Journal of Plant Production

Journal homepage: www.jpp.mans.edu.eg
Available online at: www.jpp.journals.ekb.eg

Influence of Potassium Silicate on Water Deficit Tolerance for Some Rice Genotype

Hasnaa A. Ghazy*

Rice Research Department, Field Crops Research Institute, Agricultural Research Center, 33717 Sakha - Kafr El-Sheikh, Egypt.

Cross Mark

ABSTRACT

Field experiments were conducted during the 2019 and 2020 seasons at The Experimental Farm of Sakha Research Station, Kafr El-Sheikh, Egypt, to study the impact of different irrigation regimes, potassium silicate on growth, grain yield, and water productivity of some rice genotypes. The experiments were laid out in a strip-split plot design, with three replications. The vertical plots contained four irrigation regimes, i.e., irrigation every 4-day (I1), alternate 4-day on and 4- (I2),6- (I3), and 8- (I4) days off. However, the horizontal plots consisted of four potassium silicate rates, namely, 0, 1, 2, and 3 % potassium silicate. Meanwhile, the sub-sub plots consisted of three rice genotypes (Sakha 108, Giza 178, and Egy-Kor 27). The main results revealed the growth characteristics, grain yield, and its components were significantly decreased with increasing period from I1 up to I4. The potassium silicate at 3% followed by 2 % registered high values of the study traits. Giza 178 had the highest values of the study traits except for panicle length, panicle weight, and 1000-grain weight which recorded the highest value with Sakha 108. Irrigation every 4-day consumed the highest amount of irrigation water while the lowest amount was received by I4. The treatment I3 irrigation recorded the highest water productivity as compared to other treatments. Generally, under the same conditions, it is possible to cultivate Giza 178 rice cultivar and alternate irrigation as 4-day on + 4-day off with spray 2 % of potassium silicate for highest grain yield and acceptable water productivity.

Keywords: Rice, alternate wet/dry, potassium silicate, grain yield and water productivity.

INTRODUCTION

Rice (*Oryza sativa* **L.**) is a major staple food for much of the world's population. World food security remains largely dependent on irrigated lowland rice, which is the main source of rice supply (Khan *et al*., 2006). Freshwater for irrigation is becoming scarce because of population growth and increasing urban and industrial development. Nowadays, rice production was compromised as many areas of the world are affected by water scarcity in the agriculture sector, which affects food security. The competition with other water usages will limit the water available for irrigated agriculture (Mancosu *et al*., 2015)

Rice as a semi-aquatic plant consumes plenty of water. Thus, it is necessary to adopt agricultural policies that use less water than the main pathway for enhancing the water use efficiency in irrigation by concentrating on engineering and agronomic management. These approaches for using less water as suggested by (Abuzeed *et al*., 2018) include irrigation intervals, alternate wetting and drying, systems such as sprinkler and drip irrigation systems, covering soil surface and agronomic practices as tillage, drought-tolerant varieties, and spraying anti-stress and anti-transpirant (Abu El-Azm and Youssef, 2015). The alternate wet/dry irrigation (AWDI) method of cultivating rice implies that rice fields are not kept continuously submerged but are intermittently dried during the rice-growing stage (Kumar and Rajitha, 2019)

All plants contain silicate (Si) at different concentrations according to species, ranging from 0.1 to 10% in dry weight (El-Sheery, 2017). Most Si compounds in the soil consist of silicon dioxide, silicate minerals, and aluminum silicates, none of which are available for plant uptake. Some researchers believe that plant roots generally take up silicon in the form of soluble silicic acid Si (OH) 4. Also, SiO_2 can be absorbed directly by plants (Mitani and Ma., 2005). After uptake in the xylem is deposited in any part of the plant, within or between cells or as part of the cell wall in the case of the leaf epidermis (Laane, 2018).

Importantly, silicon exerts many beneficial effects on plants (Deshmukh *et al*., 2017): (a) structural strength; (b) an active role in many physiological processes e.g., a regulatory role in the uptake of other plant nutrients; (c) a role in growth and development, especially when plants are exposed to abiotic stresses (drought, salinity, acidity, etc.) and biotic stresses because Si increases plant resistance by stimulating defense reaction mechanisms decreasing damage from insects and diseases (Siddiqui *et al*.,2018).

The rationale for the use of foliar sprays with silicon compounds is the assumption that foliar Si feeding could compensate for low uptake by the roots in the case of low availability of absorbable silicon in the soil, and the relatively complicated absorption process of Si by the roots, resulting in enhanced silicon uptake with beneficial effects. Also, silicon influences water relations and improves photosynthesis and improve water status in leaf under drought stress (Coskun *et al*., 2016). The role of potassium silicate in improving growth characteristics have been

*** Corresponding author.**
E-mail address: hasnaa.rrtc@gmail.com

DOI: 10.21608/jpp.2021.100753.1068

observed and produces more grain yield especially rice crop (Ahmad *et al*., 2013).

Therefore, the study aimed to explore the effect of different irrigation regimes and various rates of potassium silicate on grain yield characteristics associated with optimum grain yield and water-saving irrigation of some rice genotypes.

