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RESEARCH ARTICLE

Chemical and physical properties of aromatic rice varieties as influenced by transplanting date in transplant *aman* season

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Abstract: A field experiment was conducted at the Hajee Mohammad Danesh Science and Technology University Farm, Dinajpur, Bangladesh during transplant *aman* (T. *aman*) season of 2004 to determine the influence of transplanting date on the physical and chemical properties of grain of five local and three modern aromatic rice varieties of Bangladesh. The varieties Kataribhog, Radhunipagal, Chinigura, Badshabhog, Kalizera, BRRI dhan34, BRRI dhan37 and BRRI dhan38 were transplanted during the period 15 July to 3 September at 10 day intervals. The physical and chemical characteristics measured in the study were milling outturn, head rice outturn, 1000-grain weight, grain length, length breadth ratio, grain elongation ratio, volume expansion ratio, protein content, amylose content and cooking time. The transplanting date, variety and transplanting date×variety interaction effect had significant effect on all the characteristics studied except on cooking time where only the variety was found to be significant and on length breadth ratio where only the transplant date was found to be not significant. Chemical and physical properties except cooking time were found to be influenced by transplanting date in T. *aman* season. Suitable transplanting date was found to be between 4 to 14 August in T. *aman* season in order to improve physical and chemical properties of aromatic rice. However, the best compromise between physical and chemical properties, particularly the protein content, may be achieved by transplanting around 24 August. In case of all planting dates, weight of 1000 grains, grain length, length breadth ratio and, volume expansion ratio were highest in BRRI dhan38 while the highest protein and amylose contents were found in Kalizera and BRRI dhan34, respectively.

Key words: Aromatic rice, chemical properties, physical properties, T. *aman* season, transplanting date.

INTRODUCTION

Aromatic rice varieties are rated best in quality and fetch a much higher price than non-aromatic rice. The demands for aromatic rice both for internal consumption and also for export show an increasing trend[1]. Most of the aromatic rice varieties in Bangladesh are traditional photo-period sensitive types and are grown during transplant *aman* (T. *aman*) season[2]. Selection of the right variety and suitable date of transplanting are important factors for maximizing quality rice production. Yield of rice differs with location, seasons and different dates of planting within a season etc[3]. Transplanting of *aman* rice generally commences in mid July and continues through September and even early October[4]. The yield of rice markedly declined with delayed planting time[5-6]. The information on varietal response to date of planting is limited, particularly in respect of physical and chemical properties of aromatic rice. Therefore, the present investigation was undertaken to study the influence of date of transplanting on physical and chemical properties of aromatic rice varieties.

METHODS AND MATERIALS

The experiment was conducted at the Hajee Mohammad Danesh Science and Technology University Farm, Dinajpur, Bangladesh during T. *aman* season of 2004. The experimental site was a medium high land with sandy loam soil having a pH value of 6.0. The experiment was laid out in a randomized complete block design with three replicates. Six dates of transplanting used in the experiment were 15 July (D_1), 25 July (D_2), 4 August (D_3), 14 August (D_4), 24 August (D_5) and 3 September (D_6). Five local and three modern aromatic rice varieties namely, Kataribhog (V_1), Radhunipagal (V_2), Chinigura (V_3), Badshabhog (V_4), Kalizera (V_5), BRRI dhan34 (V_6), BRRI dhan37 (V_7) and BRRI dhan38 (V_8) were used in the study. The unit plot size was 4.0m × 2.5m. Seedlings were grown at 10 d

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intervals in different seedbeds starting from 15 June. The 30 d old seedlings were transplanted at a spacing of 20 cm×15 cm using three seedlings/hill. All other cultural practices were done uniformly as per recommendations. Entire plots were harvested to obtain grain yield. After drying, grain samples of appropriate quantities were taken randomly from each plot to record physical and chemical parameters.

