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EVALUATION OF GRAIN AND NUTRITIONAL QUALITY OF TRANSPLANTED AMAN RICE UNDER DIFFERENT NITROGEN LEVELS

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Abstract

Quality is one of the key characteristics of rice and is largely governed by nitrogen application. An experiment was conducted to scrutinize the effect of nitrogen on quality characteristics of rice, with three nitrogen levels (*viz.* 50 kg N ha^{-1}, 100 kg N ha^{-1} and 150 kg N ha^{-1}) and four varieties/lines (*viz.* SAU ADL1, BRRI dhan70, BRRI hybrid dhan6 and SAU ADL11). Results revealed that quality characters of transplanted *Aman* rice were significantly influenced by nitrogen, variety and their interaction. Increasing trend was observed with the increasing level of nitrogen from 50 to 150 kg ha^{-1} regarding hulling percentage and milling outturn while decreasing trend was observed in case of apparent amylose content and imbibition ratio. Maximum protein content (9.60%) and gel consistency (96.16 mm) were recorded at 100 kg N ha^{-1}. Among the studied materials, SAU ADL11 performed better in case of all studied parameters. Although interaction of 150 kg N ha^{-1} with SAU ADL1 and SAU ADL11 gave maximum value of hulling percentage and milling outturn. In interaction of 100 kg N ha^{-1} with these two lines gave maximum protein, gel consistency and satisfactory levels of all quality characters. So, it can be suggested to carry out further investigation with these two rice lines having 100 kg N ha^{-1}.

Introduction

Rice is the most important cereal crop and staple food in Bangladesh. It is the traditional source of carbohydrate and protein for Bangladeshi people. About two-third of total calorie and one-half of total protein requirement on daily basis of a person is provided by rice (BBS, 2013). Among the rice growing countries, Bangladesh owns third position in rice area and fourth position in rice production (BRRI, 2017). Traditionally, scientist focalizes to increase yield per unit area to feed the enormous population. But now Bangladesh has reached self-sufficiency in case of rice production (Kabir, 2015). So, consumer's favour for better quality rice has been increased. Again, people of Bangladesh cannot afford other protein sources due to their unavailability and higher cost. So, now it is high time to pay attention to quality rice production to satiate consumer preference and make a stand against famishment. For this, rice genotypes having promising features should be explored. Quality of rice is not only hinged on varietal characteristics but also application of nitrogen. Nitrogen is the most important element in fertilizer which influenced grain quality mostly eating/cooking quality (Da-wei *et al.,* 2017). Not only scanty application of nitrogen fetters quality rice production but also excessive nitrogen hampers grain quality (Mannan *et al.*, 2009). So, a suitable combination of nitrogen and variety

is required to improve the quality of rice. Although, a number of experiments were done on the effects of nitrogen on quality of rice but comparative study on the performance of rice genotypes with modern inbred and hybrid varieties for different levels of nitrogen is very few in Bangladesh. Keeping above facts in view, an investigation was done to explore the potentiality of rice genotypes concerning various quality contributing characters of modern inbred and hybrid varieties.

Materials and Methods

The present investigation was carried out during *Aman* season of 2017 (July- December/2017) at the Agronomy field of Sher-e-Bangla Agricultural University, Dhaka-1207 (23°77′N latitude and 90°33′E longitude). The experiment consisted of three nitrogen levels (*viz.* 50, 100 and 150 kg N ha^{-1}) and four varieties/lines (*viz.* SAU ADL1, BRRI dhan70, BRRI hybrid dhan6 and SAU ADL11). SAU ADL1 (SAU ADL: - Sher-e-Bangla Agricultural University Agronomy Department Line) and SAU ADL11 were derived from seeds of a rice line supplied by an NGO, Suranjana under various field observations by the Agronomy department of Sher-e-Bangla Agricultural University. The experiment was laid out in a split-plot design with three replications. Nitrogen was assigned in the main plots and variety/line in the sub-plots. At maturity, the crop was harvested, threshed and winnowed for grain collection. About 500 g grain from each plot was sun dried at about 14% moisture level and stored for grain quality evaluation. Grain quality was analyzed at Grain Quality and Nutrition Division, Bangladesh Rice Research Institute. Quality data was recorded as hulling percentage, percentage of milling outturn (MOT), protein content, apparent amylose content, alkali spreading value (ASV), imbibition ratio and gel consistency. A 100 g grain sample was dehulled in a laboratory huller and the weight of dehusked kernel was recorded. Hulling percentage was computed as:

