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Effect of planting methods on growth duration and yield performances of Aus rice at Barishal region of Bangladesh

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Abstract

Planting methods affect growth duration, yield components and yield of rice, although the effects are highly variable on location, variety and the growing season. Therefore, present study aimed to evaluate the effect of planting methods on growth duration, yield components and yield of Aus rice varieties at Barishal region. Treatments of the experiment consisted of three varieties (Binadhan-19, Binadhan-21, BRRI dhan48) and four planting methods (direct seeding, sprouted seeding, seed dibbling, seedling transplanting) and assigned in randomized complete block design. Results showed that the variety Binadhan-21 took shortest duration for 50% flowering (65 days) and maturity (91 days) when sprouted seed was used as planting method. Binadhan-21 planted with sprouted seed also exhibited lower plant height (105.20 cm), maximum number of effective tiller per hill (19.0), higher panicle length (23.73 cm), filled grain per panicle (63.73), and higher weight of 1000 grains (25.67 g) which contributed to higher yield (4.07 t ha^{-1}) as compared to other varieties and planting methods. Planting of Binadhan-21 with sprouted seed during Aus season is therefore suggested for better yield of rice at Barishal region of Bangladesh.

Keywords: Aus rice, Barishal region, planting methods, growth duration, yield

Introduction

Rice is the widely cultivated cereal in Bangladesh. It has a significant influence on agrarian economy of Bangladesh. Rice has been being used as food for more than 4000 years and rice is the staple food for about 557 million people throughout the world (Manzanilla *et al.* 2011). High content of nutrients makes this cereal popular as it is the great source of protein, amino acid, sugar and many other essential nutrients (Khatun and Mollah 2024). Bioactive compounds including polyphenols are also present in rice which have direct effect on antioxidants, anti-inflammatory and antiobesity activity in the human body (Khatun and Mollah 2024, Khatun and Kim 2021). Rice also contains some phenolic compounds which inhibit the angiotensin converting enzyme (Khatun *et al.* 2022) and help to reduce blood pressure by relaxing the veins (Ondetti *et al.* 1977).

In Bangladesh, rice is grown in three growing seasons viz. Aus, Aman, and Boro (Islam *et al.* 2016). Aus rice is generally grown between April and August. During June to July, the total rainfall is mostly irregular and insufficient, resulting in water stress to Aus rice. Insufficient water inhibits assimilate translocation and grain formation causing yield loss in Aus rice (Palanog *et al.* 2014). Yield loss also depends on the growth stage and duration, intensity of drought stress, seed sowing methods along with insect pest infestation (Mollah and Arifuzzaman 2024). It was reported that severe drought stress during the vegetative stage and mild drought stress during the flowering stage causes 20% and 28% yield losses, respectively (Kumar *et al.* 2014). Water stress at or before panicle initiation reduces the number of potential spikes and inhibits assimilate translocation to the grains, resulting in low grain weight and a rise in empty grains.

In the Barishal region, Aus rice is grown in about 1,97,754 hectares of land producing about 5,23,102 metric ton grains with an approximate yield of 2.65 ton per hectare (BBS 2023). The most practiced cultivation methods of Aus rice are direct seeding, dibbling and transplanting methods. Transplanting method of rice cultivation involves raising, uprooting and transplanting of seedlings which is a resource and cost intensive as well as time consuming method since the preparation of seedbed, the raising of seedling and the transplanting are labor and time intensive operations. Contrary, direct seeding ensures good stand establishment, higher tillering and sometimes higher

grain yield but weed problem is common in direct seeding Aus rice (Awan *et al.* 2011). Therefore, it is imperative to establish alternate method of Aus rice cultivation incorporating new varieties to enhance rice production in southern belt of Bangladesh. The present study thus, aimed to evaluate the effect of different planting methods on growth duration, yield attributes and yield of Aus rice at Barishal region of Bangladesh.

