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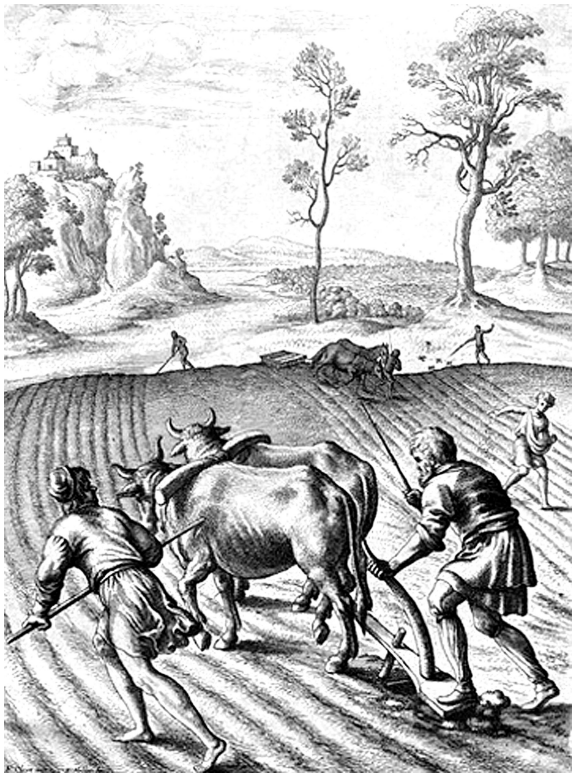

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Effect of Culm Cutting Height and Nitrogenous Fertilizer on the Yield of Ratoon of Late Boro Rice

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Abstract: In ratoon, crop cutting height of culm at above 15 cm was found to be favourable for plant attributes especially 1000 grains weight, grain yield and straw yield. On the other hand, 120 kg N ha^{-1} noticed for the tallest plant, the highest bearing tillers $hill^{-1}$, sterile spikelets $panicle^{-1}$, 1000 grains weight, grain yield and straw yield. In treatment combination of 15 cm culm cutting height of culm and 120 kg N ha^{-1} was found to produce also the highest grain yield. The highest grain yield (1.56 t ha^{-1}) resulted from ratoon crop was 25.16% of the primary crop. The yield and most of the other plant attributes were lower and field duration was also shorter in ratoon crop than those of the primary crop.

Key words: Culm cutting height, nitrogenous fertilizers, ratoon, late boro rice

Introduction

Ratooning is more or less a general practice of sugar-cane production in Bangladesh. Though in Bangladesh not much of rice ratooning have been done and it has not yet attracted the attention of researchers but in some advanced countries of the world like USA, Japan, Formosa, India, Swaziland and China specially in Hunan, Hupei, Szechuan and Kweichow province (Yang, 1940) the ratooning of rice is being practiced to some extent and its advantages realized. It is known as stubble rice in USA, regeneration rice in China, second flowering in rice in London, UK and ratoon rice in India and Bangladesh. Rice ratooning has a great economic advantage as an alternative to double cropping in monsoon areas and increase in rice production in Asia (Krishnamurthy, 1988). Ratooning means the production of a second crop from the stubble through formation of new tillers and branches at the base and nodes of the harvested plant of the previous crops with or without land tillage being done. The factors which affected ratooning ability and grain yield i.e. cutting height, maturity of main crop at harvest, main crop cultural practices (spacing, fertilizer, water management) temp., light intensity etc. (Vergara *et al.*, 1988). Reddy *et al.* (1988) found that the ratoon crop yields were 42-61% of the main crop yields. He also found from another field study, 24% shorter growth duration and 59% higher mean yield than the main crop. Applying N after the main crop harvest consistently increased ratoon crop yields (Turner and McIlrath, 1988). Although the yield of ratoon crop is less but it saves time, cost of land preparation, seedlings and planting, realize economic use of machineries and irrigation problem than the primary crop. Ratoon crop gives satisfactory yields if the stubble of the primary crop is left with 2-3 stem nodes (Volkova and Smetanin, 1970). Like the normal method of rice culture, ratoon crop also responds positively with the fertilization. Increasing N application increased yields, while stubble height had no effect on ratoon yields (Balasubramanian and Ali, 1990). Bollich *et al.* (1988) showed that, with good management, newly developed high yielding semidwarf cultivars can produce significantly higher ratoon crop yields. Mahadeveppa *et al.* (1988) shown that varieties differ widely in ratooning ability, type of tillers produced, growth period duration, grain quality and yield. The ratoon crop matured in 70 days and produced grain yields of up to 3.0 t ha^{-1}, compared with a maturity time of 102 d and a grain yield of 3.9 t ha^{-1} in the preceding main crop (Setty *et al.*, 1993).

