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EFFECT OF GA_3 AND ROW RATIO OF RESTORER (R) AND CMS LINES (A) ON DIFFERENT CHARACTERS AND SEED PRODUCTION OF BRRI HYBRID DHAN[2]

M.H. RAHMAN[1] , M.M KHATUN[2], M.S.R. KHAN[3]
M.A.K. MIAN[4] AND M.G. RASUL [4]

Abstract

An experiment was conducted at the experimental farm of Bangladesh Rice Research Institute (BRRI), Gazipur, during November to May 2009-10 to study the effect of GA_3 and row ratio of restorer and CMS lines on different characters and F_1 seed production of BRRI hybrid dhan[2]. The treatments were of four levels of GA_3 viz., (i) control, (ii) 150 g/ha, (iii) 250 g/ha, and (iv) 350 g/ha and five row ratios (R:A) viz., (i) 2:8, (ii) 2:10, (iii) 2:12, (iv) 2:14, and (v) 2:16. Different doses of GA_3 significantly influenced growth and yield components of rice except total tillers/hill and 1000-grain weight. The highest F_1 seed yield (2.34 t/ha) of BRRI hybrid dhan2 was obtained with an application of GA_3 @ 250 g/ha which enhanced the maximum number of effective tillers, the highest number of grains/panicle, panicle exsertion rate and outcrossing rate. The lowest seed yield (1.10 t/ha) was produced without application of GA_3 i.e., control. The row ratio of 2:12 and 2:8 produced the highest (2.05 t/ha) and the lowest (1.63 t/ha) F_1seed yield, respectively. The interaction between GA_3 and row ratio of restorer and CMS lines was significant for F_1 seed yield. The highest F_1 seed yield (2.90 t/ha) was obtained with the application of GA_3 @ 250 g/ha at the row ratio of 2:12 (R: A). The lowest seed yield (0.95 t/ha) was recorded without application of GA_3 (control) at row ratios of 2:16.

Keywords: GA_3, row ratio, out crossing rate, yield and hybrid seed production.

Introduction

Hybrid seed is the product of hybridization between two genetically dissimilar parents. Plants germinated from the hybrid seeds often become vigorous in growth. Hybrid vigour has been primarily exploited in cross-pollinated crops due to obvious advantage of pollinating system and ease of producing hybrid seeds. The development of hybrid rice breeding technology involves improvement and evaluation of parental lines, evaluation of the degree of heterosis for yield and techniques for seed production. To produce hybrids on a commercial scale, it is

[1]Scientific Officer, Hybrid Rice Project, Bangladesh Rice Research Institute (BRRI), Gazipur-1701, [2]Scientific Officer, HRC, Bangladesh Agricultural Research Institute (BARI), Gazipur-1701, [3]AEO, DAE, Khamarbari, Farmget, Dhaka, [4]Professor, Dept.of GPB, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur-1706, Bangladesh.

