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Effect of Plant Growth Regulators on Growth and Yield of Egyptian Hybrid Rice One Under Saline Soil Conditions

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ABSTRACT

Two field experiments were conducted under saline soil during 2013 and 2014 seasons at Research Farm of El Sirw Agricultural Research Station, Damietta province, Egypt. Improving salinity tolerance and grain yield of hybrid rice were the main objectives of the current study. The experimental soil was clayey with salinity levels of 7.70 and 7.30 dS/m in 2013 and 2014 seasons, respectively. Egyptian hybrid rice one (EHR1) variety was used in this study. The studied treatments were including; water (spray control treatment), GA_3 with concentration (5, 10, 15 ppm), Auxin with concentration (5, 10, 15 ppm), Cytokinin with concentration (5, 10, 15 ppm). Those substances were sprayed at mid tillering, panicle initiation and booing stage. At heading the growth parameters of EHR1 was measured at heading stage as well as plant chemical contents were estimated. Grain yield and its components were estimated at harvest. The factorial design was used in the experiment with three replications. The obtained results showed that foliar spray treatments were found to be increased effective in enhancing growth plants of EHR1 and increased nutrient leaf content such as N and K. therefore, the salinity withstanding of EHR1 was raised resulted in proper growth and reasonable grain yield under salt stress. Applying Cytokinin or Auxin at 10 ppm as foliar application was most effective treatment in improving rice productivity under salt affective soils.

Keywords: Hybrid, Rice, PGRs, GA_3, Auxin, Cytokinin, Salinity.

INTRODUCTION

Salt stress is one of the major abiotic stress factors that affect almost every aspect of physiology and biochemistry of a plant resulting in yield reduction (Foolad, 2004). Thus, it is a serious threat to agricultural productivity, especially in arid and semi-arid regions (Parvaiz, A. and S. Satyawati 2008).

Under saline conditions, plants establish physiological mechanisms of salinity tolerance such as osmotic adjustment against tissue water loss and ion uptake, and transport control against ion toxicity (Naito *et al*., 1994). Osmotic adjustment is achieved by the synthesis of inorganic solutes in the cells, which prevents internal water loss resulting in the maintenance of water relations (Sahu *et al*., 1993 and Saneoka *et al*., 1999). Ion compartmentation, exclusion, retranslocation, and control of uptake and transport can guard against ion toxicity (Tsuchiya *et al*., 1994).

Improvement for salinity tolerance would be of significant value for a sensitive crop like rice when it is grown on lands with salinity problems. Although, rice is one of the most important food crops in the world, both economically and nutritionally. It ranks among most sensitive into salinity (Maas and Grattan, 1999). Not only rice is considerably less tolerant to salinity than wheat, but also salinity affects its reproductive development quite differently. Some researchers have used PGRs for reducing or eradicating the negative effects of salinity (Kabar, 1987). For example, the exogenous application of PGRs, auxins (Khan *et al*., 2004), gibberellins (Afzal *et al*., 2005) and cytokinins produces some benefit in alleviating the adverse effects of salt stress and also improves germination, growth, development and seed yields and yield quality (Egamberdieva, 2009).

GA_3 plays a vital role in improving rice growth as well as yield and yield components of hybrid rice under saline soil conditions (Bassiouni., 2008). Auxin (IAA) plays a major role on regulating plant growth. For example, it controls vascular tissue development, cell elongation, and apical dominance. However, Prakash and Prathapasenan (1990) reported that NaCl caused a significant reduction in IAA concentration in rice leaves GA3 has been reported to be helpful in enhancing rice growth under saline conditions. Growth and yield parameters of rice were significantly increased in response to application of cytokinin under saline stress (Zahir *et al*., 2001)

The present study was carried out to promote growth and yield of Egyptian hybrid rice one under saline soil using PGRs.

