NITROGEN FERTILIZER EFFECT ON TILLERING, DRY MATTER PRODUCTION AND YIELD OF TRADITIONAL VARIETIES OF RICE

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ABSTRACT

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Influence of variable doses of N fertilizer on growth, tillering and yield of three traditional rice varieties was compared with that of a modern variety in a field experiment. The experiment was conducted at Bangabandhu Sheikh Mujibur Rahman Agricultural University farm Salna, Gazipur during Aman season of 1996 to determine the tillering pattern, total dry matter production and yield performance of three local and one modern cultivar as influenced by nitrogen fertilizer. Application of 60 kg N ha^{-1} produced more TDM and lesser ineffective tillers. Traditional varieties accumulated higher amount of vegetative dry matter than the modern variety. Cultivar KK-4, a high yielding variety outyielded (4772 kg ha^{-1}) the indigenous varieties Jharapajam (4150 kg ha^{-1}), Lalmota (3628 kg ha^{-1}) and Bansful Chikon (3575 kg ha^{-1}). Application of 30 kg N ha^{-1} appropriate for low responsive traditional varieties produced the highest yield (4451 kg ha^{-1}).

Key words: Traditional rice varieties, nitrogen fertilizer, tillering, dry matter and yield.

INTRODUCTION

Rice (*Oryza sativa*) is the staple food for nearly half of the world's population. Rice is the single most important crop in Bangladesh occupying over 75% of total cultivated area (BBS, 1999). Although there has been a spectacular growth in the production of rice in Bangladesh during the past several decades, the demand for rice is still on the increase because of ever increasing population. The response of rice to the application of nitrogen is almost universal; the extent of response of maximum grain yield with a particular varietal type depends upon differences among soils, seasons and the response potential of the variety (Rao, 1985). Among the various factors affecting nitrogen response in rice, varietal type is of particular significance (De Datta, 1970). Literature on the influence of nitrogen on the growth and yield of modern rice across ecosystems abound. However, similar information's on the traditional varieties are scanty. After the attainment of self-sufficiency in food grains, there has been increasing demand for quality rice, particularly of indigenous varieties. Against this background information on the magnitude of nitrogen response of traditional rice varieties are essential. The tiller number and total dry matter production is closely correlated with yield depending on the rice cultivar (Tanaka, 1968). Bangladesh has had a large number of rice cultivars and land races. With the introduction of modern varieties, traditional varieties under cultivation have dwindled drastically; but still the area occupied by those of old varieties exceeds 30% of the total land under Aman rice. With the introduction of modern varieties, research efforts have been intensified for raising yield potentials of short statured modern varieties but the local varieties somehow escaped the attention of the scientists over the past few decades. The present study compared the tillering pattern and dry matter production of traditional varieties of rice at variable doses of N fertilizer with a view to better understanding the causes of variation in yield performance.

MATERIALS AND METHODS

A field experiment was conducted in Aman season of 1996 at the Bangabandhu Sheikh Mujibur Rahman Agricultural University, Salna, Gazipur with three traditional cultivars (viz. Jharapajam, Lalmota, Bansful Chikon) and a modern cultivar (viz. KK-4) grown as check each at four levels of nitrogen (0, 30, 60 and 90 kg ha^{-1}). The traditional varieties were originated in south and southeastern districts of Bangladesh and the modern variety was collected from Khoenkhen, Thailand. The three indigenous local varieties represent medium to bold grain rice while KK-4 is exotic long and slender grained rice. The treatments were arranged in a split-plot design and replicated three times. Unit plot was $10m^2$. Thirty days old seedlings were planted on August 20, 1996 maintaining two seedlings in each hill. Seedlings were planted in rows 25 cm apart and the distance between the hills in a row was 10 cm. A blanket rate fertilizer at 40 kg P_2O_5, 20 kg K_2O, 20 kg S and 8 kg Zn ha^{-1} was applied uniformly in all the plots and thoroughly incorporated into the soil at the time of final land preparation. Nitrogen was applied as per treatments in the form of urea in three splits- once immediately after the establishment of seedlings, the next was at maximum tillering stage and final top dressing was done at panicle initiation stage. Intercultural operations and plant protection measures were taken as and when necessary. For the determination of growth and other characters, plants were sampled from the plots at 15 days interval. At

each sampling, 10 hills per plot were pulled out from the second row avoiding the border effect. The number of tillers in each 10 hills was counted and means of each hill were recorded. Plant parts were separated as green leaf, dead leaf, leaf sheath, stem and panicle and oven dried at 80^0 C for 48 hours and total dry weight recorded. Grain yield of rice was determined harvesting a sample area of $5m^2$ from the middle of each plot.

