Improving the Productivity of hybrid rice seed through application Nitrogen, Potassium splitting and spraying of different sources of hormone

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ABSTRACT:

This study was conducted at the Farm of Rice Research Department, FCRI, ARC Egypt, during 2020 and 2021 summer seasons, to study the effect of apply the nitrogen, potassium splitting and growth regulators on hybrid rice seed yield for the parental lines of Egyptian hybrid No. 1., like, IR69625A line and Giza 178 R, were used to cultivate on 20th of April for A line in one time With three intervals for R line to get good synchronization and in split-spilt plot design with three replications The main plots were devoted to the three nitrogen applications (N), While sub-plots were occupied at the three potassium applications (K) and the three growth regulators applications (GR) was arranged at random in the sub-subplots, the subplot was (4.5 x 5m = 22.5 m2). The data were recorded on growth characters i.e., Plant height, days to heading, flag leaf area, yield characters i.e., Number of panicles/plant, Panicle length, Seed set %, panicle weight and grain yield. The results showed that, the morphological and seed yield characters affected by splitting method for Nitrogen and Potassium fertilizer, as well as, different sources of hormones, from the results it could be concluded that., high gram yield of hybrid rice seed when application, of Nitrogen fertilizer in three splits, potassium in two splits (basal and foliar) and spray by GA_3, gave seed yield of (3.09 t/ha. and 3.015 t/ha.) during the two successive seasons.

Keywords: Hybrid rice; GA_3, Seed production; Nitrogen and Potassium fertilizer**.**

INTRODUCTION

Rice (*Oryza sativa*, L.) is one of the most important agricultural food crops for more than half of the world population Moreover, it's a very important cereal crop in Egypt for either consumption and or export. The total cultivated area by rice is about 1.182 million feddan which produced about 4.560.000 million tons of paddy rice (EAS 2021). In spite of rice is salt sensitive crop, but it's considered as reclamation crop for saline soil because of its flooding condition.

Highly productivity of rice depends on high seed quality and apply of optimum cultural practices, so as to increase the national production it could be increase the total area covered with high seed quality. High quality seed reflects on the increasing national income Anonymous. 2009.

Plant growth regulators (PGRs) are organic compounds that can promote, inhibitor modify physiological processes of plants. Growth regulators like GA_3, NAA and chemicals like K_2PO_4 along with boron as foliar spray play an important role to improve panicle emergence, seed set percent and seed yield of hybrid rice seed production. Application of GA_3 at 5 per cent, panicle emergence is recommended in hybrid seed production, to improved plant height, flag leaf angle, panicle exsertion, pollination, synchronization in flowering and seed set percentage (Wu *et al*., 2011). Gibberellins (GA_3) are a large family of natural products that regulate many developmental processes in plants, including seed germination; stem elongation, and induction of flowering. Over the years, more than a hundred GA_3 have been identified from organisms, amongst, which only few compounds are available in large quantities such as the relatively cheap natural derived phyto hormone named gibberellic acid (GA_3), Tian *et al.* (2017).

Also, potassium is one of the three major plant nutrients; the application to rice crop has received least attention, even though potassium accounts for a greater share of total nutrients removed from the soil by rice crop. Response of rice to applied potassium is highly variable (Vidya, 2011). Potassium plays an important role in rice plant nutrition. Continuous application of potassium improves all soil properties and perhaps the use of higher rates of nitrogen. Application of potassium along with nitrogen has become very necessary due to intensive agriculture with high yielding varieties. Therefore, the present study aimed to study the effect of apply the nitrogen and potassium splitting, as will as, growth regulator on hybrid rice seed production of the parental lines of Egyptian hybrid No. 1.

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 2020 and 2021. The main objectives are to determine the optimum time for add nitrogen, potassium fertilizers and growth regulators (as foliar application) on growth characters and yield and its components of hybrid rice seed productions.

The materials under study included two parental lines IR69625A; (female line) with abortive sterility and Giza178R (restorer line) to produce F_1 hybrid seed for promising hybrid SK.2034H (IR69625A / Giza 178 R) The Experimental design was a split-split plot design with three replications The main plots were devoted to the three nitrogen applications (N), While sub-plots were occupied at the three potassium applications (K) and the three growth regulators applications (GR) was arranged at random in the sub-subplots, the subplot was (4.5 x 5m = 22.5 m^2).

Three nitrogen applications were added 150 kg N/ha., as urea 46%) at 20 days from transplanting (N_1). 2) Half at basal (B) + Half at 20 days from transplanting (N_2). 3) One-third at basal (B) + one-third at 20 days from transplanting + one-third at 40 days from transplanting (N_3). The sub-plots were occupied by the three treatments of potassium applications at the rate of (60 kg K_2O/ha, by potassium sulphate 48% K_2O). 1) One time, as basal application 60kg/ha (K_1). 2) Half was added at basal (B) and half after 30 days from transplanting (K_2), 3) 20kg/ha was added at basal (B) and 20kg/ha after 30 days from transplanting and 20 kg/ha after 50 days from transplanting (K_3). Where the sub sub-plots were occupied by the three treatments of growth regulators (Leaf foliar) application at 1) Indole Acetic Acid (IAA) (30 g/ha.) (100% concentration) (GR_1). 2) Ascorbic Acid (30 g/ha.) (100% concentration). (GR_2) and 3) Gibberellins (GA_3) (30 g/ha.) (100% concentration). (GR_3) (40% concentration at 15% from flowering and the 60% second at 45% from flowering). Other cultural practices were done according the recommendation of growing hybrid rice seed productivity (RRTC, 2020). The data were recorded according to Standard Evaluation System (SES) of IRRI (2008) for all the studied characters i.e plant height (cm), panicle length (cm) , panicle weight (g) , number of panicles/hill, number of filled grains/panicle (grain), number of total grains/panicle (grain), seed set (%) , 1000-grain weight(g), panicle exsertion (%), grain yield/hill (g) and harvest index (%).All the data collected were subjected to the analysis of variance according to Gomez and Gomez, 1984. Treatment means were compared by Duncan's multiple range test (Duncan, 1955). All statistical analysis was performed using analysis of variance technique by means of "COSTAT" computer software package.