MATERIALS AND METHODS

The experiment was conducted at The Experimental Farm of Sakha Research Station, Agricultural Research Center, Kafr El-Sheikh, Egypt during the 2019 and 2020 seasons. The current study examined the effect of different irrigation regimes, potassium silicate at different concentrations on some rice genotypes. The average meteorological data (from May to September) of the experimental sites were 33.0 and 31.9 °C for maximum temperature, 16.5 and 23.8 °C for minimum temperature. 82.4 and 81.2 % for relative humidity, 6.5 and 6.3 mm/day for pan evaporation in the 2019 and 2020 seasons, respectively. All experiments were preceded by a barley crop (Hordeum vulgare.). The results of mechanical and chemical soil properties are presented in Table 1.

Table 1. Mechanical and chemical analysis of the experiments soil in both seasons.

Soil analysis		2019	2020
Soil texture (%)		clayey	clayey
pH		8.05	8.20
EC (dSm^{-1})		2.00	2.05
Organic matter %		1.65	1.70
Available NH_4	mg kg^{-1}	14.50	15.60
Available NO_3	mg kg^{-1}	12.00	13.80
Available P	mg kg^{-1}	13.00	14.00
Available K	mg kg^{-1}	280	270
Available Zn	mg kg^{-1}	1.15	1.16

Experimental design and land preparation

The experiment was laid out in a strip-split plot design, with three replications. The vertical plots were devoted to four irrigation regimes i.e.

I1- Irrigation every 4-day.

I2- Alternate 4-day on + 4-day off,

I3- Alternate 4-day on + 6-day off, and

I4- Alternate 4-day on + 8-day off, with 5-7 cm water head at the time of water addition. However, the horizontal plots were occupied by four spray rates of potassium silicate (0 without potassium silicate, 1, 2, and 3% of potassium silicate). The potassium silicate was applied after 20 and 40 days from transplanting. However, the sub-sub plots consisted of three rice genotypes (Sakha 108, Giza 178, and Egy-Kor 27).

Table 2. Origin, type, and duration of the studied rice genotypes.

Genotype	Original	Type	Duration (days)
Sakha 108	Egypt	Japonica	135
Giza 178	Egypt	Indica/japonica	135
Egy-Kor 27	Korea	Indica/japonica	138

The experimental sites and the nursery were well ploughed and leveled. The experiments were sown on the 7th of May in the two seasons of study. Seeds of rice cultivars, at the rate of 120 kg/ha each, were soaked in sufficient water for 24 hours and incubated for another 48 hours to enhance their germination.

Nitrogen, phosphorus, and zinc were added to nursery as recommended. Seedlings were carefully pulled from the nursery after 30 days from sowing and distributed through the plots. The sub-sub-plot size was 25 m^2 (5× 5 m).

Seedlings were manually transplanted in 20 x 20 cm spacing between hills and rows, at the rate of 4-5 seedlings/hill. The other usual agricultural practices of growing rice were performed as the recommendation of the Rice Research and Training Center.

To avoid lateral irrigation water movement and more water control, each main plot was separated by two-meter-wide ditches. A water pump, provided with a calibrated water meter was used for all water measurements. Water productivity (WP) was calculated as the weight of grains per unit of water used (kg grains/m^3 water).

At the booting stage, plants of three hills were randomly taken from each sub-sub-plot to estimate dry matter production and leaf area. Leaf area index of plant samples was measured by Portable Area Meter (Model LI–3000A), then leaf area index (LAI) was estimated.

At harvest, plant height was estimated and the total numbers of panicles of ten random hills were counted. Ten random panicles were collected from each plot to estimate panicle length, number of filled grains/panicle, number of unfilled grains/panicle, panicle weight, and 1000-grain weight. Grain and straw yields were randomly measured from an area of 6 m2 (2 x 3 m) and grain yield was adjusted to 14 % moisture content, and then the yield of the 6 m2 was computed and transferred to tons per hectare.

For milling quality, 150 grams of grains were taken from each treatment to determine some of the grain milling recovery (hulling, milling, and head rice percentage) according to the methods described by Juliano (1971).

Determination of silica (mg/g): The protocol for the measurement of silica content was conducted according to the method described by Dai *et al* ., (2005).

Statistical Analysis

Data collected were statistically analyzed using the analysis of variance technique according to Gomez and Gomez (1984). Duncan's Multiple Range Test was used to compare the treatment means (Duncan 1955). All statistical analyses were accomplished using analysis of variance technique using "COSTAT" statistical software package.

RESULTS AND DISCUSSION

A-Growth characteristics:

The result in Table 3 shows that leaf area index (LAI), dry matter (DM) at the booting stage as well as plant height at harvest were significantly influenced by irrigation regimes in both seasons. The data showed that the highest values were recorded at I1 without any significant differences with those produced by I2 treatment in both seasons. However, the lowest values were observed at I4. The reduction in LAI and DM and plant height. might be attributed to the reduction in the number of the tiller, total leaf area, death of the lower leaves, and plant growth, in general, affected by lack of water. However, the increased plant height might be attributed to the significant effect of water in encouraging cell division and elongation. Also, it might be due to favorable root growth and higher mobility of nitrogen in soil solution and its absorption by plant roots, resulting in higher vegetative growth and total dry matter increased with increasing water supply. These results are in agree with those obtained by Hameed *et al*. (2019), Hossain *et al*. (2020) and Kobua *et al*. (2021).