RESULTS AND DISCUSSION

Tillering pattern

Both nitrogen fertilizer application and variety exerted significant influence on the production and retention of tillers through growth stages (Fig. 1 and fig. 2). Averaged over nitrogen fertilizer treatment, cultivar KK-4 produced the largest number of tillers (414 m^{-2}) followed by Lalmota (377m^{-2}) at maximum tillering stage, while Bansful Chikon produced the least (355m^{-2}). This was rather expected because the high yielding varieties normally produced larger number of tillers (IRRI, 1988). Tiller mortality began past the maximum tillering stage and the number of tillers per unit area declined gradually reaching the lowest at maturity stage. The highest rate of tiller mortality was observed in KK-4 (44%) and the least (33-34%) in Lalmota and Bansful Chikon. At maturity, cultivar Lalmota displayed the largest number of tillers (251 m^{-2}). However, the magnitude of differences in tillers at maturity was minimum that ranged between 224 and 251 m^{-2}.

From table 1 it is discernible that irrespective of varietal differences higher the nitrogen, greater was the number of tillers. Earlier, Takahashi and Sasiprapa (1976) observed that plants absorbing N from tillering to panicle initiation tended to increase the number of tillers.

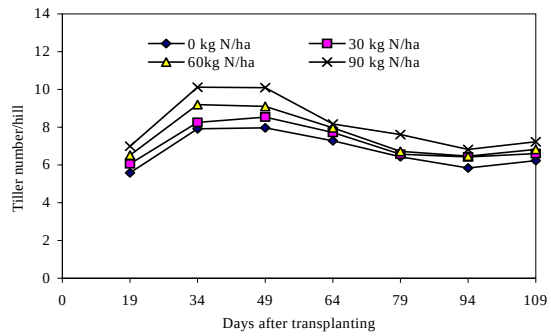

Figure 1. Tiller number of rice as influenced by nitrogen fertilizer rates

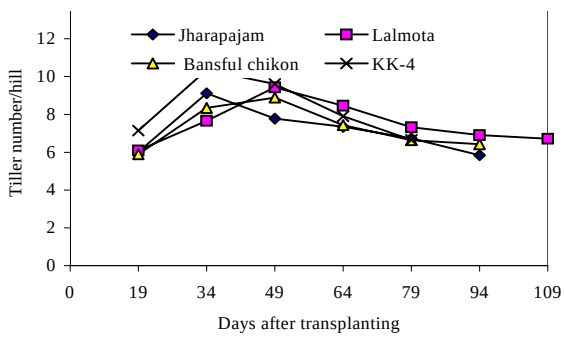

Figure 2. Tiller number of rice as influenced by different varieties

Varietal differences in the production and retention of unproductive tillers as influenced by nitrogen fertilizer applied are shown in fig. 3. Two varieties Jharapajam and Lalmota showed the lowest percentage of unproductive tillers at maturity and nitrogen fertilizer application seems to have little influence on the production of unproductive tillers in these two varieties. But in Bansful Chikon and KK-4 the percentage of unproductive tillers was appreciably higher and nitrogen fertilizer application influenced greatly the rate of unproductive tiller production. An application of 60 kg N ha^{-1} tended to keep the percentage of unproductive tillers at a minimum, but it was higher when the rate increased to 90 kg ha^{-1}.

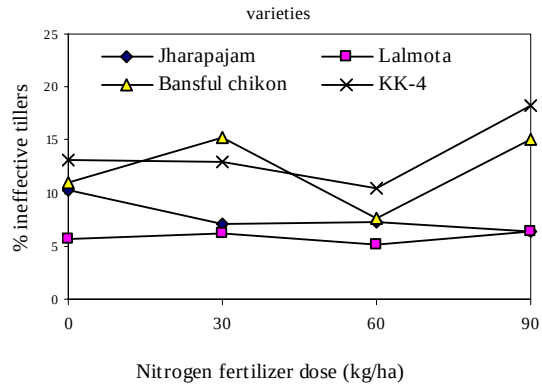

Figure 3. Influence of variety and nitrogen fertilizer on the production of ineffective tillers in rice at maturity

Total dry matter production

Total dry matter (TDM) accumulations in rice as observed at heading and maturity stages are shown in table 2. TDM ranged between 817 gm^{-2} and 1051 gm^{-2} at heading and 1127 gm^{-2} and 1383 gm^{-2} at maturity. Averaged over nitrogen fertilizer treatments, Lalmota and Bansful Chikon produced more TDM at heading than the other varieties. On the contrary, Bansful Chikon and Jharapajam accumulated higher amount of DM at maturity while KK-4 produced the least. A closer look at the results reveals that Jharapajam had significantly higher dry matter production during the post-heading period than the other two varieties. At heading stage, TDM tended to increase linearly with increasing rate of applied nitrogen.

