Effect of Seeding Rate and Ga_3 Application on Hybrid Rice Seed Productivity under Seed Production Plots

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ABSTRACT

Two field experiments were carried out at the Experimental Farm of Sakha Agricultural Research Station, Kafr El–Sheikh Governorate, Egypt, during the two successive summer seasons of 2007 and 2008.The field experiments were conducted to study the effect of seeding rate and GA_3 doses in the hybrid rice seed production plots on growth characters, yield and its components of F_1 hybrid rice plants.

The material under this study included the parental lines IR 69625 A as (female line) and Giza 182 (restorer line) to produce the seeds of F_1 hybrid rice (SK 2058 H). A split-plot design with three replication was used. The main plot was devoted to seeding rate of 20, 24and 28 kg seeds/ha, while the GA_3 doses were assigned in the sub plots. Four doses of GA_3 (BERLEX) 300, 350, 400 g/ha and a control treatment (spraying with water) in two spraying times.

The results showed that, Plant height and flag leaf angle were highly significantly affected by the different doses of GA_3 and different seeding rate. The female parent of the hybrid, SK 2058 H, had a wide variation for panicle exsertion. The hybrid seed yield was highly significantly affected by GA_3 application. It was increased by using 300g GA_3/ha, indicating the positive effect of application. The1000-grain weight was decreased with increasing the doses of GA_3 while the application of high doses of GA_3 increased the seed set percentage, but reduced the grain filling rate. The grain yield of the IR69625A was highly affected by the seeding rate and GA_3 applications. Results also showed that using 20 or 24 kg seeds/ha from IR69625A and GA_3 application by the rate of 350 g/ha may be the best combination for hybrid rice seed production.

INTRODUCTION

Hybrid rice seed production is a systematic, complex and demanding approach compared with inbred seed production.The most important step from research for commercialization of hybrid rice is hybrid seed production. The timely supply, of cheap and good quality hybrid rice seeds from reliable channels is prerequisite to the rapid expansion of hybrid rice grown area.

A good panicle exsertion in a male sterile parent would expose a higher number of spikelets for out crossing compared to male-sterile line showing incomplete panicle exsertion. Similarly, in complete panicle exsertion in a pollen parent (restorer) would result in lower pollen release into the air. Therefore, a good panicle exsertion in both seed (female) and pollen parent is essential in a hybrid rice seed production to attain high out crossing rate (Virmani, 1994).

Most of the hybrid male sterile parents developed in Egypt and elsewhere are based on CMS lines having the wild abortive (WA) backgrounds. Incomplete panicle exsertion in most of the CMS lines based on the wild abortive type is one of the major impediments in obtaining higher seed yield as 20-30% of the panicles are enclosed in the flag leaf sheath.

Many scientists recommended GA_3 application to increase seed yield (Yuan, 1985; Xu and Li, 1988; Virmani, 1995 and Virmani *et al.*, 1997).

Extensive research in China and IRRI indicated that GA_3 application, use the optimum seed parent: pollen parent ratio, small and horizontal flag leaves are important to increase the yield of the female parent via increasing out crossing rate. Using GA_3 by a rate of 120-180 g/ha were recommended in China in 1990s (Xu and Li, 1988).

GA_3 application helps to complete panicle exsertion of the panicle out of the flag leaf sheath in CMS lines and increased the grain yield at least by 0.870 t /ha when used 200g/ha of GA_3 comparing without applied GA_3.(Abo yousef 2003).

GA_3 application increased ear extension from the flag leaf sheath, cross pollinated seed set and seed yield, while, seed weight was slightly but significantly decreased by GA_3 application (Duan and Ma, 1992).

The main objectives of this investigation were study the effect of different seeding rate and GA_3 application on growth, yield and its components of F_1 hybrid rice plants.

MATERIALS AND METHODS

This study was carried out at the experimental Farm of Sakha Agriculture Research station, Kafr EL-Sheikh governorate, Egypt during the two successive summer seasons of 2007 and 2008 to investigate the effect of different seeding rate and GA_3 application on growth, yield and its components of F_1 hybrid rice plants.

