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Palash Mandal
Department of Agronomy and Haor Agriculture, Sylhet Agricultural University, Sylhet, Bangladesh

Md Sazzad Hossain
Department of Agronomy and Haor Agriculture, Sylhet Agricultural University, Sylhet, Bangladesh

Imtiaz Miah
Department of Agricultural Chemistry, Sylhet Agricultural University, Sylhet, Bangladesh

Md Rafat Al Foysal
Department of Agronomy and Haor Agriculture, Sylhet Agricultural University, Sylhet, Bangladesh

Mozammel Hoque
Department of Agronomy and Haor Agriculture, Sylhet Agricultural University, Sylhet, Bangladesh

Mohammed Noor Hossain Miah
Department of Agronomy and Haor Agriculture, Sylhet Agricultural University, Sylhet, Bangladesh

Corresponding Author:
Mohammed Noor Hossain Miah
Department of Agronomy and Haor Agriculture, Sylhet Agricultural University, Sylhet, Bangladesh

Agronomic performance of bioseed hybrid rice genotypes in Bangladesh

Palash Mandal, Md Sazzad Hossain, Imtiaz Miah, Md Rafat Al Foysal, Mozammel Hoque and Mohammed Noor Hossain Miah

Abstract
An experiment was conducted at two locations of Sylhet district of Bangladesh with seven hybrid rice genotypes of Bioseed India Ltd (Bio-404, Bio-453, Bio-543, Bio-460, Bio-648, Bio-649 and Bio-650) to evaluate their yield potentials. The experiment was laid out in a randomized complete block design with three replications. Results indicated, Bio-649 produced the highest yield with short duration and less disease infection. The maximum grain yields of Bio-649 were 9.1 and 10.46 t ha^{-1}, respectively at Sylhet Agricultural University (SAU) farm and farmer's field, Khadimnagar. These yields were higher than the two check varieties at both locations. The lowest grain yields of the hybrid rice genotype Bio-648 were 4.23 and 7.16 t ha^{-1}, respectively at SAU and farmer's fields. The results revealed, Bio-649 is suitable for *Aman* season and can be considered to proceed with further research at several locations of Bangladesh.

Keywords: Hybrid rice, location, variety, growth duration, yield

Introduction
Rice (*Oryza sativa*) is one of the most important cereal grains in the world today and about half of the population depend on rice as a staple food [1]. The increase in grain yield has resulted from the developed new high yielding inbred varieties and hybrid rice varieties [2]. Hybrid rice is generally a short duration and non-lodging commercial rice crop grown from F1 seeds of a cross between two genetically distinct parents [2]. The average rice yield in Bangladesh is lower than the other rice growing countries of the world [3]. Rice contributes more than 80% to the total food supply and more than 95% of population consumes rice to fulfill 76% of calorie and 66% of total protein requirement [4, 5]. Therefore, in case of Bangladesh the issue of 'food security' can be replaced by 'rice security' [6]. In Bangladesh, due to favorable soil and climatic conditions rice is extensively cultivated throughout the year which covers 80% of the total cultivable area [7]. Rice production is increased more than double in the last five decades mainly due to increased grain yield rather than increased planting area [8]. Besides, the cultivable land is turning into non-cultivable land around @1% every year [9]. Therefore, it is necessary to take more steps for increasing the production level of rice from per unit of land.
Hybrid rice technology offers an opportunity to increase rice yields and thereby ensure a steady supply of it [10]. Generally, hybrid rice varieties show higher yield potential over inbred varieties. It can contribute to increase rice yield about 15-20% over the best modern varieties [11]. The increased yield of hybrid rice also increases profitability and help in achieving food security [10]. Bangladesh Rice Research Institute (BRRI) already released seven hybrid rice varieties (four for *Boro* season, two for *Amam* season and one for *Aus* season [12]. Although the hybrid rice has high yield potential, at the same time it is reported they are susceptible to disease too [13]. The yield and disease susceptibility of hybrid rice also differ due to variation of growing environment and season. In these circumstances, it is crucial to find out more alternate hybrid rice varieties for cultivation in kharif-II season in Bangladesh. In the present study, seven hybrid rice genotypes of Bioseed Research (India) Pvt Ltd were put into trials along with two Bangladeshi released hybrid varieties at two different locations in Sylhet district of Bangladesh with a view to evaluate their overall yield performances at Sylhet in Bangladesh.

