# RESPONSE OF THREE RICE CULTIVARS TO SOME GROWTH STIMULATORS UNDER DIFFERENT IRRIGATION INTERVALS

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**ABSTRACT:** *Two field experiments were carried out at the Experimental Farm of Rice Research and Training Center (RRTC), Sakha, Kafr El-Sheikh, Egypt, during 2013 and 2014 seasons, to study the response of three Egyptian rice cultivars (Sakha 101, Giza 178 and Giza 179) to foliar spraying with solution of some growth stimulator compounds (ascorbic acid, humic acid and citric acid as well as water) under three irrigation intervals (every 3, 6 and 9 days). The solutions of ascorbic acid and citric acid were applied as foliar spray with the concentration of 2g /liter. While, the solution of humic acid was sprayed at the concentration of 5ml /liter. The stimulators were applied two times at 35 and 45 days after transplanting. A split-split plot design with three replications was used. The main plots were assigned to the three irrigation intervals, the sub-plots to the three rice cultivar and the sub-sub plots to foliar application of growth stimulators. Shorting irrigation interval from 9 to 3 or 6 days resulted in a significant increase in leaf area index, dry weight $m^{-2}$, flag leaf area, number of tillers $m^{-2}$, number of panicles $m^{-2}$, plant height, number of filled grains $panicle^{-1}$, biological yield and grain yield in both seasons. Irrigation continuously (every 3 days) and every 6 days were statistically at par in all growth measurements, yield attributes and grain yield $ha^{-1}$ in both seasons. There were no significant differences among the three rice cultivars in LAI, number of tillers $m^{-2}$, number of panicles $m^{-2}$ and number of filled grains $panicle^{-1}$ and grain yield $ha^{-1}$ in both seasons as well as dry matter accumulation $m^{-2}$ in the second season. Giza 178 cultivar was among those having high flag leaf area and plant height in both seasons. However, plants of rice cv. Giza 179 significantly accumulated dry matter $m^{-2}$ greater than those of Giza 178 in the first season. The 1000-grain weight was greater in Sakha101 cultivar than in the two other cultivars. Foliar application of the tested growth stimulators resulted in a significant increase in LAI, dry weight $m^{-2}$, flag leaf area and plant height, number of panicles $m^{-2}$, number of filled grains $panicle^{-1}$, 1000-grain weight, biological yield and grain yield compared with foliar application of water (control) in both seasons. Foliar spraying with solution of ascorbic or humic acids recorded the highest values of these characters in both seasons. However, percentage of unfilled grains was significantly decreased by application of stimulators compounds in the two seasons. All the first and second order interactions had a significant effect on grain yield in the two seasons. It can be concluded that irrigation every 6 days along with ascorbic acid or humic acid as foliar praying could be recommended for optimum grain yield of rice cvs Giza 178 or Giza179 under these conditions of this experiment at Kafr El-Sheikh Governorate.*

***Key words:*** *Rice, Irrigation interval, rice cultivar and growth stimulator.*

## INTRODUCTION

Rice (*Oryza sativa, L.*) is considered one of the major food and export crop in A.R. Egypt and it is one of the important strategic cereal crops in Egypt and the world. It is a major source of food for more than 2.7 billion people and is planted on about one-tenth of the earth's arable land.So, increasing its production is a national target in Egypt to enhance food security, the rice is adapted to growing under flooded conditions such as the Egyptian conditions. One third of the world's population will experience severe water scarcity within the next 25 years. In 2025 Per capita availability of water resources decline more than the past decade. Agriculture share of water will decline at an even faster rate because of increasing competition for available water urban and industrial sectors, Rice is consider as the single biggest “user” of fresh water. Egypt nowadays is facing a big problem of water scarce Moreover, the consumption per capita less than 750m, which leads to water poverty, at that time we must think seriously about urgent solution to overcome the water consuming crops like rice. Rice is mostly grown under submerged soil conditions and requires much water compared with other crops. Rice is one of the major water consuming crops and as the flooding method in rice for irrigation by the farmers and with what Egypt was facing trying to reduce the share of the Nile water must therefore look at new water management methods led to irrigation water saving without significant reduction in yield. Increasing rice production has been problem due to limited land available and water shortage (Naeem *et al.*,2010), Plants, growth and production are affected by natural stresses in the form of biotic and abiotic stresses, inversely. The abiotic stress causes loss of hundred million dollars annually, because of reduction and loss of products (Mahajan and Tuteja, 2005). One of the main constraints of rice cultivation and production is water shortage during periods of low rainfall, which affects the vegetative growth rate and grain yield (Tao *et al.*, 2006). It is estimated that more than 50% of the world rice production area is affected by drought (Bauman *et al.*, 2005). Drought stress during the vegetative growth, flowering, and terminal stages of rice cultivation can cause spikelet sterility and unfilled grain (Kamoshita *et al.*, 2004). Usually, drought during the grain-filling process induces early senescence and shortens the grain-filling period, but increases remobilization of assimilates from the straw to the grains (Plaut *et al.*, 2004).