Samples were milled raw and analyzed for physical and chemical properties. Grain physical and chemical properties were measured at the Grain Quality and Nutrition Division Laboratory, Bangladesh Rice Research Institute, Gazipur. Milled rice out-turn was determined by dehulling 200 g rough rice in a Satake Rice Mill, followed by 75 polishing in Satake Grain Testing Mill TM-05. Head rice out-turn was determined by separating broken grains from milled rice by hand. Milled rice out-turn and head rice out-turn were expressed as percentage of rough and milled rice respectively. Grain length and breadth were measured by slide calipers. Amylose content was determined by the procedure of Juliano[7]. Protein content was calculated from nitrogen and it was determined by the micro Kjeldahl method[8,9]. Volumes of cooked and milled rice were measured by amounts of water displacement. Data were analyzed following the ANOVA technique and mean differences were adjudged with Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Analyses of variance for all the grain quality characteristics studied are presented in Table 1. The transplanting date, variety and transplanting date × variety interaction effect were found to significantly affect all characteristics studied except cooking time where only variety was found to have a significant effect and the length breadth ratio where transplanting date was found to be not significant. Interaction effect of variety × transplanting date for physical and chemical characteristics were further studied using response curves (Figures 1 and 2).

Different varieties responded differently to different dates of transplanting with respect to milling out-turn. The highest and lowest degrees of varietal differences were found for D_6 and D_1 to D_3, respectively. Even for D_5, variety Badshabhog showed the highest milling recovery of about 73 % while all the other varieties showed milling recoveries around 70 %. In general, milling recovery increased from D_1 to D_3 and remained the same untill D_4 and started to decrease from D_5. Thus, the period D_3 to D_4 would be the best time of planting to attain the highest milling recovery (around 71 %) with minimum varietal differences. With respect to head rice out-turn, BRRI dhan37 and BRRI dhan38 always resulted in a lower head rice out-turn than the rest of the varieties.The response of BRRI dhan38 became highly unpredictable after D_4. Best time of planting to maximize head rice out-turn is around D_4 for BRRI dhan37 and BRRI dhan38 and is around D_3 for rest of the varieties. With respect to 1000-grain weight and grain length, three variety groups were identified based on their response to the planting dates. The first group (BRRI dhan37 & BRRI dhan38) had the highest grain weight and length for all transplanting dates and showed minimum varietal differences for D_3 and D_4. They showed reduction in both parameters after D_3. Variety Kataribhog being in the second group had intermediate grain weight and lengths and showed a similar response as the first group to different planting dates. Third group which includes rest of the five varieties had the lowest grain weight and lengths and showed a response similar to the first group. Thus, best time of planting to maximize grain weight and length for all varieties would be D_3 to D_4.

BRRI dhan37 & BRRI dhan38 had the highest length breadth ratio while Kataribhog had an intermediate value. The rest of the five varieties had lower length breadth ratio (Figure 1). However, some of the varieties in the lower length breadth ratio group showed an increasing trend in length breadth ratio with delay in transplanting date. BRRI dhan34 had the highest grain elongation ratio with all the planting dates and an increasing trend in grain elongation ratio with delay in transplanting date. Thus the variety BRRI dhan34 showed its highest grain elongation ratio which was about 2.3 for D_6 (Figure 1). Some of the varieties including Chinigura with the lowest grain elongation ratio for D_6 showed a decreasing trend in grain elongation ratio with delay in transplanting date. Variability of volume expansion ratio between varieties appeared highly unpredictable for all transplanting dates. However, highest volume expansion ratio was found for D_1 for BRRI dhan38 and lowest for D_2 for Kataribhog & BRRI dhan34.

Protein content gradually increased from D_1 to D_6. Delayed transplanting at D_6 maximized the protein content in brown rice for all the varieties. Amylose content remained the same from D_1 to D_5 for most of the varieties and showed its lowest value for D_6 transplanting date for all the varieties. BRRI dhan34 showed its highest amylose content (26%) for D_4 (Figure 2). In contrast, amylose content was reported to increase[10] with the delay in transplanting.