Materials and Methods
Experimental site, design and setup
The trial was conducted at two locations, agronomy field laboratory of Sylhet Agricultural University (SAU) and the other one at a farmer's field of Khadimnagar of Sylhet district. The experiment was laid out in a randomized complete block design (RCBD) with three

replications. The size of each plot was 4 m x 2 m at SAU farm and 5 m × 3 m at famer's field at Khadimnagar. Soils of the experimental fields were slightly acidic (pH: 5.5-6.0) and non-calcarious dark grey flood plain under AEZ 20 (Sylhet basin). The seven hybrid rice genotypes i.e, Bio-404 (V1), Bio-453 (V2), Bio-543 (V3), Bio-460 (V4), Bio-648 (V5), Bio-649 (V6), Bio-650 (V7) were collected from Bioseed Research (India) Pvt Ltd. The check varieties were BRRI hybrid dhan3 (V8) and BRRI hybrid dhan4 (V9). The seedlings were raised in the well-prepared nursery beds where recommended doses of *Dolochun* ($CaCO_3.MgCO_3$) and N P K S and Zn fertilizers were applied. Sprouted seeds were sown in well prepared nursery bed.

Crop Husbandry

The main fields received well decomposed cow dung @ 5 t ha^{-1} soon after first opening of the land and a light irrigation was done and kept for 3 days. Then it was again ploughed and lime (*Doluchun*) was applied @ 1.0 t ha^{-1}. The inorganic fertilizers were applied @ 78, 16, 50, 15 and 2 kg ha^{-1} of N, P, K S and Zn, respectively from the sources of urea, triple super phosphate (TSP), muriate of potash (MP), gypsum and $ZnSO_4$. The whole amount of TSP, MP, gypsum and Zn was applied as basal on final land preparation. The nitrogenous fertilizer urea was applied in three equal splits at the final land preparation, 15 days after transplanting and panicle initiation stage. Twenty five days-old single healthy seedling was transplanted with a planting spacing of 20 cm × 20 cm in the main field. The experimental plots were weeded and irrigated properly. Pest controlling measures were also taken as per requirement.

Data collection and analysis

The time of seedling transplanting, 50% flowering and maturity of hybrid lines were recorded. At maturity, randomly selected 10 hills were collected from the centre region of each plot. Data on plant height, total tillers $hill^{-1}$, length of panicle and yield and yield attributes like panicles $hill^{-1}$, spikelets $panicle^{-1}$, grains $panicle^{-1}$, and sterile grains $panicle^{-1}$, 1000 grain weight, straw and grain yield were recorded. All the measured data were finally analyzed by the computer package program MSTAT-C [14]. The means were separated with LSD ($\leq$0.05).

Results and Discussion

Vegetative characteristics

Plant characters like plant height and total tillers $hill^{-1}$ differed significantly among the genotypes in both locations. Plant height ranged from 90.0 cm (Bio-543) to 117.8 cm (Bio-453) at SAU field and 100.6 cm (Bio-650) to 119.5 cm (Bio-453) at farmer's field (Table 2). The Bio-453 showed similar results from closer spacing (15 cm x 15 cm) which was observed by Chowdhury *et al.* (2019) [15]. In another experiment with Bioseed (Bio-786), the plant height was also recorded within the range of this study Choudhary and Suri (2018) [16].

The total number of total tillers $hill^{-1}$ was the highest in Bio-453 (12.3) at SAU field while BRRI hybrid dhan4 produced maximum the at farmer's field (12.7). Similar result was obtained in another study using two seedlings $hill^{-1}$ of the line Bio-453 by Chowdhury *et al*. (2019) [15]. In general, the total tillers $hill^{-1}$ of farmer's field was higher than that of SAU field.

Yield attributes

In terms of panicles $hill^{-1}$, no significant differences were found within the lines when grown in SAU field. However, rice genotypes differed appreciably in the farmer's field in terms of panicles $hill^{-1}$. The maximum (9.2) and minimum (6.1) number of panicle $hill^{-1}$ in farmer's field were from Bio-543 and BRRI hybrid dhan4, respectively. The results of spikelets $panicle^{-1}$ indicated that Bio-460 had higher capacity of producing spikelets $panicle^{-1}$. The highest number of grains $panicle^{-1}$ (99.7) was recorded in Bio-404 and the lowest (65.8) in Bio-543 at SAU farm (Table 1). In the farmer's field Bio-460 produced the highest spikelets $panicle^{-1}$ (95.2) and Bio-648 prodeced the lowest (62.4) (Table 2).

At SAU farm, the filled grain percentage was the highest in Bio-453 (82.0%) and the lowest was in Bio-543 (62.8%) and at farmer's field the maximum was in Bio-453 (74.9%) and the minimum in Bio-404 (49.9%). The maximum (47.8) and minimum (20.7) sterile spikelets $panicle^{-1}$ of SAU location was in Bio-460 and Bio-453, respectively (Table 1). On the other hand, at farmer's field the maximum (74.5) and minimum (29.1) sterile spikelets $panicle^{-1}$ was recorded in Bio-543 and Bio-453, respectively (Table 2).