RESULTS AND DISCUSSION

The results presented in Table (1) showed that, the effect of Nitrogen, Potassium and leaf foliar applications, as well as, their interactions with yield characters, the number of filled grains/panicles, total grains/panicle and Seed set % were highly affected by nitrogen application during both seasons.

The highest values for Number of Filled grains/panicles were (64.18 and 64.37 grain) with the second Nitrogen application (N_2) and the lowest values were (55.81 and 56.74 grain) with the Nitrogen application (N_1) during both seasons, respectively. Also the highest values for Number of total grains/panicle were (164.12 and 176.05 gram) with the second Nitrogen application (N_2) during both seasons, respectively. The lowest values were (154.01 and 142.79 grain) with the Nitrogen application (N_1) during 2020 and 2021 seasons, respectively. The highest values for Seed set (%) were (35.45 and 36.60%) with first dose of Nitrogen application (N_1) during both seasons, respectively. The lowest values were (32.32 and 31.89%) N2 treatment of Nitrogen application (N_2) during 2020 and 2021 seasons, respectively. These results indicated that Seed set (%) were highly affected by Nitrogen applications. The results were agreement with Zhang *et al* (2021), The use of less chemical N fertilizer and a higher planting density could enhance the sustainability of the grain yield and reduce fertilizer loss via a novel crop management scheme for perennial rice.

Also, the data in Table (1) indicated that, there were significant differences among Potassium applications for Number of Filled grains/panicles, total grains/panicle and Seed set, in both seasons. The highest values were obtained from third Potassium application dose (K_3) the highest values for Number of Filled grains/panicles and Seed set were (68.88 and 66.40grain) and (36.09 and 36.62%) in both seasons, respectively. Also the highest values for Number of grains/panicle were (166.55 and 156.77grain) with the second potassium application dose (K_2) in both seasons, respectively. But the lowest values were (54.33 and 53.42grain), (146.53 and 150.81grain) and (30.62 and 31.38%) with the first dose of Potassium application (K_1) during 2020 and 2021 seasons, respectively. These results showed that, the traits of Seed set were highly affected by applied different Potassium application. The results were in case agreement with these obtained by Kalala *et al* (2017) recommended that, 10 kg P/ha and 50 kg K/ha be used as optimum rate for rice production in P and K deficient soils of Kilombero valley.

Moreover results in Table (1) indicated that, there were significant differences among the Leaf foliar applications of hormones for Number of total grains/panicle, Number of fertile grains/panicle and Seed set during both seasons. The highest values for Number of total grains/panicle and Seed set were (68.33 and 66.66grain) and (35.66 and 36.78%) at third Leave foliar application (GA_3) in both seasons, respectively. Also the highest values for Number of total grains/panicle were (162.31 and 156.41grain) with the first Leaf foliar application (IAA) in both seasons, respectively. But, the lowest values for Number of total grains/panicle and Seed set were (53.85 and 54.62grain) and (31.20 and 31.52 %) at first Leaf foliar application (IAA) during 2020 and 2021 seasons, respectively. Also the lowest values for Number of total grains/panicle were (155.38 and 149.76grain) with the third Leaf foliar application (GA_3) in both seasons, respectively. These results indicated that highly affected by applied different.

Data in Table (2) showed that, the interactions between nitrogen and potassium application had a significant effect on Filled grains/panicle, which recorded the desirable values (72.77and 70.55 grain) with apply the nitrogen in three splits (N_3), and apply the potassium in three splits K 9-9-7kg, during the two seasons, indicated to apply the nitrogen in different splits plus apply the potassium sulfate may be increase the nitrogen response then increase the nitrogen use efficiency will increase the crop growth rate and filled grains/panicles

Data in Table (3) showed that, the interactions between nitrogen and leave foliar application had a significant effect on filled grains/panicle, which recorded the desirable values (73.77-70.22grain) with apply the nitrogen in two splits N_2, and apply the leaf foliar from GR_3 during the two seasons, indicated to apply the nitrogen in different splits plus apply the growth regulators may be increase the grain filling rate and filled grains/panicle. In the similar study Thirthalingappa *et al*. (1999). Mentioned that, the probable reason for increasing 1000-grain weight under application of GA3 may be attributed to the role of GA3 in delayed senescence of plants, by delayed destruction proteins and chlorophyll, this due to increase photosynthetic area, subsequently metabolic compounds, which restore in the grains. On the other hand, Jagadeeswari *et al*. (1998) found that the 1000-grain weight was decreased by applying GA3.

Data in Table (4) showed that, the interactions between potassium and leaf foliar application had a significant effect on Filled grains/panicles, which recorded the desirable values (77-77.44grain), with apply the potassium in K_3, which, apply the leaf foliar with GR_3 during the two seasons, indicated to apply the nitrogen in different splits plus apply the potassium sulfate may be increase the photosynthetic rate in the flag leaf and filled grains/panicle.

Data in Table (5) showed that, the interactions between nitrogen, potassium and leaf foliar application had a significant effect on Filled grains/panicle, which recorded the desirable value with apply the Nitrogen in three splits N_3, and apply the potassium in three split K_3 plus GR_3 as a foliar application during the two seasons.