MATERIALS AND METHODS

The study was carried out in the two seasons of 2013 and 2014 at the Experimental Farm of El Sirw Agricultural Research Station, Damietta Governorate, Egypt. The soil was clayey with salinity level of 8.00 and 7.50 dSm^{-1} (Soil were chemically analyzed according to Piper, 1950) in the first and second seasons, respectively as shown in Table (1).

Table (1): Some physical and chemical properties of the soil in the experimental sites:

season	ECe dsm^{-1}	pH	Na^{+1}	Ca^{+2} Mg^{+2}	K^{+1}	HCo^{-}	Cl	So_4^{-2}	N %	Available ppm	
			meg l^{-1}							p	k
2013	8.0	8.4	48	31	0.32	8.0	43	23.5	0.028	12	250
2014	7.5	8.3	45	29	0.31	6.7	33	25.6	0.026	11	240

Plants of EHR1 were sprayed with following materials at mid tillering, panicle initiation and booting stages; 1-water (control treatment), 2- GA_3 (5 ppm), 3- GA_3 (10 ppm), 4- GA_3 (15 ppm), 5- Auxin (5 ppm), 6-

Auxin (10 ppm), 7-Auxin (15 ppm), 8- Cytokinin (5 ppm), 9- Cytokinin (10 ppm), 10- Cytokinin (15 ppm) as a foliar spray.

1) Seed and nursery treatments

Seeds of EHR1 at the rate of 23.8 kg/ha were soaked in water for 24h at 30+ 2 ºc then placed between two layers of saturated gunny bags up to chitting (just appearance of radical) at 30+ 2 ºc.

The nursery seedbed preparation was well performed. The nursery was fertilized with calcium super phosphate (15.5% P_2O_5) at the rate of 4 kg/ Kerat (Kerat = 175 m^2) on the dry soil before plough. Nitrogen in the form of urea (46.0% N) was added at the rate of 3 kg/ Kerat, after the last plough before leveling and immediately before sowing. Rice grains at the rate of 23.8 kg/ha for hybrid rice were prepared. Therefore, it was broadcasted with 2-3 cm standing water in the nursery in April, 25th in both seasons. Weeds were chemically controlled by Saturn (50%) at the rate of 4.76 liter /ha.

The permanent field was well prepared as it indicated in the nursery. Calcium super phosphate (15.5% P_2O_5) was added in the rate of 238 kg/ha on the dry soil before ploughing. Thirty days old seedlings were transplanted at the rate of 2-3 seedlings/hill with spacing of 20×20 cm, which were sown with 2-3 cm of standing water in the land. Potassium sulphate (48% K_2O) was applied at the rate of 58 kg K_2O/ha into two equal doses as basal application and at maximum tillering stage. The nitrogen in the form of urea at the rate of 165 kg/ha was applied into four splits, 1/4 at tillering stage + 1/4 at maximum tillering stage + 1/4 at panicle initiation (PI) +1/4 at the beginning of booting stage (B.S). The rest of cultural practices of rice under saline soil were followed according to the recommendation of Rice Research and Training Center.

2) Data recorded:

The data were collected at two stages as following:

A-Growth characteristics at heading stage:

At heading stage, five hills were randomly taken and transferred to Lab to determine the following traits: leaf area index (LAI), chlorophyll content (SPAD value), dry matter production (g m^{-2}), and number of tillers/hill, heading date and plant height.

Nitrogen content in shoot according to (Hafez and Mikkelsen 1981), potassium and sodium content in shoot by using Flam photometer, Model E.E.L., according to (Jackson, 1967) were estimated.

B-Grain yield and its Components:

At harvest time, five main panicle were randomly taken from each plants to estimate the following characters; number of panicles/hill, panicle weight (g), number of filled grains $panicle^{-1}$, number of unfilled grains $panicle^{-1}$, 1000-grain weight (g). The six inner rows were harvest, dried and threshed to estimated grain yield (t ha^{-1}), straw yield (t/ha^{-1}) and harvest index (HI). The grain yield was adjusted based on 14% moisture.

Statistical Analysis:

The experiment was designated in a randomized complete blocks with three replications.