The material under study included two parental lines IR69625A (female line) with abortive type of sterility

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and Giza182R (restore line) to produce F_1 hybrid seed for promising hybrid SK.2058H. A split plot –design with three replications was used. The main plot was devoted to three seeding rate of, 20 kg/ha (15 kg/ha of A line and 5 kg of R line), 24 kg/ha (18 kg of A line and 6 kg of R line) and 28 kg/ha (21 kg of A line and 7 kg of R line).While, four doses of GA_3 application, (0, 300, 350, 400) g/ha, were arranged at random in the sub plot.

The dosages of GA_3 were applied in two spraying times of both A line and R line plants.

First spray: 40% of GA_3 dosage was solved in a small amount of ethanol alcohol (70%), then it mixed with 50 litre of water and sprayed when 15-20% of panicles were at heading.

Second spray: 60% of GA_3 was added as mentioned previous when 35-40% of panicles were at heading (two days after the first spray) according to Prabagaran and Ponnuswamy (1997).

Data were recorded according to standard evaluation system of IRRI 1998, for all studied characters. The following characters were involved in this study: flowering date, flag leaf area (cm^2),plant height (cm), number of tillers/m^2, 1000-grain weight, panicle weight (g), Panicle exsertion percentage, seed set percentage, harvest index and grain yield.

All collected data were subjected to analysis of variance according to Gomez and Gomez (1984). Treatment means were compared by Duncan's multiple range test (Duncan, 1955). All statistical analysis were performed using analysis of variance technique by means of "IMSTAT" computer soft ware package.

RESULTS AND DISCUSSION

Data presented in Table 1 showed that the flowering date was highly affected by seed rate in the first year. Using 20 kg seeds/ha delayed the flowering date up to 104.00 days from sowing, but plants in the third seeding rate were relatively earlier and flowered after 101.75days from sowing. Significant differences among the GA_3 doses were detected for days to heading. Increasing GA_3 doses from 0 to 400 g/ha led to increase the days to flowering by about 4 days on the seed parent.Data presented in Table 1 showed that the flag leaf area was highly affected by seed rate in the two years. The highest value of flag leaf area from combined data (33.42 cm^2) was recorded for the first seed rate, but the lowest data value (31.93 cm^2) was detected by the third seed rate during the two seasons.

The statistically analyzed data, indicated that there were significant differences among the GA_3 doses for flag leaf area. The highest values were 35.47 and 37.24 cm^2 for the doses of 400 g GA_3 in 2007 and 2008 seasons, respectively. But, the lowest values were 26.17 and 27.11 cm^2 for the control treatment (spraying with water) in the both seasons, respectively, indicating that the GA_3 played an important role in increasing of flag leaf area. In this respect, Arian *et al.* (1990) found that leaf area was higher in plants grown from high density seeds.

Data illustrated in Table 2 showed that, the plant height and No. of tillers/m^2 were affected by seed rate in the two summer seasons (2007 and 2008) The highest values of plant height; 113.1 and 110.06 cm; were detected under the third seeding rate in 2007 and 2008, respectively.

Table 1. Effect of seed rate and GA_3 dose, as well as their interaction on flowering date (day) and flag leaf area (cm^2) during 2007 and 2008 seasons

Main effect and interaction	Flowering date(day) at 30%		Combined	Flag leaf area(cm^2)		Combined
	2007	2008		2007	2008	
Seed rate (A)						
20	104.00a	102.33	103.16a	33.44a	33.41a	33.42a
24	103.25a	101.91	102.58a	32.30ab	32.46b	32.38b
28	101.75b	101.16	101.54b	31.64c	31.21c	31.93 b
F – Test	**	NS	**	**	**	**
GA_3.doses (B)						
0	101.00d	99.44c	100.22d	26.17d	27.11d	26.64d
300	102.55c	101.00b	101.77c	32.12c	31.53c	31.83c
350	103.66b	103.00a	103.33b	35.07b	34.89b	34.98b
400	104.77a	104.00a	104.38a	35.47a	37.24a	36.86a
F – Test	**	**	**	**	**	**
Interaction						
A x B	NS	NS	NS	NS	*	*

*,** and NS : significant at the 0.05, 0.01 level of probability and not significant, respectively.