Materials and methods

The experiment was conducted at the research farm of Bangladesh Institute of Nuclear Agriculture Substation, Barishal during May to September 2024. This area lies between 22.8162 °N latitude, 90.3137 °E Longitude and 2 meters altitude from the sea level (Khatun and Mollah, 2023). Alternate hot and cold season is the characteristic climatic condition of this region. This area belongs to the Agro-Ecological Zone of Active Ganges Floodplain (AEZ 10) with alluvium, and calcareous brown floodplain soils having low organic matter. Soil of this area is mildly alkaline with pH ranging from 5.8 to 6.5, cation exchange capacity (CEC) 25.58 and silty clay loam texture (Mollah and Khatun, 2024). For the preparation of soil, repeated tillage followed by sun drying was carried out. Fertilization was performed accordingly to confirm successful crop production.

The treatments of the experiment comprised of three high yielding Aus rice varieties (Binadhan-19, Binadhan-21 and BRRI dhan48) and four planting methods viz. direct seeding of dry seed, seed dibbling, direct seeding of sprouted seed and seedling transplanting. It was a factorial experiment conducted in randomized complete block design with three replications. For direct seeding, continuous sowing of dry seed (40 kg ha^{-1}) in line was done and light irrigation was applied to facilitate germination and plant establishment. For seed dibbling, three seeds were kept in prepared holes with line to line distance of 20 cm in the assigned plots having soil moisture at field capacity. For sprouted seed, seeds were soaked in bucket water on the same date of direct seeding of dry seed. After 24 hours, water was removed from the seeds and kept tightly in gunny bags. After 48 hours when seeds sprouted, were sown manually in line maintaining 20 cm line to line distance in the assigned plots. These sprouted seeds were also sown in the seedbed for raising seedlings for transplanting. 25-day-old seedlings were transplanted (single seedlings $hill^{-1}$) with a spacing of 20 cm × 15 cm. All agronomic practices and fertilizer applications were performed uniformly for all the treatments suggested for rice cultivation (Khatun *et al.* 2020). Flowering and maturity of rice varieties occurred at different times irrespective of planting method and variety was recorded. After physiological maturity, five hills were collected from each plot for recording yield contributing parameters and one quadrate was harvested in every plot for determination of yield that converted to ton per hectare. All data were subjected to statistical analysis separately by using analysis of variance technique by SPSS software. The difference among treatment means was compared by using Duncan's Multiple Range Test at 5% probability levels.

Results and discussion

Various planting methods and varieties significantly ($P < 0.05$) affected the growth duration of the Aus rice varieties. The maximum growth duration was observed for BRRI dhan48 planted in seedling transplanting method (106 days) which was followed by Binadhan-21 planted in same method (102 days) and BRRI dhan48 planted in seed dibbling method (99 days) as presented in Table 1. In contrast, the lowest growth duration was observed for Binadhan-19 planted as direct sowing of sprouted seeds (90 days) which was followed by Binadhan-21 in the same planting method (91 days), Binadhan-19 in direct seeding of dry seed (92 days) and Binadhan-19 in seed dibbling method (92 days) Maximum duration for 50% flowering was observed combinedly for BRRI dhan48 (81 days) and Binadhan-21 (81 days) in seedling transplanting method which was followed by Binadhan-19 in seedling transplanting (76 days) and Binadhan-21 in direct seeding of dry seed (75 days). On the other hand, the lowest duration for 50% flowering was observed combinedly for Binadhan-19 (65 days) and Binadhan-21 (65) in direct seeding of sprouted seed planting method.

Planting methods and varieties significantly ($P < 0.05$) controlled plant height as well as number of tillers (Table 1). The maximum plant height was observed in BRRI dhan48 planted as sprouted seed (126.20 cm) which was followed by BRRI dhan48 in seed dibbling method

Table 1. Effect of variety and planting methods on phenology and growth of Aus rice

