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Panicle Exertion Enhancement of Hybrid Rice (PSB RC72H) As Influenced By Sowing Frequency, Male to Female Row Ratio and Gibberellic Acid

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Abstract: *Hybrid rice farming calls for important consideration to successfully productive growth and harvest of plants. Seed yield performance of female parent of PSB Rc72H was investigated at the Experimental Area of Research Extension and Training (RET), Central Luzon State University, Science City of Muñoz, Nueva Ecija, Philippines from December 2004 to May 2005 based on individual and interaction effects of GA_3 application, male to female row ratio, and sowing frequency.The study was carried out in a 2 x 3 x 3 factorial Experiment in Randomized Complete Block Design with three replications. The treatments are as follows: Factor A- Sowing Frequency of R lines; Factor B- Male to female Row Ratio; and Factor C- Rate of GA_3. Results showed that the degree of panicle exertion was significantly increased by rate of GA_3 at 180 g ha^{-1} application but not on the male and female row ratio and sowing frequency of R-lines and their interaction effects. Significant improvement was also observed on the percent seed setting in sowing frequency of one time, 2:12 male to female row ratio application of GA_3 of 120 gm ha^{-1}, and the interaction between one time sowing of R-line and GA_3 application. Moreover, significant increase was noted in filled grain due to interaction effects between sowing frequency of R-line and male to female row ratio. Filled grains increased also in one time sowing frequency of R-line while unfilled grains was significantly higher in two times sowing frequency of R-line than one time and male to female row ratio of 2:16.*

Keywords: *Hybrid rice, Gibberellic acid, parental lines, sowing frequency, yield*

I. Introduction

Rice (*Oryza sativa L.*) is the staple food and most important cropof the Philippines [1]. It is one of the sources of income of many Filipino people. In a global perspective, it serves as one of the most important food that feeds more than half of the world's population [2] and its demand will surely increase because of rising population and outpaced production [3].To decipher this existing problem, hybride rice technology integrating GA_3 application and other farming methods and practices has been widely accepted practice in various countries. It involves improvement and evaluation of parental lines, evaluation of the degree of heterosis for yield and techniques for seed production [4].

Hybrid seed technology needs an efficient and economic seed production package so that adoption can be enhanced. It is an alternative to increase the yield potential of rice which is the ultimate goal in rice breeding. The involvement of Gibberellic acid (GA_3), parental lines, male to female row ratio, and sowing intervals is the highlight of this study. These overall give greater opportunities to produce seedlings with healthy tillers which is the basis for increased panicle size.Thus, hybridization is contingent upon the synchronization of pollination and stigma receptivity [3].

Alternative solution of rice production problem in the country may not enough to counter shortage. The answer of longevity initiatives is a must to alleviate futurenational food emergency. This investigation is a helpful strategy for the promotion of a secured and productive harvest. It aimed to determine the seed yield performance of female parent of PSB Rc72H throughapplication of GA3, male to female row ratio, sowing intervals of R lines, and assess their interaction effects in the rice plants.

II. Materials And Methods

The study was conducted to determine the yield performance of PSB Rc72H parental lines (A x R) as influenced by sowing frequency, male to female row ratio and GA_3 application. The treatments were: Factor A – sowing frequency of R line (once and twice); Factor B – male to female row ratio; 2:12 rows, 2:14 rows and 2:16 rows; and Factor C – rate of GA_3; 120 gm ha^{-1}, 150 gm ha^{-1} and 180 gm ha^{-1} with three replications per treatment arranged in a 2 x 3 x 3 factorial experiment in a Randomized Complete Block Design.

Seedling Management

The seeding rate used was 10 kg/ha for R line and 20 kg/ha for A line. During the pre-germination, the R line seeds were soaked for 24 hours and A line seeds for 12 hours following the recommended differential

seeding schedule (Fig. 1). The seeds were soaked and water was changed every 6 hours. The seeds were incubated for 24 hours in a warm and shady place.