Means followed by a common letter(s) aren't significantly differed at 0.05 level.

Table 2. Effect of seed rate and GA_3 dose, as well as their interaction on Plant height (cm) and number of tillers/m^2 during 2007 and 2008 seasons

Main effect and interaction	Plant height (cm)		Combined	No. of tillers/ m^2		Combined
	2007	2008	2007	2007	2008	
Seed rate (A)						
20	108.69c	108.45b	108.57 c	314.75a	302.83a	308.79a
24	110.03b	109.70a	109.86 b	300.91b	302.50a	301.70a
28	113.1a	110.06a	111.58 a	282.00c	281.41b	281.70b
F – Test	**	**	**	**	**	**
GA_3.doses (B)						
0	86.44d	85.75d	87.00c	178.77d	177.88c	178.32d
300	114.04c	113.40c	113.72b	293.55c	282.55b	288.05c
350	118.46b	117.53b	118.00a	352.77b	354.11a	353.44b
400	121.38a	120.94a	121.16a	371.77a	367.77a	369.77a
F – Test	**	**	**	**	**	**
Interaction						
A x B	**	*	**	**	**	**

* and **: significant at the 0.05, and 0.01 level of probability, respectively.
Means followed by a common letter(s) aren't significantly differed at 0.05 level.

While, the highest value of No. of tillers/m^2 were 314.75 for 20 kg/ha of seeding date in the first season. But, the lowest values of plant height were 108.69 and 108.45 cm under 20 kg seeds/ha. Data also showed that the high density of seeds/m^2 decreased tillering ability and increased the growth rate of seedling, due to increase the competition on the light and nutrition elements.

On the other side, increasing GA_3 application from zero to 400 g/ha were associated with increasing in plant height from 78.00 cm to 121.16 cm in the combined analysis of the two seasons indicating the role of GA_3 in enhancement the stem elongation of parental lines.

Number of tillers/m^2 were significantly affected by GA_3 application. Increasing GA_3 doses up to 400 g/ha resulting in increasing number of tillers/m^2 from 178.32 to 369.77 as a combined over the two seasons but the differences between 350 and 400 g were not significant in the second season.

The interaction between the seed rates and GA_3 application were highly significant in the two summer seasons of 2007 and 2008.In this respect, Vijayalakshmi *et al.* (2006) found that application of GA_3 at the rate of 75 g/ha to parental lines gave the highest plant height (69.8 cm).

Data in Table 3 showed that flag leaf angle was decreased with each increasing in seeding rate up to 28 kg seeds/ha. The highest flag leaf angle; 36.36^o and 36.51^o were detected under 20 kg seeds/ha in both seasons. While, the lowest values; 33.09 and 34.16^o were obtained under 28 kg seeding rate in the two seasons. Moreover, the highest value for flag leaf angle were 40.23 and 43.74^o with using 400 g GA_3/ha in the two seasons, respectively. But, the inferior values were detected under the control, indicating the major role of GA_3 in increasing the flag leaf angle. These results were in general agreement with those reported by Sushil *et al.* (2003) who reported that GA_3 had a positive effect on flag leaf angle.

Data in Table 4 indicate that there were significant differences among GA_3 doses and seed rate for 1000-grain weight in both seasons. The highest values were (24.70 and 24.41 g) when 28 kg seeds/ha was used in the two seasons, respectively. But, the lowest values were (24.15 and 24.01 g) under the second seeding rate in the two seasons, respectively.

Moreover, the values of 1000-grain weight were inversely affected by GA_3 application, the heaviest 1000-grain weight were obtained under the control treatment in the two seasons. These results indicated that the increasing of out crossing will increase the seed set % and decrease grain filling rate, similar results were obtained by Gaballa (2004). Seed weight was significantly decreased by GA_3 (Duan and Ma, 1992).