Milling out-turn (%) , head rice out-turn (%) , 1000-grain weight (g), grain length (mm), grain length breadth

Table 1: Analyses of variance for each of the grain quality characteristics of aromatic rice

Source of Variance	Degree of freedom	Mean squares for grain quality characteristics									
		Milling outturn (%)	Head rice outturn (%)	1000 grain weight (g)	Grain length (mm)	Length Breadth ratio	Grain elongation ratio	Volume expansion ratio	Protein content (%)	Amylose content (%)	Cooking time (min)
Transplanting date (Factor A)	5	21 1**	105 44**	7 17**	0 114**	0 007NS	0 048**	0 437**	7 206**	1 952**	0 000011NS
Variety (Factor B)	7	6 03**	211 90**	125 68**	12 13**	3 61**	0 41**	1 706**	3 455**	6 362**	160 714**
Transplanting date × Variety	35	3 07**	12 14**	0 38**	0 027**	0 009**	0 017**	0 789**	0 536**	0 362*	0 0001NS
Error	94	1 56	1 64	0 073	0 012	0 004	0 003	0 023	0 060	0 204	0 078

** = Significant at 0 01 probability level

* = Significant at 0 05 probability level

NS = Not significant

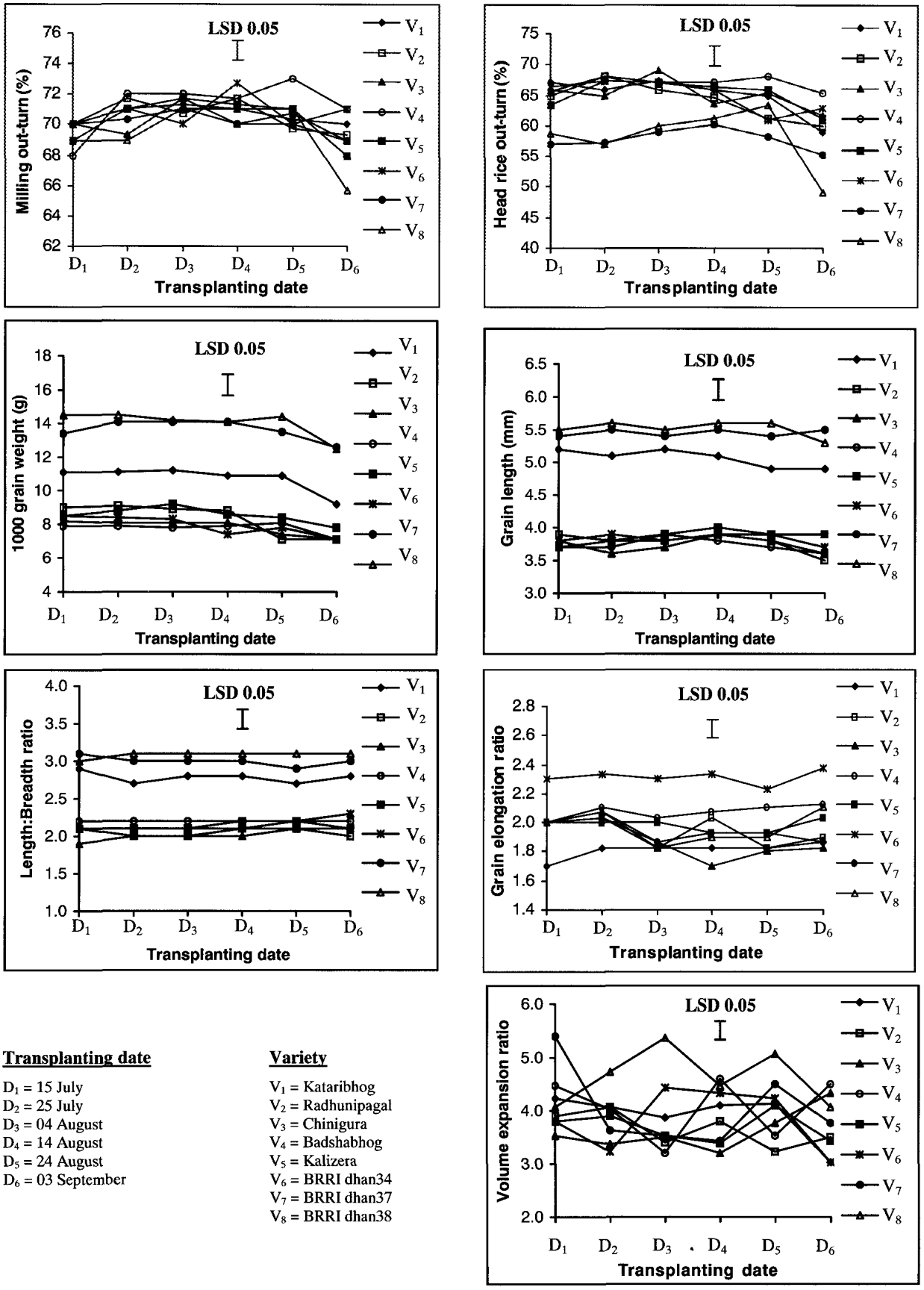
Table 2: Influence of transplanting date and variety on cooking time.