Treatments		Flowering (days)	Maturity (days)	Plant height (cm)	Effective tillers hill^{-1}
Varieties	Planting methods				
Binadhan-19	Direct seeding	69^{d}	92^{f}	110.93 ± 0.76^{e}	16.60 ± 0.60^{b}
	Seed dibbing	66^{f}	92^{f}	111.40 ± 1.74^{e}	17.33 ± 1.68^{ab}
	Sprouted seeding	65^{g}	90^{h}	108.53 ± 0.12^{e}	17.67 ± 1.55^{ab}
	Transplanting	76^{b}	97^{d}	103.27 ± 0.70^{g}	17.27 ± 1.37^{ab}
Binadhan-21	Direct seeding	69^{d}	93^{e}	105.13 ± 1.42^{f}	16.13 ± 1.01^{b}
	Seed dibbing	67^{e}	93^{e}	104.33 ± 0.58^{f}	12.40 ± 0.69^{c}
	Sprouted seeding	65^{g}	91^{g}	105.20 ± 1.06^{g}	19.00 ± 1.59^{a}
	Transplanting	81^{a}	102^{b}	98.67 ± 2.52^{h}	13.90 ± 1.13^{c}
BRRI dhan48	Direct seeding	75^{b}	97^{d}	112.60 ± 0.53^{c}	15.67 ± 1.04^{bc}
	Seed dibbing	72^{c}	99^{c}	119.87 ± 1.55^{b}	15.93 ± 0.31^{bc}
	Sprouted seeding	67^{e}	96^{d}	126.20 ± 1.39^{a}	18.13 ± 1.62^{a}
	Transplanting	81^{a}	106^{a}	113.20 ± 1.06^{d}	17.07 ± 1.05^{ab}

Values within same column with different letters are significantly different according to DMRT at 5% level of significance.

(119.87 cm) and BRRI dhan48 planted in direct sowing of dry seeds (112.60 cm). In contrast, the lowest plant height was observed for Binadhan-21 planted in seedling transplanting method (98.67 cm) which was followed by Binadhan-19 in seedling transplanting planting (103.27 cm) and Binadhan-19 in direct sowing of dry seeds (105.13 cm). Maximum effective tillers per hill was observed in Binadhan-21 for sowing of sprouted seeds (19.00) which was followed by BRRI dhan48 sown as sprouted seeds (18.13), Binadhan-19 sown as sprouted seed (17.67), Binadhan-19 in seed dibbling (17.33) and Binadhan-19 in seedling transplanting (17.27) method. On the other hand, the lowest number of effective tillers per hill was observed in Binadhan-21 planted in seed dibbling (12.40) method which was followed by Binadhan-21 planted in seedling transplanting method (13.90).

Panicle characteristics of Aus rice had also been affected by the planting methods and varieties (Table 2). Maximum length of panicle was observed in BRRI dhan48 planted in seed dibbling method (23.73 cm) which was followed by Binadhan-19 planted in direct sowing of seeds (23.30 cm) and Binadhan-19 planted in seedling transplanting (23.20 cm). In contrast, the lowest panicle length was obtained from Binadhan-19 planted as sprouted seed (21.40 cm) which was followed by Binadhan-21 planted in seed dibbling method (21.77 cm) and Binadhan-19 planted in seed dibbling method (21.83 cm).

Maximum number of filled grain per panicle was obtained from BRRI dhan48 planted as sprouted seed (70) which was followed by seedling transplanting (68) and direct sowing of dry seeds (66.07) of the same variety. However, the lowest number of filled grains in each panicle was observed in Binadhan-21 planted in direct sowing of seeds (42) which was followed by Binadhan-19 planted as sprouted seed (42.13) and Binadhan-19 planted as direct sowing of seeds (45.33).

The lowest number of unfilled grains per panicle was obtained from Binadhan-21 planted as sprouted seed (12.20) which was followed by Binadhan-19 planted in seed dibbling method (14.27) and Binadhan-19 planted in seedling transplanting method (14.73). In contrast, the maximum number of unfilled grains was obtained from Binadhan-19 (34.80) which was followed by BRRI dhan48 (29.73) and Binadhan-21 (27.27) when all these were planted as direct sowing of dry seeds.