Potassium silicate recorded the highest values of LAI, DM, and plant height at a potassium silicate rate of 3%, without any significant difference between potassium silicate rates of 2% in both seasons (Table 3). The increase in silica levels led to the plants being more erect and reduced the self-shading of lower leaves of the canopy, which made the plants more photosynthetic efficient and better able to exploit the space available to intercept solar radiation, consequently increasing leaf area index, dry matter, and plant height. A similar result was found by Zanão Júnior *et al.* (2010), De Oliveira *et al.* (2016), Wissa. (2017) and Mikhael *et al.* (2018).

Table 3. Leaf area index (LAI) and dry matter at the booting stage as well as plant height at harvest of some rice genotype as affected by irrigation regimes and rate of potassium silicate in 2019 and 2020 seasons.

Treatment	LAI		Dry matter (g/m^2)		Plant height (cm)	
	2019	2020	2019	2020	2019	2020
Irrigation regimes (I):						
I1	4.51a	4.71a	1129.7a	1145.0a	96.55a	100.05a
I2	4.33a	4.53a	1123.4a	1138.7a	90.69b	98.98a
I3	4.04b	4.14b	1088.3b	1098.3b	87.69c	90.43b
I4	2.97c	3.06c	879.8c	890.5c	84.05d	86.09c
F. test	**	**	**	**	**	**
Potassium silicate (%) (K):						
0	3.06c	3.20c	1032.9d	1045.8d	86.77d	90.89d
1	3.81b	3.96b	1045.1c	1058.0c	88.85c	93.02c
2	4.46a	4.61a	1062.4b	1075.2b	90.91b	95.08b
3	4.52a	4.67a	1080.7a	1093.5a	92.43a	96.55a
F. test	**	**	**	**	**	**
Rice genotype (G):						
Sakha108	4.10b	4.25b	1057.8b	1070.7b	89.56b	93.76b
Giza 178	4.37a	4.52a	1067.4a	1080.2a	93.51a	97.62a
Egy-Kor 27	3.41c	3.56c	1040.6c	1053.5c	86.16c	90.27c
F. test	**	**	**	**	**	**
Interactions:						
I X K	NS	*	NS	**	NS	NS
I X G	NS	NS	**	**	NS	NS
K X G	NS	NS	NS	NS	**	**
I X K X G	NS	NS	NS	NS	NS	NS

Irrigation every 4-day (I1), alternate 4-day on and 4- (I2), 6- (I3) and 8- (I4) day off. * = Significant at 0.05 level, ** = Significant at 0.01 level and NS= Not significant.

The cultivar Giza 178 was superior to Sakha108 and Egy-Kor 27 in leaf area index, dry matter production, and plant height in both seasons (Table 3). On the contrary, the rice genotype Egy-Kor 27 recorded the lowest values of study traits. This might be due to the different genetic backgrounds of rice genotypes. Similar results were also reported by Patil *et al*. (2017), Mikhael *et al*. (2018) and Gaballah *et al*. (2021).

The interaction between irrigation regimes and potassium silicate rates significantly produced the highest LAI and DM production in the second season only (Table 4). The combination of irrigation every 4-day(I1) and alternate 4-day on + 4-day off (I2), with spraying potassium silicate rates of 3 and 2% gave the highest LAI and DM. However, the lowest value was produced in alternate 4-day on + 8-day off (I4) with 0 (without potassium silicate) treatment in the 2020 seasons (Table 4). These results support the findings of Patil *et al*. (2017) and Mikhael *et al*. (2018).

Table 4. Leaf area index and dry matter production as affected by the interaction between irrigation regimes and potassium silicate in 2020 season.

Potassium silicate (%)(K)	LAI				Dry matter (g/m^2)			
	Irrigation regimes(I)							
	I1	I2	I3	I4	I1	I2	I3	I4
0	3.56cd	3.40d	3.24d	2.61e	1117.4h	1111.1i	1070.6l	883.8p
1	4.37bc	4.28bc	4.06c	2.13e	1132.8e	1126.5g	1086.1k	886.4o
2	5.41a	5.19ab	4.56bc	3.27d	1153.6c	1147.3d	1106.9j	893.0n
3	5.52a	5.25a	4.70b	3.23d	1176.2a	1169.9b	1129.5f	898.4m

Irrigation every 4-day (I1), alternate 4-day on and 4- (I2), 6- (I3) and 8- (I4) day off.

The interaction between irrigation regimes and rice genotype was significant concerning dry matter production in both seasons (Table 5). The combination of irrigation every 4-day with Giza 178 produced the highest dry matter production (1143.1 and 1158.5 g/m^2). However, the lowest value (871.7 and 882.3 g/m^2) was produced in I4 with the Egy-Kor 27 in both seasons, respectively.

