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Comparative Study on Seed Production Potentiality of Selected Rice (*Oryza sativa* L.) Hybrid Combinations

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ABSTRACT

The seed production potentialities of selected 20 hybrid rice combination were assessed in this study. Higher seed yield potentiality and earliness in maturity were two of the most important indicators for popularizing hybrid rice variety in Bangladesh. The field performance of the selected hybrid rice combinations were found to vary significantly for different traits except number of total spikelets per panicle showed insignificant variation among the hybrid rice genotypes. The highest number of tillers per plant was recorded in BRRI7A/BRRI31R (17.33) which was followed by BRRI10A/BRRI20R (16.33) and BRRI7A/BRRI20R (16.17). Maximum number of panicles per plant was produced by BRRI7A/BRRI31R (14.00) which was followed by BRRI10A/BRRI31R (13.07), and BRRI11A/BRRI31R (12.47). The highest number of filled spikelets per panicle was produced by BRRI7A/BRRI31R (48.20) which was followed by IR79156A/BRRI31R (47.83) and BRRI7A/BRRI10R (44.63) respectively. The highest value for percent out crossing rate (%OCR) was observed in the combination of BRRI7A/BRRI31R (50.23%) which was followed by BRRI10A/BRRI10R (46.40%). The highest value for grain yield per plant was recorded in BRRI7A/BRRI31R (8.17g) followed by BRRI10A/BRRI10R (7.85 g) and BRRI11A/BRRI15R (7.68 g), respectively. The lowest value for grain yield per plant was found in IR79156A/BRRI31R (3.97 g). Considering comparative study of floral traits, BRRI7A/BRRI31R hybrid rice combination has good commercial prospects but seed production potentiality under Bangladesh conditions needs to be estimated with fine tune.

Key words: Out crossing rate, seed production, potentiality and combinations

INTRODUCTION

Rice is arguably the most important staple food crop in the world. More than half of the world's population consumes rice as their primary source of food, and will almost certainly continue to use rice as the main diet in the future. The most remarkable achievement of Bangladesh since her independence in 1971 is the acceleration of rice production, enabling her self-sufficiency in food production rather than an import dependent one. The production of food grain was 8.74 million metric tons (MMT) in 1971-72 which increased to 34.70 million metric tons in 2014-15 (BBS, 2018).

Hybrid rice technology is one of the most talked issues in our country where strengthening food security is a priority agenda. Feeding the expanding population from the decreasing cultivable land is a great challenge to our agriculture. Moreover, climate change and bio-energy have added extra challenges to food security issue. How to solve this problem? The only option is to expand vertically to balance the equation, food = people. Hybrid rice, as it has the capability to increase yield by 15-20% more than even the best HYV, can be an answer for vertical expansion. Vertical increase in yield can meet the food demand of expanding population. There is a gradual development of hybrid rice cultivation in our country since 2001-2002 to 2016-17. The area planted to hybrid rice in the country during Boro 2016-17 was around 0.7 Mha has contributed 3-4 MT of additional rice

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to the total rice production of the country (AIS, 2018).

Therefore, to break the present yield ceiling of semi-dwarf modern varieties, hybrid rice seems to be an attractive viable alternative if suitable parental lines and effective seed production infrastructure are developed in the public, private, or NGO sectors of the country as well as seed production units should be closely linked with its hybrid rice research units to expedite the transfer of this technology. Therefore, these experiments have been taken for selection of suitable hybrid combination for development of effective seed production ability. So the objective of the research programme was selection of suitable hybrid combination and modifications of the currently used strategies for F_1 hybrid seed production.

MATERIALS AND METHODS

The experiment was conducted at the experimental farm of Bangladesh Rice Research Institute (BRRI), Gazipur during November to May 2017-18. The soil of the experimental field was clay loam in texture having pH of 6.2. It belongs to the Chitra soil series of red brown terrace. Five cytoplasmic-genetic male sterile (CMS) lines (IR75608A, IR79156A, BRRI7A, BRRI10A and BRRI11A) and four (BRRI10R, BRRI15R, BRRI20R and BRRI31R) restorer lines were used. Twenty seed production combinations (IR75608A/RRI10R, IR75608A/BRRI15R, IR75608A/BRRI20R, IR75608A/BRRI31R, IR79156A/BRRI10R, IR79156A/BRRI15R, IR79156A/BRRI20R, IR79156A/BRRI31R, BRRI7A/BRRI10R, BRRI7A/BRRI15R, BRRI7A/BRRI20R, BRRI7A/BRRI31R, BRRI10A/BRRI10R, BRRI10A/BRRI15R, BRRI10A/BRRI20R, BRRI10A/BRRI31R, BRRI11A/BRRI10R, BRRI11A/BRRI15R, BRRI11A/BRRI20R and BRRI11A/BRRI31R) were used in this study. The seed of these parental lines were collected from Hybrid rice division of BRRI. Seeds of all genotypes were soaked separately following BRRI prescribed duration gap between A and R lines for 48 hours in clothes bag. Soaked seeds were picked up from water and wrapped with straw and gunny bag to increase the temperature for facilitating germination. The germinated seeds were sown in seed bed for raising seedlings. The land was prepared thoroughly by 3-4 times ploughing and cross ploughing followed by laddering to obtain a good puddled condition.