Data in Table (6) showed that, the interactions between nitrogen and potassium application had a significant effect on Total grains/panicle, which recorded the desirable values (205.55-205.77grain) with apply the Nitrogen in two splits N_2, while, apply the potassium in three splits K_3 during the two seasons, indicated that the application potassium sulfate in different splits will increase the nitrogen response then increase the nitrogen use efficiency then carbohydrate accumulation which increase the total grains/panicles.

Data in Table (7) showed that, the interactions between nitrogen, potassium and leave foliar application had a significant effect on Total grains/panicles, which recorded the desirable values with apply the nitrogen in two splits N_2, and apply the potassium in one split K_1 with GR_3 as a foliar application (222.33 and 215grain) during the two seasons, that, may be referred to the balance of fertilizer plus growth regulator enhancement the number of grains/panicle.

Data in Table (8) showed that, the interactions between nitrogen and potassium application had a significant effect on Seed set (%), which recorded the best values (37.63 and 37.34grain) with apply the Nitrogen in three splits N3, and apply the potassium in two splits K_2 during the two seasons, indicated to apply the nitrogen in different splits plus apply the potassium sulfate will increase the Nitrogen use efficiency then the crop growth rate and seed set (%).

Data in Table (9) showed that, the interactions between nitrogen and leave foliar application had a significant effect on Seed set %, which recorded the desirable values (36.47 and 38.51 %) with apply the nitrogen in one splits N_1, while, apply the leave foliar in two splits GR_3 during the two seasons, indicated to apply the nitrogen in different splits plus apply the growth regulators will increase the nitrogen response and nitrogen use efficiency then the crop growth rate and seed set %.

Data in Table (10) showed that, the interactions between potassium and leaf foliar application had a significant effect on Seed set%, which recorded the desirable values (38.23 and 41.46%) with apply the potassium in three splits K_3, and apply the leaf foliar from GR_3 during the two seasons, indicated to apply the nitrogen in different splits plus apply growth regulator will increase the nitrogen response then crop growth rate and seed set%.

Data in Table (11) showed that, the interactions between nitrogen, potassium and leaf foliar application had a significant effect on Seed set (%), which recorded the desirable values with apply the nitrogen in two splits N_2, while, apply the potassium in three splits K_3 and GR_3 as a foliar application (38.96 and 44.32%) during the two seasons. These results may be attributed to the role of GA3 in increasing panicle exsertion % and wide opening of pale and lemma of spikelet and increasing the period of stigma receptivity for pollen grains. These results are in harmony with these obtained by Kalavathi *et al*. (2000) and Abo Youssef (2003).

Results in Table (12) revealed the effect of Nitrogen, Potassium and Leave foliar application, as well as, the effect of interaction on 1000- grain weight, Seed yield and harvest index. The highest values for 1000- grain weight and harvest index were (23.43 and 23.69gm) and (21.37 and 21.12%) with the second Nitrogen application (N_2) during 2020 and 2021 seasons, respectively. But the lowest values were (22.30 and 23.66gm) and (18.77 and 20.78%) with the Nitrogen application (N_1) during 2020 and 2021 seasons, respectively.

These results indicate that, 1000- grain weight, seed yield and harvest index (%) were highly affected by Nitrogen applications. Data showed that, 1000- grain weight, grain yield and harvest index was highly affected by Nitrogen applications in both seasons.

Also the highest values for grain yield were (3.18 and 3.24 ton/ha) with the third Nitrogen application (N_3) during 2020 and 2021 seasons, respectively. But the lowest values were (2.85 and 2.90 ton/ha) with the Nitrogen application (N_1) during 2020 and 2021 seasons, respectively.

Highly significant differences between Potassium applications which. Showed the highest values for 1000- grain weight were (24.31 and 24.88g) with the third Potassium application (K_3) during 2020 and 2021 seasons, respectively. But the lowest values were (22.30 and 24.06g) with the first Potassium (K_1) application during 2020 and 2021 seasons, respectively. In the similar results by Abd El-Rahman, *et al* (2004) The highest values for seed yield and harvest index were (3.05 and 3.36 ton/ha) and (22.28 and 24.02%) with the second Potassium application (K_2) during 2020 and 2021 seasons, respectively. But the lowest values were (2.91 and 2.88 ton/ha) and (18.84 and 19.75%) with the first Potassium application (K_1) during 2020 and 2021 seasons, respectively.

Also, the data in Table (12) indicated that, there were highly significant differences among the Leaf foliar application for 1000- grain weight, seed yield and harvest index in both seasons. The highest values of 1000- grain weight, grain yield and harvest index were obtained from third Leave foliar application (GR_3) (23.08 and 24.89g), (3.10 and 3.22ton/ha) and (21.36 and 23.11%) during both seasons respectively.

The lowest values for 1000- grain weight, grain yield and harvest index were (22.46 and 23.88g), (2.91 and 2.98 ton/ ha) and (19.47 and 20.68%) with the first Leave foliar (IAA) application during 2020 and 2021 seasons, respectively. These results indicate that 1000- grain weight, grain yield and harvest index were highly affected by Leave foliar application.

Data in Table (12) show that, the interaction among the Nitrogen, Potassium and Leave foliar applications, was highly significant for grain yield during 2020 and 2021 seasons, the highest values of grain yield were (3.68 and 3.69 ton) by using third Nitrogen application (N_3) with the second Potassium applications(K_2) and the third Leave foliar application (GA_3)during both seasons.

