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INFLUENCE OF AGRONOMIC MANAGEMENTS ON GROWTH AND YIELD OF BORO RICE

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Abstract

The study was carried out at Sher-e-Bangla Agricultural University, Dhaka from December 2018 to April 2019, to find out the agronomic practices on the growth and yield of *Boro* rice. The trial was conducted with two rice varieties namely V_1 (BRRI dhan84) and V_2 (BRRI hybriddhan5), and 5 different agronomic practices such as M_0 (no management), where variety in maim-plot and management practices in sub-plot. The results showed significant variations in weed severity, and l yield of *Boro* rice. Specific observations included plants reaching heights of 24.81 cm, 51.56 cm, 86.71 cm, and 119.21 cm at 20, 45, 70 days after transplanting (DAT), and at harvest, respectively. V_2 exhibited a higher grain yield (5.36 t ha^{-1}) but a reduced straw yield (4.97 t ha^{-1}) compared to V_1. Generally, regardless of the agronomic practices, BRRI dhan84 exhibited greater plant height, except under the 'no management' practice. The grain yield (6.70 t ha^{-1}) was obtained with M_6, and the maximum straw yield (6.55 t ha^{-1}) to M_4. The interaction effects showed that highest grain yield (7.35 t ha^{-1}) from V_2M_6, while with V_1M_0.The most significant yield reduction for BRRI dhan84 was 84% with no management and 80% with no fertilizer, while BRRI hybriddhan5 showed a 71% reduction under similar conditions.

Introduction

Rice is the primary crop in Bangladesh, occupying 75% of the total cropped area, with 92% of farmers cultivating it (Rekabder, 2004). Approximately 75% of all cropped regions and over 80% of irrigated zones are dedicated to rice (BRKB, 2017). While Bangladesh boasts an average rice yield of 3.26 t ha^{-1} (BBS, 2022), its productivity lags behind countries like China, Japan, and Korea, all of which have average yields of t ha^{-1} (FAO, 2009).

Different fertilization approaches can influence plant growth, maturation, size, phytochemical content, and seed properties (Mevi Schütz *et al.*, 2003).

Water management, particularly during the *Boro* season's flowering stage, affects water use efficiency (Maity and Sarkar, 1990). Water shortages at various growth stages can severely impact grain yield (Patel, 2000). Furthermore, weeds pose the most significant challenge to rice yield, with global yield losses to pests estimated at 40%. Of these losses, weeds are responsible for a staggering 32% (Rao *et al.*, 2007).

Effective agronomic strategies profoundly influence rice growth and yield. Yield decreases are often due to suboptimal weed, nutrient, and irrigation management. Consequently, comprehensive management techniques are crucial for optimal rice production in Bangladesh. However, many Bangladeshi farmers spend excessive time and effort on weed control while neglecting proper fertilization and irrigation. Its objectives encompass comparing two *Boro* rice

varieties, evaluating individual agronomic techniques on rice growth, and examining the combined impact of variety and agronomic practices on *Boro* rice performance.

Materials and Methods

The experiment was carried out at Sher-e-Bangla Agricultural University's field in Sher-e-Bangla Nagar, Dhaka. This site is positioned at a latitude of 23 º74´N and a longitude of 90º35´E, and it stands 8.2 meters above sea level. The soil here originates from "The Modhupur Tract" or AEZ- 28, as categorized by FAO in 1988. This topsoil has an olive-gray, silty clay texture, dotted with distinct dark yellowish-brown spots. It has a pH of 5.6 and contains 0.45% organic carbon.The trial was carried in out in a split-plot design with three replications where variety (BRRI dhan84 and BRRI hybriddhan5) in main-plot and management practices in sub-plot.. on variety, and seven different management i.e., no managements(M_0), No weeding, (M_1), No fertilizer application, but all other managements (M_2), no irrigation in reproductive and ripening stage, but all other managements (M_3), No insecticides, but all other managements (M_4), no Fungicides/bactericides, but all other managements (M_5), complete managements (M_6)

The var. BRRI dhan84, on average, stands between 90-96 cm tall during its ripening stage, bearing medium fine, white grains. It completes its life cycle in approximately 140-145 days and produces an average grain yield of 6.0-6.5 t ha^{-1}, as reported by BRKB in 2017. The experiment area received fertilization as per recommended methods: 200 kg N, 80 kg P_2O_5, 125 kg K_2O, 20 kg S, and 10 kg Zn. Urea was applied in three portions while other fertilizers were added during the final land preparation. Crop management was based as per need.