All data collected were subjected to standard statistical analysis according to Gomez and Gomez (1984) using the computer program (IRRISTAT). The treatment means were compared using Duncan's multiple range test (Duncan, 1955).

RESULTS

1-Growth characteristics at heading stage:

Data in Table 2 indicated that foliar spray treatments had favorable effects on growth parameters at heading stage. All foliar spray treatments significantly increased hybrid rice growth; leaf area index, chlorophyll content and dry matter production in both seasons over control. Spraying rice plants with auxin at 15 ppm gave the highest LAI and dry matter production in both seasons, while foliar spray with 15 ppm cytokinin gave the highest values of chlorophyll content without any significant differences with the treatments of 10 and 15 ppm in both seasons. On the other hand, the lowest values of growth parameters were produced by control treatment (Table2). Similar findings had been reported by Pain and Basu, (1985); Acharya *et al*., (1990); Liu *et al*., (2011) and El-Ekhtyar *et al*., (2014).

Table 2: Some growth characteristics of EHR1 as affected by foliar spraying treatments under saline soil in 2013 and 2014 seasons.

Characters	LAI		Chlorophyll content (SPAD value)		Dry matter production (g/$hill^{-1}$)	
Treatments	2013	2014	2013	2014	2013	2014
Control	4.68d	5.15d	38.66c	38.67d	29.2f	30.6e
5 ppm GA_3	5.46bcd	5.78bc	39.4bc	40.67c	32.37e	33.1d
10 ppm GA_3	5.85abc	6.12ab	41.0ab	43.1ab	39.53c	41.0c
15 ppm GA_3	6.07ab	6.23ab	39.43abc	43.13ab	44.60ab	45.4ab
5 ppm auxin	6.04ab	6.11abc	40.2abc	41.37bc	35.37d	39.0c
10 ppm auxin	6.19ab	6.45a	41.10ab	41.7abc	44.57ab	46.3ab
15 ppm auxin	6.30a	6.51a	40.97ab	41.6abc	46.10a	47.07a
5 ppm cyt.	5.19cd	5.56cd	39.5abc	41.6abc	32.33e	34.03d
10 ppm cyt.	5.95abc	6.08abc	41.43ab	43.0ab	42.57b	44.57b
15 ppm cyt.	6.12ab	6.32ab	41.53a	43.27a	43.77b	45.13ab
F. test	*	**	*	**	**	**

GA_3 = Gibberellic acid, cyt = cytokinin, FS = foliar spray * and ** indicated P< 0.05and P<0.1 respectively. In each column means designated by the same letter are not significantly different at 5% level, according to DMRT.

Data in Table 3 indicated that foliar spraying treatments significantly increased number of tillers and plant height in both seasons as compared with control treatment and shrink period to heading date. As seen in Table 3 the salinity significantly restricted the rice growth at heading stage as in control treatment, but foliar spraying treatments, particularly cytokinin at and 10, 15 ppm and auxin at 10 ppm could alleviate harmful effect of salts improving number of tillers. The tallest plants were recorded with GA_3 at 15 ppm without any significant differences with Auxin and Cytokinin at 10 or 15 ppm. Meanwhile, the control treatment gave the shortest plants. GA_3 reduced period from sowing to heading compared with the other treatments. These results are in agree with those of Awan and Alizai, (1989); Kuiper *et al*., (1990); Prakash and Prathapasenan, (1990) and Singh, (1996).

Table 3: Some growth characteristics of EHR1 as affected by foliar spray treatments under saline soil in 2013 and 2014 seasons.