Results in Table 4 revealed that, the effect of seed rate and different doses of GA_3 were highly significant on the panicle weight of 69625A as a female line in the two successive seasons. The highest values were (2.20 and 2.16 g) when 20 kg/ha seed rate was applied, but the lowest values were (2.06 and 2.12 g) when 28 kg/ha seed rate was used, indicating that increasing no of panicles /m^2 was combined with decreasing the grain filling rate.

Table 3. Effect of seeding rate and GA_3 dose, as well as, their interaction on flag leaf angle during 2007and 2008 seasons

Main effect and interaction	Flag leaf angle (°)		Combined
	2007	2008	
Seed rate (A)			
20	36.36 a	36.51 a	36.42 a
24	34.34 b	34.39 b	34.36 b
28	33.09 b	34.16 b	33.62 b
F – Test	**	**	**
GA_3 doses (g/ha) (B)			
0	28.12 d	26.77 d	27.45 d
300	33.81 c	32.88 c	33.35 c
350	36.23 b	36.68 b	36.46 b
400	40.23 a	43.74 a	41.98 a
F – Test	**	**	**
Interaction (A x B)	**	**	**

**: significant at the 0.01 level of probability.
Means followed by a common letter(s) aren't significantly differed at 0.05 level.

Table 4. Effect of seed rate and GA_3 dose, as well as their interaction on1000-grain weight (g) and panicle weight (g) during 2007 and 2008 seasons

Main effect and interaction	1000-grain weight(g)		Combined	Panicle weight(g)		Combined
	2007	2008		2007	2008	
Seed rate (A)						
20	24.48a	24.27ab	24.37a	2.20a	2.16a	2.16a
24	24.15b	24.01b	24.08b	2.19b	2.14b	2.16b
28	24.70a	24.41a	24.55a	2.06a	2.12c	2.09c
F – Test	*	**	*	**	*	**
GA_3.doses (B)						
0	25.53a	25.43a	25.48a	1.86d	1.75c	1.81d
300	24.42b	24.12b	24.27b	2.11c	2.44b	2.12c
350	24.08ab	24.11b	24.10b	2.20b	2.17b	2.18b
400	23.73c	23.27c	23.50c	2.44a	2.433a	2.43a
F – Test	**	**	**	**	**	**
Interaction A x B	*	**	**	*	**	**

*and** : significant at the 0.05and0.01 levels of probability, respectively.
Means followed by a common letter(s) aren't significantly differed at 0.05 level.

Data also showed that using 400 g from GA_3 was associated with increasing panicle weight during the two seasons (2007 and 2008). The lowest values; 1.86 and 1.75 g were detected in case of the control in the two seasons, respectively. These data show that, the panicle weight were highly affected by applied different doses of GA_3.

Results in Table 5 revealed the effect of seeding rate and GA_3 application as well as their interaction on panicle exsertion (%) and seed set percentage. Data in Table 5 indicate that there were significant differences among seed rates and GA_3 doses for the panicle exsertion (%) and seed set percentage in both season.

The highest values for panicle exsertion 80.6 and 81.01% were obtained under the intermediate seeding rate of female IR69625A during 2007 and 2008 seasons. But, the lowest values were; 79.28 and 79.12; in case of seeding rate of 28 kg/ha in both seasons for IR 69625 A, respectively. These data show that panicle emergence was highly affected by high quantity of seeds.

Each increase of GA_3 dose was associated with increasing panicle exsertion. The highest values of panicle exsertion; 92.03 and 91.68; were detected under 400g GA_3 during the two seasons. But, the lowest values ; 54.48 and 55.04; were obtained in case of the control.

These results are in harmony with those reported by Lei et al. (2006).

Data in Table 5 indicate that there were significant differences among the seeding rates and the GA_3 doses for seed set percentage in both seasons. The highest values of the seed set percentage (32.82 and 32.54%) were obtained under 20kg/ha during 2007 and 2008 seasons as well as with using GA_3 by a rate of 400 g/ ha; (40.41and 40.47%); during 2007 and 2008,. But, the lowest seed set percentage (28.55 and 28.35%) were detected under the third rate during 2007 and 2008 seasons. These results agreed with those of Jagadeeswari et al., (2004) and Abo-Youssef (2003).