Planting methods and varieties significantly ($P < 0.05$) affected the grain yield in Aus rice as illustrated in Table 2. For 1000 grain weight, the maximum weight was obtained from BRRI dhan48 sowing the sprouted seeds (28.27 g) which was followed by Binadhan-21 sowing the sprouted seeds (25.67 g) and BRRI dhan48 sowing in seed dibbling method (24.0 g). In contrast, the lowest weight of 1000 grains were obtained from Binadhan-19 planted

Table 2. Effect of variety and planting methods on yield components and yield of Aus rice

Treatments		Panicle length (cm)	Filled grain panicle^{-1}	Unfilled grain panicle^{-1}	1000-grain weight (g)	Grain yield (t ha^{-1})
Varieties	Planting methods					
Binadhan-19	Direct seeding	23.30 ± 1.27^{a}	45.33 ± 2.53^{ef}	34.80 ± 1.91^{a}	22.07 ± 0.12^{e}	3.30 ± 0.21^{c}
	Seed dibbing	21.83 ± 1.20^{bc}	45.60 ± 2.43^{ef}	14.27 ± 2.20^{de}	22.40 ± 0.53^{de}	3.72 ± 0.19^{b}
	Sprouted seeding	20.88 ± 0.39^{c}	42.93 ± 0.90^{f}	17.13 ± 1.86^{d}	22.13 ± 0.23^{e}	3.29 ± 0.20^{c}
	Transplanting	23.20 ± 1.07^{a}	65.40 ± 1.04^{c}	14.73 ± 1.15^{de}	22.80 ± 0.35^{d}	3.63 ± 0.21^{b}
Binadhan-21	Direct seeding	22.67 ± 1.10^{ab}	42.00 ± 1.22^{f}	27.27 ± 1.50^{bc}	22.40 ± 0.53^{de}	3.06 ± 0.34^{cd}
	Seed dibbing	21.77 ± 0.35^{bc}	54.47 ± 1.30^{d}	21.07 ± 1.03^{c}	22.33 ± 0.58^{de}	3.66 ± 0.20^{b}
	Sprouted seeding	23.73 ± 0.92^{a}	63.73 ± 1.29^{cd}	12.20 ± 0.92^{e}	25.67 ± 0.23^{b}	4.07 ± 0.11^{a}
	Transplanting	22.10 ± 0.81^{b}	48.73 ± 1.90^{e}	22.07 ± 1.72^{c}	22.47 ± 0.50^{de}	3.07 ± 0.13^{cd}
BRRI dhan48	Direct seeding	23.17 ± 0.81^{ab}	66.07 ± 1.58^{bc}	29.73 ± 2.19^{b}	23.67 ± 0.58^{cd}	2.35 ± 0.16^{d}
	Seed dibbing	23.73 ± 0.06^{a}	63.80 ± 2.60^{cd}	17.33 ± 2.16^{d}	24.00 ± 0.31^{c}	3.39 ± 0.29^{bc}
	Sprouted seeding	24.47 ± 1.14^{a}	70.00 ± 1.44^{a}	20.47 ± 1.21^{cd}	28.27 ± 0.46^{a}	4.19 ± 0.24^{a}
	Transplanting	21.43 ± 1.08^{bc}	68.00 ± 1.25^{b}	17.40 ± 2.09^{d}	23.40 ± 0.53^{cd}	3.64 ± 0.23^{b}

Values within same column with different letters are significantly different according to DMRT at 5% level of significance.

in direct sowing method (22.07 g) which was followed by Binadhan-19 sown as sprouted seeds (22.13 g) and Binadhan-21 planting in seed dibbling method (22.33 g). The highest grain yield was obtained from BRRI dhan48 sown as sprouted seed (4.19 t ha^{-1}) which was followed by Binadhan-21 sown as sprouted seed (3.97 t ha^{-1}) and Binadhan-19 sown in seed dibbling method (3.72 t ha^{-1}). On the other hand, the lowest yield was obtained from BRRI dhan48 planted in direct seed sowing method (2.35 t ha^{-1}) which was followed by Binadhan-21 planted in direct seed sowing method (3.06 t ha-1) and Binadhan-21 planted in seedling transplanting method (3.07 t ha^{-1}).

Conclusion

Planting methods significantly affected on the growth duration, yield components and yield of Aus rice varieties. Among the varieties, Binadhan-21 sown with sprouted seed exhibited better performance with its shorter growth duration, and plant height but higher number of effective tiller per plant, panicle length and filled grain per panicle which contributed the highest yield of the variety. Therefore, cultivation of Binadhan-21 planting with direct seeding of sprouted seed is suggested for better yield of Aus rice at Barishal region of Bangladesh.

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