After harvesting field remains seasonal fallow for two to three months. Ratoon crop can be grown in this lean period. Boro rice is damaged often by northwesters and hailstorm. This damage could be partially compensated by ratooning in Bangladesh. In late boro ratooning is advantageous, when there are possibilities of damage of harvestable crop by flood because ratooning requires less growth duration than main crop. However, the farmers of the country are not familiar with the ratooning practices in boro rice. Sufficient information based on research works is still lacking on this regard in both home and abroad. Considering the above facts, the present research has been undertaken. It also helps to see the effect of culm cutting height of ratoon and nitrogen fertilizer dose on ratoon seedling production efficiency and to assess the yield potential and economics of the ratoon crop in late boro rice.

Materials and Methods

The study was conducted at the net house of the Department of Agronomy, Bangladesh Agricultural University, Mymensingh. The experiment was carried out in pots. The rice variety BR2 (mala) was selected for experimental work. The growth period was from July to September, 1998. The yield range between 5.5-6.5 t ha^{-1} in boro season. The experiment comprised of the following treatments:

A. Culm cutting height of plant (cm)
$H_1 = 5$
$H_2 = 10$
$H_3 = 15$

B. Level of N fertilization (kg ha^{-1})
N_1 = Control
N_2 = 40
N_3 = 80
N_4 = 120

The experiment was laid out in RCBD. The unit pot size was 204 m^2 in diameter and 36 pots were included in the experimental work. Only N-fertilizer was applied into three splits after cleaning the pots in the ratoon crop according to the treatments. The crops were infested with weeds which were controlled by uprooting by hand as and when required. The crop was attacked by grass hopper *(Nephotettix nigropictus)*. Dimecron 100 EC was applied @ 1.5 t ha^{-1} to control the insects. The pots were observed frequently to notice any change in plant characters throughout the field duration of crop.

The ratoon crop was harvested plot wise when 80% of grain was ripened. The harvested crop was threshed, cleaned and sun dried. The grain was finally dried in an electric oven until its moisture content reduced to 12%. Observations were made on the following plant characters from each pot: I) plant height (cm), ii) number of total tillers $hill^{-1}$, iii) number of effective tillers $hill^{-1}$, iv) panicle length (cm), v) number of grains $panicle^{-1}$, vi) number of sterile spikelets $panicle^{-1}$, vii) 1000 grains weight (g), viii) grain yield (kg) and ix) straw yield (kg).

All data were analyzed statistically. The significance of mean difference were adjusted by Duncan's multiple range test (Gomez and Gomez, 1984).

Results and Discussion

Culm cutting height significantly affected the plant height, total tillers and effective tillers $hill^{-1}$ and grain yield (Table 1). Su *et al.* (1988) concluded that when a ratoon crop is required, the cutting height of the first crop should be determined in accordance with the cultivar used. Andrade *et al.* (1988) work with some cultivars at different cutting heights. He found that cutting at 10 cm reduced the ratooning ability of all cultivars tested. The best ratoon yields occurred with a cutting height of 30 cm. The tallest plant (108.21 cm) was obtained from the culm cutting height of 15 cm. On the contrary, the shortest plant (93.04 cm) was

Table 1: Effect of culm cutting height on crop characters in ratoon crop of late boro rice cv. BR2

	Characters								
Treatments	Plant height (cm)	Breeding tillers hill^{-1} (No.)	Effective tillers hill^{-1} (No.)	Panicle length (cm)	Grains panicle^{-1} (No.)	Sterile spikelets panicle^{-1} (No.)	1000 grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
H_1	93.04b	4.47b	2.82b	18.49	76.50	36.33	20.95	0.68c	1.60
H_2	99.21b	5.74a	3.47ab	18.61	77.50	35.67	20.95	0.90b	1.65
H_3	108.21a	5.67a	4.22a	18.59	74.75	35.58	21.14	1.30a	1.65