But, the lowest values were (2.18 and 2.08 ton) for (N1) with at (K1) with the second Leave foliar application (Ascorbic acid), during 2020 and 2021 seasons, respectively. These data indicate that, there were highly affected by applied third Nitrogen applications and increased the seed yield when applying a second Potassium applications with third Leaf foliar application. In the same line Padmore (2017) found that, the N level increased within a particular K level, the crop maintained a similar rate of photosynthesis and dry matter production. Also, it confirmed when N:K was applied at a 2:1 ratio, grain yield was the highest and chalkiness at its lowest.

Data in Table (13) showed that, the interactions between nitrogen and potassium application had a significant effect on 1000-grain weight, which recorded the desirable values (25.66 and 27.07gm) with apply the nitrogen in three splits N_3, and the potassium in one splits K_1during the two seasons, indicated to apply the nitrogen in different splits plus the potassium sulfate in one split in early growth stage, may be enhancement the accumulation for the carbohydrate and increase grain filling rate.

Data in Table (14) showed that, the interactions between nitrogen and potassium application had a significant effect on Grain yield (t/ha.), which recorded the best values (3.22 and 3.44t/ha) with apply the nitrogen in three splits N_3, while, apply the potassium in two splits K_2, during the two seasons, indicated to apply the nitrogen in different splits will increase the nitrogen response then increase the nitrogen use efficiency plus apply the potassium sulfate will increase the crop growth rate and seed yield/unit. The increase in biomass yield could be attributed to the increase in plant height, number of tillers /m2, number of panicles/hill, panicle weight, seed setting percentage and 1000-grain weight, which increased with application of GR_3. The obtained results are in full agreement with those reported by Ponnuswamy and Prabagaran (1997); Jagadeeswari *et al.* (1998); Singh and Sahoo (1998) and Abo Youssef (2003).

Data in Table (15) showed that, the interactions between nitrogen and leaf foliar application had a significant effect on grain yield (t/ha.) ,which recorded the best values (3.49 an d3.51t/ha) with apply the nitrogen in three splits N_3, which, apply the leaf foliar in two splits GR_3 in the two seasons, indicated to apply the nitrogen in different splits will increase the nitrogen response then increase the nitrogen use efficiency plus apply the growth regulators will increase the crop growth rate and seed yield/unit. These results may be due to the fact that applied GA3 produced higher number of panicles/m2 maximum panicle exsertion percentage, the highest panicle length, maximum seed setting percentage, and heavier 1000-grain weight, which consequently gave higher grain yield. Similar results were obtained by Prasad et al. (1989); Duan and Ma (1992); Ponnuswamy and Prabagaran (1997); Jagadeeswari et al. (1991); Kalavathi *et al*. (2000) and Abo Yossef (2003).

Data in Table (16) showed that, the interactions between potassium and leaf foliar application had a significant effect on grain yield (t/ha.), which recorded the best values (3.49 and 3.51 t/ha) with apply the potassium in one splits K_1, which, apply the leaf foliar in two splits from GR_1 in the two seasons, indicated to apply the nitrogen in different splits will increase the nitrogen response then increase the nitrogen use efficiency plus apply the potassium sulfate will increase the crop growth rate and seed yield/unit.

Data in Table (17) showed that, the interactions between nitrogen, potassium and leave foliar application had a significant effect on grain yield, which recorded the best values (3.68 and 3.69 t/ha) with apply the nitrogen in three splits N_3, while, apply the potassium in two splits K_2 and apply GR_3 as a growth regulators in the two seasons, indicated to apply the nitrogen in different splits will increase the nitrogen response then increase the nitrogen use efficiency plus apply the potassium sulfate will increase the crop growth rate and seed yield/unit.

Data in Table (18) showed that, the interactions between nitrogen, potassium application had a significant effect on Harvest index, which recorded the best values (23.68 and 25.62%) with apply the nitrogen in three splits N_3, while, apply the potassium in one split K_1 during two seasons, indicated to apply the nitrogen in different splits will increase the nitrogen response then increase the nitrogen use efficiency plus apply the potassium sulfate will increase the crop growth rate and Harvest index.

Data in Table (19) showed that, the interactions between nitrogen and leaf foliar application had a significant effect on Harvest index ,which recorded the best values (24.15 and 24.97%) with apply the nitrogen in three splits N_3, while, apply the leave foliar in two splits GR_3 in the two seasons, indicated to apply the nitrogen in different splits will increase the nitrogen response then increase the nitrogen use efficiency plus apply the growth regulators will increase the crop growth rate and Harvest index.

Data in Table (20) showed that, the interactions between potassium and leave foliar application had a significant effect on Harvest index, which recorded the best values (23.68 and 25.18%) with apply the potassium in two splits K_2, while, apply the leave foliar in two splits of GR_3 in the two seasons, indicated to apply the nitrogen in different splits will increase the nitrogen response then increase the nitrogen use efficiency plus apply the potassium sulfate will increase the crop growth rate and Harvest index.

Data in Table (21) showed that, the interactions between nitrogen, potassium and leaf foliar application had a significant effect on Harvest index, which recorded the best values (27.77 and 29.13%) with apply the nitrogen in two splits N_2, while, apply the potassium in two splits K_2, and apply GR_3 as a growth regulators in the two seasons, indicated to apply the nitrogen in three times will increase the nitrogen response then increase the nitrogen use efficiency plus apply the potassium sulfate will increase the crop growth rate and Harvest index.

CONCLUSION:

Finally, the results concluded that, apply the nitrogen fertilizer on three splits pass, potassium sulfate on two split and apply GA_3 as a source to hormones increased the seed set % of female parent then hybrid seed production, and could be used as a recommended for hybrid rice seed production.