The experiment was laid out in a randomized complete block design (RCBD) with three replications. The unit plot size was 4m × 2m. Fertilizer were applied @ 270, 130, 120, 70, and 10 kg/ha of urea, TSP, MOP, zinc sulphate and gypsum, respectively. Total urea was applied in three installments at 15, 35 and 55 days after transplanting (DAT). One third of MOP was applied with 2ndtop dressing of urea. Thirty-day-old seedlings of R and A lines were transplanted @ 3-4 seedlings and 2 seedlings per hill, respectively. The row spacing maintained for R-R, R-A and A-A lines were 40, 30 and 15 cm respectively. Hill spacing for both R and A lines were maintained 15 cm. Transplanting was done on different dates as per experimental treatments. Row directions were perpendicular to wind direction. Synchronization of flowering was adjusted at different panicle initiation stages by applying 2% phosphorus solution for earliness and 1% nitrogen fertilizer solution for delay. Proper isolation was maintained through deployment of polythene barriers among the entries. Gibberellic acid (GA_3) at the rate of 220 g/ha was used to improve panicle exertion and prolong duration of floret opening and stigma receptivity. Supplementary pollination was done with a bamboo stick at peak anthesis period for 3 to 4 times maintaining an interval

of 30 minutes between them. Intercultural operation, irrigation and protection measures were maintained properly. Seed yield was harvested when it reached physiological maturity stage. Randomly ten hills were selected in each plot and the data were recorded on-days to first flowering, days to 50% flowering, days to maturity, plant height, panicle length, flag leaf length (cm), number of tillers per plant, number of spikelets per panicle, number of filled spikelets per panicle, grain yield per plant, straw yield per plant, harvest index and percent out crossing rate. Data were analyzed using STAR computer software ANOVA-2 and Microsoft Excel programme 2007.

RESULTS AND DISCUSSION

The analysis of variance revealed significant differences among the tested hybrid combinations that indicated the seed production feasibility of hybrid rice combinations exist except for number of total spikelet's per panicle. It showed insignificant variation among the hybrid rice combinations under the present experiment (Table 1).

Table 2 shows the mean performance of hybrid combinations. The highest mean for plant height was found in IR75608A/BRRI20R (97.07 cm) which was followed by IR75608A/BRRI10R (96.37 cm) and IR75608A/BRRI31R (96.00 cm). The lowest mean for plant height was observed in BRRI11A/BRRI20R (80.17 cm) which was followed by BRRI10A/BRRI31R (81.33 cm).

Islam (2013) completely supported the findings of the present experiment when investigating approved hybrid rice genotypes for their seed quality assessment. The longest period for first flowering was found in IR79156A/BRRI15R (122.93 days) followed by IR75608A/BRRI15R (121.43 days) and IR79156A/BRRI10R (121.38 days),

Table 1. Analysis of variance for different characters in 20 combination rice hybrids (A × R) during Boro 2017-18.

Source of Variance	DF	Character												
		Plant height (cm)	No. of tillers /plant	Days to first lowering	Flag leaf length	Days to 50% flowering	Panicle length (cm)	No. of total grain/panicle	No. of filled grain/	Out crossing rate (%)	Days to maturity	Seed yield/plant (g)	Straw yield/plant (g)	Harvest index
Treatment (MS)	19	121.50**	5.41**	133.27**	29.95**	133.27**	3.44**	128.94^{NS}	33.68**	97.61**	136.13**	4.26**	46.29**	15.14**
Replication (MS)	2	12.11	8.96	27.75	7.10	26.96	4.72	1807.85	21.34	79.57	14.59	0.677	7.46	34.00
Error (MS)	38	0.8997	1.928	0.691	2.797	0.691	1.174	125.267	8.689	0.595	0.67	0.125	1.803	3.258
CV %		1.04	9.38	0.72	7.02	0.69	4.80	8.46	7.36	2.12	0.55	6.32	7.85	7.28

