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A COMPARATIVE ANALYSIS ON PERFORMANCE OF HYBRID AND INBRED RICE IN BORO SEASON

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ABSTRACT

With a view to compare the performance of hybrid and inbred rice, a field experiment was conducted at the research farm of Bangladesh Rice Research Institute (BRRI), Gazipur during *Boro* season, 2008-2009. Two rice varieties (hybrid Heera2 and inbred BRRI dhan45) and six planting dates (30 December, 15 January, 30 January, 15 February, 01 March and 16 March) were selected. The experiment was laid out in split-plot design (RCBD) with four replications, placing variety at main-plot and planting date at sub-plot. Heera2 produced tillers rapidly at vegetative phase but the tillers retention capacity was lower at post-flowering stage compared to BRRI dhan45, regardless of planting dates. Tillers production reduced gradually with delayed planting in both varieties. Heera2 exhibited significantly higher plant height and higher flag leaf photosynthetic rate at flowering over BRRI dhan45. Different planting dates did not exert considerable effect on flag leaf photosynthetic rate at flowering. Heera2 was out yielded BRRI dhan45 in early planting (30 December and 15 January). At delayed planting, grain filling (%) declined rapidly in Heera2 in comparison to BRRIdhan45. Grain yield decreased @ 36.55 kg $ha^{-1}day^{-1}$ and 68.74 kg $ha^{-1}day^{-1}$ in Heera2 and BRRI dhan45, respectively after 30 December planting. This result suggests that hybrid Heera2 is suitable only for early *Boro* season.

Keywords: hybrid rice varieties, inbred rice, tillering pattern, flag leaf, yield attributes

INTRODUCTION

Hybrid rice is able to produce 15-20% higher yield over the conventional variety (Julfiquar, 2009). The agronomic management of hybrid rice differed considerably from that of inbred rice varieties primarily because of heterosis (Yan, 1988). Inherited yield potentials of the hybrid rice however, can be realized by providing suitable agronomic management package to the crop. A non-monetary input, time of planting is the most important factor influencing the growth and yield of rice. It is possible to increase the grain yield of hybrid rice by planting at early or optimum time of the seasons (Pan *et al.,* 1998 and Om *et al.,* 1996) but late planting reduces the yield of rice due to shortening of vegetative period. Determination of optimum time of planting is more important in case of hybrid rice because of its relatively higher degree of thermo-sensitivity during the flowering and grain-filling stages compared to conventional high-yielding varieties (Nayak *et al.,* 2003). Optimum planting time determines the time of flowering and it has greatly influence on dry-matter accumulation, spikelets $panicle^{-1}$ filled grain $panicle^{-1}$, grain size and yield. However, the physiological basis for heterosis remains still unclear. The optimum planting time is mainly depends on prevailing agro-climatic conditions. Since hybrid rice is a new introduction to our country and not much work has been done on it i.e. little is known about morpho-physiological behaviour of hybrid rice in Bangladesh context. Hybrid rice has already gain positive experience in *Boro* season. Based on the above scenario, this research program was chalked out to investigate the tillering, photosynthetic efficiency and yield of hybrid and inbred rice varieties at different planting dates in *Boro* season.

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MATERIALS AND METHODS

The experiment was laid out in a split-plot design with three replications at the research farm of BRRI, Gazipur during December, 2008 to June, 2009. Two rice variety viz. BRRI dhan45 (inbred) and Heera2 (indica hybrid), and six planting dates (30 December, 15 January, 30 January, 15 February, March 01 and 16 March) were selected for this experiment. Variety and Planting date were used as main plot and sub plot treatments, respectively. The individual (unit) plot size was 4 m X 5 m (20 m^2). 30 days old seedlings were transplanted maintaining 25 cm x15 cm spacing and one seedling $hill^{-1}$ (for both hybrid and inbred varieties). Cowdung was applied in unit plot @ 5 t ha^{-1} and chemical fertilizers such as urea, triple superphosphate, muriate of potash, gypsum and zinc sulphate were applied @ 160-100-110-40-10 kg ha^{-1} in order to supply of NPKS and Zn respectively (BRRI, 2008). Cowdung was applied 15 days before land preparation. All the fertilizers was applied as basal dose except urea which was applied as top dressing in 3 equal installments at 10 days after transplanting (DAT), tillering stage and panicle stage. Intercultural operations were done as and when necessary. Data were recorded on tillers $hill^{-1}$ at 10 days interval starting from 30 DAT, flag leaf photosynthetic rate, stomatal conductance, transpiration rate, and intercellular CO_2 conc. at flowering stage, plant height at maturity, days to flowering and maturity, panicle exertion (%) yield and yield components. A portable photosynthetic system (Model LI 6400, USA) was used to recorded photosynthetic data. The collected data were analyzed using the statistical computer package program MSTAT-C (Russell, 1986). The difference between the pairs of treatment mean was adjudged by Lsd test.