Various metrics such as plant height, leaf area index (LAI), number effective non-effective tillers $hill^{-1}$ and panicle length were measured. Leaf area index calculated by foliage from 5 hills canopy, measuring the leaf area per plot and dividing it by the plot land surface area. Grains were categorized as filled or unfilled, counted the data from 10 panicles per plot. The weight of 1000 - grains were measured at 12% moisture content. Both grain and straw yields were calculated from each plot's converted to as t ha^{-1}. Biological yield was calculated with the following formula: Biological yield = Grain yield + Straw yield. Harvest index was calculated as:

$$HI = \frac{\text{Economic yield (grain weight)}}{\text{Biological yield (Total dry weight)}} \times 100$$

Finally, the data was analyzed for any significant variations between the treatments. by using Duncan's Multiple Range Test at a 5% probability level Gomez and Gomez (1984).

Results and Discussion

Plant height

Plant height showed numeric differences at 20, 45, and 70 DAT, and significant differences at harvest for both BRRI dhan84 and BRRI hybriddhan5 (Table 1). The tallest plants at 45, 70 DAT and at harvest were from V_1 (BRRI dhan84) with heights of 24.81 cm, 51.56 cm, 86.71 cm, and 119.21 cm respectively. Conversely, the shortest plants were from V_1 (BRRI hybriddhan5) with heights of 25.28 cm, 49.53 cm, 79.61 cm, and 104.08 cm. The variations in plant height were attributed to the inherent varietal characteristics. At 20, 45, 70 DAT, and at harvest, the tallest plants were observed under M_6 (recommended management) with heights of 25.65 cm, 53.713 cm, 87.26 cm, and 118.15 cm respectively. In contrast, the shortest plants, with heights of 22.73 cm, 39.76 cm, 66.95 cm, and 93.88 cm respectively, were recorded under M_0 (no management). Considering the interaction between variety and management, the tallest plants at 20, 45, 70 DAT, and at harvest were from V_1M_6 (BRRI dhan84 + recommended

management) with respective heights of 25.89 cm, 55.6 cm, 89.32 cm, and 127.4 cm. The shortest plants, on the other hand, were from V_1M_0 (BRRI hybriddhan5 + no management) with heights of 22.92 cm, 36.93 cm, 61.28 cm, and 90.6 cm, respectively.

Leaf area index

The leaf area index (LAI) showed numeric variation at 20 and 45 DAT and significant variation at 70 DAT for both BRRI dhan84 and BRRI hybriddhan5 (Table 1).

Table 1. Effect of variety, agronomic managements, and treatment interaction on plant height (cm) and leaf area index (LAI) of *Boro* rice