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Table 1: The effect of nitrogen, potassium splits and leave foliar with their interactions on Filled grains, Total grains/panicles and seed setting% of the parental line of hybrid No. 1 during 2020 and 2021 seasons.

Treatment	Filled grains/panicle		Total grains/panicles		Seed setting (%)	
	2020	2021	2020	2021	2020	2021
Nitrogen level						
N_1	55.81b	56.74c	154.01c	142.79c	35.45 a	36.60a
N_2	64.18a	64.37a	164.12a	167.05a	32.32 c	31.89c
N_3	63.96a	62.07b	159.85b	148.84b	33.61b	34.94b
F- test	**	**	**	**	**	**
potassium level						
K_1	54.33c	53.44c	146.53c	150.81c	30.62c	31.38c
K_2	60.74b	61.33b	166.55a	156.77a	34.66b	35.43b
K_3	68.88a	68.40a	164.89b	151.10b	36.09a	36.62a
F- test	**	**	**	**	**	**
Growth regulators						
GR_1	53.85c	54.62c	162.31a	156.41a	31.20c	31.52c
GR_2	61.77b	61.88b	160.28b	152.52b	34.52b	35.03b
GR_3	68.33a	66.66a	155.38c	149.76c	35.66a	36.87a
F- test	**	**	**	**	**	**
Interaction						
N x K	**	**	*	*	**	**
N x GR	**	**	NS	NS	**	**
K x GR	**	**	*	*	**	**
N x K x GR	**	**	*	*	**	**

*Significant at 5 % level, ** highly Significant at 1 % level, NS Not Significant

Letter(s) refer to Duncan's multiple range Test

N_1:150 kg N/ha., as urea 46%) at 20 days from transplanting.

N_2: Half at basal + half at 20 days from transplanting.

N_3: One-third at basal + one-third at 20 days from transplanting+ one-third at 40 days from transplanting.

K_1: (60 kg K_2O/ha, by potassium sulphate 48% K_2O). One time, as basal.

K_2: Half was added at basal and half after 30 days from transplanting .

K_3: 20kg/ha was added at basal and 20kg/ha after 30 days from transplanting and 20 kg/ha after 50 days from transplanting .

GR_1: Indole Acetic Acid (IAA) (30 g/ha.) (100% concentration).

GR_2: Ascorbic Acid (30 g/ha.) (100% concentration).

GR_3: Gibberellins (GA_3) (30 g/ha.) (100% concentration).

Table 2: The effect of Nitrogen and potassium splits with their interactions on Filled grains/panicle of female line during 2020 and 2021 seasons.

Nitrogen level	Filled grains/panicle					
	2020			2021		
	potassium level			potassium level		
	K_1	K_2	K_3	K_1	K_2	K_3
N_1	47.55d	57.55c	62.33b	49e	55d	66.22b
N_2	58.55c	62.44b	71.55a	56.11d	61.66c	68.44ab
N_3	56.88c	62.22b	72.77a	55.22d	67.33b	70.55a

Table 3: The effect of Nitrogen splits and leaf foliar for hormones with their interactions on Filled grains of female line during 2020 and 2021 seasons.

Nitrogen level	Filled grains/panicle					
	2020			2021		
	Growth regulators			Growth regulators		
	GR_1	GR_2	GR_3	GR1	GR_2	GR_3
N_1	51.00f	56.22e	60.22d	53.44e	56.11d	60.66c
N_2	53.33f	65.44c	73.77a	51e	65b	70.22a
N_3	57.22e	63.66c	71.00b	59.44c	64.55b	69.11a

Table 4: The effect of potassium splits and leaf foliar for hormones with their interactions on Filled grains/panicle of female line during 2020 and 2021 seasons.

potassium level	Filled grains/panicle					
	2020			2021		
	Growth regulators			Growth regulators		
	GR_1	GR_2	GR_3	GR_1	GR_2	GR_3
K_1	48.88f	55.88d	58.22cd	52.66e	51.33e	56.33d
K_2	52.11e	60.33c	69.77b	53.00e	64.77c	66.22c
K_3	60.55c	69.11b	77.00a	58.22d	69.55b	77.44a

Table 5: The effect of nitrogen, potassium splits and leaf foliar for hormones with their interactions on Filled grains/panicle of female line during 2020 and 2021 seasons.

Nitrogen level	potassium level	Filled grains/panicle					
		2020			2021		
		Growth regulators			Growth regulators		
		GR_1	GR_2	GR_3	GR_1	GR_2	GR_3
N_1	K_1	44.66l	46.66kl	51.33ijk	50.33gh	43.33i	53.33fh
	K_2	51.66ijk	59.66eh	61.33efg	48hi	58.66df	58.33df
	K_3	56.66gj	62.33dg	68cd	62ce	66.33bc	70.33b
N_2	K_1	47.33kl	63.66def	64.66de	49.66gh	60df	58.66df
	K_2	50.66jk	62dg	74.66b	48hi	64.33cd	72.66b
	K_3	62dg	70.66bc	81a	55.33eg	70.66b	79.33a
N_3	K_1	54.66hij	57.33fi	58.66eh	58df	50.66gh	57df
	K_2	54hij	59.33eh	73.33b	63cd	71.33b	67.66bc
	K_3	63dg	74.33b	82a	57.33df	71.66b	82.66a

Table 6: The effect of nitrogen and potassium doses with their interactions on Total grains/panicle of female line (IR96925A) during 2020 and 2021 seasons.