Variety*	Transplanting date**						
	D_1	D_2	D_3	D_4	D_5	D_6	Average
	(min)	(min)	(min)	(min)	(min)	(min)	(min)
V_1	15 0	15 0	15 5	15 0	15.0	15 0	15 0b
V_2	14 0	14.0	14.0	14.0	14.0	14.0	14 0c
V_3	12.5	12 5	12 5	12 5	12.5	12.5	12 5de
V_4	11 5	11 5	11 5	11 5	11 5	11.5	11.5f
V_5	12.0	12.0	12.0	12 0	12.0	12 0	12.0ef
V_6	13.0	13.0	13.0	13.0	13.0	13.0	13.0d
V_7	19 0	19 0	19.0	19.0	19.0	19.0	19.0a
V_8	19 0	19 0	19.0	19.0	19.0	19.0	19.0a
Average	14.5	14.5	14 5	14 5	14.5	14.5	14 5

Values in a column followed by different letters differ significantly, whereas values followed by common letters do not differ significantly at 5% level of probability.

*V_1 = Kataribhog
V_2 = Radhunipagal
V_3 = Chinigura
V_4 = Badshabhog
V_5 = Kalizera
V_6 = BRRI dhan34
V_7 = BRRI dhan37
V_8 = BRRI dhan38

**D_1 = 15 July
D_2 = 25 July
D_3 = 04 August
D_4 = 14 August
D_5 = 24 August
D_6 = 03 September



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D_1 = 15 July
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V_1 = Kataribhog
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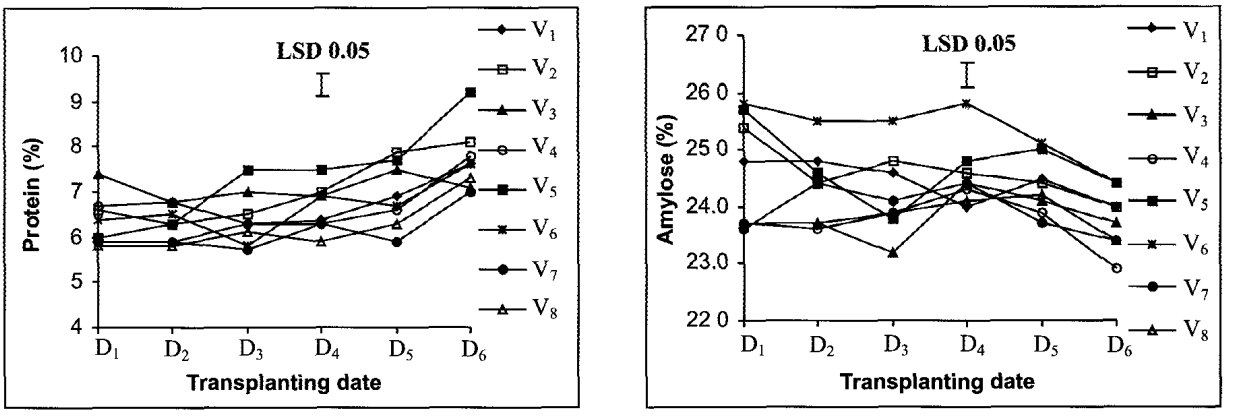
V_5 = Kalizera
V_6 = BRRI dhan34
V_7 = BRRI dhan37
V_8 = BRRI dhan38