$$\text{Hulling percentage} = \frac{\text{Weight of dehusked kernel}}{\text{Weight of paddy}} \times 100$$

A 200 g rough rice was dehulled in Satake Rice mill, followed by 45 second polishing in a satake rice grain Testing Mill TM-05 from which Milling outturn (MOT) was determined by following equation:

$$\text{Milling outturn (\%)} = \frac{\text{Weight of milled rice}}{\text{Weight of rough rice}} \times 100$$

Standard micro Kjeldahl procedure of AOAC (1995) was used for the determination of nitrogen and crude protein was estimated by multiplying the nitrogen content by a factor 5.95. Apparent amylase content (AAC) was determined by the procedure of Juliano (1971). Alkali spreading value (ASV) was determined according to the procedure of Little *et al.* (1958). Volumes of cooked and milled rice were measured by water displacement method. Five grams of milled rice was placed in a graduated cylinder containing 50 ml of water and the change in volume was noted. Five grams of milled rice was cooked and then the cooked rice was placed in the same cylinder and the change in volume was measured. The imbibition ratio (IR) is the ratio of change in the volume of cooked to raw rice (Dipti *et al.,* 2002). A rapid, simple test, complementary to the test for amylose content, was developed based on the consistency of a cold 4.4% milled rice paste in 0.2 M KOH (Cagampang *et al.,* 1972). All the collected data were analyzed following the analysis of variance (ANOVA) technique and using Statistix 10 package and the mean differences were adjudged by LSD test (Gomez and Gomez, 1984).

Results and Discussion

Effect of nitrogen levels

Nitrogen exhibited significant influence on grain quality of transplanted *Aman* rice (Table 1). Both hulling percentage and milling outturn were increased with increasing nitrogen levels and reached its maximum at 150 kg N ha^{-1}. But milling outturn at 150 kg N ha^{-1} was statistically similar with 100 kg N ha^{-1}. Gharieb *et al.* (2016) gave an explanation of such increase that the application of nitrogen increased grain filling rate and consequently decreased the hull thickness. They also explicated the reason of increasing milling outturn with nitrogen levels such that grain metabolic substances were enhanced with increasing nitrogen levels which ultimately enhanced the milling percentage. The lowest protein (8.55%) was obtained from 50 kg N ha^{-1} but protein obtained from 100 and 150 kg N ha^{-1} was statistically similar with each other. Murthy *et al.* (2015) also recorded significant effect of nitrogen on protein content. Apparent amylose content and imbibition ratio decreased with increasing nitrogen levels. Tayefe *et al.* (2014) opined that AAC was decreased with the increase in nitrogen level. Dong *et al.* (2007) delineated the cause that with an increase of nitrogen fertilizer, activation of starch branching enzymes increased and as a result amylopectin percentage increased while in contrast AC decreased. Gel consistency increased from 50 to 100 kg N ha^{-1} then it again lowered down. Similar findings were reported by Tayefe *et al.* (2014) who opined that with an increase in the used amount of nitrogen fertilizer to a certain point, an increase in GC and then a lowering trend resulted. Nitrogen had no significant influence on alkali spreading value which ranged from 5.38 to 5.28 due to different nitrogen levels.