Rice cultivars differed in plant height, number of tillers per plant, total biomass, harvest index and grain yield. The differences among genotypes for all growth traits, yield component, biological yield and grain yield indicate appreciable amount of variability among the genotypes (Sokoto and Muhammad, 2014).

Oxidative stress, which results from overproduction of reactive oxygen species (ROS), is regarded as an important component in expression of water deficit-induced metabolic alterations in plants (Sharma and Dubey 2005),

The positive effects of humic substances on plant growth have demonstrated the importance of optimum mineral supply, independent of nutrition (Yildirim, 2007). Ascorbic acid (AsA), another important organic molecule serves as detoxification of reactive oxygen species (Khan *et al.*, 2006) It is also involved in biosynthesis of many other plant hormones, (Barth *et al.*, 2006).

So, the major goal is improving agronomic practices especially foliar application of some growth stimulators and water management to find ways for saving more irrigation water and determine the best cultivars productivity under this condition to obtain the highest yield of rice.

## MATERIALS AND METHODS

Two field experiments were carried out at the Experimental Farm of Rice Research and Training Center (RRTC), Sakha, Kafrelshiekh, Egypt, during 2013 and 2014 seasons, to study the response of three Egyptian rice cultivars (Sakha 101 and Giza

178, Giza 179) to foliar spraying with solution of some growth stimulators (ascorbic acid, humic acid and Citric acid as well as water) under three irrigation intervals (every 3, 6 and 9 days). The previous crop was wheat in the two seasons. The soil of the experimental field was clayey in texture. Chemical analysis of soil samples taken from 0 to 30 cm depth in the experimental sites before soil preparation in both seasons are shown in Table 1.

The experimental design was split split-plot with three replications. The main plots were assigned to the three irrigation intervals, the sub-plots were allocated to the three rice cultivar and the sub-sub plots were allocated to foliar application of growth stimulator compounds. The plot size was 3 m x 4 m (12 $m^2$). The experimental soil was fertilized with phosphorus in form of calcium superphosphate (15.5 % $P_2O_5$) at the rate of 50 kg $P_2O_5$ $ha^{-1}$ before the soil preparation. Nitrogen fertilizer at the rate of 165 kg N $h^{-1}$ in the form of urea (46.5% N) was added in three equal splits at basal before transplanting, 30 and 45 days after transplanting. The solutions of growth stimulators were applied with the concentration of 2 g/liter for ascorbic acid, 5 ml/liter for humic acid and 2 g/liter for citric acid as seed soaking before sowing in nursery and foliar spraying at 35 and 45 days after transplanting in the permanent field. Seed of each cultivar at the rate of 140 kg $ha^{-1}$ were soaked in the mentioned solutions and water as control for 24 hr then incubated for 48hr to hasten early germination. Pre-germinated seeds were uniformly broadcasted in the nursery on 23$^{th}$ and 22$^{th}$ May in 2013 and 2014 seasons, respectively. The permanent field was well prepared, i.e. plowed twice followed by good wet leveling. Seedlings were carefully pulled from the nursery after 30 days from sowing and distributed through the plots. Seedlings were manually transplanted in 20X20 cm spacing at the rate of 3-4 seedlings/hill. All other agronomic practices were followed as recommended during the growing season.

Plant sample (five hills) were taken randomly from each plot at 105 days after sowing to estimate growth characters ,i.e. leaf area index, flag leaf area ($cm^2$) and dry matter g $m^{-2}$ , number of tillers $m^{-2}$ and plant height . At harvesting, (125 days after sowing for Giza179 and 135 days after sowing for Giza178 and Sakha101) number of panicles $m^{-2}$ was counted. Ten panicles were selected randomly to estimate number of filled grains, unfilled grains % and 1000-grain weight. The total weight of both grain yield and biological yield were recorded as tons $hectare^{-1}$. The weight of grains was adjusted to 14% moisture content.

The obtained 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 was performed using analysis of variance technique by means of "MSTATC" computer software package.