Nitrogen level	Total grains/panicles					
	2020			2021		
	potassium level			potassium level		
	K_1	K_2	K_3	K_1	K_2	K_3
N_1	150.44f	152.77f	168.11e	150.66e	154.55e	158.55e
N_2	203.44ab	187.66c	205.55a	193.33b	184.55c	205.77a
N_3	180.55d	183.66d	201.00b	169.11d	180.55c	198.88ab

Table 7: The effect of nitrogen, potassium splits and leaf foliar for hormones with their interactions on Total grains/panicle of female line during 2020 and 2021 seasons.

Nitrogen level	potassium level	Total grains/panicles					
		2020			2021		
		Growth regulators			Growth regulators		
		GR_1	GR_2	GR_3	GR_1	GR_2	GR_3
N_1	K_1	155.33hi	147ij	149ij	152ij	150ij	150ij
	K_2	141.66j	156hi	160.66gi	146j	154hj	163.66fj
	K_3	153.33hj	166.33gh	184.66ef	157gj	160fj	158.66gj
N_2	K_1	206.66bc	187.66e	222.33a	183.66bf	202.33ac	215.00a
	K_2	188e	183.33ef	191.66de	183.33bf	177.33dh	193ae
	K_3	187.33e	203cd	220a	198.66ad	204ab	214.66a
N_3	K_1	180.33ef	172fg	189.33e	171.33ei	162.33fj	172.33ei
	K_2	172.66fg	183ef	195.33ce	173.66ei	179cg	190.33be
	K_3	185ef	202.33cd	215.66ab	194ae	189be	192.66ae

Table 8: The effect of nitrogen and potassium splits with their interactions on seed set% of female line during 2020 and 2021 seasons.

Nitrogen level	Seed set (%)					
	2020			2021		
	potassium level			potassium level		
	K_1	K_2	K_3	K_1	K_2	K_3
N_1	31.65c	33.14c	37.08a	32.51c	35.55bc	41.75a
N_2	28.67d	33.22c	35.07b	28.98d	33.39c	33.29c
N_3	31.55c	37.63a	36.14ab	32.65c	37.34b	34.82c

Table 9: The effect of nitrogen splits and leaf foliar for hormones with their interactions on seed set % of female line during 2020 and 2021 seasons.

Nitrogen level	Seed set (%)					
	2020			2021		
	Growth regulators			Growth regulators		
	GR_1	GR_2	GR_3	GR_1	GR_2	GR_3
N_1	34.05ab	35.83ab	36.47a	35.16bc	36.14bc	38.51a
N_2	27.68d	34.17ab	35.12ab	27.04e	33.62cd	35.008bc
N_3	31.87c	33.56b	35.39ab	32.38d	35.33bc	37.11ab

Table 10: The effect of potassium splits and leaf foliar for hormones with their interactions on seed set % of female line during 2020 and 2021 seasons.

potassium level	Seed set %					
	2020			2021		
	Growth regulators			Growth regulators		
	GR_1	GR_2	GR_3	GR_1	GR_2	GR_3
K_1	27.35e	33.01cd	31.51d	31.36cd	29.92d	32.86c
K_2	31.55d	34.20c	37.24a	31.88cd	38.10b	36.30b
K_3	34.7bc	36.35ab	38.23a	31.33cd	37.06b	41.46a

Table 11: The effect of nitrogen, potassium splits and leave foliar for hormones with their interactions on seed set % of female line during 2020 and 2021 seasons.

Nitrogen level	potassium level	Seed set (%)					
		2020			2021		
		Growth regulators			Growth regulators		
		GR_1	GR_2	GR_3	GR_1	GR_2	GR_3
N_1	K_1	28.75fg	31.77cf	34.45ad	33.12ei	28.88ik	35.55df
	K_2	36.46ac	38.25ab	38.17ab	32.87ei	38.11ce	35.66df
	K_3	36.95ab	37.48ab	38.96a	39.49bd	41.44ac	44.32a
N_2	K_1	23.01h	33.93ad	29.08eg	27.06jk	29.65hk	30.22gk
	K_2	26.94g	33.77ae	36.81ab	26.19k	36.32df	37.67ce
	K_3	33.09bf	34.80ad	37.31ab	27.86jk	34.88dg	37.13ce
N_3	K_1	30.3dg	33.34bf	31.006dg	33.90eh	31.25fj	32.82ei
	K_2	31.26dg	30.58dg	37.57ab	36.57df	39.88bd	35.57df
	K_3	34.06ad	36.77ab	37.6ab	26.65jk	34.88dg	42.93ab

Table 12: The effect of nitrogen, potassium splits and leaf foliar hormones with their interactions on 1000-gran weight, grain yield (t/ha.) and Harvest index of the parental line of hybrid No 1 during 2020 and 2021 seasons.

Treatment	1000-grain weight/gm		Grain yield (t/ha.)		Harvest index %	
	2020	2021	2020	2021	2020	2021
Nitrogen level						
N_1	22.30c	23.66c	2.85c	2.90c	18.77c	20.78c
N_2	24.95a	24.99a	3.00b	3.05b	21.37a	22.12a
N_3	23.08b	24.89a	3.18a	3.24a	20.70b	22.05b
F- test	**	**	**	**	**	**
potassium level						
K_1	22.57c	24.06c	2.91c	2.88c	18.84c	19.75c
K_2	23.45b	24.60b	3.05a	3.36a	22.28a	24.02a
K_3	24.31a	24.88a	3.007b	2.99b	19.72b	21.27b
F- test	**	**	**	**	**	**
Growth regulators						
GR_1	22.46c	23.88c	2.91c	2.98c	19.47c	20.68c
GR_2	23.57b	24.30b	2.96b	3.02b	20.02b	21.25b
GR_3	24.30a	25.37a	3.10a	3.22a	21.36a	23.11a
F- test	**	**	**	**	**	**
Interaction						
N x K	**	**	**	**	**	**
N x GR	NS	NS	**	**	**	**
K x GR	NS	NS	**	**	**	**
N x K x GR	NS	NS	**	**	**	**

*Significant at 5 % level, ** highly Significant at 1 % level, NS Not Significant

Letter(s) refer to Duncan's multiple range Test

N_1:150 kg N/ha., as urea 46%) at 20 days from transplanting.