Table 5. Dry matter production at booting and plant height at harvest of some rice genotype as affected by the interaction between the study factors.

Genotype(G)		2019				2020			
		Irrigation regimes(I)							
		I1	I2	I3	I4	I1	I2	I3	I4
Dry matter (g/m^2)	Sakha 108	1133.0c	1126.8d	1091.6h	879.8k	1148.4c	1142.1d	1101.6h	890.5k
	Giza178	1143.1a	1136.8b	1101.7g	887.7j	1158.5a	1152.2b	1111.7g	898.4j
	Egy-Kor 27	1112.8e	1106.5f	1071.4i	871.7l	1128.1e	1121.8f	1081.4i	882.3l
		Potassium silicate rates (%)(K)							
		0	1	2	3	0	1	2	3
Plant height (cm)	Sakha 108	86.4efg	87.3ef	91.3c	93.3b	90.5ef	91.e	95.5c	97.4b
	Giza178	89.4d	93.9ab	95.1ab	95.6a	93.6d	98.1ab	99.2ab	99.7a
	Egy-Kor 27	84.5g	85.4fg	86.4efg	88.4de	88.6f	89.5f	90.5ef	92.5de

Irrigation every 4-day (I1), alternate 4-day on and 4- (I2), 6- (I3) and 8- (I4) day off.

The interaction between potassium silicate rates and rice genotype was significant concerning plant height in both seasons (Table5). It was clear from the results obtained that the shortest plants were recorded by the rice genotype Egy-Kor 27 with the 0 (without potassium silicate) treatment. However, the tallest plants were obtained by potassium silicate rates of 3% followed by 2% without any significant differences with the cultivar Giza 178 for these traits in the 2019 and 2020 seasons.

B- Grain yield and its attributes:

Grain yield and its attributes (number of panicles /hill, panicle length, number of filled grains/ panicles, number of unfilled grains/ panicles, panicle weight, 1000-grain weight, grain and straw yield) were significantly affected by irrigation regimes (Table 6). The highest grain yield and most of its attributes were recorded with irrigation every 4-day (I1) which was on a par with (I2). On the other hand, the number of unfilled grains/ panicles increased with alternate 4-day on + 8-day off (I4). Water stress reduced the number of plants within the unit area due to the death of tillers as drought stress decreases the number of panicles. Under well-watering treatment and the availability of nutrients led to an increase in the number of tillers bearing panicles and the number of filled grains/panicle. These findings agree with those obtained by El-Refaee, (2012), Alhassan *et al*. (2016), Graham-Acquaah *et al*. (2019) and Gaballah *et al*. (2021).

The highest values of grain yield were recorded by irrigation every 4-day (10.96 and 11.58 t/ha), without any significant differences with alternate 4-day on + 4-day off (10.74 and 11.36 t/ha). However, the lowest values (7.16 and 7.99 t/ha) were obtained by alternate 4-day on + 8-day off. The increase of grain yield, with continuous flooding, could be attributed to increased grain yield attributes. Usually, water deficit shortens the grain-filling period and can result in a reduction in grain weight. Similar results were reported by Pandey *et al*. (2014). Also, such results might be interpreted by the increase in soil moisture content during the vegetative growth of rice plants, which affected the activity of cell division and elongation, and improved physiological processes inside the plant such as photosynthesis, enzyme activity, transportation of the dry matter content to panicles. As high grain yield resulted in more grain filling and weight panicles according to Li *et al*. (2017) and Hossain *et al*. (2020).

Data associated with number of panicles /hill, panicle length, number of filled grains/ panicles, number of unfilled grains/ panicles, panicle weight, 1000-grain weight, grain and straw yields were influenced by potassium silicate in the two studied seasons (Table 6). The potassium silicate rate of 3% gave the highest values, and it was on a par with the potassium silicate rate of 2% on grain yield and all other traits, in the two seasons. Except for the number of unfilled grains/ panicles, this produced the highest value under 0 (without potassium silicate) treatment. The potassium silicate rate of 3% recorded the highest grain yield (10.20 and 10.94 t/ha) followed by 2% (9.93 and 10.67 t/ha) without any significant difference between each in both seasons, receptivity. The increase in thousand grains weight with the application of silicon might be coupled with enhanced photosynthetic activity and efficient translocation of photosynthetic. That resulted in better assimilation of carbohydrates and a greater number of filled grains leads to an increase in thousand grains weight. This might be due to high nutrient status and moisture-holding capacity, which is the prime requirement of paddy. The favorable impact of potassium silicate as the foliar application might be attributed to increasing leaf water potential. These results corroborate those obtained by Jawahar and Vaiyapuri, (2010). The erectness exposed the plant to sunlight and enhanced the photosynthetic activity and assimilation of constituents. The application of silicon to rice enhanced the sturdiness in the plant and helped grow erect without lodging. This assimilation promotes the growth and development of the crop and reduces the incidence of pests and disease. The crop's vigorous growth might be the reason for increasing the grain yield. These results corroborate those obtained by Patil *et al*. (2017). The highest straw yield was mainly associated with increased plant height and the number of tillers per hill. The accumulation of silicon in plant parts reduced their lodging and enhanced resistance against biotic and abiotic stress. All these factors ultimately might have resulted in higher straw yield. These results conform to the findings of Aarekar *et al*. (2014) and Patil *et al*. (2017).