RESULTS AND DISCUSSION

Tillering dynamics

The tested varieties differed significantly in tillers production and responded differently to different planting dates in respect of number of tillers $hill^{-1}$ (Figure 1). Hybrid Heera2 exhibited rapid tillers production up to 50 DAT over BRRI dhan45, regardless of planting dates. This result is in partially consonance with Khan *et al.* (1998) and Yang *et al.* (2007) who reported that hybrid rice variety showed vigorous growth at early stage. At peak, number of tillers $hill^{-1}$ decreased gradually with delayed planting due to reduction of vegetative phase by increased temperature. Number of tillers $hill^{-1}$ was more or less similar in both varieties at peak but tillers retention capacity was lower in Heera2 at post-flowering stage compared to BRRI dhan45 in early planting.

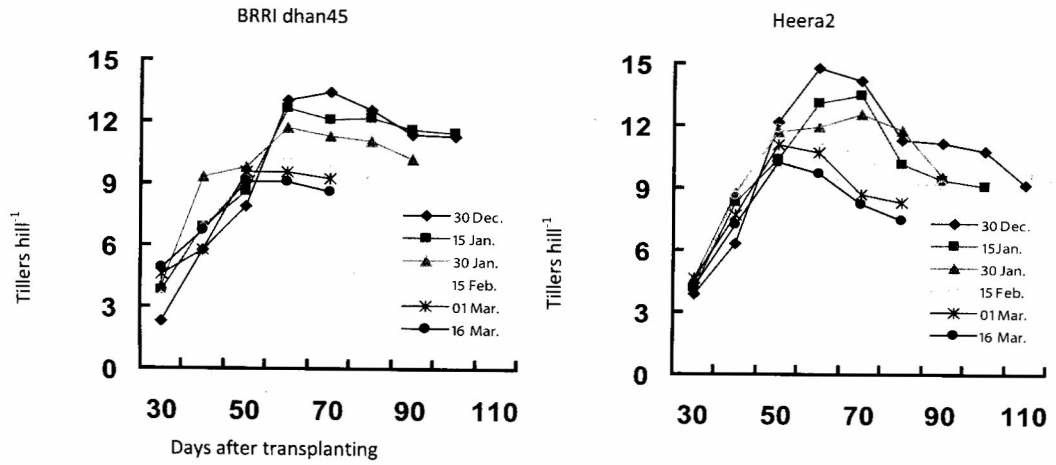

Fig. 1. Tillering pattern of BRRI dhan 45 and Heera2 at six planting dates in *Boro* season

Growth behaviour

Table 1 shows that plant height at flowering was significantly higher in Heera2 (74.72 cm) compared to BRRI dhan45 (66.52 cm). Days to flowering and days to maturity were markedly higher in Heera2 (110.78 and 128.56) than that of BRRI dhan 45 (98.00 and 121.72). There was no difference between hybrid Heera2 and inbred BRRI dhan 45 in respect of panicle exertion (%). Planting dates significantly influenced the plant height, days to flowering, days to maturity and panicle exertion (%). The highest plant height (77.83 cm), days to flowering (121.17), days to maturity (142.83) and panicle exertion (88.67%) were recorded from 30 December planting while correspondingly the lowest plant height (61.20 cm) days to flowering (86.33) days to maturity (111.67) and panicle exertion (66.17) was obtained from 16 March planting. Interaction effect of variety and planting time on plant height, days to flowering, days to maturity and panicle exertion percent were significant. The highest plant height was obtained from the combination of Heera2 and 15 January planting (82.40 cm) which was statistically similar with Heera2 and 30 December planting (81.00 cm) and the lowest was observed in BRRI dhan 45 with 15 March planting (55.33 cm). The highest days to flowering (127.00), days to maturity (147.33) and panicle exertion (91.33 %) were recorded in Heera2 at 30 December planting. The lowest days to flowering (71.33), days to maturity (106.00) was observed in BRRI Dhan45 in 16 March planting but the lowest panicle exertion (%) was found in Heera2 at 16 March planting. It reflected that panicle exertion (%) of Heera2 is more sensitive to delayed planting compared to inbred BRRI dhan45 in *Boro* season. This finding is in agreement with Nayak *et al.* (2003) who stated that hybrid rice has higher degree of thermo-sensitivity compared to inbreed.