**Table 1: Chemical analysis of the experimental soil (0-30 cm depth) in 2013 and 2014 seasons.**

| Season | PH | Organic matter (%) | Total N (ppm) | Available p (ppm) | Available K (ppm) |
|---|---|---|---|---|---|
| 2013 | 8.3 | 1.4 | 430 | 12 | 451 |
| 2014 | 8.0 | 1.6 | 465 | 15 | 478 |

## RESULTS AND DISCUSSION

### I . Growth characters:

Data in Table 2 show that irrigation interval had a significant effect on leaf area index (LAI), dry matter accumulation (g $m^{-2}$), flag leaf area ($cm^2$) and number of tillers $m^{-2}$ and plant height in both seasons. Prolonging irrigation interval resulted in a significant reduction in all the mentioned traits in both seasons. Irrigation continuously (every 3 days) or every 6 days, being insignificant increasing for those traits compared with irrigation every 9 days in the two seasons. Such effect of sufficient water could be attributed mainly to its role in the stimulation of various physiological processes including cell division and cell elongation of internodes resulting in taller plants, more tillers formation, leaf numbers and photosynthetic area (leaf area), which resulted in more photosynthetic production and consequently increased dry matter accumulation. The promoting effects of water on dry matter production, leaf area index and number of tillers were previously reported by El-Saka (2013) and Ghazy (2010).

The three rice cultivars exhibited a significant difference in dry weight in the first season, flag leaf area and plant height in both seasons (Table 2). The relative ranking of rice cultivars with these respects was inconsistent in both seasons. Giza 178 cultivar was among those having high flag leaf area and plant height in both seasons. However, plants of rice cv. Giza 179 significantly accumulated dry matter greater than those of Giza 178 in the first season. On the other hand, there were no significant differences among the three rice cultivars in LAI and number of tillers in both seasons as well as dry matter accumulation in the second season. Varietal difference could be mainly attributed to genetic variability among rice cultivars. In this concern, Bastawisi *et al.* (2003), Zayed *et al.* (2007) and El-Kallawy (2008) found varietal differences in some of the mentioned traits.

Foliar application of growth stimulators had a significant effect on LAI, dry weight $m^{-2}$, flag leaf area and plant height in both seasons. Rice plants sprayed with solution of ascorbic or humic acids significantly exceeded those sprayed with water (control) in these respects in the two seasons. However, there were no significant differences among the plants sprayed with citric acid, ascorbic acid, humic acid in the most mentioned traits in both seasons. The stimulative effect of stimulators materials on these growth traits may be due to auxinic action of both ascorbic and citric acid on enhancing cell division and cell enlargement which reflected positively on plant height and dry matter accumulation. On the other hand, it can be found that foliar application of growth stimulators had no significant effect on number of tillers $m^{-2}$ in both seasons. These results are in agreement with those obtained by Gharib *et al.* (2011) who found that foliar spraying with ascobien (13% citric acid, 25% ascorbic acid plus 62% organic materials) resulted in a significant increase in dry matter accumulation, plant height and number of tillers/$m^2$ of rice compared with the control treatment. In this connection, Osman *et al.* (2013) and Rabello *et al.* (2014) came to the same conclusion.

The first order interactions significantly affected all the mentioned growth characters in both seasons, except number of tillers $m^{-2}$. None of the second order interaction had a significant effect on all studied growth characters in the two seasons (Table 2).

### II. Grain Yield Attributes and Biological Yield:

Means of studied yield attributes (panicle numbers, number of filled grains $panicle^{-1}$, unfilled grains %, 1000-grain weight) and biological yield $ha^{-1}$ of three rice cultivars as affected by irrigation interval and foliar application of growth stimulators in 2013 and 2014 are presented in Tables (3).

**Table (2): Leaf area index, dry matter accumulation(g $m^{-2}$), flag leaf area($cm^2$), number of tillers ($m^{-2}$) and plant height(cm) of rice as affected by cultivar, irrigation interval and growth stimulators in 2013 and 2014 seasons.**

