.6
<i>Variety</i>				
'Ranjit'	57.9	26.2	5.6	1.8
'Sabita'	36.0	4.3	7.6	1.1
'Pooja'	46.2	14.5	7.2	1.5
'Swarna'	62.8	31.2	5.2	2.0
'Swarna sub 1'	57.7	26.0	5.6	1.8

Economics

Additional requirement of man-days on raising the second nursery and double transplanting were partially compensated by avoiding gap filling and less weeding. Development of tillers at the second nursery helped in reducing seed rate to one-fourth under double transplanting. The total cost of production of 1 kg grain under double transplanting was lower (₹6.0) than the transplanting (₹6.4). Double transplanting resulted higher net returns and benefit: cost ratio than normal transplanting which is owing to higher grain yield. 'Swarna' recorded highest benefit: cost ratio and least cost of production of 1 kg grain followed by 'Ranjit' and 'Swarna Sub 1', while 'Sabita' recorded least benefit: cost ratio and highest production cost.

Based on the above findings, double transplanting is beneficial under rainfed lowland rice ecosystem where generally water stagnation occurs. 'Swarna', 'Ranjit' and 'Swarna Sub 1' high-yielding varieties of rice were found economically viable and suitable for double transplanting under rainfed lowland rice ecosystem.

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