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OPTIMIZATION OF GA_3 AND ROW RATIO FOR SEED YIELD OF A PROMISING HYBRID RICE VARIETY

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Abstract

GA_3 application at the rate of 225 g/ha with 12 rows of cytoplasmic male stenile (CMS) line and two rows of restorer lines appeared to be the optimum for highest yield of rice. This combination found results of per out crossing rate (OCR) (3.29 t/ha) for F_1 seed production.

Rice is the staple food of about half the world's population, of which more than 90% of the rice consumers inhabit in Asia. It is recorded that the growth of rice productivity has declined in recent years due to little improvement in the rice yield potential. To overcome this challenge, the adoption of hybrid rice technology as experienced in China would offer an alternative to raise further the rice yield potential by exploiting the genetic expression of heterosis or hybrid vigor (FAORAP and APSA 2014, Nguyen 2010). In Bangladesh, hybrid rice developed following the three line systems. The weakness of this system is low level of F_1 seed production. The low rate of seed production is due to lack of high panicle exertion and low outcrossing rate of own developed CMS lines. Application of GA_3 stimulates the cells elongation and can improve yield promisingly. So, it is necessary to measure appropriate dosages of GA_3 and row ratio for a promising hybrid rice combination which is far better than released BRRI hybrid dhan2. Keeping in view of these needs, the present investigation was undertaken to study the appropriate dosages of GA_3 and row ratio on hybrid seed production.

The experiment was conducted at the experimental farm of Bangladesh Rice Research Institute (BRRI), Gazipur, during November to May 2013-14. The restorer line (R) BRRI31R and CMS line (A) BRRI7A developed by the Bangladesh Rice Research Institute (BRRI) have been used as parent material in the experiment. The line BRRI31R and BRRI7A mature after 148 and 145 days, respectively. The experiment was laid out in RCB factorial 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, 2014, while A lines were transplanted on 8 January, 2014. Number of rows used were 2 : 8, 2 : 10 2 : 12 and 2 : 14. 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 @ 270, 130, 120, 70, 10, 7 kg/ha and 15 t/ha, respectively. One fourth urea and full doses of TSP, 2/3 MP, full doses of gypsum, zinc, borax were applied at the time of final land preparation and cowdung was applied at the time of first land opening and was mixed thoroughly with soil. The rest of the urea were applied as top dress in three equal splits at 10 - 12 days after transplanting, active tillering stage and panicle initiation stage with rest doses of MP (30 and 50 - 55 days after transplanting), respectively. Weeding was done as and when required and 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. 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. GA_3 dosages were applied @ 0, 75, 150, 225 and 300 g/ha at 5 - 10 and 30 - 35% of heading of parental lines as per treatment basis. Supplementary pollination was done by shaking the pollen parents (R line) with bamboo sticks. This operation was done 4 - 5 times in between 9 a.m. and 11.30 a.m. 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. Data were recorded from 10 randomly selected hills excluding border rows for panicle exertion rate, out crossing rate and yield. Panicle exertion rate and out crossing rate were measured using the following formula:

Panicle exertion rate (PER)

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

Outcrossing rate (OCR)

$$\text{PER (\%)} = \frac{\text{Number of filled grain}}{\text{Total number of spikelet}} \times 100$$

Different row ratios of restorer and CMS lines significantly influenced the panicle exertion rate, OCR and seed yield of this hybrid combination. Interaction effect of level of GA_3 and different row ratios were also highly significant. The application of GA_3 influences panicle exertion, spikelet opening angle and other floral traits which increases outcrossing rate of CMS lines leading higher yield (Table 1). Application of GA_3 at the rate of 75 g per hectare increased panicle exertion and out crossing rate and seed yield over control but it was not significant. Xu

Table 1. Effect of GA_3 and row ratio on seed yield of a promising hybrid (BRRI7A/BRRI31R) during Boro season of 2013-2014.