Legend: DF = Degree of freedom, NS = Insignificant and ** Significant at the 1% level of significance, CV= Co-efficient of variation.

whereas BRRI7A/BRRI31R took the shortest time (102.93 days) which was followed by BRRI7A/BRRI20R (103.60 days). The longest period for 50% flowering was found in IR79156A/BRRI15R (128.27 days) followed by IR75608A/BRRI15R (126.77 days) and IR79156A/BRRI10R (126.71 days), on the other hand BRRI7A/BRRI10R and BRRI7A/BRRI31R took the shortest time (108.27 days) which was followed by BRRI7A/BRRI20R (108.93 days). Shikder (2010) found similar results while working with exotic hybrid rice genotypes in Boro season. Rice varieties in Boro season showed great fluctuations on flowering dates. These results are in close agreement with the previous findings by Roy (2006) and Ali 2007. The highest mean number of tillers per plant was recorded in BRRI7A/BRRI31R (17.33) which was followed by BRRI10A/BRRI20R (16.33) and BRRI7A/BRRI20R (16.17). The lowest mean number of tillers per plant was observed in IR75608A/BRRI10R (12.53) which was followed by IR75608A/BRRI20R (12.77) and IR75608A/BRRI15R (12.83). Rice plant generally produces more number of tillers than panicles. Unproductive tillers or the tillers that are produced at later dates and do not produce panicles before harvest are rather wasteful process (Mamin, 2003). The above findings were also supported by Saha (1998). Yadav (2001) also found similar trend in case of significant variability for number of tillers per plant in rice. The longest flag leaf length was found in IR75608A/BRRI15R (31.37cm) which were followed by BRRI10A/BRRI20R (29.80 cm) and IR79156A/BRRI10R (25.63 cm). The shortest flag leaf length was recorded in IR75608A/BRRI10R (15.97 cm). Maximum number of panicles per plant was produced by BRRI7A/BRRI31R (14.00) which was followed by BRRI10A/BRRI31R (13.07), and BRRI11A/BRRI31R (12.47). The minimum number of panicle per plant was produced by IR75608A/BRRI15R (8.17) which was followed by IR75608A/BRRI10R (8.37). Islam (2013) somehow agreed with the present results. They found moderate number of panicle per plant with high genetic advance in percent of mean during working with developed hybrid rice genotypes. Rahman (2010) completely supported the findings of the present experiment while working with BRRI hybrid dhan2 variety for hybrid seed production.

The longest day to maturity was recorded 154.60 days in IR79156A/BRRI15R which was followed by IR75608A/BRRI15R (153.10 days). BRRI7A/BRRI10R took the shortest time (134.33 days) for maturation which was followed by BRRI7A/BRRI31R (134.67 days) and BRRI7A/BRRI20R (135.00 days). This feature indicated less influence of environment on the expression of this character. Hossain (2004) reported similar results of the present study, while working with 30 rice genotypes. Nath (2005) also supported the above findings for days to maturity in T. Aman rice varieties. The longest panicle length was observed in IR79156A/BRRI10R (24.60 cm) which was followed by IR75608A/BRRI20R (24.57 cm) and BRRI7A/BRRI10R (24.40 cm) respectively. The shortest panicle length was observed in IR75608A/BRRI10R (21.17 cm) which was followed by IR79156A/BRRI31R (21.33 cm). Bhandarkar *et al,* (2002) evaluated 52 genotypes of rice and reported high heritability for panicle length which supported the present outcomes. The highest number of total spikelets per panicle was found in genotype IR79156A/BRRI31R (148.87) which was followed by BRRI7A/BRRI10R (140.90). The lowest number of total spikelets per panicle was recorded in genotype BRRI11A/BRRI31R (119.97) which was followed by BRRI11A/BRRI20R.

Shikder (2010) completely supported the findings of the present experiment while investigating enormous exotic hybrid rice genotypes for their seed quality assessment. The highest value for percent out crossing rate (%OCR) was produced by the combination BRRI7A/BRRI31R (50.23%) which was followed by BRRI10A/BRRI10R (46.40%). The lowest value for percent out crossing rate

(%OCR) was found in the combination of BRRI7A/BRRI15R (30.30%) which was followed by BRRI7A/BRRI10R (32.47%). The highest value for straw yield per plant was recorded in BRRI7A/BRRI31R (25.50 g) which was followed by BRRI10A/BRRI10R (24.60 g) and BRRI10A/BRRI15R (23.97 g) respectively. The lowest value for straw yield per plant was found in IR79156A/BRRI31R (12.20 g) which was followed by BRRI7A/BRRI15R (13.70 g). The highest value for harvest index was found in BRRI11A/BRRI15R (28.53%) which was followed by BRRI7A/BRRI15R (28.16) and BRRI7A/BRRI10R (26.06%) respectively. The lowest value for harvest index was recorded in BRRI10A/BRRI15R (17.02%) which was followed by BRRI11A/BRRI10R (23.73%). Iftekharudduala *et al.* (2001) found low GCV and PCV with high heritability and high genetic advance in percent per mean in irrigated rice which is more or less similar to the present study.