essential to change the function of male and female reproductive systems of rice plants. A breakthrough came with the discovery and development of the cytoplasmic genetic male sterility system from a wild rice in 1964 (Yuan, 1966). The genetic tools essential for production of hybrid rice-cytoplasmic genetic male sterile (A) line, maintainer (B) line and restorer (R) line-were developed in China and in 1976 the first batch of hybrid rice was released (Virmani *et al*. 1997). Practices involved in producing hybrid rice seeds using a male sterility system include use of an isolated field, timing of seeding of parent lines of seed parent to pollen parent plants. The proper sowing time is dictated by the number of days required from sowing time to panicle formation. The sowing should be so adjusted that the crop comes to panicle stage soon after the end of high temperature period. Seedlings with healthy tillers are the basis for increased panicle size. For hybrid seed production, the seedling of both parents should be standardized. The ratio of female and male lines is generally kept at 2:10-12; and the row spacing 10 x 10 cm for male parent and 20 x 15 cm for female parent. Two seedlings are planted per hill. The two parents of a hybrid combination may differ in their growth duration and, therefore flower at different times even when sown on the same date. To produce hybrid seed successfully on a commercial scale, male and female parents planted side by side in fixed row ratio should flower simultaneously, which is called synchronization. This synchronization can be achieved by seeding them on different dates (Yuan, 1985 and Virmani, 1994). The hybrid rice is new to Bangladesh farmers and its seed production technology is not yet well acquainted to them in relation to effective transplanting ratio and time of CMS (female plant) and restorer lines (male plant). Hybrid rice requires intensive and special management. Therefore, an attempt was made to produce hybrid rice seed in the farmer's field involving different transplanting row ratio and transplanting time of parental lines (CMS and restorer line). Exsertion of panicle from flag leaf sheath is a major problem in WA based CMS lines, as 25 to 35% of the panicle remains inside the flage leaf sheath, thereby making these spikletes unavailable for cross-pollination and resulting low seed set. To overcome this problem, different techniques were tried earlier, such as splitting open the leaf sheath manually; spray GA_3, urea and boric acid singly or combinedly and in combinations along with other practices, such as leaf clipping and rope pulling. Of all the practice applications, GA_3 was found to be the most effective and practically feasible. Besides, detailed study of different floral traits offers a guideline to promote outcrossing rate in CMS lines in obtaining more seed from the seed parent.

Keeping the above points in view, the present research was undertaken with the following specific objective: to assess the performance of BRRI hybrid dhan2 for production of F_1 seed and related characters upon applications of GA_3 at different concentrations and the proper row ratio of restorer and CMS lines

Materials and Method

The experiment was conducted at the experimental farm of Bangladesh Rice Research Institute (BRRI), Gazipur, during November to May 2009-10. The restorer line (R) BRRI10R and CMS line (A) BRRI10A developed by the Bangladesh Rice Research Institute (BRRI) have been used as parent material in the experiment. The line BRRI10R and BRRI10A mature after 150 days and 147 days, respectively. The experiment was laid out in a Randomized Complete Block Design with three replications. Thirty days 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. However, R lines were transplanted on 7 January 2010, while A lines were transplanted on 8 January 2010 to satisfy the experimental requirements. Number of rows for different treatments was different, such as 2:8, 2:10 2:12, 2:14, and 2:16. To accommodate varying number of rows, plot size also varied accordingly. Row directions were perpendicular to wind direction. Urea, TSP, MP, gypsum, zinc, borax, and cowdung were applied @ 370, 250, 370, 150, 20, 7 kg/ha, and 15 t/ha, respectively as mentioned in Chinese Production Technical handout. Urea, TSP, MP, gypsum, zinc, borax (250, 250, 250, 150, 20, 7 kg/ha) were applied at the time of final land preparation and cowdung was applied at the time of 1st land opening and was mixed thoroughly with soil. The rest of the urea and MP were applied as top dress in two equal splits at active tillering stage and panicle initiation stage (30 and 50-55 days after transplanting), respectively. Weeding was done twice by hand pulling on 15 and 30 days after transplanting. To control the pests/ diseases, necessary measure was taken. Space isolation of 50 m and a time isolation of 21 days were considered for hybrid seed production. Moreover, the experimental field was surrounded by an additional 20 rows of R lines to avoid any possibility of cross pollination. The off-type plants were removed by hand pulling during different growth stages. To ensure easy dispersal of pollen and higher cross pollination of panicles of CMS plant, flag leaf clipping is very important. At booting stage, flag leaf blades were cut with the help of a sickle in such a way that two thirds of the flag leaf were removed. Supplementary pollination was done by shaking the pollen parents (R line) with bamboo sticks. This operation was done 4-5 times in between 9 am to 11.30 am for a period of 10 days. The crop was harvested when 80% of the seeds became golden yellow in colour. Grains were sun-dried and adjusted at 14% moisture content to estimate grain yield. In the experiment, data were recorded from 10 randomly selected hills excluding border rows per plot. Data were collected for the following parameters- plant height, number of total tillers per hill, number of bearing tillers/hill, number of grains/panicle, Number of sterile spikelets/panicle, 1000-grain weight, and yield