Table 1. Effect of variety and planting dates on growth behaviour of BRRI dhan45 and Heera2 at six planting dates in *Boro* season

Variety and planting dates	Plant height (cm.)	Days to flowering	Panicle exertion (%)	Days to maturity
Variety				
BRRI dhan45	66.52	98.00	78.56	121.72
Heera2	74.72	110.78	80.06	128.56
Lsd (0.05)	4.26	2.21	5.33	2.12
Planting date				
30 Dec.	77.83	121.17	88.67	142.83
15 Jan.	77.40	114.83	86.67	133.50
30 Jan.	77.93	107.33	84.33	127.67
15 Feb.	67.85	100.83	79.00	120.33
01 Mar.	61.50	95.83	71.00	114.83
16 Mar.	61.20	86.33	66.17	111.67
Lsd (0.05)	7.38	3.83	9.23	3.68
Interaction				
BRRI dhan45 X 30 Dec.	74.67	115.33	86.00	138.33
BRRI dhan45 X 15 Jan.	72.40	111.00	89.00	132.33
BRRI dhan45 X 30 Jan.	77.73	106.67	86.00	129.00
BRRI dhan45 X 15 Feb.	60.00	96.67	74.67	117.00
BRRI dhan45 X 01 Mar.	59.00	87.00	61.67	107.67
BRRI dhan45 X 16 Mar.	55.33	71.33	74.00	106.00
Heera2 X 30 Dec.	81.00	127.00	91.33	147.33
Heera2 X 15 Jan.	82.40	118.67	84.33	134.67
Heera2 X 30 Jan.	78.13	108.00	82.67	126.33
Heera2 X 15 Feb.	75.7	105.00	83.33	123.67
Heera2 X 01 Mar.	64.00	104.67	80.33	122.00
Heera2 X 16 Mar.	67.07	101.33	58.33	117.33
Lsd (0.05)	10.43	5.42	13.06	5.20

Within a column for each site, means followed by the same letters are not significantly different according to Lsd test (0.05).

Flag leaf physiology

Flag leaf photosynthesis rate at flowering varied distinctly between Heera2 and BRRI dhan45 (Table 2). Higher photosynthetic rate was recorded in Heera2 (24.11 μ mol CO_2 $m^{-2}s^{-1}$) than that of inbred BRRI dhan45 (20.59 μ mol CO_2 $m^{-2}s^{-1}$). These two varieties also showed significant variation incase of stomatal conductance, intercellular CO_2 conc. and transpiration rate like photosynthetic rate (Table 2). Flag leaf photosynthesis rate at flowering did not significantly affected by planting dates or interaction of variety and planting date (Table 2). Flag leaf photosynthetic rate, stomatal conductance and intercellular CO_2 conc. were the maximum in early planting (30 December) and thereafter gradually decreased with delayed planting. The combined effect of planting date and variety on flag leaf stomatal conductance, intercellular CO_2 conc. and transpiration rate were significant (Table 2). These results indicated that higher flag leaf photosynthesis rate at flowering is the inherent character of hybrid Heera2 and flag leaf stomatal conductance, intercellular CO_2 conc. and transpiration rate at flowering were more sensitive to climatic condition compared to flag leaf photosynthesis rate at flowering.