Rice genotype significantly varied in grain yield and its attributes in both seasons (Table 6). The Sakha 108 significantly registered the maximum values of panicle length, panicle weight, and 1000-grain weight. Meanwhile, rice genotype Egy-Kor 27 recorded that the highest values of number of unfilled grains/ panicles. However, rice genotype Giza 178 produced the highest value of the number of panicles /hill, the number of filled grains/ panicles, grain yield, and straw yield in both seasons. On contrary, the lowest grain yield was produced by rice genotype Egy-Kor 27. The results might be related to genetic factors which resulted from genetic makeup relations for the studied rice varieties. The results are in accordance agrees with the findings of El-Habet, (2021).

Table 6. Number of panicles /hill, panicle length, number of filled grains/ panicles and number of unfilled grains/ panicles of some rice genotype as affected by foliar application of potassium silicate and irrigation regimes in both seasons.

Treatment	No. of panicles /hill		Panicle length (cm)		Number of filled grains/ panicles		Number of unfilled grains/ panicles		Panicle weight (g)		1000-grain weight (g)		Grain yield (t/ha)		Straw yield (t/ha)	
	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
Irrigation regimes (I):																
I1	19.3a	22.3a	21.2a	23.1a	137.8a	138.8a	5.06d	7.39c	3.40a	3.89a	26.96a	27.58a	10.96a	11.58a	12.45a	12.86a
I2	18.4a	21.4a	20.7a	22.6a	134.7a	137.0a	6.95c	7.53c	3.20a	3.69a	26.74a	27.36a	10.74a	11.36a	12.15a	12.54b
I3	16.2b	17.7b	18.6b	19.5b	123.2b	127.6b	10.99b	12.54b	2.59b	3.01b	25.56b	26.32b	9.56b	10.32b	11.44b	11.85c
I4	14.3c	15.8c	17.4c	18.0c	113.6c	118.9c	18.30a	19.68a	2.04c	2.30c	23.16c	23.99c	7.16c	7.99c	9.16c	9.76d
F. test	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
Potassium silicate (%) (K)																
0	14.7d	17.0d	17.2c	18.5c	117.8c	122.5c	10.95a	12.47a	2.28d	2.70d	24.82c	25.48c	8.82c	9.48c	10.54c	1099c
1	16.6c	18.9c	19.3b	20.6b	125.0b	129.0b	10.31b	11.87b	2.67c	3.08c	25.48b	26.16b	9.48b	10.16b	11.21b	11.65b
2	17.8b	20.1b	20.4a	21.7a	131.3ab	133.3ab	10.08c	11.52c	3.02b	3.43b	25.93a	26.67a	9.93a	10.67a	11.60ab	12.06ab
3	19.0a	21.3a	21.0a	22.3a	135.2a	137.3a	9.94d	11.27d	3.27a	3.68a	26.18a	26.94a	10.20a	10.94a	11.86a	12.31a
F. test	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
Rice genotype (G):																
Sakha108	17.0b	19.3b	20.5a	21.8a	128.3b	131.3b	10.74b	12.18b	3.31a	3.73a	26.24a	27.03a	9.56b	10.21b	11.26b	11.72b
Giza 178	18.6a	20.8a	19.5b	20.8b	140.3a	143.5a	8.92c	10.36c	2.79b	3.21b	25.56b	26.25b	10.24a	11.07a	11.91a	12.37a
Egy-Kor 27	15.5c	17.8c	18.5c	19.8c	113.4c	116.6c	11.31a	12.81a	2.32c	2.73c	25.00c	25.66c	9.02c	9.66c	10.73c	11.17c
F. test	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
Interactions:																
IX K	NS	NS	NS	NS	*	*	NS	NS	*	NS	NS	NS	*	*	*	*
IX G	NS	NS	NS	NS	*	NS	NS	NS	NS	NS	NS	**	**	**	**	**
K X G	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
I X K X G	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Irrigation every 4-day (I1), alternate 4-day on and 4- (I2), 6- (I3) and 8- (I4) day off. * = Significant at 0.05 level, ** = Significant at 0.01 level and NS= Not significant.

The interaction between irrigation regimes and potassium silicate was significant for the number of filled grains/ panicles in both seasons (Table 7). The combination of irrigation every 4-day with potassium silicate rate 3% recorded the highest number of filled grains/ panicles, followed by potassium silicate rate of 2% under the same irrigation treatment. On the other hand, the lowest value (101.7 and 110.4) was produced in alternate 4-day on + 8-day off (I4) with 0 (without potassium silicate) treatment in both seasons, respectively. The interaction between irrigation regimes and rice genotypes was significant concerning the number of filled grains/ panicle in the 2019 season (Table 7). The highest number of filled grains/ panicle (152.3) was produced by the combination of Giza 178 under I1 and I2 treatment. While, the lowest value (105.7) was produced by Egy-Kor 27 and I4 treatment in 2019 season.