Panicle exsertion rate (PER)

$$\text{PER (\%)} = \frac{\text{Length of exserted panicle}}{\text{total length of panicle}} \times 100$$

Outcrossing rate (OCR)

$$\text{OCR (\%)} = \frac{\text{Number of filled grains}}{\text{Total number of spikelets}} \times 100$$

The data were analyzed following the ANOVA technique and the mean differences were adjusted by the Duncan's Multiple Range Test (Gomez and Gomez, 1984) using a statistical computer package MSTAT.

Results and Discussion

Mean performance of GA_3 concentrations on growth, yield component, and F_1 seed production of BRRI hybrid dhan2

Different doses of GA_3 significantly influenced growth and yield components of rice except total tillers/hill and 1000-grain weight (Table 1). The highest plant height (126.50 cm) was observed from 350 g GA_3/ha, which was statistically similar to 250g GA_3/ha (123.80 cm) and the shortest one (91.49 cm) from control (Table 2). Plant height increased with increasing GA_3 levels. These results were similar to those obtained by Kim and Heu (1988) who recorded a positive effect of GA_3 level on plant height. The increase in plant height due to greater elongation responses to GA_3.The maximum number of total tillers/hill (13.25) was observed from 250g GA_3/ha and minimum from 350g GA_3/ha (13.02). The other two concentrations, control and 150g GA_3/ha showed intermediate effect on number of total tillers/hill. The progressive improvement in the formation of tillers with 250g GA_3/hill might be due to availability of GA_3 which enhanced tillering. These results are in full compliance with those of Nitumoni *et al*. (2000) who stated that the total tillers/hill increased upon application of GA_3 due to late tillers converted into productive tillers. The highest number of bearing tillers/hill (12.27) was produced with the treatment 250g GA_3/ha and the lowest one (8.94) was recorded in control. The other two concentrations 150g GA_3/ha and 350g GA_3/ha showed similar number of tillers/hill (10.94) and (10.97). Adequacy of GA_3 at 250 g/ha probably favoured the proper cellular activates during panicle formation and development, which led to increase number of effective tillers/hill. IRRI (1993) reported that the bearing tillers/hill was increased upon application of GA_3/due to late tillers converted into productive tillers. The highest number of grains/panicle (61.57) was obtained from 250 g GA_3/ha. The lowest number of grains/panicle (33.69) was obtained from control (Table 2). The highest GA_3 level 350 g/ha produced lower number of grains/panicle than 250g GA_3/ha. Adequate supply of GA_3 contributed to grain formation which increased the number of grains/panicle with increasing GA_3 level. These results were in compliance with those of Zhu *et al*. (1998) who reported the positive influence of