Characters	Number of tillers/hill		Heading date (days)		Plant height (cm)	
Treatments	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Control	20.0d	21.07e	97.67a	97.0a	97.53d	96.94c
5 ppm GA_3	22.0c	23.0cd	97.67a	96.33abc	104.0abc	102.13b
10 ppm GA_3	22.7bc	23.5bcd	96.1b	95.67c	105.3ab	104.47ab
15 ppm GA_3	22.3c	23.2bcd	94.77c	94.67d	107.1a	106.0a
5 ppm auxin	22.71bc	22.9cd	97.33a	96.67ab	101.67bc	102.3b
10 ppm auxin	23.67ab	23.8abc	95.33bc	96.0bc	104.0abc	103.73ab
15 ppm auxin	23.3abc	23.4bcd	95.32bc	96.0bc	105.07ab	105.9a
5 ppm cyt	22.0c	22.3de	97.2a	96.67ab	103.27bc	102.37b
10 ppm cyt	24.0ab	24.53ab	97.33a	97.0a	104.3abc	103.67ab
15 ppm cyt	24.33a	25.07a	97.33a	96.67ab	103.9abc	103.93ab
F. test	**	**	**	**	*	*

GA_3 = Gibberellic acid, cyt = cytokinin, FS = foliar spray * and ** indicated P< 0.05and P<0.1 respectively. In each column means designated by the same letter are not significantly different at 5% level, according to DMRT.

Regarding to N %, K^+ %, Na^+ % and Na^+/K^+ ratio in shoot at heading date, data in Table 4 showed that foliar spraying treatments significantly boosted N% and K% and decreased Na^+% and Na^+/K^+ ratio in shoot over control treatment in both seasons. The highest value of N% was given by cytokinin at 10 ppm without any significant differences with GA_3 10 ppm and Auxin at the same concentration 10 ppm. Meanwhile, foliar spray with 10 ppm cytokinin gave the highest K^+ % without any significant differences with auxin and cytokinin at 15 ppm. On the other hand, the lowest means of N% and K^+% were obtained by control treatment in both seasons. The treatment with cytokinin at 10 or 15 ppm recorded the lowest values of Na^+ and Na^+/K^+ ratio and the highest values of them were obtained with control treatment. Similar findings had been reported by Tang and Yu, (2002); Zayed *et al.*, (2006) and El-Ekhtyar *et al*., (2014)

Table 4: N, K^+, Na^+ leaf contents and Na/K ratio of EHR1 as affected by foliar spray treatments under saline soil in 2013 and 2014 seasons.

Characters	N-content (%)		K-content (%)		Na^+-content (%)		Na^+/K^+ ratio	
Treatments	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Control	1.86d	1.99d	0.99d	1.26c	0.59a	0.57a	0.596a	0.453a
5 ppm GA_3	1.95cd	2.08a-d	1.13bc	1.29bc	0.57ab	0.55b	0.509b	0.425ab
10 ppm GA_3	2.12ab	2.15ab	1.19b	1.33abc	0.51d	0.51e	0.430cd	0.383cde
15 ppm GA_3	2.05bc	2.02cd	1.22b	1.34abc	0.51d	0.48g	0.419d	0.375ef
5 ppm auxin	2.06bc	2.06a-d	1.06cd	1.33abc	0.56bc	0.54c	0.529b	0.408bc
10 ppm auxin	2.10ab	2.11a-d	1.22b	1.36abc	0.50d	0.50f	0.408de	0.369de
15 ppm auxin	2.00bcd	2.07a-d	1.36a	1.41ab	0.50d	0.47h	0.369ef	0.333fg
5 ppm cyt	1.95cd	2.04bcd	1.20b	1.34abc	0.55c	0.53d	0.462c	0.401bcd
10 ppm cyt	2.24a	2.17a	1.37a	1.47a	0.48e	0.46i	0.351f	0.316g
15 ppm cyt	2.11ab	2.13abc	1.36a	1.47a	0.47e	0.45j	0.348f	0.311g
F. test	**	**	**	*	**	**	**	**

GA_3 = Gibberellic acid, cyt = cytokinin, FS = foliar spray * and ** indicated P< 0.05and P<0.1 respectively. In each column means designated by the same letter are not significantly different at 5% level, according to DMRT.