Table 2. Mean SD and SE value of seed yield contributing character of selected approved combinations of hybrid rice.

Combination	Plant height (cm)	No. of tillers / plant	No. of panicle/ plant	Panicle length (cm)	No. of total grain/ panicle	Out crossing rate (%)	Flag leaf length (cm)	Straw yield/plant (g)	Harvest index	Days to first flowering	Days to 50% flowering	Days to maturity
IR75608A/BRRI10R	96.37a	12.53f	8.37i	21.17f	129.63	33.50h	15.97h	15.44c-e	25.55a-c	120.21b-d	125.55b-d	151.88b-d
IR75608A/BRRI15R	94.33cd	12.83ef	8.17i	22.67b-f	124.47	36.07g	31.37a	15.73c-e	24.95c	121.43b	126.77b	153.10b
IR75608A/BRRI20R	97.07a	12.77ef	8.60hi	24.57a	137.76	31.83i-k	21.77fg	14.30c-f	24.88c	119.93cd	125.27cd	151.60cd
IR75608A/BRRI31R	96.00ab	14.00c-f	9.30g-i	23.27a-e	129.83	42.40d	23.81b-f	20.00b	24.63c	118.93d-f	124.27d-f	150.60d-f
IR79156A/BRRI10R	93.33cd	14.07b-f	9.90d-i	24.60a	127.07	31.17kl	25.97b	13.97d-f	26.41a-c	121.38b	126.71b	153.05b
IR79156A/BRRI15R	94.13cd	12.93d-f	9.67f-i	21.53ef	134.63	32.83h-j	25.07b-d	16.25c	26.03a-c	122.93a	128.27a	154.60a
IR79156A/BRRI20R	92.93de	14.87b-e	10.70c-h	22.49c-f	135.27	41.07e	22.63d-g	20.67b	24.94c	120.27b-d	125.60b-d	151.93b-d
IR79156A/BRRI31R	93.87cd	13.93c-f	9.77e-i	21.33f	148.87	31.67jk	23.23b-g	12.20f	24.38c	120.93bc	126.27bc	152.60bc
BRRI7A/BRRI10R	92.90de	15.50a-c	11.33b-g	24.40ab	140.90	32.47h-j	25.63bc	15.43c-e	26.06a-c	102.93k	108.27k	134.33k
BRRI7A/BRRI15R	93.17cd	15.33a-c	12.33a-c	21.87d-f	132.98	30.30l	24.90b-d	13.70ef	28.16ab	104.60j	109.93j	136.00j
BRRI7A/BRRI20R	94.57bc	16.17a-c	12.00a-e	23.73a-c	129.89	33.60h	23.13c-g	15.63c-e	25.37bc	103.60jk	108.93jk	135.00jk
BRRI7A/BRRI31R	91.60e	17.33a	14.00a	23.43a-d	135.26	50.23a	24.60b-e	25.50a	24.29c	102.93k	108.27k	134.67jk
BRRI10A/BRRI10R	81.43gh	15.83a-c	11.67b-f	22.60c-f	129.13	46.40b	24.20b-f	24.60a	24.19c	115.55i	120.88i	147.21i
BRRI10A/BRRI15R	83.03f	15.33a-c	12.00a-e	21.60ef	132.00	37.87f	23.70b-g	23.97a	17.02d	117.07gh	122.4gh	148.73gh
BRRI10A/BRRI20R	82.67fg	16.33ab	12.17a-d	22.00c-f	138.96	35.53g	29.80a	16.13cd	23.95c	116.93gh	122.27gh	148.60gh
BRRI10A/BRRI31R	81.33gh	15.90a-c	13.07ab	22.13c-f	133.07	32.53h-j	21.77fg	14.50c-e	24.59c	116.40hi	121.73hi	148.07hi
BRRI11A/BRRI10R	82.00fg	15.20a-d	11.03b-g	21.93d-f	134.50	32.97hi	22.90c-g	14.20c-f	23.73c	117.93e-g	123.27e-g	149.60e-g
BRRI11A/BRRI15R	82.17fg	14.17b-f	10.67c-h	22.30c-f	128.80	44.80c	20.97g	19.97b	28.53a	118.93d-f	124.27d-f	150.60d-f
BRRI11A/BRRI20R	80.17h	15.27a-c	11.43b-g	21.90d-f	123.60	32.33h-k	22.77d-g	15.43c-e	24.07c	119.27de	124.60de	150.93de
BRRI11A/BRRI31R	81.67f-h	15.77a-c	12.47a-c	22.03c-f	119.97	36.67fg	22.03e-g	14.37c-f	24.34c	117.60f-h	122.93f-h	149.27f-h
Mean	89.24	14.80	10.93	22.58	132.28	36.31	23.81	17.10	24.80	115.99	121.32	147.62
SD	6.33	1.81	2.00	1.42	13.55	5.87	3.16	4.04	2.85	6.66	6.65	6.69
SE	1.415	0.405	0.447	0.318	3.030	1.313	0.707	0.903	0.637	1.489	1.487	1.496
CV%)	1.04	9.38	12.55	4.80	8.46	2.12	13.27	7.85	7.28	0.717	0.685	0.554