The interaction between irrigation regimes and potassium silicate was significant for panicle weight in the 2019 season (Table 7). The combination of irrigation every 4-day and potassium silicate rate of 3% produced the highest panicle weight (3.87 g), without any significant difference with I2. However, the lowest value (1.50 g) was produced in I4 under 0 (without potassium silicate) treatment.

The interaction between irrigation regimes and rice genotypes was significant for 1000-grain weight in the 2019 and 2020 seasons (Table 7). Sakha 108 produced the highest 1000-grain weight (27.39 and 28.24) under irrigation every 4-day, without any significant difference with I2. Meanwhile, the lowest value (22.76 and 23.59) was produced in I4 and Egy-Kor 27 in both seasons.

The interaction between irrigation regimes and potassium silicate was significant for grain yield in both seasons (Table 7). The highest grain yield value was obtained by potassium silicate rate 3 and 2% under I1 treatment followed by I2 irrigation treatment, without any significant difference between each other. However, the lowest value was produced by I4 and 0 (without potassium silicate) treatment in both seasons. The interaction between irrigation regimes and rice genotypes was significant for grain yield in both seasons. The highest grain yield was obtained by Giza 178 followed by Sakha108 under I1 and I2 treatment. While the lowest value was produced by Egy-Kor 27 and in I4 treatment in both seasons.

The interaction between irrigation regimes and potassium silicate was significant for straw yield in both seasons (Table 7). The highest straw yield values were obtained by I1 followed I2 treatment (with no significant difference between each other) with potassium silicate rate of 3 and 2% insignificant difference between. However, the lowest value was produced by 0 (without potassium silicate) treatment and I4 treatment, in both seasons. The interaction between irrigation regimes and rice genotypes was significant for straw yield in both seasons. The highest straw yield values were obtained by Giza 178 followed by Sakha108 under irrigation of I1 or I2 treatment. However, the lowest value was produced by Egy-Kor 27 under I4 in both seasons.

Table 7. Grain yield and some of its attributes as affected by the interaction between the study factors

Trait	Treatment	2019				2020			
		Irrigation regimes							
		I1	**I2**	**I3**	**I4**	**I1**	**I2**	**I3**	**I4**
Number of filled grains/ panicles	Potassium silicate (%)(K)								
	0	130.1b	128.1bc	111.0d	101.7e	131.1c	130.3c	117.9e	110.4f
	1	136.4ab	133.0b	119.8c	110.8d	137.3b	135.2bc	126.9cd	116.4e
	2	140.4ab	136.2ab	128.8bc	119.7c	141.3ab	138.4b	130.4c	123.0d
	3	144.0a	141.5a	133.2b	122.0c	145.0a	143.7a	134.8bc	125.4d
	Rice genotype(G)	2019							
		I1	I2	I3	I4				
	Sakha108	140.6b	137.6b	122.5c	112.4d				
	Giza 178	152.3a	148.9a	137.2b	122.5c				
	Egy-Kor 27	120.3cd	117.6cd	109.8d	105.7d				
Panicle weight (g)	Potassium silicate (%)(K)								
	0	2.88cd	2.53de	2.21e	1.50g				
	1	3.26bc	3.07c	2.44de	1.90f				
	2	3.60ab	3.48b	2.72d	2.28e				
	3	3.87a	3.72ab	2.99cd	2.49de				
1000-grain weight (g)	Rice genotype(G)	2019				2020			
	Sakha108	27.39a	27.17ab	26.50cd	23.87g	28.24a	27.84ab	27.35bc	24.70g
	Giza 178	27.04ab	26.85bc	25.50e	22.86h	27.55b	27.52b	26.23e	23.69h
	Egy-Kor 27	26.40cd	26.20d	24.66f	22.76h	26.96cd	26.71d	25.39f	23.59h
Grain yield (t/ha)	Potassium silicate (%)(K)								
	0	10.42bc	10.07c	8.61e	6.16g	10.99cd	10.68d	9.37f	6.89i
	1	10.80b	10.61bc	9.27d	7.23f	11.42bc	11.23c	10.03e	7.96h
	2	11.14ab	11.02ab	10.05c	7.52f	11.78ab	11.64b	10.83d	8.45g
	3	11.47a	11.26a	10.30c	7.75f	12.14a	11.88ab	11.07c	8.68g
	Rice genotype (G)								
	Sakha108	11.04ab	10.85bc	9.50e	6.86h	11.55b	11.36bc	10.23e	7.69h
	Giza 178	11.39a	11.17ab	10.52cd	7.87g	12.24a	12.01a	11.35c	8.70g
	Egy-Kor 27	10.45cd	10.20d	8.66f	6.76h	10.96cd	10.71d	9.39f	7.59h
Straw yield (t/ha)	Potassium silicate (%)(K)								
	0	11.92bc	11.47c	10.61d	8.16f	12.32bc	11.87c	11.01e	8.76g
	1	12.30b	12.05bc	11.27c	9.23e	12.70bc	12.41bc	11.67d	9.83f
	2	12.64ab	12.42ab	11.85bc	9.52e	13.04ab	12.25c	12.25c	10.12f
	3	12.97a	12.66ab	12.06bc	9.75e	13.37a	12.46bc	12.46bc	10.35f
	Rice genotype (G)								
	Sakha108	12.54ab	12.25bc	11.41d	8.86f	12.94ab	12.65a-c	11.81c	9.46e
	Giza 178	12.86a	12.57ab	12.35b	9.87e	13.29a	12.97ab	12.75a-c	10.47d
	Egy-Kor 27	11.95c	11.64cd	10.58f	8.76f	12.35a-c	12.00bc	10.98d	9.36e