Treatment	PER (%)	OCR (%)	Seed yield (t/ha)
GA_3 doses			
GA_3 (0)	67.62	28.79	1.326
GA_3 (75)	72.42	31.83	1.464
GA_3 (150)	78.79	39.05	2.197
GA_3 (225)	83.11	53.00	2.892
GA_3 (300)	81.35	46.11	2.331
Lsd (0.05)	0.2263	0.713	0.078
CV (%)	0.21	1.25	2.72
Row ratio			
2 : 8	75.30	38.29	1.909
2 : 10	76.61	39.35	2.019
2 : 12	78.10	41.10	2.205
2 : 14	76.62	40.29	2.035
Lsd (0.05)	0.2024	0.638	0.070
CV (%)	0.21	1.25	2.72

** Significant at 1% level of probability. PER (%) = Panicle exertion rate. OCR (%) = Out crossing rate.

and Li (1988) reported 13% higher seed yield with application of GA_3 in rice. Rahman *et al*. (2010) also reported similar results, while conducted experiments on row ratio of restorer (R) and cytoplasmic male sterility (A) lines on seed production of BRRI hybrid dhan2. Application of GA_3 at the rate of 150 g per hectare increased panicle exertion and out crossing rate and seed yield over control significantly.

GA_3 application at the rate of 225 g per hectare produced the highest seed yield coupled with highest panicle exertion and out crossing rate of CMS lines but application of GA_3 at the rate of 300 g per hectare exhibited negatively on panicle exertion, out crossing and seed yield. It might be due to excessive growth that hamper pollen dispersion and ultimately gave lower seed yield. 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. Seed yield increased with the increase of row ratios except for row ratio 2 : 14. Panicle exertion rate is one of the major components to predict the ability of a CMS line for producing sufficient amount of F_1 seed. Highest panicle exertion, out crossing rate and seed yield was obtained from 2 : 12 row ratios while ratio 2 : 14 showed lower seed yield. This is because in 2:14 row ratio number of plant population was much more higher than 2 : 12 ratios and thus while supplementary pollination was made pollen grains not able to pollinate whole plants properly resulting lower seed yield. Interaction effect of different levels of GA_3 and row ratios on restorer and CMS lines significantly influenced panicle exertion, out crossing rate and seed yield (Table 2). The highest panicle exertion rate (84.34) was found at 225 GA_3 and 2 : 12 row ratio.

Table 2. Interaction effect of GA_3 and row ratio on seed yield of a promising hybrid (BRRI7A/ BRRI31R).

Treatment combination		PER (%)	OCR (%)	Seed yield (t/ha)
GA_3 (0)	2 : 8	65.60	26.05	1.290
	2 : 10	67.61	27.78	1.323
	2 : 12	69.66	29.47	1.367
	2 : 14	67.60	31.87	1.323
GA_3 (75)	2 : 8	70.72	30.29	1.413
	2 : 10	72.57	31.35	1.483
	2 : 12	73.65	32.35	1.540
	2 : 14	72.76	33.34	1.420
GA_3 (150)	2 : 8	78.19	38.03	2.030
	2 : 10	78.71	38.88	2.223
	2 : 12	80.13	40.89	2.407
	2 : 14	78.11	38.38	2.127
GA_3 (225)	2 : 8	82.11	51.39	2.563
	2 : 10	83.23	52.65	2.730
	2 : 12	84.34	55.57	3.293
	2 : 14	82.76	52.39	2.983
GA_3 (300)	2 : 8	79.89	45.68	2.250
	2 : 10	80.94	46.07	2.337
	2 : 12	82.73	47.25	2.417
	2 : 14	81.85	45.45	2.320
Lsd (0.05) for GA_3		0.2263	0.7129	0.0784
Lsd (0.05) for row ratio		0.2024	0.6376	0.0701
Lsd (0.05) for GA_3 × row ratio		0.2613	0.8231	0.0905
CV(%)		0.21	1.25	2.72

** Significant at 1% level of probability. PER (%) = Panicle exertion rate. OCR (%) = Out crossing rate.

Maximum seed yield (3.29 t/ha) was obtained from the application of GA_3 at the rate of 225 g/ha with row ratio of 2 : 12. Zheng *et al.* (2011) found that suitable dosages of GA_3 application could improve the photosynthetic capacity, delay the leaf senescence and promote the rate of rice seed-setting. From the present experiment, it can be concluded that the application of GA_3 level of 225 g/ha at row ratio of 2 : 12 showed significant effects on seed yield of this hybrid combination. Further experiments should be taken at different locations to confirm this finding.

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