Treatments	Plant height (cm)				Leaf Area Index (LAI)			
	20 DAT	45 DAT	70 DAT	At harvest	20 DAT	45 DAT	70 DAT	At harvest
Variety								
V_1	24.81	51.56	86.71	119.22	0.09 b	3.30 a	6.86 a	7.06 a
V_2	25.29	49.54	79.61	104.08	0.10 a	2.35 b	6.44 b	5.20 b
SE	0.45	0.97	1.21	1.69	0.01	0.2	0.18	1.52
CV (%)	17.00	16.29	8.97	8.26	33.41	22.85	8.78	80.43
Agronomic managements								
M_0	22.74b	39.76c	66.95b	93.88c	0.09 a	1.30 b	1.67 c	2.08 d
M_1	23.22b	41.96c	71.25b	105.17b	0.09 a	1.37 b	3.25 c	3.74 cd
M_2	26.27a	58.87a	88.44a	116.27a	0.12 a	3.81 a	5.91 b	4.67 bc
M_3	25.56ab	52.52b	90.18a	115.83a	0.10 a	3.28 a	9.30 a	8.98 a
M_4	26.02ab	53.98b	86.85a	114.62a	0.09 a	3.27 a	8.70 a	7.68 a
M_5	25.88ab	53.05b	91.19a	117.63a	0.10 a	3.33 a	8.34 a	6.76 ab
M_6	25.66	53.71	87.26a	118.15a	0.11 a	3.43 a	9.40 a	9.00 a
SE	1.03	1.12	1.40	1.69	0.01	0.26	0.51	0.61
CV (%)	11.48	5.49	6.12	5.46	31.48	33.66	27.48	35.98
Combined influence of variety and agronomic managements								
V_1M_0	22.54 b	42.58 de	72.61 d	97.16 de	0.08 abc	1.72 cde	2.13ef	2.95 ef
V_1M_1	22.87 b	38.94 ef	70.94 d	111.20 b	0.07 c	1.11 de	2.51ef	3.17 ef
V_1M_2	26.50 ab	60.04 a	92.60 ab	125.90 a	0.11 abc	4.83 a	6.68bcd	5.54 cde
V_1M_3	27.16 ab	53.92 bc	94.82 a	123.53 a	0.10 abc	3.61 ab	8.6ab	9.12 abc
V_1M_4	24.94 ab	54.79 bc	91.46 ab	124.80 a	0.08 abc	3.71 ab	9.62ab	9.64 ab
V_1M_5	23.75 ab	55.04 bc	95.22 a	124.53 a	0.07 bc	3.95 ab	8.65ab	8.05 abc
V_1M_6	25.89 ab	55.60 abc	89.32 abc	127.40 a	0.12 ab	4.15 ab	9.84a	10.98 a
V_2M_0	22.92 b	36.93 f	61.28 e	90.60 e	0.09 abc	0.87 e	1.22f	1.21 f
V_2M_1	23.56 ab	44.98 d	71.56 d	99.13 cde	0.11 abc	1.62 cde	3.99def	4.31 def
V_2M_2	26.03 ab	57.70 ab	84.28 bc	106.63 bcd	0.12 ab	2.78 bc	5.14cde	3.80 def
V_2M_3	23.95 ab	51.11 c	85.53 bc	108.13 bc	0.10 abc	2.94 bc	10a	8.85 abc
V_2M_4	27.10 ab	53.16 bc	82.23 c	104.43 bcd	0.08 abc	2.82 bc	7.77abc	5.72 cde
V_2M_5	28.01 a	51.04 c	87.16 abc	110.73 b	0.13 a	2.72 bc	8.02abc	5.47 cde
V_2M_6	25.42 ab	51.82 c	85.20 bc	108.90 bc	0.10 abc	2.71 bcd	8.96ab	7.02 bcd
SE=	1.13	1.09	1.99	2.39	0.01	0.37	0.72	0.86
CV (%)	11.48	5.49	6.12	5.46	31.48	33.66	27.48	35.98

In a column mean values having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability by DMRT Test.V_1: BRRI dhan84, V_2: BRRI hybriddhan5; M_0: No management, M_1: No weeding, but all other managements, M_2: No fertilizer application, but all other managements, M_3: No Irrigation in reproductive and; ripening stage, but all other managements, M_4: No Insecticides, but all other managements, M_5: No Fungicides/bactericides, but all other managements, M_6: Complete Managements.

The highest LAI values at 20, 45, and 70 DAT were 0.09, 3.3, and 6.9 respectively, was recorded from V_1 (BRRI dhan84). On the other hand, the lowest values were 0.1, 2.35, and 6.44 respectively from V_2 (BRRI hybriddhan5). Different agronomic managements showed significant impacts on the LAI at 20, 45, and 70 DAT. Specifically, the highest LAI values were observed under M_6 (recommended management) with values of 0.11, 3.43, 9.40, and 9.00 respectively. Conversely, the lowest LAI values 0.09, 1.30, 1.67, and 2.08 respectively, were recorded under M_0 (no management). The interaction between variety and management revealed the highest LAI values at 20, 45, 70 DAT, and harvest from V_1M_6 (BRRI dhan84 + recommended management) with 0.12, 4.15, 9.84, and 10.98 respectively. The lowest values were from V_2M_0 (BRRI hybriddhan5 + no management) with values of 0.09, 0.87, 1.22, and 1.21, respectively.