N_2: Half at basal + half at 20 days from transplanting.

N_3: One-third at basal + one-third at 20 days from transplanting+ one-third at 40 days from transplanting.

K_1: (60 kg K_2O/ha, by potassium sulphate 48% K_2O). One time, as basal.

K_2: Half was added at basal and half after 30 days from transplanting .

K_3: 20kg/ha was added at basal and 20kg/ha after 30 days from transplanting and 20 kg/ha after 50 days from transplanting .

GR_1: Indole Acetic Acid (IAA) (30 g/ha.) (100% concentration).

GR_2: Ascorbic Acid (30 g/ha.) (100% concentration).

GR_3: Gibberellins (GA_3) (30 g/ha.) (100% concentration)

Table 13: The effect of nitrogen and potassium splits with their interactions on 1000-grain weight of female line during 2020 and 2021 seasons.

Nitrogen level	1000-grain weight					
	2020			2021		
	potassium level			potassium level		
	K_1	K_2	K_3	K_1	K_2	K_3
N_1	20.38d	21.83c	24.69ab	22.03c	23.15bc	25.81ab
N_2	24.40ab	22.92bc	24.79ab	24.67ab	25.26ab	24.75ab
N_3	25.66a	22.88bc	23.45bc	27.09a	23.78bc	24.09bc

Table 14: The effect of nitrogen and potassium splits with their interactions on grain yield (t/ha.) of female line during 2020 and 2021 seasons.

Nitrogen level	Grain yield (t/ha.)					
	2020			2021		
	potassium level			potassium level		
	K_1	K_2	K_3	K_1	K_2	K_3
N_1	3.12ac	2.75de	3.09bc	2.36f	3.31ac	3.15d
N_2	2.83de	2.72e	2.86d	3.28c	3.30ac	2.40f
N_3	3.19ab	3.22a	3.05c	3.00e	3.44a	3.42ab

Table 15: The effect of nitrogen splits and leave foliar for hormones with their interactions on grain yield (t/ha.) of female line during 2020 and 2021 seasons.

Nitrogen level	Grain yield (t/ha.)					
	2020			2021		
	Growth regulators			Growth regulators		
	GR_1	GR_2	GR_3	GR_1	GR_2	GR_3
N_1	3c	2.84d	3.12b	3.08b	2.74d	3.03b
N_2	2.90cd	2.89cd	2.69e	2.91c	3.09b	3.12b
N_3	2.81d	3.15b	3.49a	3.09b	3.12b	3.51a

Table 16: The effect of potassium splits and leave foliar for hormones with their interactions on grain yield (t/ha.) of female line during 2020 and 2021 seasons.

potassium level	Grain yield (t/ha.)					
	2020			2021		
	Growth regulators			Growth regulators		
	GR_1	GR_2	GR_3	GR_1	GR_2	GR_3
K_1	2.66d	3.33a	3.16b	2.83d	3.46a	3.10c
K_2	3.19b	2.71d	2.84c	3.22bc	3.40a	2.71e
K_3	2.87c	2.84c	3.30a	3.24b	2.85d	3.10c

Table 17: The effect of nitrogen, potassium splits and leave foliar hormones with their interactions on grain yield t/ha of female line during 2020 and 2021 seasons.

Nitrogen level	potassium level	Grain yield (t/ha.)					
		2020			2021		
		Growth regulators			Growth regulators		
		GR_1	GR_2	GR_3	K_1	GR_2	GR_3
	K_1	2.65hj	3.20df	3.50ac	K3	2.08m	2.37ik
N_1	K_2	3.60ab	2.18mn	2.47hj	3.68a	3.02fg	3.31be
	K_3	2.75gi	3.15dg	3.39bd	2.92gh	3.13dg	3.40b
	K_1	2.37kl	3.66a	2.48ik	3.12dg	3.48ac	3.23df
N_2	K_2	3.51ac	2.46ik	2.38kl	3.05eg	3.59ab	3.67a
	K_3	2.83gi	2.55gh	3.21df	2.55hi	2.20lm	2.47kl
	K_1	2.95fh	3.12eg	3.49ac	2.73hi	2.57gh	3.41be
N_3	K_2	2.47hj	3.50ac	3.68a	2.94gh	3.57ab	3.69a
	K_3	3.02bd	2.82gi	3.31ce	3.59ab	3.23cf	3.43ad

Table 18: The effect of nitrogen and potassium splits with their interactions on harvest index of female line during 2020 and 2021 seasons.

Nitrogen level	Harvest index					
	2020			2021		
	potassium level			potassium level		
	K_1	K_2	K_3	K_1	K_2	K_3
N_1	21.32bc	19.74cd	21.05bc	18.06d	24.52ab	23.78bc
N_2	21.85b	17.53e	16.93e	22.3c	18.89d	18.24d
N_3	23.68a	19.25d	21.18bc	25.62a	21.93c	21.79c

Table 19: The effect of nitrogen splits and leave foliar for hormones with their interactions on Harvest index of female line during 2020 and 2021 seasons.