Figure 1: Physical characteristics, namely milling out-turn, head rice out-turn, 1000 grain weight, grain length, length breadth ratio, grain elongation ratio and volume expansion ratio, of aromatic rice varieties as influenced by transplanting date in T. *aman* season.



Transplanting date

D_1 = 15 July
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V_3 = Chinigura
V_4 = Badshabhog
V_5 = Kalizera
V_6 = BRRI dhan34
V_7 = BRRI dhan37
V_8 = BRRI dhan38

Figure 2: Protein content (%) and amylose content (%) of aromatic rice varieties as influenced by transplanting date in T. *aman* season

Table 3: Monthly average day temperature (°C), rainfall (mm), relative humidity (%) and sunshine (hours) of the experimental site in T *aman* season of 2004

Weather parameter	Month					
	July	August	September	October	November	December
Temperature (°C)	28 4	30 0	28 5	25 9	22 5	19 3
Rainfall (mm)	601	154	317	330	0	3
Relative humidity (%)	84	78	84	79	75	82
Sunshine (h)	3 6	6 2	3 6	6 7	8 2	7 1

ratio, grain elongation ratio, volume expansion ratio, protein content (%), amylose content (%) and cooking time significantly varied among the varieties (Table 1). Among the aromatic varieties, Badshabhog recorded the highest milling out-turn and it was identical with that of Kataribhog, Radhunipagal and BRRI dhan34. Head rice out-turn was the highest in Badshabhog and 1000-grain weight, grain length, length breadth ratio and volume expansion ratio were comparatively higher in BRRI dhan38 (Figure 1). Grain elongation ratio was higher in the Badshabhog. BRRI dhan37 and BRRI dhan38 were medium slender type varieties. Protein content of the varieties varied from 6.1% to 7.33% in brown rice (Figure 2). Highest protein content and amylose content have been recorded in Kalizera and in BRRI dhan34, respectively. Previous studies[11] indicated that among 12-scented rice varieties, amylose content varied from 22.0 to 25.9 and protein content varied from 6.5 to 9.0%. Grain elongation and volume expansion ratio were comparatively higher in BRRI dhan34 and BRRI dhan38, respectively. The cooking time of the varieties varied from 11.5 to 19.0 minutes. Cooking time was higher in BRRI dhan37 and BRRI dhan38 (Table 2). Higher protein content and volume expansion ratio were recorded in local aromatic rice varieties compared to that of modern varieties.

It was observed that monthly average day temperature, rainfall, relative humidity gradually decreased but sunshine hours increased from early to late T. *aman* season of the study (Table 3).

From the results of the experiment, it is evident that to improve physical and chemical properties of aromatic rice other than protein content, the preferred dates of transplanting are from 4 to 14 August in T. *aman* season. Scientists[12] have made a similar observation, that late planting of Basmati rice varieties under Hyderabad conditions in August improved the quality traits. For optimum growth and best grain qualities, aromatic rice require relatively low temperature and clear sunny days from early to late maturity stage[13]. However, the best compromise between physical and chemical properties may be achieved by transplanting around the 14th of August in T. *aman* season since protein content increased while physical properties, particularly milling out-turn, head rice out-turn and 1000 grain weight decreased when transplanted after the 14th of August.

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