Effective tillers hill^{-1}

For BRRI dhan84 and BRRI hybriddhan5, the number of effective tillers per hill at harvest showed notable variation (Table 2).

Table 2. Effect of variety, agronomic managements, and interaction on number of effective tillers, non-effective tillers hill^{-1}, panicle length, number of filled grains panicle^{-1} and number of unfilled grains panicle^{-1} of *Boro* rice

Treatments	Number of effective tillers hill^{-1}	Number of non-effective tillers hill^{-1}	Panicle length (cm)	Number of filled grains panicle^{-1}	Number of unfilled grains panicle^{-1}
Variety					
V_1	10.83 a	0.26 b	25.91a	123.81	26.00
V_2	7.33 b	0.54 a	24.36a	161.24	16.29
SE	0.44	0.02	1.59	51.86	14.64
CV (%)	3.87	4.63	20.49	12.05	3.40
Agronomic managements					
M_0	5.60 d	0.17 a	22.43b	101.17c	8.50d
M_1	8.20 bc	0.50 a	24.68b	146.50ab	15.17cd
M_2	7.27 cd	0.50 a	24.04b	125.50bc	20.50bc
M_3	10.90 a	0.37 a	24.77b	143.17ab	26.17ab
M_4	10.90 a	0.53 a	25.94ab	165.17a	22.67ab
M_5	9.90 b	0.40 a	28.65a	155.50a	28.17a
M_6	10.80 a	0.33 a	25.44ab	160.67a	26.83ab
SE	0.59	0.09	0.87	101.17c	8.50d
CV (%)	4.21	14.58	12.45	146.50ab	15.17cd
Combined influence of variety and agronomic managements					
V_1M_0	7.53 de	0.02 cde	22.86 b	93.00f	7.67f
V_1M_1	8.93 cd	0.60 bc	24.98 b	134.67cde	15.67def
V_1M_2	8.80 cd	0.40 b-e	23.76 b	98.00f	20.00cd
V_1M_3	12.33 ab	0.20 de	25.02 b	123.67def	36.33ab
V_1M_4	14.00 a	0.07 e	26.37 b	143.00bcde	27.33bc
V_1M_5	11.20 bc	0.13 e	32.52 a	135.00cde	39.33a
V_1M_6	13.00 ab	0.13 e	25.86 b	139.33cde	35.67ab
V_2M_0	3.67 f	0.07 e	21.99 b	109.33ef	9.33ef
V_2M_1	7.47 de	0.40 b-e	24.39 b	158.33abcd	14.67def
V_2M_2	5.73 ef	0.6 bc	24.31 b	153.00abcd	21.00cd
V_2M_3	9.47 cd	0.53 bcd	24.52 b	162.67abc	16.00def
V_2M_4	7.80 de	1.00 a	25.50 b	187.33a	18.00cde
V_2M_5	8.60 d	0.67 ab	24.79 b	176.00ab	17.00def
V_2M_6	8.60 d	0.53 bcd	25.02 b	182.00a	18.00cde
SE	0.95	0.09	0.87	8.12	2.22
CV (%)	4.21	14.58	12.45	14.55	26.83

In a column mean values having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability. Additional details are as Table 1.

BRRI dhan84 (V_1) had a higher with averaging 10.83, while BRRI hybriddhan5 (V_2) averaged at 7.33. Various agronomic practices and their interaction with different varieties caused significant differences. The highest average (10.90) from M_4 (all managements except insecticides), with the least (5.60) under M_0 (no management). The combined practice of BRRI dhan84 and M_4 showed the highest of 14.00, but when BRRI hybriddhan5 was combined with M_0, (3.65).

Non-effective tillers hill^{-1}

The number of non-effective tillers per hill at harvest also varied between BRRI dhan84 and BRRI hybriddhan5, influenced by agronomic practices and rice varieties (Table 2). BRRI hybriddhan5 (V_2) recorded a higher of 0.54, in contrast to BRRI dhan84's (V_1) 0.26. M4 practice led to the highest average of 0.53, while M_0 resulted in the least at 0.17. The combination of BRRI dhan84 with M_4 resulted in the peak count of 1.00. Conversely, BRRI hybriddhan5 combined with M_0 marked the lowest at 0.07 in BRRI dhan84 combinations.