Legend: SD= Standard deviation (SD), SE= Standard error and CV= Co-efficient of variation.

The highest number of filled spikelets per panicle was produced by BRRI7A/BRRI31R (48.20) which was followed by IR79156A/BRRI31R (47.83) and BRRI7A/ BRRI10R (44.63) respectively. Table 3 shows the lowest number of filled spikelets per panicle exhibited by BRRI11A/BRRI31R (36.27) which was followed by BRRI10A/ BRRI15R (36.37). Almost similar result was quoted by Bidhan *et al*. (2001) who reported high heritability coupled with high genetic advance for number of filled spikelet's per panicle.

The highest value for grain yield per plant was recorded in BRRI7A/BRRI31R (8.17g) which was followed by BRRI10A/ BRRI10R (7.85 g) and BRRI11A/BRRI15R (7.68 g) respectively. Table 3 shows the lowest value for grain yield per plant found in IR79156A/BRRI31R (3.97 g) which was followed by BRRI11A/ BRRI10R (4.44 g). Similar report was presented by Shrirame and Muley (2003) who worked out high co-efficient of variability with high heritability for grain yield per plant in hybrid rice. Mishra and Verma (2002) also reported high heritability coupled with high genetic advanced for yield per plant in rice. Iftekharudduala et al. (2001) reported high variation among genotypes in respect of the trait which is similar to the present study. Roy (2006) also expressed similar agreement with the results of the present study.

Table 3. F_1 seed production potentiality of different CMS lines crossed with restorer lines.

Combination	No. of filled grain/panicle	F_1 seed yield per plant (g)
IR75608A/BRRI10R	40.40b-d	5.29c-f
IR75608A/BRRI15R	37.73cd	5.23c-f
IR75608A/BRRI20R	39.13cd	4.74e-h
IR75608A/BRRI31R	38.53cd	6.54b
IR79156A/BRRI10R	38.67cd	5.01d-h
IR79156A/BRRI15R	40.87b-d	5.71c
IR79156A/BRRI20R	40.40b-d	6.87b
IR79156A/BRRI31R	47.83a	3.97i
BRRI7A/BRRI10R	44.63ab	5.42cd
BRRI7A/BRRI15R	36.63cd	5.37cd
BRRI7A/BRRI20R	37.33cd	5.31c-e
BRRI7A/BRRI31R	48.20a	8.17a
BRRI10A/BRRI10R	38.60cd	7.85a
BRRI10A/BRRI15R	36.37cd	4.90d-h
BRRI10A/BRRI20R	41.20bc	5.07d-g
BRRI10A/BRRI31R	40.63b-d	4.72f-h
BRRI11A/BRRI10R	39.30cd	4.44hi
BRRI11A/BRRI15R	38.53cd	7.68a
BRRI11A/BRRI20R	39.37cd	4.90d-h
BRRI11A/BRRI31R	36.27d	4.63gh
Mean	40.03	5.59
SD	4.14	1.21
SE	0.926	0.271
CV	7.36	6.32

Legend: SD= Standard deviation (SD), SE= Standard error and CV= Co-efficient of variation.

Seed production feasibility of hybrid rice combination in Boro season 2017-18, BRRI7A/BRRI31R hybrid rice combination showed considerable positive significant variation over an average in respect of yield and desirable variation for earliness in maturity.

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