These results indicated that the GA_3 played an important role in increasing the out crossing rate as increase the blooming period, the floret opining angle and stigma exsertion. GA_3 application increased cross pollination seed yield (Duan and Ma, 1992).

Data presented in Table 6 revealed that panicle exsertion percentage was significantly affected by the interaction between seeding rate and GA_3 doses. The panicle exsertion values were maximized when rice plants treated by GA_3 at dose of 400 g/ha and seed rate of 24 kg/ha. (93.23 and 93.13 %) in the two seasons, respectively. while the control treatment (spraying with water) and 28 kg/ha gave lowest one (53.96 and 54.26) during 2007 and 2008 seasons. These concluded that, it could be use the seed rate of 24 kg/ha,and applied 350g/ha GA_3 as an optimum treatment to get good panicle exsertion percentage. Similar results were obtained by Duan and Ma (1992) who found that GA_3 application increased panicle extension from the flag leaf sheath.

Data presented in Table 7. revealed that the seed setting percentages were maximized (43.83 and 44.46%) with application of 400g GA_3/ha when seed rate was 20 kg/ha, in both seasons, while such estimates were inferior (13.3.%) under control treatment and combined with seeding rate of 28 kg/ha in both seasons.

Table 5. Effect of seed rate and GA_3 dose, as well as their interaction on panicle exsertion (%) and seed set percentage during 2007 and 2008 seasons

Main effect and interaction	Panicle exsertion (%)		Combined	Seed set percentage		Combined
	2007	2008		2007	2008	
Seed rate (A)						
20	79.72b	79.92b	79.82b	32.82a	32.54a	32.68a
24	80.60a	81.01a	80.81a	29.61b	29.45b	29.53b
28	79.28c	79.12c	79.20c	28.55c	28.35c	28.45c
F – Test	**	**	**	**	**	**
GA_3.doses (B)						
0	54.48d	55.04d	54.76d	14.83d	14.53d	14.68d
300	83.74c	83.82c	83.78c	31.36c	31.15c	31.26c
350	89.21b	89.55b	89.38b	34.72b	34.30b	34.51b
400	92.03a	91.68a	91.86a	40.41a	40.47a	40.44a
F – Test	**	**	**	**	**	**
Interaction A x B	**	**	**	**	**	**

** : highly significant at the 1% level of probability.

Means followed by a common letter(s) aren't significantly differed at 0.05 level.

Table 6. Panicle exsertion percentage as affected by the interaction between GA_3 dose and seed rate in 2007 and 2008 seasons

Seeding rate	GA_3 doses (g/ha)							
	2007				2008			
	0	300	350	400	0	300	350	400
20	55.00g	84.73e	88.60d	90.56c	55.93e	84.93d	89.33b	89.73b
24	54.50g	83.06f	91.60bc	93.23a	54.93e	83.90d	92.16a	93.13a
28	53.96g	83.43ef	87.43d	92.30ab	54.26e	82.86d	87.16c	92.20a
Interaction A X B	**	**	**	**	**	**	**	**

** : highly significant at the 1% level of probability.

Means followed by a common letter(s) aren't significantly differed at 0.05 level.

Table 7. Seed setting percentage as affected by the interaction between GA_3 dose and seed rate in 2007 and 2008 seasons

Seeding rate (kg/ha)	GA_3 dose (g/ha)							
	2007				2008			
	0	300	350	400	0	300	350	400
20	15.50g	35.43cd	36.53c	43.83a	15.20f	34.50cd	36.00c	44.46a
24	15.66g	30.30e	33.83d	38.66b	15.06f	30.30e	34.00d	38.43b
28	13.33h	28.36f	33.80d	38.73b	13.33g	28.66e	32.90d	38.53b
Interaction A X B	**	**	**	**	**	**	**	**

* and **: significant at the 0.05 and 0.01 level of probability, respectively.
Means followed by a common letter(s) aren't significantly differed at 0.05 level.