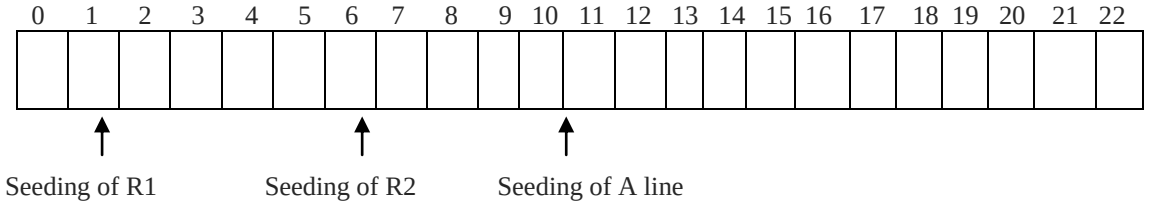

Fig. 1. Differential seeding of male and female parents.

Gibberellic Acid Application

Gibberellic acid (GA_3)was applied thrice to both parents following the treatments used (120, 150 and 180 gm ha^{-1}). The first spraying of GA_3 of 36, 45 and 54 gm ha^{-1} (30 %) was applied at 20 percent heading (panicle exerted about 2 inches from the leaf sheath). The second spraying of GA_3 of 60, 75, and 90 gm/ha (50 %) was done 3 days after the first application. The remaining amount of GA_3 of 24, 30 and 36 gm ha^{-1}, (20 %) was sprayed on the fourth day. GA_3 powder with 80 percent purity was used. This was dissolved in 20 ml of 75 percent isopropyl alcohol before it was mixed with water.

By using the ultra low volume (ULV) sprayer, the amount of water required to spray one hectare was 50 liters. The amount of water required to spray each treatment (plot) was calculated using the formula:

$$\text{Volume of water} = \frac{\text{Plot size } (m^2) \times 50}{10{,}000\ (m^2)}$$

Water Management

At transplanting time, the field was kept saturated until the recovery of seedlings. Ten days after, 1 – 2 cmlevel of water was supplied until the maximum tillering stage of the crop. At the maximum tillering stage, the water was drained until the field slightly cracked. Water level of 2-3 cm was maintained during panicle initiation. During flowering period, the field was kept saturated but at the time of GA_3 application 3-5 cm water level was maintained. Water was gradually withdrawn from the field until finally drained at about two weeks before harvesting.

III. Results And Discussion

Degree of Panicle Exertion

A difference was observed on the degree of panicle exertion as influenced by GA_3 application but not male to female row ratio and sowing frequency of R-line and their interaction. The highest panicle exertion of 77.06 percent was recorded in 180 g GA_3 per hectare while 120 and 150 g per hectare had a mean of 75.38 and 75.17 percent, respectively (Fig. 2). Plants sprayed with 180 g per hectare significantly exerted more panicles.This shows that increasing GA_3 application has direct relationship to panicle exertion [5].Observations imply that the percentage of exerted panicles is a function of the increase in length of the upper internodes to the inability of the upper most internode to elongate [6]. Spraying of 180 g GA_3 ha^{-1} under PhilRice condition has caused a panicle exertion of about 45-50% [7].Besides improving panicle exertion, GA_3 also increased the stigma exertion as well as during the timethe spikelet is open and has active stigma receptivity [8]. The degree of panicle exertion was increased with GA_3 application at 250 grams concentration per hectare has obtained only 42 percent panicle exertion [4].

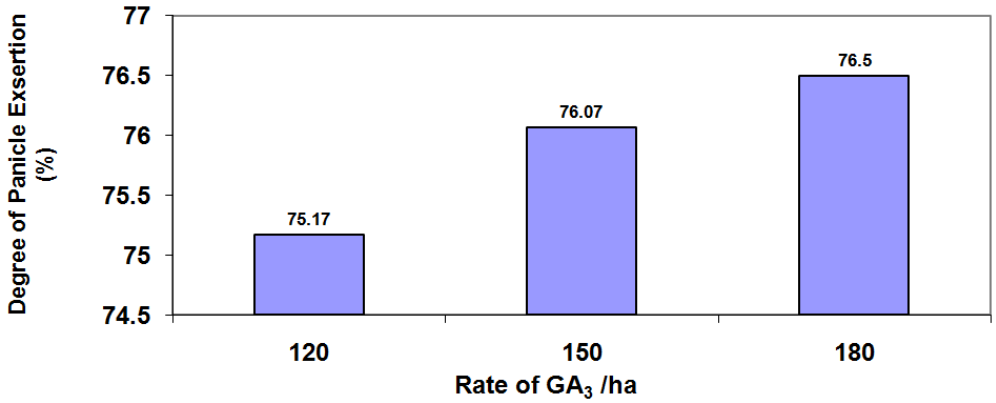

Fig. 2. Degree of panicle exertion of A-line at different rates of GA_3 application.