| Factor | Leaf area index | Dry weight (g $m^{-2}$) | Flag leaf area ($cm^2$) | No. of Tillers/$m^2$ | Plant height (cm) |
|---|---|---|---|---|---|
| | | | 2013 season | | |
| **Irrigation, day (I):** | | | | | |
| Continuous | 6.54 a | 1609 a | 22.10 a | 541 a | 86.80 a |
| 6 | 5.75 a | 1480 ab | 20.72 b | 528 a | 82.60 a |
| 9 | 4.24 b | 1316 b | 18.27 c | 470 b | 75.80 b |
| F test | ** | * | ** | ** | * |
| **Cultivar ( C ):** | | | | | |
| Sakha 101 | 5.94 | 1439 ab | 19.71 b | 508 | 82.20 a |
| Giza 178 | 4.98 | 1400 b | 22.03 a | 518 | 84.30 a |
| Giza 179 | 5.60 | 1567 a | 19.35 b | 514 | 78.70 b |
| F test | NS | * | ** | NS | * |
| **Stimulators (S):** | | | | | |
| Control | 4.58 b | 1321 b | 18.83 c | 499 | 79.20 c |
| Ascorbic acid | 5.88 a | 1525 a | 22.43 a | 516 | 84.70 a |
| Humic acid | 5.81 a | 1539 a | 20.51 b | 524 | 82.50 ab |
| Citric acid | 5.77 a | 1488 a | 19.68 bc | 514 | 80.50 bc |
| F test | ** | * | * | NS | ** |
| **Interaction :** | | | | | |
| I x C | * | * | * | NS | ** |
| I x S | * | ** | ** | NS | ** |
| Cx S | ** | * | * | NS | * |
| I x C x S | NS | NS | NS | NS | NS |
| | | | 2014 season | | |
| **Irrigation, day (I):** | | | | | |
| Continuous | 7.10 a | 1888 a | 23.91 a | 576 a | 95.30 a |
| 6 | 6.86 a | 1747 ab | 22.99 ab | 545 b | 93.10 a |
| 9 | 5.35 b | 1488 b | 21.73 b | 487 c | 85.70 b |
| F test | * | ** | ** | * | * |
| **Cultivar ( C ):** | | | | | |
| Sakha 101 | 6.65 | 1661 | 21.74 b | 534 | 91.90 b |
| Giza 178 | 6.51 | 1687 | 23.22 a | 538 | 97.30 a |
| Giza 179 | 6.15 | 1775 | 23.67 a | 536 | 85.00 c |
| F test | NS | NS | ** | NS | ** |
| **Stimulators (S):** | | | | | |
| Control | 5.45 b | 1544 b | 21.32 b | 529 | 89.70 b |
| Ascorbic acid | 6.81 a | 1807 a | 24.15 a | 541 | 92.60 a |
| Humic acid | 6.97 a | 1766 a | 23.46 a | 540 | 91.70 ab |
| Citric acid | 6.52ab | 1714 a | 22.58 ab | 533 | 91.60 ab |
| F test | ** | ** | ** | NS | * |
| **Interaction :** | | | | | |
| I x C | * | * | * | NS | ** |
| I x S | ** | ** | * | NS | * |
| Cx S | * | * | * | NS | ** |
| I x C x S | NS | NS | NS | NS | NS |

*, ** and NS indicate P< 0.05 , P< 0.01 and not significant, respectively. Means of each factor designated by the same latter are not significantly different at 5% level using Duncan's Multiple Range Test.

**Table (3): Biological yield(t ha$^{-1}$) and some grain yield attributes of rice as affected by cultivar, irrigation interval and growth stimulators in 2013 and 2014 seasons.**

| Factor | No. of Panicles/m$^2$ | No. of Filled grains/panicle | Unfilled grains (%) | 1000-grain weight (g) | Biological yield (t ha$^{-1}$) |
|---|---|---|---|---|---|
| | | | 2013 season | | |
| **Irrigation, day (I):** | | | | | |
| Continuous | 530.0 a | 122.0 a | 3.60 b | 25.19 a | 22.55 a |
| 6 | 508.0 a | 115.0 ab | 6.50 a | 24.34 b | 20.82 a |
| 9 | 438.0 b | 102.0 b | 8.10 a | 23.41 c | 17.03 b |
| F test | ** | * | ** | ** | ** |
| **Cultivar ( C ):** | | | | | |
| Sakha 101 | 491.0 a | 107.0 a | 6.00 a | 27.13 a | 19.59 b |
| Giza 178 | 493.0 a | 115.0 a | 6.20 a | 20.23 c | 21.16 a |
| Giza 179 | 492.0 a | 117.0 a | 6.00 a | 25.58 b | 19.65 b |
| F test | NS | NS | NS | ** | ** |
| **Stimulators (S):** | | | | | |
| Control | 469.0 b | 102.0 b | 7.70 a | 23.31 c | 19.27 b |
| Ascorbic acid | 509.0 a | 120.0 a | 4.30 c | 24.96 a | 21.01 a |
| Humic acid | 506.0 a | 121.0 a | 5.40 bc | 24.81 ab | 20.41 ab |
| Citric acid | 484.0 b | 110.0 b | 6.80 ab | 24.18 b | 19.82 ab |
| F test | ** | * | * | ** | ** |
| **Interaction :** | | | | | |
| I x C | NS | NS | * | ** | ** |
| I x S | ** | * | * | ** | ** |
| Cx S | ** | * | * | ** | * |
| I x C x S | ** | ** | * | ** | ** |
| | | | 2014 season | | |
| **Irrigation, day (I):** | | | | | |
| Continuous | 550.0 a | 108.0 a | 4.30 b | 26.35 a | 27.07 a |
| 6 | 519.0 b | 103.0 a | 5.20 ab | 25.42 ab | 24.09 ab |
| 9 | 453.0 c | 97.0 b | 6.90 a | 24.68 b | 21.49 b |
| F test | ** | * | ** | * | ** |
| **Cultivar ( C ):** | | | | | |
| Sakha 101 | 508.0 a | 99.0 a | 6.60 a | 28.30 a | 25.72 a |
| Giza 178 | 507.0 a | 109.0 a | 4.90 b | 21.45 c | 24.30 b |
| Giza 179 | 507.0 a | 100.0 a | 4.90 b | 26.69 b | 22.62 c |
| F test | NS | NS | ** | ** | * |
| **Stimulators (S):** | | | | | |
| Control | 487.0 c | 89.0 b | 7.00 a | 24.56 b | 22.32 b |
| Ascorbic acid | 525.0 a | 109.0 a | 4.90 b | 25.91 a | 25.77 a |
| Humic acid | 516.0 ab | 114.0 a | 4.80 b | 26.03 a | 24.91 a |
| Citric acid | 501.0 bc | 98.0 ab | 5.20 b | 25.42 a | 23.86 ab |
| F test | * | * | ** | ** | ** |
| **Interaction :** | | | | | |
| I x C | NS | Ns | * | ** | ** |
| I x S | ** | * | * | ** | ** |
| Cx S | ** | * | * | ** | ** |
| I x C x S | ** | * | * | ** | ** |