Table 2. Effect of variety and planting dates on physiological parameters of flag leaf of BRRI dhan45 and Heera2 at six planting dates in *Boro* season

Variety and planting dates	Photosynthesis μ mol CO_2 $m^{-2}s^{-1}$	Stomatal conductance mol $m^{-2}s^{-1}$	Intercellular CO_2 conc. (ppm)	Transpiration μ mol $m^{-2}s^{-1}$
Variety				
BRRI dhan45	20.58	0.45	260.66	6.93
Heera2	24.92	0.67	276.42	9.10
Lsd (0.05)	1.81	0.07	7.15	0.63
Planting date				
30 Dec.	24.22	0.73	276.64	8.00
15 Jan.	22.69	0.53	256.36	7.28
30 Jan.	22.63	0.58	272.11	9.23
15 Feb.	23.71	0.61	279.39	9.22
01 Mar.	21.21	0.47	267.11	9.01
16 Mar.	22.05	0.45	259.61	8.45
Lsd (0.05)	ns	0.12	12.38	1.10
Interaction				
BRRI dhan45 X 30 Dec.	22.41	0.62	275.60	7.90
BRRI dhan45 X 15 Jan.	20.81	0.50	253.78	6.21
BRRI dhan45 X 30 Jan.	19.76	0.48	255.33	7.99
BRRI dhan45 X 15 Feb.	20.73	0.39	263.89	7.38
BRRI dhan45 X 01 Mar.	19.81	0.42	263.33	6.17
BRRI dhan45 X 16 Mar.	19.98	0.33	252.00	5.94
Heera2 X 30 Dec.	26.03	0.85	277.67	8.10
Heera2 X 15 Jan.	24.58	0.57	258.94	8.35
Heera2 X 30 Jan.	25.50	0.69	288.89	10.48
Heera2 X 15 Feb.	26.69	0.82	294.89	11.06
Heera2 X 01 Mar.	22.61	0.52	270.88	11.83
Heera2 X 16 Mar.	24.11	0.57	267.22	10.96
Lsd (0.05)	ns	0.17	17.50	1.55

Within a column for each site, means followed by the same letters are not significantly different according to Lsd test (0.05). ^{ns} Non - significant.

Yield and its components

Significantly higher number of spikelets m^{-2}, higher spikelets sterility (%) and heavier individual grain were achieved from Heera2 (24536) than that of BRRI dhan45 (Table 3). The lower number of panicles $hill^{-1}$ was recorded from Heera2 (8.56) compared to inbred BRRI dhan45 (9.81), irrespective of planting date. It indicated that higher number of spikelets $panicles^{-1}$ contributed to higher number of

Table 3. Effect of variety and planting dates on yield and yield components of BRRI dhan45 and Heera2 at six planting dates in *Boro* season

Variety and planting date	Panicles hill^{-1}	Total spikelets m^{-2}	Spikelets sterility (%)	1000 grain weight (g)	Grain yield (t ha^{-1})	Harvest index
Variety						
BRRI dhan45	9.81	20594	34.96	24.95	2.98	0.31
Heera2	8.56	24536	40.86	26.93	3.06	0.36
Lsd (0.05)	0.79	3464.17	5.34	0.78	0.27	ns
Planting date						
30 Dec.	10.40	28223	29.00	25.87	5.13	0.55
15 Jan.	10.07	24114	32.79	25.97	4.31	0.48
30 Jan.	9.72	22455	39.34	25.64	3.25	0.35
15 Feb.	8.84	21083	40.87	26.16	2.60	0.27
01 Mar.	7.82	20297	43.16	26.09	1.51	0.24
16 Mar.	8.27	19284	49.79	25.93	1.21	0.21
Lsd (0.05)	1.37	5998	13.41	ns	0.46	0.08
Interaction						
BRRI dhan45 X 30 Dec.	10.93	27853	33.37	25.02	4.37	0.48
BRRI dhan45 X 15 Jan.	11.143	23446	31.31	24.89	4.15	0.47
BRRI dhan45 X 30 Jan.	10.83	22053	37.24	24.70	3.08	0.32
BRRI dhan45 X 15 Feb.	9.20	15451	33.05	25.10	2.35	0.26
BRRI dhan45 X 01 Mar.	8.10	19748	36.41	25.24	2.13	0.23
BRRI dhan45 X 16 Mar.	8.63	15015	38.36	24.76	1.93	0.11
Heera2 X 30 Dec.	9.87	28593	24.64	26.71	5.88	0.55
Heera2 X 15 Jan.	9.00	24783	25.26	27.05	4.86	0.49
Heera2 X 30 Jan.	8.60	22857	41.43	26.57	3.11	0.39
Heera2 X 15 Feb.	8.47	26715	48.69	27.21	2.24	0.28
Heera2 X 01 Mar.	7.53	20847	49.92	26.94	1.29	0.24
Heera2 X 16 Mar.	7.90	23553	55.23	27.09	0.98	0.19
Lsd (0.05)	1.94	8482	18.97	ns	0.65	0.12