These results indicated that, the optimum treatment was the treatment included, the seed rate of 20 kg/ha with 400 g GA_3/ha. Moreover, the differences between the other seeding rate 24 and 28 kg/ha at 400 g GA_3/ha were insignificant. So, it could be decrease the seed rate and increase the dose of GA_3 to decrease the cost of input factors in the hybrid rice seed production plot.

Data in Table 8 showed that harvest index and grain yield were highly significantly affected by GA_3 doses and seeding rate. The highest values of harvest index (21.79 and 21.69%) were obtained under rate of 20 kg/ha during 2007 and 2008 seasons, but the lowest ones; 20.33 and 20.39 %; were detected in case of the third seeding rate during 2007 and 2008 seasons. On the other side, application of GA_3 by a rate of 400 g /ha gave the highest values of harvest index (26.34 and 26.16 %) during 2007 and 2008 seasons. respectively, while such values were inferior; 14.23 and 14.27%; under the control during two seasons. These results showed that high density of seeds and high doses of GA_3 produce the highest value of grain yield, which increase the harvest index value in the same time. Singh et al. (2003) found that grain yield was increased with each increase of GA_3 application up to 100 g/ha.

The value of grain yield was maximized under the third seeding rate but, it was minimized in case of 20 kg seeds/ ha. Moreover, the highest values were (3.48 and 3.40 t/ha) with the dose of 400 g GA_3 during 2007 and 2008 seasons. But the lowest values were (1.63 and 1.58 t/ha) under the control treatment during 2007 and 2008 seasons, respectively.

Data presented in Table 9 show that the maximum grain yield (3.75 and 3.66 t/ha) in the first and the second season, respectively were obtained when GA_3 was applied at the rate of 400g/ha under the third seeding rate (28 kg/ha). Untreated A line plants by GA_3 gave the lowest grain yield (1.46 and 1.37 t/ha) in the two seasons, respectively under the aforementioned seeding rate indicating that the hybrid rice seed yield was more affected by GA_3 application than seeding rate.

Table 8. Effect of seed rate and GA_3 dose, as well as their interaction on harvest index (%) and grain yield (t/ha) during 2007 and 2008 seasons

Main effect and interaction	harvest index(%)		Combined	grain yield(t/ha)		Combined
	2007	2008		2007	2008	
Seed rate (A)						
20	21.79a	21.69a	21.74a	2.62b	2.60b	2.61c
24	20.95b	20.86b	20.91b	2.77ab	2.68b	2.73b
28	20.33c	20.39b	20.36c	2.97a	2.83a	2.90a
F – Test	**	**	**	**	*	**
GA_3.doses (B)						
0	14.23d	14.27d	14.25d	1.63c	1.58d	1.61d
300	19.75c	19.64c	19.69c	2.83b	2.67c	2.75c
350	23.78b	23.85b	23.81b	3.22a	3.16b	3.19b
400	26.34a	26.16a	26.25a	3.48a	3.40a	3.44a
F – Test	**	**	**	**	**	**
Interaction A x B	**	*	*	*	**	**

* and **: significant at the 0.05 and 0.01 level of probability, respectively.
Means followed by a common letter(s) aren't significantly differed at 0.05 level.

Table 9. Grain yield (t/ha) as affected by the interaction between GA_3 dose and seeding rate in 2007 and 2008 seasons

Seed rate	GA_3 dose (g/ha)							
	2007				2008			
	0	300	350	400	0	300	350	400
20	1.78f	2.54e	2.97cd	3.20bc	1.76g	2.56f	2.91def	3.18bcd
24	1.64f	2.70de	3.27bc	3.47ab	1.62g	2.69ef	3.07cde	3.37abc
28	1.46f	3.26bc	3.43ab	3.75a	1.37g	2.78def	3.51ab	3.66a
Interaction A X B	*	*	*	*	**	**	**	**

The results suggest that, using 28 kg/ha seeding rate and 400 g/ha GA_3 may be the optimum treatment to get high seed yield per unit area. Moreover, the differences between the treatments (24 kg/ha seed rate with 400 g/ha GA_3) and (28 kg/ha seed rate with 350 g/ha GA_3) were insignificant in two summer seasons 2007 and 2008. As will as the differences between the treatments (20 kg /ha seed rate with 400 g/ha GA_3) and (24 kg/ha seed rate with 400 g/ha GA_3) were insignificant during the two seasons. These results were confirmed with obtained results from the panicle exsertion and seed set percentage.