2-Yield and yield attributes:

Regarding the yield and yield components, the foliar spraying treatments significantly increased all yield components and grain yield of EHR1 over control treatment (Tables 5,6and7). Foliar spraying with cytokinin at 10 ppm gave the highest values of number of panicles/hill, panicle length and panicle weight without any significant differences with 10 ppm Auxin and 15ppm cytokinin. On contrary, the lowest values of abovementioned traits were produced by the control treatment in both seasons (Table 5).

Date in Table 6 showed that the treatment of cytokinin at 10 ppm gave the highest values of filled grains without any significant differences with cytokinin at 15 ppm in both seasons. Foliar spray with GA_3 at 10 ppm gave the heaviest 1000-grain weight without any significant differences with auxin, cytokinin at 10 ppm and cytokinin at 15 ppm. The lowest values of them were produced by the control treatment. The lowest values of number of unfilled grains panicle^{-1} was obtained by 10 ppm auxin, while the highest value of number of unfilled grains was recorded by control treatment. Similar findings had been mentioned by Prakash and Prathapasenan, (1990); Singh, (1994) and Hare *et al*., (1997).

The highest grain yield was obtained when rice plants were foliarly sprayed with cytokinin at 10 ppm without significant differences with cytokinin at 15 ppm and auxin at 10 ppm treatments (Table 7). Foliar spraying treatments significantly increased straw yield of Egyptian hybrid rice one as compared with control treatment in both seasons of study. The lowest values of them were produced by control treatment. The results are in a good agreement with those reported by Awan and Alizai, (1989); Mathew and Rayan (1995); Zaher *et al*., (2001)and Peng *et al*., (2003)

Table 5: Some yield components of EHR1 as affected by foliar spray treatments under saline soil in 2013 and 2014 seasons.

Characters / Treatments	Number of panicles/hill 2013	Number of panicles/hill 2014	Panicle length (cm) 2013	Panicle length (cm) 2014	Panicle weight (g) 2013	Panicle weight (g) 2014
Control	17.80c	19.10e	21.53f	22.43e	2.72cd	3.07e
5 ppm GA_3	18.47bc	21.53d	22.17de	22.53de	2.94cd	3.27c
10 ppm GA_3	19.11abc	21.9bcd	22.80abc	23.2abc	2.80cd	3.39b
15 ppm GA_3	18.93bc	21.61cd	22.33cde	23.33abc	2.68d	3.15d
5 ppm auxin	18.58bc	21.40d	21.81ef	22.63de	2.93cd	3.10de
10 ppm auxin	19.68ab	22.50abc	23.20ab	23.53ab	3.33a	3.57a
15 ppm auxin	18.80bc	21.33d	22.70bcd	22.90cd	3.00bc	3.43b
5 ppm cyt	18.90bc	21.51d	22.17de	23.10bc	2.93cd	3.40b
10 ppm cyt	20.30a	22.91a	23.40a	23.63a	3.39a	3.58a
15 ppm cyt	20.38a	22.80ab	22.80abc	23.43ab	3.31ab	3.53a
F test	*	**	**	**	**	**

GA_3 = Gibberellic acid, cyt = cytokinin, FS = foliar spray * and ** indicated P< 0.05and P<0.1 respectively. In each column means designated by the same letter are not significantly different at 5% level, according to DMRT.

Table 6: Some yield components of EHR1 as affected by foliar spray treatments under saline soil in 2013 and 2014 seasons.

Characters / Treatments	Number of filled grains/panicle 2013	Number of filled grains/panicle 2014	Number of unfilled grains/panicle 2013	Number of unfilled grains/panicle 2014	1000-grain weight (g) 2013	1000-grain weight (g) 2014
Control	116.9c	134.0e	16.3a	12.0a	21.5c	22.10cd
5 ppm GA_3	122.3c	139.0cde	10.2b	8.0b	21.9b	22.47bc
10 ppm GA_3	132.8b	141.0bcd	7.7bcd	6.5bc	22.3a	23.10a
15 ppm GA_3	122.8c	136.0de	7.1cd	6.3bc	22.1ab	23.07a
5 ppm auxin	130.5b	137.3de	10.3b	8.0b	20.93d	21.87d
10 ppm auxin	141.0a	145.0b	4.3e	4.9c	22.1ab	22.78ab
15 ppm auxin	132.9b	143.0bc	5.6de	6.3bc	21.5c	22.17cd
5 ppm cyt	130.0b	141.0bcd	9.0bc	8.0b	21.2d	22.67ab
10 ppm cyt	145.0a	153.7a	7.1cd	6.3bc	22.2ab	23.07a
15 ppm cyt	142.0a	150.3a	6.2de	6.2bc	22.1ab	22.67ab
	**	**	**	**	**	**