Within a column for each site, means followed by the same letters are not significantly different according to Lsd test (0.05). $^{ns=}$ Non - significant.

spikelets m^{-2} in Heera2. Product of these yield components produced statistically ($p > 0.05$) identical grain yield in Heera2 (3.06 tha^{-1}) and BRRI dhan 45(2.98 tha^{-1}), irrespective of planting dates. There was no difference between Heera2 (0.36) and BRRI dhan45 (0.31) in respect of harvest index. Among six planting dates, grain yield varied from 4.13 to 0.76 tha^{-1} and the variation in grain yield among planting dates were significant ($p>0.05$). Grain yield was the highest (4.13 tha^{-1}) in 30 December and thereafter it declined gradually with delayed planting. Regardless of variety, early planting provided higher grain yield due to higher number of spikelets m^{-2} and lower spikelets sterility (%). Interaction effect of variety and planting date on grain yield was significant. Both varieties produced the highest grain yield at 30 December planting and thereafter, grain yield gradually declined. Trend of grain yield ha^{-1} clarified that Heera2 is more suitable than BRRI dhan45 in 30 December and 15 January planting. Lower spikelets sterility (%) and heavier individual grain weight contributed to the higher grain yield of Heera2 in early planting (30 December and 15 January). Rapid increase of spikelets sterility (%) provided significantly lower grain yield in Heera2 compared to BRRI dhan45 at 01 March and 16 March planting. BRRI dhan45 and Heera2 lose grain yield @ 36.55 kg ha^{-1}day^{-1} and 68.74 kg ha^{-1}day^{-1}, respectively for delayed planting considering 30 December as optimum planting date (Fig. 2). This result is consistent with the finding of Horie *et al.* (1997), Ying *et al.* (1998) and Ao *et al.* (2008) they mentioned that yield of hybrid rice varieties are very much unstable across the environment. Hybrid variety Heera2 exhibited heterosis for grain yield only at early planting (30 December and 15 January) in *Boro* season. Grain yield reduction was higher in Heera2 compared to BRRI dhan45 at delayed planting due to rapid reduction of grain filling (%). So, Inbred BRRI dhan45 is suitable for late *Boro* season. Higher flag leaf photosynthetic rate, stomatal conductance, intercellular CO_2 conc. and transpiration rate at flowering stage had little role in higher grain yield of Heera2 over BRRI dhan45 at early planting in *Boro* season.

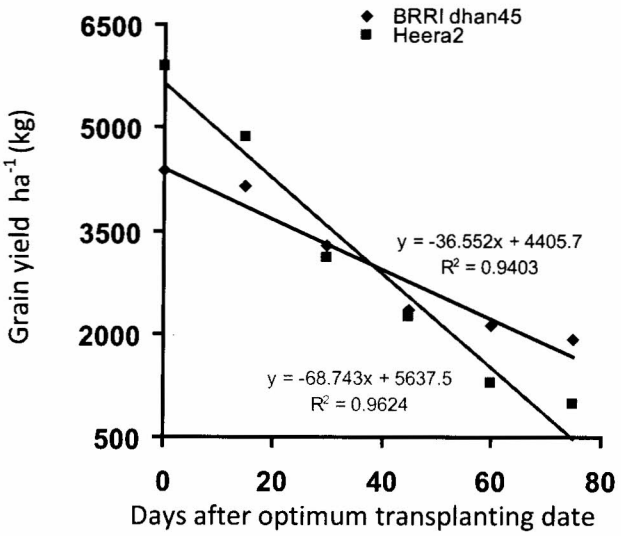

Fig. 2. Rate of grain yield reduction in BRRI dhan45 and Heera2 for delayed planting in *Boro* season

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