At SAU, the spikelet sterility percentage was minimum Bio-453(18.0%) and the maximum in Bio-453 (37.2%). But, at farmer's field it was the least in Bio-453 (25.1%) and the maximum in Bio-404 (50.1%) followed by Bio-543 (48.5) (Table 2). These results were in line with the findings of Chowdhury *et al*. (2019) [15] in Bio-453. The panicle length of the hybrid rice genotypes ranged from 22.1 cm (Bio-648) to 26.5 cm (Bio-650) at SAU field while 25.0 cm (Bio-453) to 28.1 cm (Bio-543) at farmer's field. The 1000 grain weight at SAU field was the maximum in BRRI hybrid dhan3 (30.45 g) and the least was in Bio-404 (20.90 g) (Table 1). The highest 1000 grain weight was recorded in BRRI hybrid dhan3 (30.47 g) in the farmer's field followed by Bio-650 (28.80 g). In the same location, the minimum 1000 grain weight was recorded in Bio-460 (21.52 g). Chowdhury *et al*. (2019) [15] noticed similar results in Bio-453.

Grain and straw yields

At SAU field, the highest grain yield was produced by Bio-649 (9.1 t ha^{-1}) and it followed by Bio-650 (8.28 t ha^{-1}), Bio-453 (7.40 t ha^{-1}), and Bio-460 (6.43 t ha^{-1}). In this location, the lowest grain yield was recorded in Bio-648 (4.23 t ha^{-1}). In farmer's field, the maximum grain yield was recorded in Bio-649 (10.46 t ha^{-1}) and it was followed by Bio-543 (9.14 t ha^{-1}) and Bio-650 (8.98 t ha^{-1}) and Bio-648 produced the lowest grain yield. The check varieties produced similar yield as of Bio-404. The variation of yield in different lines due to the source utilization efficiency at the grain filling stage which were not the same in all hybrids[2,17]. Straw yield at SAU field was the highest in Bio-453 (12.18 t ha^{-1}) and the least in Bio-648 (5.33 t ha^{-1}) (Table 1). Similar results were reported in Bio-453 in another study [15].

Table 1: Yield and yield contributing characteristics of hybrid rice genotypes at SAU farm

Rice genotypes	Plant height (cm)	Total tillers hill^{-1}	Panicles hill^{-1}	Spikelets panicle^{-1}	Grains panicle^{-1}	% Filled grains	% Sterility	Panicle length (cm)	1000 grains wt. (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
Bio-404	98.9	9.9	8.1	141.7	99.7	70.3	29.7	25.6	20.90	5.10	10.9
Bio-453	117.8	12.3	9.4	115.3	94.3	82.0	18.0	26.1	25.66	7.40	12.18
Bio-543	90.0	9.5	8.3	105.0	65.8	62.8	37.2	24.2	22.54	4.65	7.3
Bio-460	102.1	9.4	8.5	144.0	96.4	67.0	33.0	26.2	21.18	6.43	8.25
Bio-648	90.5	7.9	7.2	103.7	68.7	66.3	33.7	22.1	25.21	4.23	5.33
Bio-649		9.9	7.9	128.3	83.0	64.9	35.1	26.1	26.97	9.10	10.53
Bio-650	104.7	9.5	7.5	108.3	76.6	70.6	29.4	26.5	30.10	8.28	10.78
BRRI hybrid dhan3	106.7102.6	8.5	7.4	118.0	87.6	74.4	25.6	26.4	30.45	8.08	9.78
BRRI hybrid dhan4	93.4	10.2	8.7	134.0	86.3	64.5	35.5	24.7	23.81	7.35	10.28
LSD (0.05)	9.62	1.49	NS	16.35	25.91	6.97	6.97	2.38	0.980	0.474	0.355

Table 2: Yield and yield contributing characteristics of hybrid rice genotypes at farmars' field

Rice genotypes	Plant height (cm)	Total tillers hill^{-1}	Panicles hill^{-1}	Spikelets panicle^{-1}	Grains panicle^{-1}	% Filled grains	% Sterility	Panicle length (cm)	1000 grains wt. (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
Bio-404	109.3	11.3	8.7	147.7	73.6	49.9	50.1	26.6	22.07	8.66	9.06
Bio-453	119.5	9.6	6.7	116.4	87.3	74.9	25.1	25.0	21.75	8.26	9.62
Bio-543	108.7	11.8	9.2	153.7	79.2	51.5	48.5	28.1	22.22	9.14	9.40
Bio-460	111.3	11.3	8.4	167.3	95.2	56.8	43.2	26.7	21.52	8.08	9.00
Bio-648	104.2	8.4	6.4	107.5	62.4	58.0	42.0	25.7	25.43	7.16	9.00
Bio-649	107.9	10.6	7.1	122.1	75.0	61.5	38.5	25.4	27.49	10.46	8.58
Bio-650	100.6	9.4	6.4	121.1	71.7	59.5	40.5	25.6	28.80	8.98	8.28
BRRI hybrid dhan3	108.6	9.1	6.1	111.4	80.2	72.2	27.8	26.5	30.47	8.52	8.76
BRRI hybrid dhan4	95.2	12.7	8.3	144.2	83.6	58.3	41.7	25.3	23.59	7.68	9.08
LSD (0.05)	11.86	2.25	1.73	43.40	12.83	7.91	7.91	1.68	0.976	0.413	NS