GA_3 level on number of grains/panicle. The minimum number of sterile spikelets/panicle (72.75) was produced at 250 g GA_3/ha (Table 2). The results showed that number of sterile spikelets/panicle gradually decreased with decreased level of GA_3 except 350 g/ha. The medium GA_3 level, 250g/ha produced the lowest sterile spikelets, lower level of GA_3 could not fully exserted panicle in respect of sterile spikelets/panicle which might lead to yield loss. Similar results were also found by Thirthalingappa *et al*. (1999). The highest panicle exsertion rate (94.94%) was found with 250g GA_3/ha and the lowest one (46.63%) was noticed with control (Table 2). Panicle exsertion rate increased with increasing GA_3 level might be associated with stimulating effect of GA_3 on various physiological process including cell division and cell elongation in the plant. GA_3 level 250 g/ha had higher panicle exsertion rate than that of 350 g GA_3/ha for this trait. The highest outcrossing rate (45.89%) was obtained against the treatment 250 g GA_3/ha and the lowest one (25.35%) when no GA_3 was applied (Table 2). It was significantly different from the result of 350 g GA_3/ha. So, from the economic point of views, the concentration of 250 g/ha of GA3 appeared as more beneficial over other treatments. Similar results were also reported by Suralta *et al*. (2004). Apparently the maximum weight of 1000 grains (22.52 g) was observed from 250 g GA_3/ha and the minimum (22.37 g) was from control (Table 2). Results showed that the level of GA_3 was not a factor for increasing or decreasing the weight of 1000 grains. It is a genetically controlled character and genetically fixed by an individual variety. The highest seed yield (2.34 t/ha) was obtained from 250 g GA_3/ha. This might be due to higher outcrossing rate and panicle exertion as mentioned above. The lowest yield (1.10 t/ha) as observed in control which might be due to less outcrossing rate and panicle exertion. Singh and Singh (1996) reported that growth and yield of hybrid rice genotypes by exogenous GA_3 was mainly attributed to greater source and sink potentials. Jagadeeswari *et al*. (1998) proposed that GA_3 application was inevitable but it should be applied with caution since higher doses are detrimental to seed quality. The results suggested that application of GA_3 @ 250 g/ha to be optimal for gaining maximum net economic return.

Effect of row ratio of restorer and CMS lines on different characters and F_1 seed production of BRRI hybrid dhan2

Different row ratios of restorer and CMS lines significantly influenced the growth and yield components of rice except plant height, number of tillers/hill and 1000-grain weight (Table 1). The highest plant height (114.56 cm) was observed from row ratio of restorer and CMS lines at 2:8 and the shortest one (111.90 cm) from 2:12 (Table 3). Results showed that the plant height did not vary at different row ratios. The maximum number of tillers/hill (13.84) was observed from row ratio of restorer and CMS lines at 2:12, and minimum from in 2:14. The other row ratios of restore and CMS lines showed intermediate effect on number of tillers/hill (Table 3). Number of tillers did not vary due to different row ratios. Infact genetic make up of a variety is responsible for manifesting the number of total tillers/hill. The highest number of effective tillers/hill (11.37) was produced when row ratio of restorer and CMS lines was 2:8, which was statistically similar (11.27) to 2:12 ratios. On the other hand, the lowest number of effective tillers/hill (10.22) was recorded when row ratio of restorer and CMS lines was 2:10, which was statistically similar (10.28) to 2:16 (Table 3). Rahman *et al*. (2010) also reported similar results, while conducted experiments to study the influence of row ratio of restorer (R) and Cytoplasmic Male Sterility (A) lines on seed production of hybrid rice. Maximum number of grains/panicle (52.23) was produced when row ratio of restorer and CMS lines was 2:12, which was statistically similar to the treatments 2:10 and 2:14 (51.28 and 51.72, respectively). This might be due to the optimum availability of pollen that led to the highest effective grain formation. On the other hand, the lowest number of grains/panicle (46.02) was recorded in the treatment 2:16. This might be due to insufficient availability of pollen which resulted in the lowest grain formation (Table 3). Similar results were also found by Singh and Singh (1998) who conducted experiments during 1993-95 to determine the optimum row ratio of the pollen parent to the seed parent and the appropriate season for maximizing seed yields in male sterile lines and hybrid rice. Numerically, the higher number of sterile spikelets/panicle (93.59) was noticed when row ratio of restorer and CMS lines was 2:16. This might be due to minimum availability of pollen which resulted in maximum number of sterile spikelets. On the other hand, the minimum number of sterile spikelets/panicle (78.26) was recorded when row ratio of restorer and CMS lines was 2:10, which was statistically similar (79.28) with restorer and CMS lines transplanted at 2:12 ratio (Table 3). Similar results were reported by Sharma and Virmani (1994), while estimating the optimum ratio between male and female rows for hybrid seed production. Maximum panicle exertion rate (77.34%) was obtained when row ratio of restorer and CMS lines was 2:14 and the lowest number of panicle exsertion rate (74.23%) was recorded when the ratio of restorer and CMS lines was 2:8. The other row ratio of 2:10, 2:12, and 2:16 performed statistically similar results (75.44%, 75.79%, and 76.37%, respectively) (Table 3). Results showed that the differences in row ratio was not a factor for increasing or decreasing panicle exertion rate, rather genetic potentiality is fixed by an individual variety. Maximum outcrossing rate (39.64%) was recorded in 2:10, which was statistically similar to 2:12 ratio (39.56%). On the other hand, the lowest number of outcrossing rate (33.04%) was observed at 2:16 ratio (Table 3). Sharma and Virmani (1994) also recorded a positive effect of row ratio on outcrossing rate. The highest 1000-grain weight (22.54 g) was obtained when restorer and CMS lines were transplanted in 2:8 and 2:14 ratio, respectively, while the lowest one (22.31 g) was from 2:16 ratio (Table 3). Results showed that the level of row ratio was not a factor for increasing or decreasing the weight of 1000 grains. It is a genetically controlled trait and genetically fixed by an individual variety. Evidently, row ratio exhibited differences in seed yield of BRRI hybrid dhan2 (Table 1). It was evident that BRRI hybrid dhan2 produced F_1 seed yield of 2.05 t/ha when row ratio of restorer and CMS line was 2:12, which might be the outcome of maximum number of filled grains/panicle. On the other hand, the lowest seed yield (1.63 t/ha) was produced by the ratio of 2:8, which was the consequence of the lowest number of grains/panicle. The ratio 2:10 produced intermediate seed yield (1.74 t/ha) (Table 3). The row ratio of restorer and CMS lines at 2:12 had the maximum availability of pollen which resulted in the highest grain formation. Virmani and Sharma (1993) recorded a positive effect of row ratio on outcrossing rate in rice.