Table 1. Nitrogen fertilizer and varietal effect on tillering of rice

Treatment	Tillers at maximum tillering stage (m^{-2})	Tillers at heading (m^{-2})	Tillers at maturity (m^{-2})
N rates (kg ha^{-1})			
0	337	272	222
30	351	286	234
60	392	305	248
90	434	318	247
LSD(0.05)	29.7	27.8	20.0
Variety			
Jhara pajam	368	294	224
Lalmota	377	306	251
Bansful Chikon	355	266	233
KK-4	414	316	243
LSD (0.05)	33.4	21.6	18.7

Table 2. Nitrogen fertilizer and varietal effect on total dry matter and grain yield of rice

Treatment	Total dry matter (TDM) (gm^{-2})	Total dry matter (TDM) (gm^{-2})	Grain yield (kg ha^{-1})
	At heading	At maturity	
N rates (kg ha^{-1})			
0	817	1127	3398
30	886	1295	4451
60	944	1383	4389
90	1051	1298	3888
LSD(0.05)	103.11	103.11	320.38
Variety			
Jhara pajam	768	1347	4150
Lalmota	1087	1250	3628
Bansful Chikon	1063	1360	3575
KK-4	780	1139	4772
LSD (0.05)	65.02	65.02	388.63

Prasad (1981) observed the increase of TDM due to increased N application. Jharapajam and KK-4 had considerably lower amount of TDM at heading than Bansful Chikon and Lalmota. Although fertilizer nitrogen application increased TDM but even at the highest rate of nitrogen it remained lower than the DM accumulated by other two varieties grown without added nitrogen. At maturity, TDM increased with increasing rate of nitrogen fertilizer reaching a maximum at 60kg N ha^{-1} and further addition of N tended to decrease TDM.

Yield

Table 2 shows the variation in yield performance due to variation and application of nitrogen fertilizer. Yield varied between 3398 to 4451 kg ha^{-1} across N fertilizer treatments and application of 30 kg N produced statistically higher grain yield than other treatments. Further increase in N rates caused lower grain yield. Akita (1989) reported that excess nitrogen gave higher dry weight at heading causing a yield decline due to reduced ripening percentage. Grain yield varied between 3575 kg and 4772 kg ha^{-1} across varieties. KK-4 produced the highest yield (4472 kg ha^{-1}) followed by Jharapajam (4150 kg ha^{-1}). Lalmota produced (3628 kg ha^{-1}) and Bansful Chikon gave the lowest (3575 kg ha^{-1}). Variation in grain yield among the varieties thus was not due to variation of total dry matter or the number of tillers per unit area. Despite greater amount of TDM accumulation the traditional varieties produced lower grain yields suggesting low harvest index (IRRI, 1977).This was perhaps due to poor rates of translocation from vegetative organs to reproductive sinks.

Table 3. Interaction effect of nitrogen fertilizer rates and variety on harvest index of rice

Variety	Nitrogen rates (kg ha^{-1})			
	0	30	60	90
Jharapajam	0.33Bb	0.40Ba	0.41Ba	0.38Ba
Lalmota	0.36Ba	0.41Ba	0.39Ba	0.33Ca
Bansful chikon	0.35Ba	0.36Ca	0.33Ca	0.36Ca
KK-4	0.46Aa	0.48Aa	0.50Aa	0.46Aa

Means followed by common letters are not significantly different at 5% level by DMRT. Capital letter indicates nitrogen fertilizer rate and small letter indicates variety.

Limitation of sink size might also cause lesser translocation towards grains. Significant interaction effect between varieties and N fertilizer rates on HI was observed (Table 3). Evidently the traditional varieties had the lower harvest index values. N fertilizer application at 30 or 60 kg ha^{-1} had increased HI in indigenous variety Jharapajam. In other varieties, N fertilizer did not cause any increment in HI.

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