*, ** and NS indicate P< 0.05 , P< 0.01 and not significant, respectively. Means of each factor designated by the same latter are not significantly different at 5% level using Duncan's Multiple Range Test.

All studied yield attributes were significantly affected by irrigation interval in both seasons. Number of panicles $m^{-2}$, number of filled grains $panicle^{-1}$, 1000-grain weight and biological yield $ha^{-1}$ were increased by decreasing irrigation interval from every 9 days to continuous flooding (every 3 days) in the two seasons. The inverse was true in percentage of unfilled grains% in both seasons. No significant differences were found between continuous irrigation and irrigation every 6 days interval in the most these traits in both seasons. Such result indicates that with abundance of irrigation water, more tillers develop a panicle. The increase in yield attributes by irrigation continuously or every 6 days may be due to the improvement in plant growth such as dry weight $plant^{-1}$, LAI and tillers number, which reflected in turn increases in yield components such as number of panicles, number of filled grains, 1000-grain weight and biological yield $ha^{-1}$. These results are confirmed with those findings of Bozorgi *et al.* (2011) and El-Refaee *et al.* (2012).

No significant differences in number of panicles $m^{-2}$ and number of filled grains $panicle^{-1}$ was evidenced among the three rice cultivars in both seasons. However, rice cultivars exhibited significant difference in 1000-grain weight in the favour of Sakha101 cultivar compared with the other two cultivars in both seasons. The 1000-grain weight was lighter in Giza178 than in the other two cultivars. Giza178 and Giza179 cultivars, being insignificant, recorded the lowest values of unfilled grains percentage compared with Sakha101 in the second season, only. The relative ranking of the three cultivars for biological yield was inconsistent in both seasons. The highest biological yield $ha^{-1}$ was obtained from Giza178 in the first season and Sakha101 in the second season. Giza179 cultivar was among those having low biological yield $ha^{-1}$ in both seasons. These varietal differences could be mainly attributed to genetic variability among rice cultivars. Such varietal differences had been also reported by Bastawisi *et al.* (2003), Zayed *et al.* (2007) and El-Kallawy (2008).

Foliar application of growth stimulator compounds resulted in significant increase in number of panicles $m^{-2}$, number of filled grains $panicle^{-1}$, 1000-grain weight and biological yield $ha^{-1}$ compared with foliar application of water (control) in both seasons. Foliar spraying with solution of ascorbic or humic acids recorded the highest values of these yield attributes in both seasons. However, percentage of unfilled grains was significantly decreased by application of growth stimulators in the two seasons. The increase in yield attributes and biological yield with foliar application of growth stimulators was possibly due to promote the growth of rice (LAI, flag leaf area, dry matter accumulation and plant height). These results are confirmed with the findings of Taha (2008) and Gharib *et al.* (2011). In this connection, Rakshit *et al.* (2008) and Saha *et al.* (2013) stated that humic acid induced higher effective tillers $hill^{-1}$, number of filled grains, 1000-grain weight, and straw yield of rice.