Length of panicle

The length of the panicle varied between BRRI dhan84 and BRRI hybriddhan5 where BRRI dhan84 (V_1) had a longer panicle length of 25.91 cm, while BRRI hybriddhan5 (V_2) had a shorter length of 24.36 cm (Table 2). Uzzaman *et al.,* (2015) was also found significant differences in panicle length of 16 rice varieties under SRI. Different agronomic practices also influenced panicle length, with the longest (28.65 cm) observed under M_5 and the shortest (24.03 cm) in M_2 (Table 2). The longest panicle in the interaction effect of variety and agronomic management was 32.52 cm from V_1M_5 and the shortest (21.99 cm) from V_2M_0 (Table 2).

Number of filled grains per panicle

There was a numerical variation in the number of filled grains per panicle where BRRI hybriddhan5 (V_2) had a higher (161.24), whereas BRRI dhan84 (V_1) had 123.81 (Table 2). Ahmed *et al.*, (1997) and Uzzaman *et al.*, (2015) reported varying percentages of filled grains among different rice varieties. Agronomic practices also led to significant differences, with the highest no. (165.17) was observed under M_4 and the lowest (101.17) IN M_0 (Table 2). For the interaction of variety and agronomic practices, the highest and lowest counts were observed from V_2M_4 (174.67) and V_1M_0 (93.00) respectively (Table 2).

Number of unfilled grains per panicle

The number of unfilled grains per panicle also varied between the two varieties. BRRI dhan84 (V_1) had a higher (26.00), while BRRI hybriddhan5 (V_2) recorded 16.29 (Table 2). Uzzaman *et al.,* (2015) was found significant differences in panicle length 16 rice varieties under SRI. Agronomic practices influenced this count, with the highest (28.17) observed under M_5 and the lowest (8.50) in M_0 (Table 2). For the interaction between variety and agronomic practices, counts ranged from a high of 39.33 (V_1M_5) to a low of 7.65 (V_1M_0) (Table 2).

The highest number of unfilled grains per panicle (39.33) was noted in V_1M_5 (BRRI dhan84 without fungicides/bactericides) followed by V_1M_6 (35.67). Conversely, V_1M_0 (BRRI dhan84 with no management) registered the lowest (t 7.65) followed by V_1M_1, V_2M_1, V_2M_3, and V_2M_5 (Table 2).

Weight of 1000- grains

The weight of 1000- grains didn't show much variation between BRRI dhan84 and BRRI hybriddhan5, but there were significant differences among the various agronomic managements and their interactions (Table 3). The higher t weight for 1000 grains (26.70 g) from M_6

(recommended management), closely followed by M_5, M_4, and M_3. The V_2M_6 combination (BRRI hybriddhan5 + recommended management) had the maximum 1000 -grains (31.97 g) close to V_2M_4(31.88 g) whereas V_1M_0 recorded the lightest at 20.17 g.

Table 3. Effect of variety, agronomic managements, and interaction on Weight of 1000 grains (g), Grain yield (t ha^{-1}), Straw yield (t ha^{-1}), Biological yield (t ha^{-1}) and Harvest index of *Boro* rice