Panicle Length

No significant interaction effect was observed between sowing frequency of R-lines and male to female row ratios on panicle length. The length of panicle was not influenced by the rate of GA_3 application. The average length of panicle across the sowing frequency of R-lines was 24.03 and 23.87 cm. Panicle length at a row ratio of 2:14 was the longest panicle. This was followed by 2:16 and the lowest was 2:12. Among the three rates of GA_3 applied, 180 gm ha^{-1} gave the longest panicle with a mean of 24.04 cm. Next was by 150 and 120 gm ha^{-1} with a mean of 23.98 and 23.80, respectively (Table 1).

GA_3 application started at stage 10 just before the onset of flowering. Hence, effect of GA_3 on increasing the panicle length was not observed. Also, the maximum length of the panicle was attained before the start of GA_3 application. This was the reason why the effect was not observed. Panicle was perceived to be actively growing during Stage 1 to 9 of its developmental stages [9].

Table 1. Average length of panicle of A-line as influenced by sowing frequency,male to female row ratio and GA_3 application (cm).

Sowing Frequency Of R-Lines	Male Female Row Ratios	Rate Of Ga_3 G/Ha			Sowing Frequency Of R-Lines Mean
		120	150	180	
Once	2:12	23.66	23.66	23.86	
	2:14	23.76	24.46	23.58	23.86
	2:16	24.00	23.68	24.10	
Twice	2:12	23.67	23.55	24.01	
	2:14	24.25	24.45	24.11	24.03
	2:16	23.58	24.08	24.56	
Rate Of Ga_3 Mean		23.82	23.98	24.04	
Row Ratio Mean		2:12 23.73	2:14 24.10	2:16 24.00	

Percent Seed Setting

Significant effect on male to female row ratio and interaction effect between sowing frequency and the rate of $GA_3$was noted (Fig. 2). Highest percentage seed set was observed in male to female row ratio of 2:12 with a mean of 36.80 percent. This was followed by 2:14 with a mean of 35.08. The lowest was 2:16 with a mean of 31.08 percent (Fig. 3). This result revealed that asthe lower row ratio is employed, more seed yield is evident [10].

On the other hand, interaction between sowing frequency of R-line (one time) and rate of GA_3 120, 150 and 180 gm ha^{-1} had 37 percent increase on percent seed setting (Table 2). This result implies that lower ratio of male to female increases percentage seed setting due to good outcrossing capacity. This revealed that the male to female row ratio of 2:10 or 2:12 was found to be effective and standardized [4]. Beyond this, plateuing or a declining trend in yield levels was observed. These levels obtained the highest and gave longer pollen viability of male to female parent and female parent because of increased stigma receptivity, wider angle,and longer duration of spikelet opening in enhancing the seed yield [11].

Flowering synchronization in one time sowing gave more pollen to fertilize on female parents. This stated that GA_3 application for a few days within the flowering period enhanced the duration of the stigmatic receptivity of the CMS line which increased the chances of being fertilized [4].

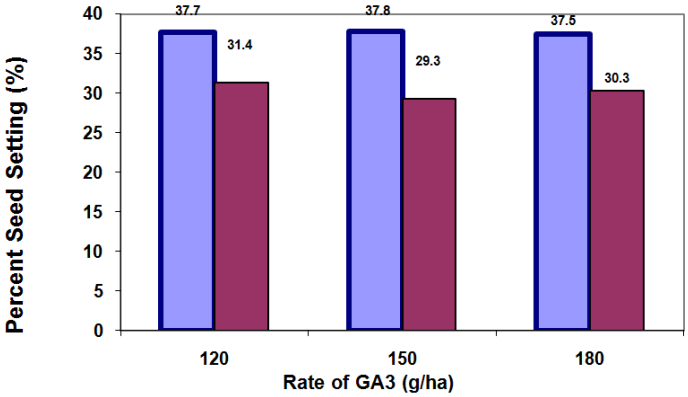

Fig. 3. Interaction effect between sowing frequency and rate of GA_3.

Furthermore, GA_3 applied to the yield parental lines increased the chance of cross pollination leading to more seed setting [7]. When one sowing of male row ratio is used instead of the current practice of three times sowing, pollen load with one sowing would increase [12].