All the first and second order interactions had a significant effect on all yield attributes and biological yield, except the interaction of irrigation interval × rice cultivar on number of panicles $m^{-2}$ and number of filled grains $panicle^{-1}$ in both seasons.

## III . Grain Yield

Means of grain yield $ha^{-1}$ of rice as affected by irrigation interval, cultivar and foliar application of growth Stimulators in 2013 and 2014 are presented in Table (4).

There was a substantial difference in grain yield (t $ha^{-1}$) among irrigation intervals in both seasons. Shorting irrigation interval from 9 to 3 days resulted in a significant progressive increase in grain yield. Irrigation every 6 or 3 days were statistically at par in grain yield in the two seasons. Thus, abundance water by irrigation every 6 or 3 days increased grain yield through increasing number of panicles $m^{-2}$, number of filled grains $panicle^{-1}$and 1000-grain weight. Similar conclusion was previously drawn by El-Refaee *et al.* (2012) and Bozorgi *et al.* (2011), who reported that grain yield and its attributes were significantly decreased as irrigation intervals increased up to nine days, with no significant differences between continuous flooding and irrigation every 6 days in grain yield.

The three cultivars did not differ in grain yield ha-1 in both seasons, this may be due to these cultivars are modern and high production capacity, including what belongs to the Japonica type(Sakha101), and what belongs to Japonica Indica type (Giza 178, Giza179) meaning that there is mated mixing between parents.

Plants foliar sprayed by growth stimulators significantly outyielded control plants in grain yield $ha^{-1}$ mostly in the two seasons. There were no significant differences among plants sprayed with ascorbic acid, humic acid and citric acid in grain yield $ha^{-1}$ in both seasons. The considerable increase in early growth, which reflected in higher grain yield attributes (number of panicle $hill^{-1}$, number of filled grains $panicle^{-1}$ and 1000-grain weight) and in turn increased grain yield. A positive association between foliar application of stimulator compounds and grain yield has been reported by Taha (2008) and Gharib *et al.* (2011). Similar results were obtained by Saha *et al.* ( 2013) and Rakshit *et al.* (2008), who stated that humic acid induced higher effective tillers $hill^{-1}$, number of filled grain,1000-grain weight, grain yield and straw yield as well as harvest index of rice plant significantly.

All the first and second order interactions had a significant effect on grain yield in the two seasons.

The interaction of irrigation interval × cultivar showed that the three cultivars did not differ in their grain yield at the same irrigation interval in both seasons. At the same cultivar, grain yield was significantly increased by shorting irrigation interval from 9 to 6 or 3 days compared with irrigation every 9 days in both seasons.

The interaction of irrigation interval × growth stimulators indicated that irrigation every 3 or 6 days, being insignificant between them but being significant increase in grain yield compared with irrigation every 9 days at any foliar spraying treatment in both seasons. The relative ranking of the interaction between irrigation interval and growth stimulators for grain yield was inconsistent in both seasons. Rice plants irrigated every 3 or 6 days and sprayed with the solution of ascorbic acid or humic acid were among those having high grain yield compared with those sprayed with water in both seasons. Application of ascorbic acid or humic acid was more effective on grain yield at irrigation every 6 and 9 days in both seasons.

The interaction of cultivar × growth stimulators induced that the three cultivars did not differ in their grain yield at the same foliar spraying treatment in both seasons. Foliar application of growth stimulators on plants of Sakha101 cultivar had no significant effect on grain yield in the two seasons. However, grain yield of Giza 178 and Giza179 was significantly increased by foliar spraying with ascorbic acid or humic acid compared with control in both seasons.

**Table (4): Grain yield (t ha$^{-1}$) of rice as affected by cultivar, irrigation interval and growth stimulators and their interactions in 2013 and 2014 seasons.**