Table 2: Effect of fertilizer on crop characters in ratoon crop of late boro rice cv. BR2

	Characters								
N level	Plant height (cm)	Breeding tillers hill^{-1} (No.)	Effective tillers hill^{-1} (No.)	Panicle length (cm)	Grains panicle^{-1} (No.)	Sterile spikelets panicle^{-1} (No.)	1000 grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
N_1	96.17b	4.41c	2.66b	18.84ab	78.78a	36.44	20.93	0.86c	1.42b
N_2	98.81b	4.59c	2.96b	18.10c	73.00b	34.22	20.89	0.99ab	1.56ab
N_3	99.32b	5.54b	2.37b	18.97ab	75.56ab	36.33	21.05	0.91bc	1.80a
N_4	106.80a	6.65a	5.03a	18.36a	77.67a	34.44	21.18	1.07	1.86a

Table 3: Effect of culm cutting height and level of N fertilizer combination on crop characters in ratoon of late boro rice cv. BR2

	Characters								
N level	Plant height (cm)	Breeding tillers hill^{-1} (No.)	Effective tillers hill^{-1} (No.)	Panicle length (cm)	Grains panicle^{-1} (No.)	Sterile spikelets panicle^{-1} (No.)	1000 grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
H1N1	96.17d-g	4.38c	2.15	18.53b	80.00ab	36.00c-e	20.85b	0.64e	1.06
H2N1	89.50fg	4.42c	2.58	17.9c	76.00bc	37.00a-d	21.16ab	0.57e	1.59
H3N1	83.67g	4.32c	2.67	18.8b	71.00d	39.33ab	21.16ab	0.66de	1.81
H1N2	102.08b-d	4.72c	3.89	18.17b	79.00ab	33.00ef	20.63b	0.84d	1.93
H2N2	92.67ef	4.35c	2.67	19.47a	82.33a	35.33c-f	20.80b	0.67e	1.14
H3N2	96.16d-f	4.53c	2.80	18.50b	71.33d	33.00cd	20.83b	1.01c	1.50
H1N3	106.50bc	6.49ab	3.21	18.70b	79.33ab	34.33ef	20.88b	1.07c	1.71
H2N3	101.5b-d	7.61a	5.21	17.80c	77.00bc	40.00a	21.30ab	0.83d	2.25
H3N3	99.67c-e	4.48c	3.17	18.53b	74.00cd	38.00a-c	21.13ab	1.25b	1.34
H1N4	109.2ab	4.80c	3.50	17.90c	71.67d	32.67f	20.70b	1.40ab	1.63
H2N4	107.80bc	5.78bc	4.22	19.40a	76.33bc	35.33c-f	21.13ab	1.00c	1.70
H3N4	116.10a	7.61a	5.99	18.53b	77.30bc	36.33b-d	21.62a	1.56a	2.94

In a column the value having common letter(s) do not differ significantly at 1% level of probability as per DMRT,
Culm cutting height of plant = H, Level of N fertilization = N,
H_1 = 5 cm, H_2 = 10 cm, H_3 = 15 cm, N_1 = Control, N_2 = 40 kg N ha^{-1}, N_3 = 80 kg N ha^{-1}, N_4 = 120 kg N ha^{-1}

produced from the 5.0 cm of culm cutting height. This might be due to more nutrient stored in 15 cm cutting height of culm than 5.0 cm for the nourishment of plant. Results indicated that the highest number (5.74) of total tillers hill^{-1} was recorded in 10 cm cutting height of culm. On the other hand, the lowest number (4.47) of total tillers hill^{-1} was found in 5.0 cm cutting height of culm. Gupta *et al.* (1987) work with some photoperiod-sensitive varieties for ratooning ability on the basis of some plant attributes like viable buds, ratoon tillers etc. He found that varietal differences in ratoon tillering were not significant, but cutting height effect and variety x cutting height interaction effects were significant. A higher cutting height value resulted in a higher ratoon tillering. Prakash *et al.* (1988) found the main crop was cut 15 cm above the ground, the number of tillers produced was highest in genotypes which had high main crop yields. The highest number (4.22) of effective tillers hill^{-1} was observed in 15 cm cutting height of culm. This was perhaps due to more food material reserved in rice plant during the production of ratoon crop. On the other hand, the lowest number (2.82) of effective tillers hill^{-1} was produced in 5.0 cm cutting height of culm.