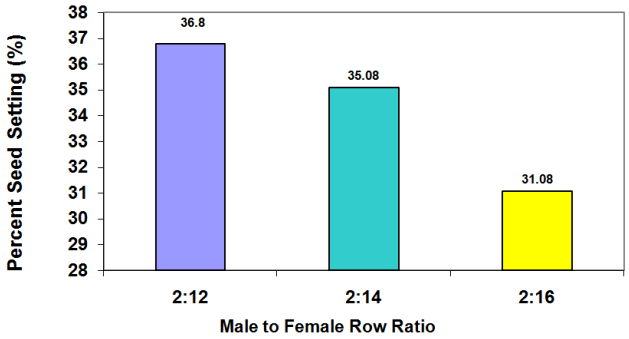

Fig. 4. Percent seed setting of A-line in different row ratio

Table 2.Percent seed setting of A-line as influenced by sowing frequency and GA_3 application (%).

RATE OF GA_3 (gm ha^{-1}) (C)	SOWING FREQUENCY (A)		MEAN
	Once	Twice	
120	37.7a	31.4 b	34.55
150	37.8a	29.3 c	33.55
180	37.5a	30.3 bc	33.86
MEAN	37.67	30.33	
ROW RATIO MEAN (B)	2:12 36.80^a	2:14 35.08^b	2:16 31.08^c

Mean in row and column with the same letter are not significantly different at 5% level by DMRT.

Number of Filled Grains per Panicle

Data showed that interaction between sowing frequency of R-line and male to female row ratio had significant effect on filled grain. Highest numbers of 56.7 filled grains were observed at one time sowing with 2:12 male to female row ratio but comparable to 2:14, and 2:16 row ratio at one time sowing with total filled grain of 54.7 and 54.0, respectively.

On the other hand, the sowing frequency of R-line produced significant result. The highest number of 55.13 filled grains was observed at one time sowing of A-line compared to two times sowing which gave a 45.12 filled grains (Fig. 4). These results of the study suggested that lower ratio and male parent flowered at once and increased the number of filled grains per panicle due to higher amount of pollen available to fertilize the female parent. More number of filled grains was developed perhaps because of the absence of pests and diseases and good synchronization of flowering between parental lines. Also, favorable conditions during the time of the study contributed to increased filled grains. It explained that although rice is self pollinated crop, significant cross pollination occurs on male sterile (female parent) plants depending on their flowering behavior, floral characteristics, and prevailing weather condition [12].

Table 3.Average number of filled grains per panicle of A-line as influenced by sowing frequency and male to female row ratio.

ROW RATIO (B)	SOWING FREQUENCY (A)		MEAN
	Once	Twice	
2:12	56.7[a]	43.1[d]	49.90
2:14	54.7[ab]	45.5[cd]	50.10
2:16	54.0[ab]	46.7[c]	50.35
MEAN	55.13[a]	45.12[b]	

Mean in row and column with the same letter are not significantly different at 5% level by DMRT.

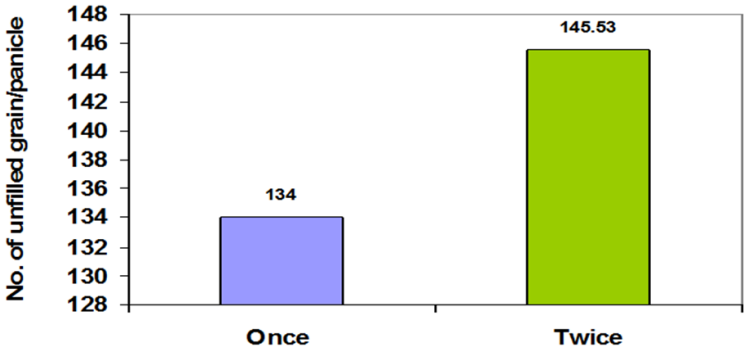

Fig. 5. Average number of unfilled grain per panicle of A-line with sowing frequency.