Irrigation every 4-day (I1), alternate 4-day on and 4- (I2), 6- (I3) and 8- (I4) day off.

C- Grain quality

Milling characteristics:

Results in Table 8 showed that the effect of irrigation regimes on milling characteristics was significant in both seasons. Increasing intervals from irrigation every 4-day to alternate 4-day on + 8-day off treatment significantly decreases milling characteristics. The highest values of hulling, milling, and head rice percentage values were obtained by I1 and I2 without any significant differences in both seasons. The milling recovery was reduced by increasing water deficit. The same result was found by Gewaily *et al.* (2019). Usually, water deficit shortens the grain-filling period and can result in a reduction in grain weight.

Grain filling pattern had a marked influence on final grain quality, this reduction causes an increase in bran production and decreases head rice (%) according to Pandey *et al.* (2014). The results presented in Table 8 of milling characters, for the four rates of potassium silicate, was significantly varied in both seasons. The highest hulling, milling and head rice percentage values were obtained by the potassium silicate rate of 3% in both seasons. However, the lowest values of all traits were recorded that the 0 (without silicate) treatment in the two seasons. Similarly Ahmad *et al.* (2013) reported that silicon is not directly evolved in quality enhancement but it controls diseases and stresses to maximize the quality.

Rice genotype shows a significant difference in milling characters in both seasons (Table 8). Rice genotype Sakha 108 produced the highest value of all traits followed by Giza 178. Meanwhile, the lowest values of hulling, milling, and head rice percentage were obtained by rice genotype Egy-Kor 27 in both seasons. The results support the findings of Gaballah *et al.* (2021).

The interactions between irrigation regimes and rice genotype on hulling were significant in the 2019 and 2020 seasons (Table 9). The highest hulling values were obtained by irrigation every 4-day (I1) treatment with Sakha108 followed by Giza 178. But the lowest value was produced in alternate 4-day on + 8-day off (I4) with Egy-Kor 27 in both seasons.

Table 8. Hulling, milling and head rice of some rice genotype as affected by foliar application of potassium silicate and irrigation regimes in 2019 and 2020 seasons.

Treatment	Hulling		Milling		Head rice(%)	
	2019	2020	2019	2020	2019	2020
Irrigation regimes (I)						
I1	79.33a	79.97a	74.28a	74.74a	61.13a	62.02a
I2	78.38a	79.02a	73.71a	74.17a	60.34a	61.23a
I3	76.15b	76.75b	70.66b	71.06b	58.03b	58.92b
I4	72.25c	72.81c	68.05c	68.41c	53.99c	54.88c
F. test	**	**	**	**	**	**
Potassium silicate (%) (K)						
0	74.24d	74.85d	70.57c	70.99c	56.01	56.90d
1	76.09c	76.70c	71.40b	71.82b	57.94c	58.83c
2	77.30b	77.91b	72.09ab	72.51ab	59.13b	60.02b
3	78.47a	79.08a	72.66a	73.08a	60.42a	61.31a
F. test	**	**	**	**	**	**
Rice genotype (G)						
Sakha108	78.0a	78.66a	72.70a	73.12a	60.32a	61.21a
Giza 178	76.52b	77.13b	71.91b	72.33b	58.16b	59.05b
Egy-Kor 27	75.01c	75.62c	70.42c	70.84c	56.65c	57.54c
F. test	**	**	**	**	**	**
Interactions:						
IX K	NS	NS	NS	NS	NS	NS
I X G	*	*	NS	NS	NS	NS
K X G	NS	NS	NS	NS	NS	NS
I X K X G	NS	NS	NS	NS	NS	NS

Irrigation every 4-day (I1), alternate 4-day on and 4- (I2), 6- (I3) and 8- (I4) day off. * = Significant at 0.05 level, ** = Significant at 0.01 level and NS= Not significant.

Table 9. Hulling percentage of rice genotypes as affected by the interaction between the study factors

Treatment	Hulling (%)							
	2019				2020			
	I1	I2	I3	I4	I1	I2	I3	I4
Sakha108	81.04a	80.3ab	77.73c	73.08f	81.68a	80.99ab	78.33c	73.64f
Giza 178	79.20b	78.09c	76.02d	72.44f	80.16b	78.73c	76.62d	73.00f
Egy-Kor 27	77.44cd	7.9cd	74.69e	71.22g	78.08cd	77.33cd	75.29e	71.78g

Irrigation every 4-day (I1), alternate 4-day on and 4- (I2), 6- (I3) and 8- (I4) day off.