Table 1. Effect of nitrogen on quality characters of transplanted *Aman* rice

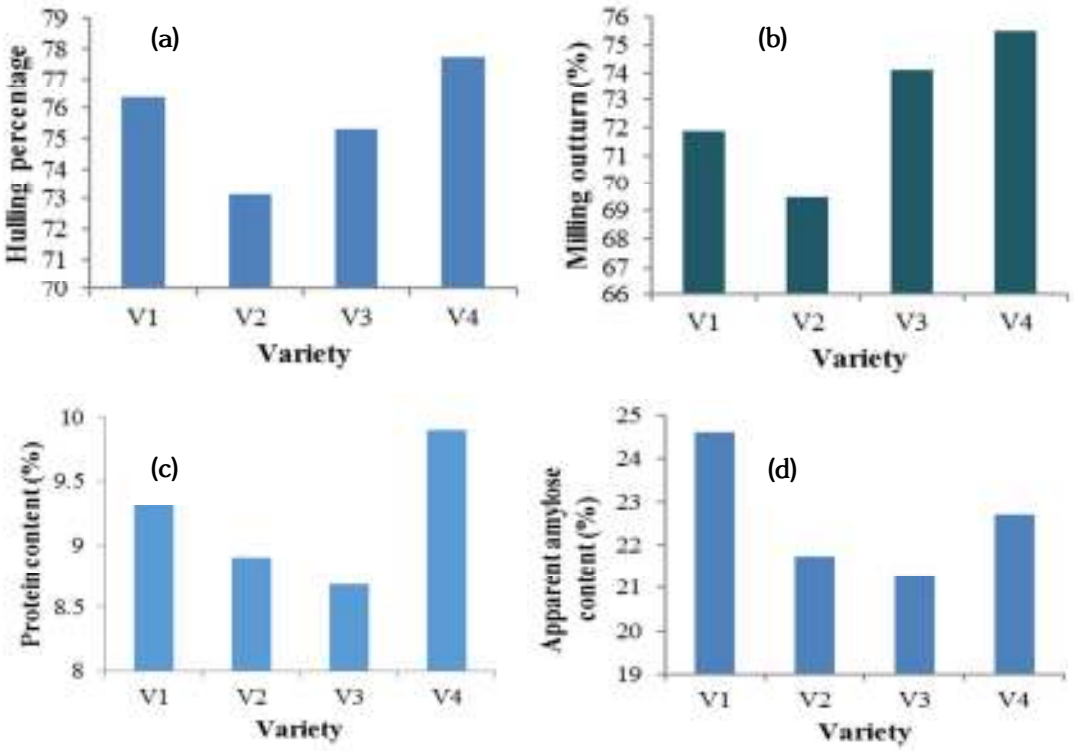
Nitrogen level	Hulling percentage	Milling outturn (%)	Protein content (%)	AAC (%)	Imbibition ratio	Gel consistency	ASV
N_1	72.78 c	68.36 b	8.55 b	24.18 a	4.48 a	88.91 b	5.38
N_2	75.44 b	74.03 a	9.60 a	22.29 b	4.35 b	96.19 a	5.28
N_3	78.66 a	75.81 a	9.48 a	21.27 c	4.20 c	89.79 b	5.38
$LSD_{(0.05)}$	2.51	2.08	0.33	0.88	0.03	3.75	NS
CV (%)	2.93	2.52	3.15	3.45	0.59	3.61	4.39

N_1= 50 kg N ha^{-1}, N_2= 100 kg N ha^{-1}, N_3= 150 kg N ha^{-1}
AAC = Apparent amylase content, ASV = Alkali spreading value