| Irrigation (I) ,day | Cultivar (C) | Stimulators (S) Control | Ascorbic acid | Humic acid | Citric acid | Mean |
|---|---|---|---|---|---|---|
| | | **2013 season** | | | | |
| | | **I x S-mean** | | | **I-mean** | |
| Continuous | | 10.14 ab | 10.43 ab | 10.49 a | 10.32 ab | 10.35 A |
| 6 | | 9.50 c | 10.09 ab | 10.11 ab | 9.91 bc | 9.90 A |
| 9 | | 7.56 e | 8.25 d | 8.12 d | 7.99 de | 7.98 B |
| | | **C x S-mean** | | | **C-mean** | |
| | Sakha 101 | 9.01 bc | 9.47 abc | 9.4 abc | 9.29 abc | 9.29 A |
| | Giza 178 | 9.17 bc | 9.75 a | 9.70 a | 9.56 ab | 9.54 A |
| | Giza 179 | 9.01 c | 9.55 ab | 9.62 ab | 9.38 abc | 9.39 A |
| | | **I x C x S-mean** | | | **IxC-mean** | |
| Continuous | Sakha 101 | 10.27 a-e | 10.50 abc | 10.59 a | 10.47 abc | 10.46 A |
| | Giza 178 | 10.15 a-e | 10.55 ab | 10.49 abc | 10.33 a-e | 10.38 A |
| | Giza 179 | 10.00 c-g | 10.25 a-e | 10.39 a-d | 10.17 a-e | 10.20 A |
| 6 | Sakha 101 | 9.52 gh | 10.03 b-f | 9.94 d-g | 9.83 e-h | 9.83 A |
| | Giza 178 | 9.55 fgh | 10.22 a-e | 10.28 a-e | 10.03 c-f | 10.02 A |
| | Giza 179 | 9.42 h | 10.01 c-f | 10.10 a-e | 9.86 e-h | 9.85 A |
| 9 | Sakha 101 | 7.25 m | 7.87 jkl | 7.67 klm | 7.56 lm | 7.59 B |
| | Giza 178 | 7.81 kl | 8.48 i | 8.33 ij | 8.31 ij | 8.23 B |
| | Giza 179 | 7.61 lm | 8.39 i | 8.37 i | 8.11 ijk | 8.12 B |
| **Stimulator-mean** | | 9.06 B | 9.59 A | 9.57 A | 9.41 AB | |
| | | **2014 season** | | | | |
| | | **I x S-mean** | | | **I-mean** | |
| Continuous | | 10.64 cd | 11.40 ab | 11.46 a | 11.28 ab | 11.19 A |
| 6 | | 10.14 d | 11.07 abc | 11.14 abc | 10.88 bc | 10.81 A |
| 9 | | 7.44 f | 8.52 e | 8.42 e | 7.67 f | 8.012 B |
| | | **C x S-mean** | | | **C-mean** | |
| | Sakha 101 | 9.39 b | 10.11 ab | 9.97 ab | 9.82 ab | 9.82 A |
| | Giza 178 | 9.46 b | 10.51 a | 10.53 a | 10.01 ab | 10.13 A |
| | Giza 179 | 9.36 b | 10.37 a | 10.52 a | 10.00 ab | 10.06 A |
| | | **I x C x S-mean** | | | **IxC-mean** | |
| Continuous | Sakha 101 | 10.74 c-h | 11.51 a | 11.41 ab | 11.35 abc | 11.26 A |
| | Giza 178 | 10.64 d-i | 11.46 ab | 11.52 a | 11.24 a-d | 11.22 A |
| | Giza 179 | 10.52 f-i | 11.22 a-d | 11.43 ab | 11.26 a-d | 11.11 A |
| 6 | Sakha 101 | 10.03 i | 10.82 b-g | 10.96 a-f | 10.58 e-i | 10.60 A |
| | Giza 178 | 10.23 ghi | 11.30 abc | 11.26 a-d | 11.05 a-f | 10.96 A |
| | Giza 179 | 10.14 hi | 11.10 a-f | 11.20 a-e | 11.00 a-f | 10.86 A |
| 9 | Sakha 101 | 7.38 k | 7.99 k | 7.52 k | 7.54 k | 7.61 B |
| | Giza 178 | 7.51 k | 8.78 j | 8.81 j | 7.72 k | 8.21 B |
| | Giza 179 | 7.42 k | 8.80 j | 8.92 j | 7.74 k | 8.22 B |
| **Stimulator-mean** | | 9.40 B | 10.33 A | 10.34 A | 9.94 A | |

Means of each factor designated by the same latter are not significantly different at 5% level using Duncan's Multiple Range Test.

The second order interaction of irrigation interval × cultivar × growth stimulators cleared that grain yield of the rice cultivar Sakha101 was gradually decreased by prolonging irrigation interval from every 3 to 9 days at any foliar spraying treatment in the most cases. The combination of irrigation every 3 or 6 days × Giza 178 or Giza179 × foliar spraying with ascorbic acid or humic acid were among those treatments produced the highest grain yield in both seasons. The rice cultivar Sakha101 irrigated every 3 days and sprayed with these growth stimulators did not differ significantly than the mentioned interactions in grain yield in both seasons.

Finally, it can be concluded that irrigation every 6 days along with ascorbic acid or humic acid as foliar praying could be recommended for optimum grain yield of rice cvs Giza 178 or Giza179 under these conditions of this experiment at Kafr El-Sheikh Governorate. Also, it can be concluded that foliar application of ascorbic acid or humic acid could be recommended for optimum grain yield of rice cvs Giza 178 or Giza179 under water shortage conditions (irrigation every 9 days) at ends of irrigation canals in Kafr El-Sheikh Governorate.