GA_3 = Gibberellic acid, cyt = cytokinin, FS = foliar spray * and ** indicated P< 0.05and P<0.1 respectively. In each column means designated by the same letter are not significantly different at 5% level, according to DMRT.

Table 7: Grain and straw yields and harvest index of EHR1 as affected by foliar spray treatments under saline soil in 2013 and 2014 seasons.

Characters / Treatments	Grain yield(t/ha) 2013	Grain yield(t/ha) 2014	Straw yield (t/ha) 2013	Straw yield (t/ha) 2014	Harvest index 2013	Harvest index 2014
Control	4.73e	5.92e	7.28c	9.20c	0.39	0.39
5 ppm GA_3	5.00de	6.47d	8.40bc	9.90bc	0.37	0.40
10 ppm GA_3	5.70bc	6.97bc	9.15ab	10.36ab	0.39	0.40
15 ppm GA_3	5.60c	6.37d	9.40ab	10.47ab	0.37	0.38
5 ppm auxin	5.10d	6.93bc	8.38bc	10.38ab	0.38	0.40
10 ppm auxin	5.83abc	7.10abc	9.17ab	10.55ab	0.39	0.40
15 ppm auxin	5.80bc	7.00bc	9.80a	11.18a	0.37	0.39
5 ppm cyt	5.60c	6.90c	9.73ab	10.33ab	0.39	0.40
10 ppm cyt	6.13a	7.22a	9.20ab	10.63ab	0.40	0.41
15 ppm cyt	5.97ab	7.12ab	9.47ab	10.78ab	0.39	0.40
	**	**	*	*	NS	NS

GA_3 = Gibberellic acid, cyt = cytokinin, FS = foliar spray * and ** indicated P< 0.05and P<0.1 respectively. In each column means designated by the same letter are not significantly different at 5% level, according to DMRT.

DISCUSSION

The current investigation clarified that applying varying foliar spray with PGRs treatments as foliar spray could significantly invigorate the plants than those obtained by traditional treatment (control) under salt stress.

The favorable effect of GA_3 is mainly attributed to enhancing IAA exertion, promoting cell elongation and division, reducing Na^+ and Cl^- uptake, increased K^+ and N uptakes and chlorophyll content of rice plant leading to high growth rate, reasonable rice growth at early and late stages, improving source-sink relation resulted in high yield components and ultimately grain yield under salt stress as compared to traditional treatment Prakash and Prathapasenan,(1990); Singh, (1996); Lee *et al*., (1999); Chen *et al*., (2005) and Bassiouni, 2008).

Auxin (IAA) plays a major role on regulating plant growth. For example, it controls vascular tissue development, cell elongation, and apical dominance. However, Prakash and Prathapasenan (1990) reported that NaCl caused a significant reduction in IAA concentration in rice leaves, so application of auxin to rice plant GA3 has been reported to be helpful in enhancing rice growth under saline conditions resulting in high grain yield.

The superiority of cytokinin treatment is inducing high grain yield. Cytokinins (CKs) regulate plant growth aspects and developmental processes, including cell division, apical dominance, chloroplast biogenesis, nutrient mobilization, leaf senescence, vascular differentiation, photomorphogenic development, shoot differentiation and anthocyanin production Mok and Mok, (2001). Cytokinins can also enhance resistance to salinity and high temperature in plants (Barciszewski *et al.*, 2000). It was hypothesized that cytokinins could increase salt tolerance by interacting with other plant hormones, especially auxins and ABA. Increase in yield and yield components of rice may be discussed with the work with Hanada *et al*., (1994) they reported that positive response of rice to cytokinin application. In a field trail, cytokinin application increased the yield of rice by 45.8% as compared to control Zahir *et al*., (2001).