Cutting height of culm did not show any significant variation on panicle length, grains panicle^{-1}, sterile spikelets panicle^{-1}, 1000 grains weight and straw yield. The longest panicle (18.61 cm) was produced from 10 cm cutting height of culm and the shortest panicle (18.49 cm) was produced in 5.0 cm culm cutting height. It happened due to some residual effect of fertilizers which were applied in the previous crop. Organic manures releases nutrients very slowly. Therefore combined application of organic and chemical fertilizers exerts a considerable residual effect on the succeeding crop. Rathore *et al.* (1995) investigated the residual effect of organic and inorganic fertilizers applied in rice field and found that the yield of succeeding crop significantly increased. The highest number (77.50) of grains panicle^{-1} was found in 10 cm cutting height of culm. The lowest number (74.75) of grains panicle^{-1} was produced in 15 cm cutting height of culm. Yoshida (1981) reviewed some works on the relationships among the yield components and concluded that, though these were mostly governed by the genotype, nutrient variations may affect the number of grains/panicle to some extent. The highest number (36.33) of sterile spikelets panicle^{-1} was found in 5.0 cm cutting height of culm. It might be due to some unknown physiological disorder occurred in plant body to accumulate food material to grains. The lowest sterile spikelets panicle^{-1} (35.58) was observed in 15 cm cutting height of culm. The highest 1000 grains weight (21.14 g) was produced where culm cutting height was maintained 15 cm. The lowest 1000 grains weight (20.95 g) was observed in both 5.0 cm and 10 cm cutting height. The highest grain yield (1.30 t ha^{-1}) was obtained from 15 cm cutting height of culm due to more accumulation of food material into grain from comparatively vigorous plants; while the lowest grain yield (0.68 t ha^{-1}) was produced at 10 cm cutting height of culm. In a treatment with cowdung and other sources of plant nutrients. Ahmed and Rahman (1991) found significantly higher yield in the following crop from the plots which received cowdung in the previous rice crop. The lowest straw yield (1.60 t ha^{-1}) was produced in 5.0 cm height; while the highest straw yield (1.65 t ha^{-1}) was obtained from the both 10 and 15 cm cutting height of culm. Cutting height had a significant effect on ratoon crop maturity, height and yield (Jones, 1986). In a field trial in Japan, Mochizuki *et al.* (2000) showed that grain yield of ratooned rice was highest with the higher cutting height.

Nitrogen fertilizer affected the plant height, tillers hill^{-1}, panicle length, grains panicle^{-1}, grain yield and straw yield at 1% level of significance. The tallest plant (106.80 cm) was observed in the treatment received 120 kg N ha^{-1}; while the shortest plant (96.17 cm) was produced in control. Bhuiyan *et al.* (1990) also reported

the similar results where the tallest plants were obtained from the highest dose of N fertilizer. The highest number of tillers hill^{-1} was produced from the treatment received 120 kg N ha^{-1} (Table 2). On the contrary, the lowest (4.40) tillers hill^{-1} was observed in control. This finding is in good agreement with that of Reddy *et al.* (1985) who reported that, nitrogen application from 0 to 120 kg ha^{-1} in three split dressings increased number of tillers hill^{-1}. The crop responded positively due to application of different levels of N fertilizer. Results indicate that the highest (5.03) effective tillers hill^{-1} was recorded with the application of 120 kg N ha^{-1} (N_4). Dixit and Singh (1979) reported the similar results where nitrogen application increased the effective tillers hill^{-1}. The lowest (2.66) effective tillers hill^{-1} was found in control. The longest panicle (18.97 cm) was produced due to receive of 80 kg N ha^{-1} (N_3); while the shortest panicle (18.10 cm) was found in 40 kg N ha^{-1} (N_2). The highest grains panicle^{-1} (78.78) was produced in control; while the lowest (73.00) grains panicle^{-1} was recorded in 40 kg N ha^{-1}. The highest number (36.44) of sterile spikelets panicle^{-1} was produced in both of the control and N fertilizer applied @120 kg ha^{-1} respectively. On the other hand, the lowest number (34.22) of sterile spikelets panicle^{-1} was observed in 40 kg N ha^{-1}. The highest grain yield (1.07 t ha^{-1}) was produced from 120 kg N ha^{-1}. Singh and Yadav (1985) observed that paddy yield was continuously increased by addition of N from 0-150 kg ha^{-1}. This finding may also be supported by the finding of Bhuiyan (1980) who reported that grain yield of rice increased with the addition of nitrogen up to a certain level. The lowest (0.86 t ha^{-1}) grain yield was recorded in control. The highest straw yield (1.86 t ha^{-1}) was observed from 120 kg N ha^{-1} and the lowest straw yield (1.42 t ha^{-1}) was in control. Results also confirm the findings of Thakur (1991), who obtained increased straw yield of rice with the increasing nitrogen levels.