The straw yields of the two checks were 9.78 and 10.28 t ha^{-1} in BRRI hybrid dhan3 and BRRI hybrid dhan4, respectively. At the farmer's field of Khadimnagar, all the genotypes and check varieties produced almost similar straw yields which ranged from 8.28 t ha^{-1} in Bio-650 to 9.62 t ha^{-1} in Bio-453 (Table 2).

Acceptability indices of hybrid rice genotypes

Flowering time and maturity: Data presented in Table 3 showed that the hybrid rice line Bio-543 required the least days (53 days in SAU field and 58 days in farmer's field for 50% flowering, as well as maturity (80 days in SAU and 84 days at farmer's field) after transplanting of seedling and also its total crop duration, was the least (106 days at SAU and 110 days at farmer's field) from seeding to maturity.

Table 3: 50% flowering and crop growth duration of rice genotypes

Rice genotypes	SAU		Khadimnagar	
	50% Flowering (DAS)	Crop growth Duration (Days)	50% Flowering (DAS)	Crop growth Duration (Days)
Bio-404	59	111	62	115
Bio-453	80	137	85	141
Bio-543	53	106	58	110
Bio-460	59	113	60	113
Bio-648	57	111	58	114
Bio-649	61	118	67	120
Bio-650	61	116	66	119
BRRI hybrid dhan3	60	114	66	120
BRRI hybrid dhan4	62	117	67	120

This hybrid line Bio-543 was followed by Bio-648, Bio-460, Bio-404 and Bio-649. The rice line Bio-453 needed the longest period of 70 and 85 days for 50% flowering and 111 and 115 days for maturity from the day of transplanting, respectively at SAU and Khadimnagar fields (Table 3). Its crop growth duration from seeding to maturity also needed the highest period among the hybrid genotypes/check varieties which were 137 and 141 days for SAU and Khadimnagar fields, respectively. The other genotypes required almost similar days as those of the check varieties (Table 3). The variations in crop growth duration, flowering and days to maturity might be due to varietal variation. Previously similar differences were identified in the genetic makeup of different genotypes while evaluating the genotypes by others [18].

Diseases infection

The disease incidence data recorded after full heading has been listed in Table 4. Bacterial blight (BB) and sheath blight (SB) were in the range of 10 -15% for BB and 5 - 20% for SB for hybrid genotypes of Bioseed at farmer's but it was almost nil (<5%) at SAU field in the scale of 1 ~ 9. Biotic resistance in a rice hybrid is determined by the resistance of its parental genotypes and whether the latter is controlled by dominant or recessive genes [10]. There was no lodging tendency observed in any of the genotypes. The overall 50% flowering time, phenotypic appearance were good and insect infestation was

very negligible as control measures were taken by applying insecticides.

Table 4: Susceptibility to diseases of rice genotypes

Rice genotypes	Disease Score of BB (1 ~ 9 scale)*	Disease Score of SB (1 ~ 9 scale)*
Bio-404	3	4
Bio-453	2	1
Bio-543	2	1
Bio-460	3	1
Bio-648	3	1
Bio-649	2	1
Bio-650	2	1
BRRI hybrid dhan3	1	1
BRRI hybrid dhan4	1	1

Here, BB = Bacterial blight and SB = Sheath blight; *1= <5%, 2 = 5-10%, 3 = 11-15%,4 =16 -20%, 5 = 21- 25%, 6 =26-30%, 7 = 27-35%, 8 = 36-40%, 9 = >50% [19].

Conclusion

In conclusion, most of the hybrid genotypes are short duration type. Among the genotypes, Bio-649 produced the maximum grain yield both at SAU field (9.10 t ha^{-1}) and Farmer's field (10.46 t ha^{-1}) with crop growth duration of average 120 days. On the other hand, crop growth duration of the Bio-404, Bio-543 and Bio-460 are from 105 to 115 days with slender grain types which are good for market value although per unit yields are lower. Moreover, less disease susceptibility of these genotypes could be a good choice for farmer motivation.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Ethical standard

The experiment conducted complies with the laws.

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