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# استجابة ثلاثة أصناف من الأرز لاضافة بعض محفزات النمو تحت فترات رى مختلفة

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## الملخص العربى

أجريت تجربتان حقليتان في المزرعة البحثية بمركز البحوث والتدريب فى الارز (RRTC) ، سخا، كفر الشيخ، مصر، خلال موسمى٢٠١٣ و ٢٠١٤، لدراسة استجابة ثلاثة أصناف من الأرز المصري (سخا ١٠١، جيزة ١٧٨، جيزة ١٧٩) للرش بمحلول بعض المواد المحفزة للنمو (حامض الأسكوربيك، حامض الهيوميك ،حامض الستريك بالاضافة الى المياة) تحت ثلاث فترات ري (كل ٣ و ٦ و ٩ أيام). هذا وقد تم رش محلول حامض الأسكوربيك أوحامض الستريك بتركيز ٢ جرام / لتر. بينما تم رش حامض الهيوميك بتركيز٥ مل / لتر. وقد تم اجراء معاملات الرش مرتين الاولى عند ٣٥ والثانية عند ٤٥ يوما من الشتل . وقد تم تنفيذ التجربة فى تصميم القطع المنشقة مرتين حيث وزعت معاملات الرى فى القطع الرئيسية ، بينما وزعت اصناف الارز فى القطع الشقية ومعاملات الرش بالمواد المحفزة للنمو فى القطع تحت شقية. ويمكن ايجاز اهم النتائج المتحصل عليها فيما يلى:

١–أدى تقليل فترة الري من ٩الى٣ أو ٦ أيام إلى زيادة معنوية في قياسات النمو (دليل مساحة الورقة، الوزن الجاف م $^{-٢}$، مساحة ورقة العلم، عدد الاشطاء م $^{-٢}$، ارتفاع النبات) ومكونات المحصول (عدد الداليات م $^{-٢}$ ، عدد الحبوب الممتلئة للدالية) بالاضافة الى المحصول البيولوجى ومحصول الحبوب للهكتار. هذا وقد كان تأثير كل من الري باستمرار (كل ٣ أيام) والرى كل ٦ أيام متساويا إحصائيا في جميع قياسات النمو، مكونات المحصول ومحصول الحبوب للهكتار في كلا الموسمين .

٢–اظهرت النتائج انه لا توجد فروق معنوية بين أصناف الأرز الثلاثة المختبرة في دليل مساحة الاوراق، عدد الاشطاء م $^{-٢}$، عدد الداليات م $^{-٢}$، عدد الحبوب الممتلئة للدالية و محصول الحبوب للهكتار في كلا الموسمين وكذلك تراكم المادة الجافة في الموسم الثاني . هذا وقد تفوق الصنف جيزة ١٧٨ فى صفات مساحة ورقة العلم وارتفاع النبات في كلا الموسمين . بينما سجلت نباتات الصنف جيزة ١٧٩ اعلى قيم لتراكم المادة الجافة للنبات في الموسم الأول. فى حين تفوق الصنف سخا١٠١ فى صفة وزن ١٠٠٠ حبة مقارنة بالصنفين الاخرين.

٣–أدى الرش الورقى بالمركبات المحفزة للنمو الى زيادة معنوية في صفات دليل مساحة الاوراق، الوزن الجاف م $^{-٢}$، مساحة ورقة العلم ، طول النبات، عدد الداليات م $^{-٢}$، عدد الحبوب الممتلئة للدالية ، وزن ال ١٠٠٠

حبة، محصول الحبوب والمحصول البيولوجى مقارنة بالرش بالماء (الكنترول) في كلا الموسمين. وقد سجلت المعاملة بالرش الورقي لمحلول حامض الاسكوربيك أوحامض الهيوميك أعلى القيم فى هذه الصفات في كلا الموسمين. بينما انخفضت نسبة الحبوب الفارغة بشكل كبير باستخدام المركبات المحفزة للنمو في كلا الموسمين .

٤-كانت جميع تفاعلات الدرجة الأولى والثانية ذات تأثير معنوى على محصول الحبوب للهكتار في الموسمين . هذا ويمكن أن نستخلص من نتائج التفاعل أن ري نباتات الأرز كل ٦ أيام مع رشها بحامض الأسكوربيك أو حامض الهيوميك يمكن التوصية به لتحقيق اعلى محصول حبوب من صنفى الأرز جيزة ١٧٨ أو جيزة ١٧٩ تحت ظروف هذا البحث بمحافظة كفر الشيخ .

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