Interaction effect between GA_3 and row ratio of restorer and CMS lines on different characters and F_1 seed production of BRRI hybrid dhan2

Interaction effect of different levels of GA_3 and row ratios of restorer and CMS lines significantly influenced the growth and yield components of rice except plant height, tillers/hill and 1000-grain weight (Table 1). The highest number of effective tillers/hill (14.03) was found when level of GA_3 was applied @ 250 g/ha to the row ratio of restorer and CMS lines of 2:14. On the other hand, the lowest number of effective tillers/hill (8.0 and 8.43) was recorded without applying GA_3 (control) with restorer and CMS lines transplanting ratio of 2:14 and 2:12, respectively (Table 4). The maximum number of grains (66.40) was found when the level of GA_3 were applied @ 250 g/ha to the row ratio of restorer and CMS lines of 2:12, while the minimum number of grains/panicle (32.87) was recorded in control of GA_3 with restorer and CMS lines transplanted in 2:12 (Table 4).The maximum number of sterile spikelets/panicle (106.80) which were recorded in the interaction of control GA_3 with 2:14 row ratio (Table 4). The highest panicle exsertion rate (98.08%) was found when GA_3 level was 250 g/ha with restorer and CMS lines transplanted at 2:14 ratio. On the other hand, the lowest panicle exsertion rate (44.00%) was recorded at control GA_3 x 2:8 (A: R) treatment (Table 4). The highest outcrossing rate (49.27%) was found when GA_3 level was 250 g/ha with restorer and CMS lines transplanted in 2:10. On the other hand, the lowest outcrossing rate (24.04%) was recorded in control GA_3 with restorer and CMS lines transplanted in 2:6 (Table 4). The lowest seed yield (0.95 t/ha) was recorded in control GA_3 x 2:16 treatment which was statistically similar to control GA_3 (1.02 t/ha) with restorer and CMS lines when transplanted at 2:8 (A: R ratio). On the other hand, the highest seed yield (2.90 t/ha) was found when GA_3 level was 250 g/ha with 2:12 ratios (Table 4). The highest grain yield might have been due to cumulative effect of the highest number of grains/panicle, the highest outcrossing rate.