Effect of variety/line

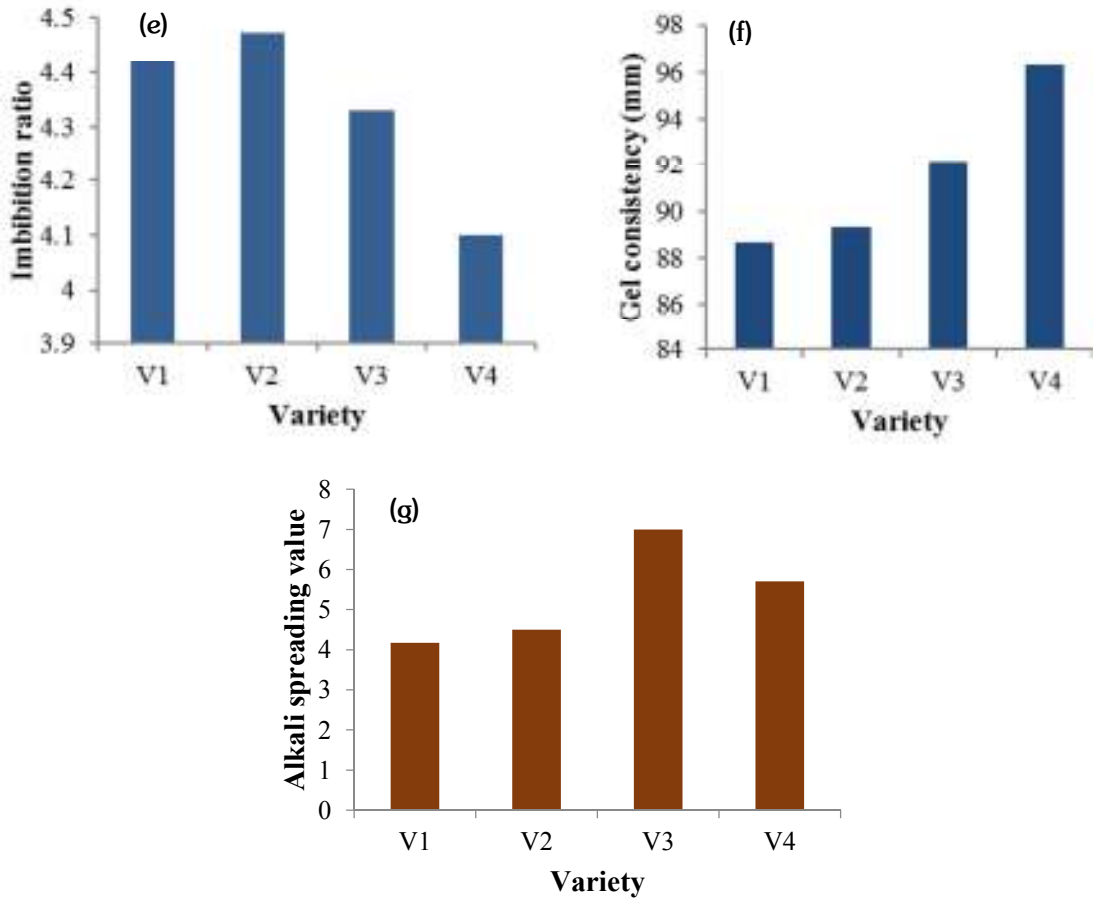
Varietal difference had significant impact on grain and nutrition quality of transplanted *Aman* rice (Figure 1 & 2). Among the tested materials, SAU ADL11 had the highest hulling percentage (77.74) and BRRI dhan70 had the lowest (73.12). Three variety/line showed milling outturn more than 70% where SAU ADL1 gave maximum value (75.49%). Variation in hulling percentage and milling outturn due to varietal differences was also reported by Shozib *et al.* (2017) and Khaled *et al.* (2014). Varieties with higher milling outturn have more shelf life and provide more whiteness that consumer desires (Hosen *et al.,* 2017). Again, SAU ADL11 contained about 13 % more protein (9.90 %) than BRRI hybrid dhan6 and considerably higher amount than other two. (Sarker *et al.,* 2014) enunciated genetic make-up as the possible reason for varietal differences regarding grain protein content. All the tested materials contained intermediate amylose content (20-25%). Among them SAU ADL1 contained significantly higher apparent amylose content (24.60%). Hosen *et al.* (2017) and Matin *et al.* (2017) reported

difference in amylose content among varieties. Rice having intermediate AAC (20-25%) provides soft and relatively sticky cooked rice (Hosen *et al.,* 2017). The highest imbibition ratio (4.47) was obtained from SAU ADL1 and lowest imbibition ratio (4.10) was obtained from SAU ADL11. Variety with higher imbibition ratio (IR) absorbs more water during cooking and considered as good quality by the lower income people (Shozib *et al.,* 2017). The imbibition ratio of BRRI dhan28 is 4.3 which means 1 kg rice could produce 4.3 kg cooked rice, a mega variety in *Boro* season in Bangladesh (Shozib *et al.,* 2017). As, SAU ADL1 had higher IR (4.47) than BRRI dhan28, so this character may be explored in HYV for mega variety release. Again, lower the imbibition ratio, higher will be the energy content per unit volume or weight of cooked rice as they have less water and more solid materials (Dipti *et al.,* 2002). So, SAU ADL11 had more energy content that other tested cultivars. The highest gel consistency (96.32 mm) was observed in SAU ADL11 followed by BRRI hybrid dhan6 (92.19 mm). The lowest gel consistency (88.67 mm) was recorded in SAU ADL1 which was statistically similar with BRRI dhan70 (89.33 mm). Tayefe *et al.* (2014) also documented the variation in gel consistency due to varietal variation. According to Graham (2002), GC 40 mm or less gives very flaky and hard rice, GC 41-60 mm gives medium flaky rice and GC more than 61 mm give soft rice. All the tested materials had GC ranging from 88-97 mm which gave soft cooked rice after cooling. The highest alkali spreading value (7.00) was obtained from BRRI hybrid dhan6 and the lowest ASV was obtained from SAU ADL1. Matin *et al.* (2017) reported that alkali spreading value was negatively correlated with the cooking time which indicates that cooking time was higher for those varieties which had low alkali spreading value.



V_1 = SAU ADL1, V_2 = BRRI dhan70, V_3 = BRRI hybrid dhan6, V_4 = SAU ADL11

Fig. 1. Effect of variety on (a) hulling percentage (b) milling outturn (c) protein content (d) apparent amylose content of transplanted *Aman* rice ($LSD_{(0.05)}$= 1.72, 3.04, 0.36 and 1.42, respectively).



V_1 = SAU ADL1, V_2 = BRRI dhan70, V_3 = BRRI hybrid dhan6, V_4 = SAU ADL11

Fig. 2. Effect of variety on (e) Imbibition ratio (f) gel consistency (g) Alkali spreading value of transplanted *Aman* rice ($LSD_{(0.05)}$= 0.03, 1.54 and 0.22, respectively).

Interaction effect of nitrogen level and variety

Significant variation in quality characters of transplanted *Aman* rice was recorded for interaction of nitrogen level and variety/line (Table 2). All the studied materials were more responsive to higher nitrogen doses regarding hulling percentage and milling outturn. Both of these parameters increased with increasing nitrogen levels among all the varieties. Khaled *et al.* (2014) also found significant effect of nitrogen and variety on hulling percentage but no significant effect on milling percentage. The maximum protein (10.36%) was obtained from SAU ADL11 fertilized with 100 kg N ha^{-1} (N_2V_4) which was statistically similar with N_3V_4 (10.15 %). Lower protein (7.51%) was obtained from BRRI hybrid dhan6 fertilized with 50 kg N ha^{-1} (N_1V_3) which was statistically similar with N_1V_2 (7.81%). The protein content of BRRI hybrid dhan6 and BRRI dhan70 increased with increasing nitrogen levels but protein content of SAU ADL1 and SAU ADL11 increased with increasing nitrogen levels from 50 to 100 kg N ha^{-1} but further increase to 150 kg N ha^{-1} could not increase protein content. Kaur *et al.* (2016) worked with a rice cultivar PAU201 and found that protein content decreased with the increasing nitrogen from 60 to 120 kg N ha^{-1}. Zhang *et al.* (2017) also found such trend of this parameter and concluded