From the above results, it could be concluded that, the optimum treatments were (20 kg/ha seeds of female line with used 400 g/ha GA_3) and or (24kg/ha seeds of female lines with used 350 g/haGA_3) which depends on the cost of 1 kg seeds of A line and the cost of gram from GA_3.

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الملخص العربي

تأثير معدلات التقاوى واضافة الجبريلين على إنتاجية تقاوى الأرز الهجين

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أجريت تجربتان حقليتان في المزرعة البحثية لبحوث الأرز بسخا RRTC، كفرالشيخ ، مصر خلال موسم 2007 – 2008 بهدف دراسة تأثير معدلات التقاوي وحمض الجبريليك. على إنتاجية تقاوي الأرز الهجين فى حقول الانتاج. وصممت التجربة بطريقة split-plot-design في ثلاثة مكررات. فالقطع الرئيسية main plot كانت مخصصة لمعدلات التقاوي(28,24,20) كجم/هكتار بينما معدلات الجبريلين كانت في subplots. وأضيفت هذه الجرعات بثلاث معدلات المعدل الأول 300وجم/هكتار والثاني 350 جم/هكتار والثالث400 جم/هكتار بالإضافة الى معاملة المقارنة (control). وأجريت عملية الرش على دفعتين الأولى وهى 40% من الكمية وذلك بعد طرد 20% من الداليات والثانية وهى 60% (بعد يومين من الأولى). للحصول على أفضل توافق زهري يمكن زراعة السلالة A IR69625 العقيمة قبل الأب بستة أيام وذلك في حالة الزراعة بمعدل تقاوي 28 كجم/هكتار.

ويمكن تلخيص أهم النتائج فيما يلى:

- أدت إضافة حمض الجبريليك بمعدل 400 جم/هكتار إلى زيادة معنوية فى مساحة الورقة العلم فى حين كانت إستجابتها أقل لمعدلات التقاوى بينما تأثر كثيرا إرتفاع النبات وزاوية الورقة العلم بإضافة جرعات الجبريلين المختلفة.
- أظهرت النتائج تأثر صفة معدل خروج السنبلة بزيادة جرعات الجبريلين عن المعاملة(control) وقد أعطت السلالة IR 69625A الأم استجابة عالية فى محصول التقاوي ودليل الحصاد. وأنخفض وزن 1000 حبة بزيادة جرعات الجبريلين المضافة حيث أنه بزيادة الجرعات تزيد نسبة العقد وينقص معدل الامتلاء وكان أفضل معدل للجبريلين هو300 جرام جبريلين للهكتار بالنسبة لوزن ال1000حبة مقارنة بالمعاملات الأخرى 350و 400 جرام .
- أدى إستخدام حمض الجبريليك بمعدل 400 جم/هكتار مع معدل تقاوى 28 كجم/هكتار إلى أعلى محصول حبوب يصل إلى 3.85 طن/هكتار خلال موسمى الزراعة.
- وقد أوضحت النتائج بالنسبة للصفات الهامة مثل (معدل خروج السنبلة ونسبة العقد وكذلك محصول الحبوب) فأنة يفضل استخدام المعاملة (20كجم / هكتار كمعدل تقاوي مع استخدام معدل جبريلين 400جم /هكتار) أو (24 كجم / هكتار كمعدل تقاوي مع استخدام معدل جبريلين 350 جم /هكتار).

من النتائج السابقة يتضح أنه من المفضل استخدام المعاملة 20كجم/ حبوب هكتار كمعدل تقاوي للسلالة الام مع الرش بالجبريلين بمعدل 400 جم/هكتار أو استخدام المعاملة 24كجم حبوب/ هكتار كمعدل تقاوي للحصول على أعلى محصول من البذرة الهجين والتى تتوقف على تكلفة 1 كجم من تقاوي السلالة إلام وتكلفة الجرام الواحد من الجبريلين.