Table 1. Analysis of variance (mean square values) for different characters and F_1 seed yield of BRRI hybrid dhan2.

Source of variation	Degree of Freedom	Mean squares								
		Plant height (cm)	No. of tillers/hill	No. of effective tillers/hill	No. of grains panicle	No. of sterile spikelets/ panicle	Panicle exsertion rate (%)	Out crossing rate (%)	1000-grain wt (g)	Yield (t/ha)
Replication	2	6.38^{NS}	24.93*	39.20*	288.80*	288.80*	337.28*	106.79*	0.47*	0.95*
GA_3 level (A)	3	3845.23*	0.14^{NS}	28.26*	2262.23*	2346.87*	8233.07*	1278.29*	0.07^{NS}	4.05*
Row ratio (B)	4	13.06^{NS}	3.51^{NS}	3.44*	75.27*	454.96*	15.86*	87.46*	0.10^{NS}	0.32*
Interaction (A x B)	12	7.56^{NS}	1.79^{NS}	2.62*	29.56*	47.62*	11.84*	18.23*	0.15^{NS}	0.12*
Error	38	15.248	4.760	0.253	2.274	2.274	1.320	0.217	0.138	0.014

*= Significant at 5% level of probability
NS=Not Significant at P≤0.5

Table 2. Mean effect of GA_3 concentrations on different characters and F_1 seed production of BRRI hybrid dhan2.

Concentration	Plant height (cm)	No. of tillers/ hill	No. of effective tillers/hill	No. of grains/ panicle	No. of sterile spikelets/ panicle	Panicle exsertion rate (%)	Out crossing rate (%)	1000-grain wt (g)	Yield (t/ha)
0 g/ha	91.49c	13.09	8.94c	33.69d	99.95 a	45.63d	25.35d	22.37	1.10d
150 g/ha	110.40b	13.11	10.94b	48.60c	86.65b	68.98c	35.99c	22.49	1.78c
250 g/ha	123.80a	13.25	12.27a	61.57a	72.75d	94.94a	45.89a	22.52	2.34a
350 g/ha	126.50a	13.02	10.97b	57.13b	74.92 c	93.79b	43.45b	22.44	1.98b
CV (%)	3.75	16.63	4.66	3.0	1.80	1.52	1.24	1.65	6.59
SE (±)	1.43	0.81	0.18	0.55	0.55	0.42	0.17	0.14	0.04

In a column, the means having same letter(s) do not differ significantly but dissimilar letters differ significantly at 5% level of significance by Duncans's Multiple Range Test (DMRT). SE= Standard error of means.

Table 3. Mean effect of Row ratio of restorer and CMS lines for different characters and F1 on seed production of BRRI hybrid dhan2.

Row ratio	Plant height (cm)	No. of tillers/hill	No. of effective tiller/hill	No. of grains/ panicle	No. of sterile spikelets/ panicle	Panicle exertion rate (%)	Out crossing rate (%)	1000-grain wt (g)	Yield (t/ha)
$R_2:A_8$	114.56	13.56	11.37a	50.01b	81.84c	74.23c	38.03b	22.54	1.63d
$R_2:A_{10}$	112.68	12.73	10.22c	51.28a	78.26d	75.44b	39.64a	22.44	1.74c
$R_2:A_{12}$	111.90	13.84	11.27a	52.23a	79.28d	75.79b	39.56a	22.45	2.05a
$R_2:A_{14}$	112.51	12.70	10.77b	51.71a	84.87b	77.34a	38.08b	22.54	1.86b
$R_2:A_{16}$	113.62	12.77	10.28c	46.02c	93.59a	76.37b	33.04c	22.31	1.73c
CV (%)	3.75	16.63	4.66	3.0	1.80	1.52	1.24	1.65	6.59
SE (±)	1.59	0.89	0.21	0.62	0.62	0.47	0.19	0.14	0.04

In a column, the means having same letter (s) do not differ significantly but dissimilar letters differ significantly at 5% level of significance by Duncans's Multiple Range Test (DMRT). SE= Standard error of means. R= Restorer line. A= CMS (cytoplasmic male sterile) line.