Nitrogen level	Harvest index					
	2020			2021		
	Growth regulators			Growth regulators		
	GR_1	GR_2	GR_3	GR_1	GR_2	GR_3
N_1	20.73bc	19.80bd	21.59b	22.73b	21.36bc	22.28b
N_2	18.82cd	19.15cd	18.33d	19.78cd	21.41bc	22.1b
N_3	18.86cd	21.10bc	24.15a	21.25bc	19.27d	24.97a

Table 20: The effect of potassium splits and leaf foliar for hormones with their interactions on Harvest index of female line during 2020 and 2021 seasons.

potassium level	Harvest index					
	2020			2021		
	Growth regulators			Growth regulators		
	GR_1	GR_2	GR_3	GR_1	GR_2	GR_3
K_1	20.74bc	19.75cd	22.43ab	19.64c	17.49d	22.12b
K_2	19.50cd	17.27e	23.68a	22.27b	24.62a	25.18a
K_3	18.17de	19.10ce	21.89ab	21.85b	19.92c	22.04b

Table 21: The effect of nitrogen, potassium splits and leave foliar for hormones with their interactions on harvest index of female line during 2020 and 2021 seasons.

Nitrogen level	potassium level	Harvest index					
		2020			2021		
		Growth regulators			Growth regulators		
		GR_1	GR_2	GR_3	GR_1	GR_2	GR_3
	K_1	18.95cg	21.93bd	23.07bc	21.33ci	15.73kl	17.12jl
N_1	K_2	23.41bc	16.29fi	19.54cg	25.03bd	22.89ch	25.66bc
	K_3	19.83cg	21.18ce	22.15bd	21.84ci	25.45bc	24.06bf
	K_1	19.77cg	26.22ab	18.01dh	19.76fj	21.62ci	25.52bc
N_2	K_2	21.43ce	14.46hi	**27.77a**	20.31ej	27.42ab	29.13a
	K_3	15.27gi	15.24gi	20.27cf	19.28gk	15.19l	20.27ej
	K_1	23.50bc	21.34ce	16.71ei	17.84il	15.12l	23.72bg
N_3	K_2	13.66i	21.08ce	23.00bd	21.47ci	23.56bh	20.77dj
	K_3	19.41cg	20.89cf	23.24bc	24.45be	19.13hk	21.80ci

تحسين إنتاج تقاوى الأرز الهجين تحت مواعيد إضافة مختلفة للنيتروجين والبوتاسيوم ومصادر منظمات النمو

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الملخص العربي

أجريت هذه الدراسة في المزرعة البحثية بسخا – محطة البحوث الزراعية –كفرالشيخ – مصر خلال موسمي الزراعة 2020 و 2021. شملت هذه الدراسة علي سلالتين الأولي السلالة العقيمة ذكريا IR69625A كأم مع السلالة المعيدة للخصوبة جيزة 178 لإنتاج تقاوي الأرز الهجين مصري 1 (سخا 2034 هجين) والتجربة صممت في تصميم القطع المنشقة مرتين في ثلاث مكررات ومساحة القطعة التجريبية (22.5.) وكانت أهم النتائج في كلا الموسمين كالآتي : كان هناك اختلافات معنوية بين مستويات المعاملات: كان هناك تأثيرا معنويا للتفاعل بين معاملات النتروجين ومعاملات البوتاسيوم علي طول النبات معدل خروج السنبلة وعدد السنابل الخصبة /للجورة ووزن السنبلة وطول السنبلة ووعدد الحبوب الخصبة/للسنبلة وعدد الحبوب الكلية/للسنبلة ونسبة العقد فى الحبوب ووزن 1000 حبة ومحصول الحبوب للجورة ومعامل الحصاد فى كلا الموسمين .كان هناك تأثيرا معنويا للتفاعل بين معاملات النتروجين ومعاملات الرش بمنظمات النمو علي طول النبات معدل خروج السنبلة وطول السنبلة وعدد الحبوب الخصبة/للسنبلة ونسبة العقد فى الحبوب ومحصول الحبوب للجورة ومعامل الحصاد فى كلا الموسمين. كان هناك تأثيرا معنويا للتفاعل بين معاملات البوتاسيوم ومعاملات الرش بمنظمات النمو علي طول النبات وعدد السنابل الخصبة/للجورة ووزن السنبلة وطول السنبلة وعدد الحبوب الخصبة/للسنبلة وعدد الحبوب الكلية/للسنبلة ونسبة العقد فى الحبوب ومحصول الحبوب للجورة ومعامل الحصاد فى كلا الموسمين. كان هناك تفاعل معنوي من الدرجة الثانية (بين العوامل الثلاثة) في صفات طول النبات معدل خروج السنبلة وطول السنبلة وعدد الحبوب الخصبة/للسنبلة وعدد الحبوب الكلية/للسنبلة ونسبة العقد فى الحبوب ومحصول الحبوب للجورة ومعامل الحصاد فى كلا الموسمين. ومن خلال النتائج السابقة نستطيع أن نوصي بأن اضافة السماد النتروجينى ثلث الكمية على البلاط وثلث الكمية بعد 20 يوم من الشتل وثلث الكمية بعد 40 يوم من الشتل مع اضافة السماد البوتاسى نصف الكمية على البلاط ونصف الكمية بعد 30 يوم من الشتل مع رش بالجبريلك على مرتين عند 15% من التزهير يضاف 40% من الجرعة وعند 45% من التزهير يضاف 60% من الجرعة أفضل التوصيات لإنتاج تقاوي الأرز الهجين مصري1 (سخا 2034 هجين) من وحدة المساحة.

الكلمات الاسترشادية: