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RICE GRAIN QUALITY ATTRIBUTES AFFECTED BY DIFFERENT RATES OF NITROGEN FERTILIZER APPLICATION

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ABSTRACT

Nitrogen fertilizer application for rice facilitates growth as well as postharvest attributes of gain quality. Grain quality attributes are defined as fitness for the purpose and may vary among individual consumers. A research study was conducted in 2005 *yala* to investigate the effect of different nitrogen rates on some grain quality attributes. The experiment was established with four nitrogen levels (0, 50, 100, 150 kgNha^{-1}) and three white pericarp rice varieties (Bg 403, Bg 379-2 and Bg 2893) arranged in a split plot design with three replicates. Quality attributes such as brown rice (BR%), head grain (HG%), protein, bran (%), contents, whiteness, hardness, ash content and amylose content were determined according to standard practices. Increasing nitrogen rates increased BR%, HG%, protein and hardness, and decreased while bran%, and whiteness. Bg 379-2 was rated the best for most quality attributes.

KEYWORDS: Grain quality, Nitrogen, Rice.

INTRODUCTION

An average Sri Lankan consumes 2286 cal daily and 979 cal are gained from rice (Central Bank, 2004). Rice contains around 65% and 71% starch in milled and brown rice respectively. Rice is the major source of dietary protein for most people in tropical Asia and also the principle source of calories and proteins of Sri Lankans because of the favourable amino acid balance. Rice protein is one of the most required nutrients and it is unique among cereal proteins being the richest in glutelin and lowest in prolamin. However, the low protein content of rice is a major nutritional limitation.

Nitrogen is one of the most limiting nutrients in rice cultivation in Sri Lanka. Yang *et al.* (2001) reported that N application at higher rates might be unsuitable for rice because it affects grain-filling rate. Application of nitrogen in three splits has been reported to increase thousand-grain weight and head grain than two splits (Ali *et al.*, 1992). Nitrogen absorbed at early growth stage is used to produce more straw than grain while N absorbed at later growth stages is used to produce more grain than straw.

In rice production, milling quality is an important factor and determines the income of farmers. Head rice is the primary factor that

determines world market prices. Nitrogen fertilization is a management tool that affects rice yield and milling quality.

Head rice is more valuable than broken and consumers prefer high head rice content and more translucent rice. Degree of milling affects the proximate composition of milled rice, milling yield and whiteness value, which influence the overall economics of the production system. This study was carried out to investigate the influence of different nitrogen rates on some rice grain quality attributes such as brown rice, head grain, protein and bran contents, whiteness and hardness values and ash and amylose contents.

MATERIALS AND METHODS

A field trial was established at Rice Research and Development Institute, Batalagoda using three rice varieties (Bg 403, Bg 379-2 and Bg 2893) with 3 replicates in *yala* 2005. Treatments were arranged in a spit plot design with four nitrogen (N) levels (0, 50, 100, 150 $kgha^{-1}$). Zero nitrogen level represented the control. As basal, 1st top and 2nd top dressings of 6, 33 and 22 $kgha^{-1}$ of N were added to N-50; 12, 66 and 44 $kgha^{-1}$ for N-100; and 18,100 and 67 $kgha^{-1}$ for N-150. Samples collected at maturity were threshed and shade dried until it reached equilibrium moisture content of 13%.

Each sample was tested for grain quality attributes such as brown rice percentage (BR%), head grain percentage (HG%), whiteness, hardness, protein, ash and amylose contents. Samples were de-hulled and milled in a Mc gill sample mill for 1 minute. BR%, HG% and amylose content of each variety were calculated according to Cruz and Kush (2000). To determine whiteness, KETT digital whiteness meter was used. The whiteness meter was calibrated using the standard plate, which has a value of 83.4. Nitrogen contents were determined by Kjeldhal method to determine protein content. Ash content was determined after ashing the head rice in a muffle furnace at 550°C for four hours. Ten undamaged, brown rice grains, without cracks were selected using a grain scope (TX200-KETT) and placed one at a time in Hardness Tester (No. 174886) to measure the hardness value.

RESULTS AND DISCUSSION

Application of high nitrogen (N) rates has increased milling attributes; BR% (Table 1) and HG% (Fig. 1). Increasing the nitrogen dose to over 100$kgha^{-1}$ did not affect BR% but increased HG%. Similar findings were reported by Jongkaewwattana *et al.* (1993); Perez *et al.* (1996) and Leesawatwang *et al.* (2004). It was evident that protein content of rice at highest N application was maximum and minimum at the lowest rate (Fig. 2). Leesawatwang *et al.* (2004) have explained that the greater abundance of insoluble protein store in peripheral region of the endosperm was closely

associated with less endosperm breakage during milling. These findings suggest that there is likely to be a threshold level of protein accumulation in the peripheral part of the grain that is required to prevent breakages during milling. According to Umetsu *et al.* (1990), the increase in grain protein content was greater with higher rates of applied N and varied with cultivars. Singh *et al.* (2001) state that grain N content decreased with increased duration of polishing and protein content decreased as the degree of polish increased for all varieties. This may be due to non-uniform distribution of protein within the endosperm.

These conclusions were also supported by the results of other workers who have observed increase in head rice and milled rice protein (Perez *et al.*, 1996). Furthermore Cagampang *et al.* (1966) found that brown rice with higher protein content was more resistant to abrasive milling than brown rice with lower protein in the same cultivar. This was explained by hardness value of brown rice when nitrogen was supplied in high amounts due to high accumulation of nitrogen in the grain. Hardness is found to be high in high nitrogen levels (Fig. 3). Results of this experiment on protein content agree with above statements made by previous researchers. Karim *et al.* (1993) reported that the Total Milled Rice percentage and HG% decreased gradually as milling pressure increased and the degree of whiteness of polished grain increased with increasing milling pressure.

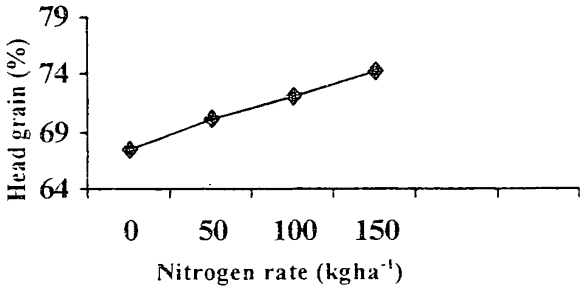

Figure 1. Head grain percent of rice at each N rate.

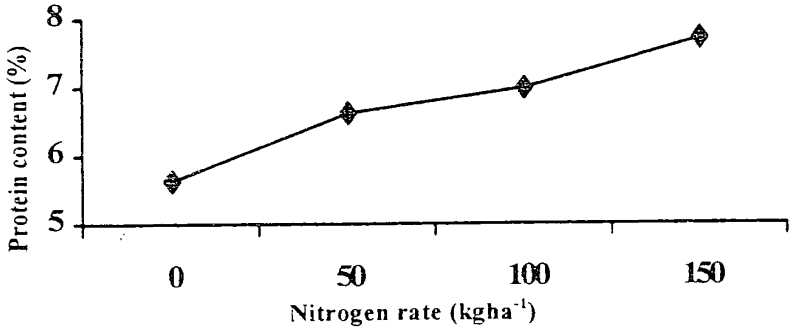

Figure 2. Protein content of rice at each N rate.

Whiteness of rice decreased gradually with the increase in nitrogen application rates (Fig. 4). Perez *et al.* (1996) reported this decrease in

whiteness was mainly due to increased protein content and not due to under milling of high protein samples. But according to the results of bran% at each N treatment, it was significantly lower at the high N application (Table 1). Therefore, it is evident that extra bran, which was not removed during milling, affects whiteness of grain. All these attributes are inter-related. Less bran removal in high N treatment gives high milling recovery. Adhering of bran to the endosperm gives less whiteness and increases storage of more nitrogen, which gives high protein content.

Table 1. Rice grain quality parameters at each nitrogen rate.

Rate of N (kgha^{-1})	*BR %* *	*Bran %**	*Ash content**	*Amylose content**
0	80.11 c	8.08 a	0.83 a	34.8 a
50	80.47 b	8.29 a	0.87 a	32.9 b
100	81.14 a	7.61 b	0.81 a	31.2 c
150	81.28 a	7.07 c	0.81 a	28.7 d

*Means with the same letters along the column are not significantly different

Amylose content of the three rice varieties could be altered by different N levels as it shows a strong negative relationship with increasing N levels (Table 1). However, they gave significant differences among the treatments falling to group of high amylose. A similar response was reported by Sartaj *et al.* (2003). Ash content didn't show any relationship to N rates (Table 1).

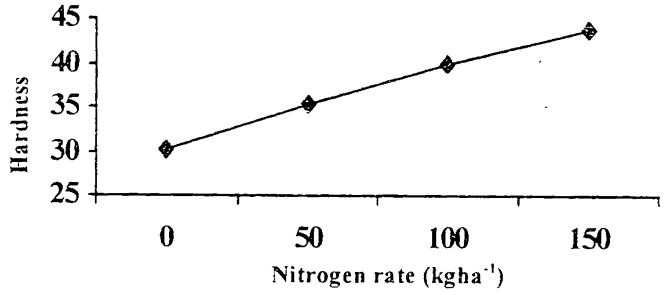

Figure 3. Hardness of rice at each N rate.

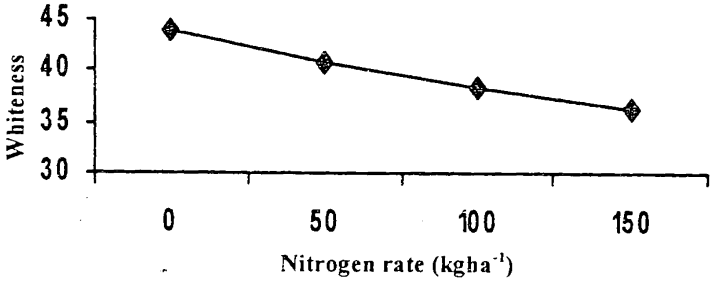

Figure 4. Whiteness of rice at each N rate.

Bg 403 and Bg 379-2 showed significantly higher HG% than Bg 2893 the values being 71.96, 71.72 and 69.34 respectively (Fig. 5). The BR% was significantly high in Bg 403 and Bg 2893 (Table 2). In contrast to HG% results of the three varieties, Bg 2893 had the highest bran% (Fig. 6).

As shown in Table 2, Bg 379-2 scored the maximum value for protein content, whiteness and ash content. Thus Bg 379-2 seems to be the best among the 3 varieties tested.

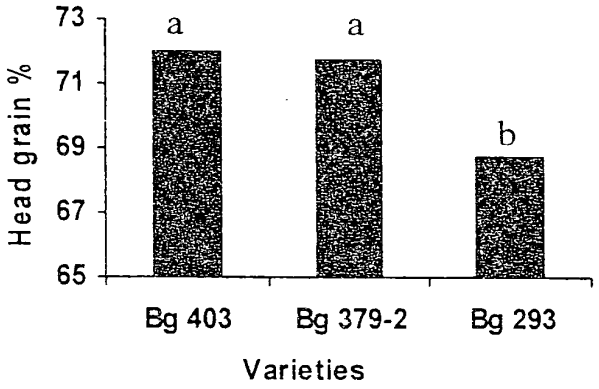

Figure 5. Head grain percent of varieties.

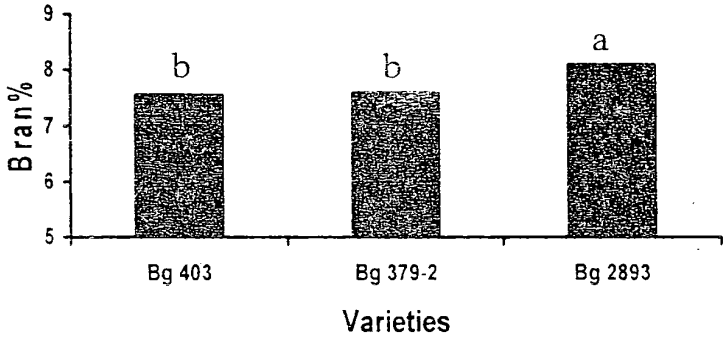

Figure 6. Bran% of varieties.

Table 2. Grain quality parameters of three varieties.

Variety	*BR % **	*Protein content**	*Whiteness**	*Hardness**	*Ash content**	*Amylose content**
Bg 403	81.00 a	6.69 b	38.27 b	36.36 a	0.78 b	30.82 a
Bg 379-2	80.39 b	7.05 a	38.08 a	38.08 a	0.96 a	32.35 a
Bg 2893	80.87 a	6.79 b	37.44 b	37.44 a	0.75 b	32.95 a

*Means with the same letters along the column are not significantly different.

CONCLUSIONS

High nitrogen application improves some quality attributes such as brown rice%, head grain%, protein content, and hardness and lessens bran removal. At the same time, high rate of N affects whiteness adversely

but not the ash content. Among the three rice varieties, Bg 379-2 was ranked the best for most quality attributes.

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