All previous plant regulators improved growth of rice and their salt tolerance as result of using cytokinin resulted in good growth, more adoption to salt stress, healthy growth, increased dry matter production, leaf are index (LAI), flag leaf area, more assimilates translocation to grains resulted in high yield components, less sterility (high fertility percentage) of rice under salt stress and subsequently higher grain yield as well as harvest index than those obtained by control treatment Bassiouni, (2008).

CONCLUSION

It could be concluded that rice productivity of EHR1 and durance were increased when rice plants were sprayed with 10 ppm of GA3 or Cytokinin under saline soil.

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تأثير منظمات النمو على نمو ومحصول الأرز الهجين المصرى تحت ظروف الأراضى الملحية

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أقيمت تجربتان حقليتان تحت ظروف الأراضى الملحية وذلك خلال موسمى ٢٠١٣ , ٢٠١٤ م بمزرعة محطة بحوث السرو الزراعية، بمحافظة دمياط. وكان الهدف من هذه الدراسة هو زيادة تحمل الملوحة وتحسين نمو وزيادة محصول حبوب الأرز صنف هجين مصرى واحد. وكانت أرض التجربه طينية ومستوى الملوحه بها ٧.٧ ديسيسمنز/م و ٧.٣ ديسيسمنز/م فى كلا الموسمين على التوالى. وقد تم إجراء المعاملات الأتية والممثلة فى ١٠ معاملات على النحو التالى وهى الرش بـ الماء (الكنترول) ،حامض الجبريللين بتركيز (٥ ، ١٠، ١٥جزء فى المليون) ،الأوكسين بتركيز (٥، ١٠، ١٥ جزء فى المليون) ، السيتوكينين بتركيز (٥ ، ١٠، ١٥جزء فى المليون) عند مراحل النمو وهى مرحلة التفريع المتوسط وبداية تكوين السنبلة ومرحلة ماقبل الطرد مباشرة. و تم تقدير صفات النمو الأتية عند مرحلة الطرد (دليل مساحة الأوراق، محتوى الكلوروفيل، المادة الجافة المتكونة/جورة، عدد الفروع/ جورة، تاريخ التزهير وطول النبات فى الأرز الهجين المصرى سخا ٢٠٣٤ وكذلك محتوي النبات من النيتروجين والبوتاسيوم والصوديوم ونسبة الصوديوم الى البوتاسيوم بالأضافة الى تقدير المحصول (الحبوب والقش ودليل الحصاد) ومكونات المحصول عند الحصاد (عدد السنابل/ جورة-١، وزن السنبلة، طول السنبلة، عدد الحبوب الممتلئة/ سنبلة، عدد الحبوب الفارغة/ سنبلة ووزن الألف حبة)، وكان التصميم الأحصائى هو العاملية فى ثلاث مكررات. أوضحت النتائج أن معاملات الرش كانت ذات تأثير معنوى فى تحسين صفات نمو الأرز صنف هجين مصرى واحد وأدت الى زيادة محتوى النبات من النيتروجين والبوتاسيوم وكذلك أدت الى زيادة تحمله للملوحة مما أدى الى زيادة محصول الحبوب بصورة معنويه. وتوصى هذه الدراسة رش بالسيتوكينين بتركيز (١٠جزء فى المليون)، أو الأوكسين بتركيز (١٠ جزء فى المليون) عند مرحلة التفريع المتوسط وبداية تكوين السنبلة وبداية خروج السنابل. حيث كلا منها له تأثير معنوى وايجابى على صفات النمو ومحصول حبوب الأرز الهجين تحت ظروف الإجهاد الملحى.