Table 4. Interaction effect of GA3 and row ratio of restorer and CMS lines on different characters and F_1 on seed production of BRRI hybrid dhan2.

GA_3 level (g/ha)	Row ratio level	No. of effective tillers/hill	No. of grains/ panicle	No. of sterile spikelets/ panicle	Panicle exsertion rate (%)	Out crossing rate (%)	Yield (t/ha)
0	R_2:A_8	10.16ghi	33.13i	100.2b	44.00h	24.96l	1.02i
	R_2:A_{10}	14.03a	35.47i	93.63d	47.00g	27.60j	1.33h
	R_2:A_{12}	8.43k	32.87i	93.97d	46.73g	25.97k	1.14hi
	R_2:A_{14}	8.00k	34.03i	106.80a	45.30gh	24.17m	1.08i
	R_2:A_{16}	9.40ij	32.97i	105.10a	45.13gh	24.04m	0.95i
1	R_2:A_8	8.73jk	49.03g	84.50f	65.13f	36.69g	1.73fg
	R_2:A_{10}	10.90d-g	44.87h	85.20f	66.73f	34.44h	1.65g
	R_2:A_{12}	9.80hi	49.60fg	83.53f	71.83e	37.29g	2.00de
	R_2:A_{14}	12.43b	53.23e	82.80f	71.10e	39.12f	1.92ef
	R_2:A_{16}	10.76d-g	46.27h	97.20c	70.10e	32.41i	1.60g
2	R_2:A_8	10.83d-g	61.50c	67.57jk	94.93bc	47.59b	1.87ef
	R_2:A_{10}	13.06b	66.40a	68.50ij	95.13b	49.27a	2.07de
	R_2:A_{12}	12.33bc	65.17ab	68.80ij	91.13d	48.53a	2.90a
	R_2:A_{14}	14.03a	63.10bc	70.60i	98.08a	47.31b	2.54b
	R_2:A_{16}	11.50cd	51.70ef	88.30e	95.41b	36.75g	2.33c
3	R_2:A_8	10.43e-h	56.40d	75.13h	92.87cd	42.89d	1.88ef
	R_2:A_{10}	11.37de	58.40d	65.73k	92.90cd	47.26b	1.90ef
	R_2:A_{12}	10.33f-h	61.27c	70.80i	93.47bc	46.43c	2.17cd
	R_2:A_{14}	10.60d-h	56.47d	79.23g	94.90bc	41.71e	1.92ef
	R_2:A_{16}	11.40d	53.13e	83.73f	94.83bc	38.97f	2.03de
CV (%)		4.66	3.0	1.80	1.52	1.24	6.59
SE (±)		0.41	1.23	1.23	0.94	0.38	0.10

In a column, the means having same letter(s) do not differ significantly but dissimilar letters differ significantly at 5% level of significance by Duncans's Multiple Range Test (DMRT). SE= Standard error of means. R= Restorer line. A= CMS (cytoplasmic male sterile) line.

Application of GA_3 and row ratio of restorer and CMS lines had profound effect on different component characters of seed yield and hybrid seed production. The highest seed yield of BRRI hybrid dhan2 produced BRRI hybrid dhan2 was produced with an application of GA_3 @ 250 g/ha. While the lowest seed yield was produced without application of GA_3 i.e. controls. The performance of BRRI hybrid dhan2 in term of seed yield was the highest when row ratio of restorer and CMS lines was 2:12 and the lowest was when the row ratio of restorer and CMS lines was 2:8. Maximum seed yield (2.90 t/ha) was obtained with the treatment combination 250 g/ha GA_3 x row ratios of 2:12 (R: A). The technology may need modification, while applying in other region of the country. However, further studies are necessary to formulate at a concrete decision.

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