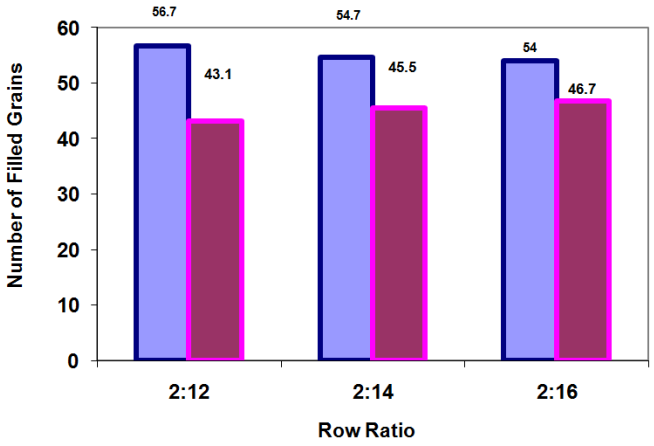

Fig. 6. Interaction effects between sowing frequency and row ratio

Number of Unfilled Grain per Panicle

Table 3 shows the significant effect of sowing frequency on R-line and male to female row ratio but not their interaction effects. Highest unfilled grain was obtained from sowing frequency of two times with a mean of 145.53 unfilled grains (Fig. 4). Significant difference was observed in 2:14 and 2:16 row ratio. These row ratios had an average number of 143.45 and 142.05 unfilled grains, respectively. The lowest was on 2:12 row ratio with a mean of 133.85 unfilled grains (Fig. 5). These results showed that higher row ratio with sowing frequency of two times increased number of unfilled grains due to the increased distance between the male parent to female parent leaving the central rows with few pollens to receive. If flowering does not synchronize, only the male parent will set seeds and the female parent will have unfilled grains. This stressed that pollens in central rows with a higher row ratio did not effectively fertilize and produce enough seed on female parent [12].

Table 4.Average number of unfilled grains per panicle of A-line as influenced by sowing frequency and male to female row ratio.

ROW RATIO (B)	SOWING FREQUENCY (A)		MEAN
	Once	Twice	
2:12	126.0	133.85	133.85[b]
2:14	135.0	143.45	143.45[a]
2:16	141.0	142.05	142.05[a]
MEAN	134.00[b]	145.53[a]	

Mean in row and column with the same letter are not significantly different at 5% level by DMRT.

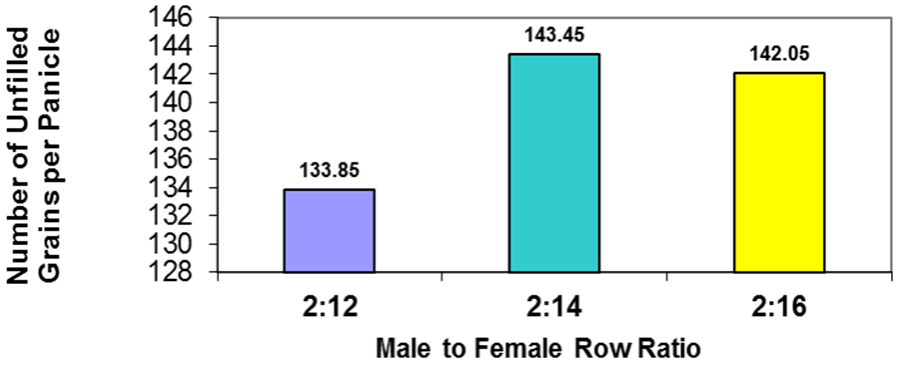

Fig. 7. Average number of unfilled grain per panicle of A-line at different row ratio.

A difference was observed on the degree of panicle exertion as influenced by GA_3 application but not on male to female row ratio and sowing frequency of R-line and their interaction. The highest panicle exertion of 76.5 percent was recorded in 180 gram GA_3 per hectare while the 120 and 150 grams per hectare had a mean of 76.07 and 75.17 percent, respectively.Plants sprayed with 180 grams per hectare significantly exerted more panicles. These observations imply that the percentage of exerted panicles is a function of the increase in length of the upper internodes to the inability of the upper most internode to elongate [6]. It further showed that under PhilRice condition spraying of 180 gm GA_3 ha^{-1} caused a panicle exertion of about 45-50% and produced a seed of about 2.0 t ha^{-1} [7]. Besides improving panicle exertion, GA_3 also increased the stigma exertion as well as the time during which the spikelet is open and has an active stigma receptivity [8].

IV. Conclusion

Significant contributions of GA_3, male to female row ratio, sowing intervals, and their individual and interaction effects were evident based on certain plant behaviors. Further rice researches are encouraged especially concentrating on additional specific number of observation periods, seasons, and applications, and doing the same experiment in other regions of the country. Using variety of hybrid seeds and measuring soil salinity and other related soil tests are also a big help for more comprehensive details and comparable results.

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