that N rate up to a certain level was sufficient to satisfy N uptake requirement of crop from soil. Apparent amylose content and imbibition ratio decreased among all the studied materials with increasing nitrogen levels. Da-wei *et al.* (2017) reported that amylose content decreased among varieties with the increase of nitrogen levels. Khaled *et al.* (2014) and Maqsood *et al.* (2013) also confirmed these results. The maximum gel consistency (97.63 mm) was obtained from SAU ADL11 fertilized with 100 kg N ha^{-1} (N_2V_4) which was statistically similar with N_3V_4 (97.32 mm), N_2V_1 (96.00 mm), N_2V_2 (96.00 mm) and N_2V_3 (95.11 mm). The lowest gel consistency (80.00 mm) was obtained from N_1V_1. Gel consistency was significantly influenced by interaction effect of nitrogen and variety that was also supported by Tayefe *et al.* (2014) who reported that interaction effect of nitrogen and variety had significant influence on gel consistency. The highest alkali spreading value (7.00) was recorded in BRRI hybrid dhan6 fertilized with 50, 100 and 150 kg N ha^{-1}. The lowest alkali spreading value (3.50) was obtained from SAU ADL1 fertilized with 50 kg N ha^{-1} (N_1V_1) and BRRI dhan70 fertilized with 150 kg N ha^{-1} (N_3V_2). The interaction of nitrogen and BRRI hybrid dhan6 had no significant influence on ASV but interaction of nitrogen with other studied materials had significant influence.

Table 2. Interaction effect of nitrogen and variety on quality characters of transplanted *Aman* rice

Interaction	Hulling percentage	Milling outturn (%)	Protein content (%)	AAC (%)	Imbibition ratio	Gel consistency	ASV
N_1V_1	74.85 cd	67.33 ef	9.50 bcd	25.67 a	4.80 a	80.00 e	3.50 e
N_1V_2	71.31 f	63.67 f	7.81 e	24.84 a	4.80 a	92.00 cd	5.50 c
N_1V_3	72.48 ef	70.27 de	7.51 e	21.85 cd	4.30 c	89.63 d	7.00 a
N_1V_4	72.48 ef	72.15 b-e	9.40 bcd	24.37 ab	4.50 b	94.00 bc	5.50 c
N_2V_1	76.77 bcd	72.79 a-d	9.60 bc	24.00 abc	4.30 c	96.00 ab	4.50 d
N_2V_2	72.28 ef	71.78 cde	9.52 bcd	21.50 d	4.30 c	96.00 ab	4.50 d
N_2V_3	74.63 de	74.89 a-d	8.93 d	21.43 d	4.50 b	95.11 ab	7.00 a
N_2V_4	78.08 bc	76.68 abc	10.36 a	22.23 bcd	4.30 c	97.63 a	5.17 c
N_3V_1	77.40 bcd	75.52 a-d	9.00 cd	24.15 abc	4.30 c	90.00 d	4.50 d
N_3V_2	75.77 cd	72.91 a-d	9.37 bcd	18.86 e	4.30 c	80.00 e	3.50 e
N_3V_3	78.82 b	77.18 ab	9.60 bc	20.58 de	4.2 d	91.83 cd	7.00 a
N_3V_4	82.67 a	77.63 a	9.93 ab	21.49 d	3.50 e	97.32 a	6.50 b
$LSD_{(0.05)}$	2.99	5.27	0.62	2.45	0.06	2.66	0.38
CV (%)	2.30	4.22	3.95	6.33	0.78	1.69	0.92

N_1 = 50 kg N ha^{-1}, N_2 = 100 kg N ha^{-1}, N_3 = 150 kg N ha^{-1}, V_1 = SAU ADL1, V_2 = BRRI dhan70, V_3 = BRRI hybrid dhan6, V_4 = SAU ADL11.

Conclusion

Nitrogen had significant impact on grain and nutritional quality of all the tested materials except alkali spreading value. The line SAU ADL11 gave highest hulling percentage, milling outturn, protein content, gel consistency, lowest imbibition ratio and intermediate amylose content. So, considering nutritive value and quality purpose, SAU ADL11 has a great potential. Again SAU ADL1 had the highest amylose content and imbibition ratio. The two targeted materials of SAU ADL1 and SAU ADL11 performed better with 100 kg Nha^{-1} in case of protein content and eating/cooking quality. But more investigation is suggested to find out a complete management package for this two promising lines.

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