Treatments	Weight of 1000-grains (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
Variety					
V_1	21.71b	4.31	5.22	9.85	45.41
V_2	31.10a	5.36	4.97	10.01	48.62
SE	1.41	0.37	0.22	0.63	5.08
CV (%)	0.33	24.69	9.31	20.64	34.99
Agronomic managements					
M_0	25.68b	1.68b	2.22 c	3.90 c	43.02 b
M_1	25.70b	1.85b	4.02 bc	8.57 b	52.15 ab
M_2	25.88b	1.98b	4.31 bc	6.29 bc	29.52 c
M_3	26.01ab	6.28a	6.50 a	12.78 a	49.20 ab
M_4	26.14ab	6.02a	6.55 a	12.57 a	49.78 ab
M_5	26.57ab	6.69a	5.47 ab	12.16 a	55.16 a
M_6	26.70a	6.70a	6.53 a	13.23 a	50.26 ab
SE	0.37	0.28	0.50	0.64	2.77
CV (%)	3.61	20.73	31.94	20.92	19.09
Combined influence of variety and agronomic managements					
V_1M_0	20.17d	1.00f	2.36 ef	4.35 ef	44.34 ab
V_1M_1	23.55c	3.71cd	3.62 def	7.92 cd	53.84 a
V_1M_2	21.60d	1.85ef	4.77 bcd	5.81 def	17.99 c
V_1M_3	21.65d	5.53b	6.36 abc	12.52 a	49.13 ab
V_1M_4	23.62c	5.67ab	7.37 a	13.24 a	47.41 ab
V_1M_5	23.66c	6.05ab	5.21 bcd	11.62 ab	55.62 a
V_1M_6	23.75c	6.34ab	6.87 ab	13.50 a	49.50 ab
V_2M_0	30.18b	1.51ef	2.07 f	3.44 f	41.69 b
V_2M_1	30.60ab	3.39cd	4.43 cd	9.22 bc	50.46 ab
V_2M_2	30.16b	2.97de	3.85 def	6.78 cde	41.04 b
V_2M_3	31.45ab	7.04ab	6.64 ab	13.04 a	49.26 ab
V_2M_4	31.88a	6.36ab	5.74 bcd	11.90 ab	52.15 ab
V_2M_5	31.47ab	7.33a	5.73 bcd	12.70 a	54.69 a
V_2M_6	31.97a	7.35a	6.34 abc	12.96 a	51.02 ab
SE	0.37	0.39	0.50	0.64	2.77
CV (%)	3.61	20.73	31.94	20.92	19.09

In a column mean values having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability. Additional details are as Table 1.

Grain yield

The grain yield didn't show any significant differences between BRRI dhan84 and BRRI hybriddhan5 but varied significantly among the different agronomic managements and their interactions (Table 3). M_6 (recommended management) yielded the highest grain yield, 6.70 t ha^{-1},

comparable to M_5, M_4, and M_3 while M_0 had the least yield. The combination V_2M_6 resulted in the highest grain yield, while V_1M_0 recorded the lowest.

Straw yield

Straw yield showed variations between BRRI dhan84 and BRRI hybriddhan5, with significant differences appearing in different agronomic managements and their interactions (Table 3). V_1 (BRRI dhan84) produced a higher straw yield of 5.22 t ha^{-1} compared to V_2 (4.97 t ha^{-1}). The highest straw yield was recorded from M_4, a management strategy without insecticides but including all other management practices. The V_1M_4 combination recorded the highest straw yield, while V_2M_0 noted the lowest.

Biological yield

Biological yield per hectare varied slightly between BRRI dhan84 and BRRI hybriddhan5 but showed significant changes depending on agronomic managements and interaction effects (Table 3). V_2 recorded the highest biological yield of 10.01 t ha^{-1}, followed by V_1 (9.85 t ha^{-1}). The combination V_1M_4 yielded the highest biological yield, whereas V_2M_0 had the least.

Harvest index

The harvest index showed significant differences based on variety, agronomic managements, and their interaction (Table 3). V_2 (BRRI hybriddhan5) had the maximum harvest index (48.62%), followed by V_1(45.91%). Among management strategies, M_5 recorded the highest harvest index, while M_2 had the lowest. When considering combinations, V_1M_5 produced the maximum harvest index, with V_1M_2 registering the minimum.

Conclusion

Based on the results presented, it's evident that agronomic management, the absence of fertilization, and lack of weeding have a substantial negative impact on grain yield. In particular, rice var. BRRI dhan84 exhibited a yield reduction of 84% with no management, 72% without fertilizer, and 43% without weeding. Similarly, BRRI hybriddhan5 showed a decrease of 83% in yield without management, 67% without fertilizer, and 62% without weeding. However, further studies need to be conducted across different agro-ecological zones, incorporating more varieties, and varying agronomic practices.

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