The interaction effects of culm cutting height and fertilization significantly affected the plant height, total tillers hill^{-1}, panicle length, grains panicle^{-1}, sterile spikelets panicle^{-1}, thousand grain weight and grain yield. Interaction effects of culm cutting height and N- fertilizers on plant height, tillers number, panicle length, grains per panicle, sterile spikelets per panicle, 1000 grains weight, grain and straw yield are presented in the Table 3. The tallest plant (116.10 cm) was noticed in the combination of 15 cm cutting height of culm and 120 kg N ha^{-1} while the shortest plant was obtained in combination of 15 cm cutting height of culm and control. The lowest number of tillers hill^{-1} observed in the combination of 15 cm cutting height and control treatment of nitrogen; while the highest number (7.61) of total tillers hill^{-1} was reported both in treatment combination of 10 cm cutting height of culm and 80 kg N ha^{-1} and 15 cm cutting height of culm with 120 kg N ha^{-1}.

Treatment combination of culm cutting height and level of N fertilization did not exert any significant effect on effective tillers hill^{-1} and straw yield. Apparently the highest (5.99) effective tillers hill^{-1} was observed in combination of 15 cm cutting height of culm and 120 kg N ha^{-1} (H_3N_4). On the contrary, the lowest effective tillers hill^{-1} was produced from the combination of 5.0 cm cutting height of culm and 0 kg N ha^{-1}). The shortest panicle (17.80 cm) was noticed in combination of 10 cm cutting height of culm and 80 kg N ha^{-1} (H_2N_3); while the tallest panicle (19.47 cm) was noticed in the combination of 10 cm cutting height of culm and 40 kg N ha^{-1}. The lowest (71.00) grains panicle^{-1} was found in treatment combination of 15 cm cutting height of culm and control fertilization. On the other hand, the highest (82.33) grains panicle^{-1} was produced in combination of 10 cm cutting height of culm and 40 kg N ha^{-1}. The highest sterile spikelets panicle^{-1} (40.00) was found in 10 cm cutting height of culm and 80 kg N ha^{-1}; while the lowest sterile spikelets panicle^{-1} (32.67) were observed in treatment combination of 5.0 cm cutting height of culm and 120 kg N ha^{-1}. The highest 1000 grains weight (210.2 g) was obtained at 15 cm cutting height of culm and 120 kg N ha^{-1}. On the contrary, the lowest 1000 grains weight (20.63 g) was produced in 5.0 cm culm cutting height with 40 kg N ha^{-1}. The highest grain yield (1.56 t ha^{-1}) was obtained in 15 cm cutting height of culm with 120 kg N ha^{-1}. On the contrary, the lowest amount of grain (0.57 t ha^{-1}) was obtained from 10 cm culm cutting height and control. Results indicate that, the highest straw yield (2.25 t ha^{-1}) was obtained in 10 cm culm cutting height with 80 kg N ha^{-1}. On the other hand, the lowest straw yield (1.06 t ha^{-1}) was found with 5.0 cm cutting height of culm and control.

Crop cutting height and N-fertilizer have remarkable effects on yield and yield contributing characters in ratoon crop of rice. Therefore, optimum crop cutting height and N-fertilization could increase yield of ratoon rice and thus could be utilized shorter fallow after harvest of rice.

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