Table 10 shows the data related to silica content in leaf and husk in rice genotypes as influenced by the different rates of potassium silicate and irrigation regimes. Irrigation treatment on silica content in leaf and husk was increased significantly by increasing interval from irrigation every 4-day to alternate 4-day on + 8-day off treatment in both seasons. The highest values of silica content values were obtained by irrigation I4 and I3 without any significant differences in both seasons. The irrigation every 4-day treatment gave the lowest values of silica content in both seasons. On the other hand, determination data revealed that the four rates of potassium silicate were significantly varied in their silica content (mg/g) in both seasons.

Regarding silicon content (mg/g), the highest value of potassium silicate rate was 3% followed by potassium silicate rate 2% in both studied season (Table10). There was a high silica content in the straw than in husk which could be attributed to the accumulation of silica in the cell wall of culms and leaves. This strengthens the rice internodes, minimizing the lodging and the angle between the leaves and culms. Thus, the erectness of the leaves allows light to penetrate most of the rice leaves for better photosynthesis. As a result, photosynthesis and other biological process improve plant growth and yield (Patil *et al*. 2017 and Mikhael *et al*. 2018).

Table 10. Silicon content in leaf and husk (mg/g) of some rice genotype as affected by foliar application of potassium silicate and irrigation regimes.

Treatment	Silica in leaf		Silica in husk	
	2019	2020	2019	2020
Irrigation regimes (I)				
I1	4.37b	4.66b	1.49c	1.82d
I2	4.80b	5.09b	1.92b	2.23c
I3	5.66a	6.04a	2.06b	2.51b
I4	5.95a	6.33a	2.51a	2.96a
F. test	**	**	**	**
Potassium silicate (%) (K)				
0	3.59c	3.93c	1.81c	2.19d
1	5.39b	5.73b	1.96b	2.34c
2	5.49b	5.83b	2.06a	2.45b
3	6.31a	6.64a	2.15a	2.53a
F. test		**	**	**
Rice genotype (G)				
Sakha108	5.30b	5.64b	1.97b	2.36b
Giza 178	5.77a	6.10a	2.15a	2.53a
Egy-Kor 27	4.52c	4.85c	1.87c	2.25c
F. test	**	**	**	**
Interactions:				
IX K	NS	NS	**	*
IX G	*	*	NS	NS
K X G	NS	NS	NS	NS
I X K X G	NS	NS	NS	NS

Irrigation every 4-day (I1), alternate 4-day on and 4- (I2), 6- (I3) and 8- (I4) day off. * = Significant at 0.05 level, ** = Significant at 0.01 level and NS= Not significant.

Rice genotype showed a significant difference in silicon content in both seasons (Table 10).

Rice genotype Giza 178 produced the highest value of silica content in leaf and husk.

Meanwhile, the lowest values of silica content were obtained by rice genotype Egy-Kor 27 in both seasons.

The interaction between irrigation regimes and rice genotype had a significant effect on silica content in leaves in both seasons (Table 11).

The combination of I4, and Giza178 produced the highest silicon content in leaf (6.95 and 7.33 mg/g) followed by Sakha 108 (6.06. 6.33mg/g) in both seasons.

Meanwhile, the lowest value (4.05 and 4.34mg/g) was produced in I1 with Egy-Kor 27 in two seasons.

Table 11. Silicon content in leaf and husk (mg/g) affected by the interaction between the study factors

Treatment	**Silica content in leaf**							
	2019				**2020**			
	I1	**I2**	**I3**	**I4**	**I1**	**I2**	**I3**	**I4**
Rice genotype (G)								
Sakha108	4.39cd	4.86cd	5.90b	6.06b	4.68cd	5.15cd	6.28b	6.44b
Giza 178	4.68cd	5.16c	6.28	6.95a	4.97cd	5.45c	6.66b	7.33a
Egy-Kor 27	4.05d	4.37cd	4.81cd	4.84cd	4.34d	4.66cd	5.19cd	5.22cd
Treatment	Silica content in husk							
	2019				2020			
	I1	I2	I3	I4	I1	I2	I3	I4
	Potassium silicate (%)(K)							
0	1.16g	1.63def	1.99de	2.46abc	1.48g	1.95e	2.44b	2.91a
1	1.41fg	1.90de	2.05cd	2.48abc	1.73e	2.21cd	2.50b	2.93a
2	1.59e	2.03cd	2.10bcd	2.52ab	1.91e	2.35bc	2.55b	2.97a
3	1.831de	2.10bcd	2.11bcd	2.57a	2.15d	2.42b	2.56b	3.02a

Irrigation every 4-day (I1), alternate 4-day on and 4- (I2), 6- (I3) and 8- (I4) day off.

The interaction between irrigation regimes and potassium silicate had a significant effect on silica content in the husk in the two seasons (Table 11).

The combination of I4, and potassium silicate rate 3% produced the highest silica content in the husk (2.57 and 3.05mg/g) without a significant difference between potassium silicate rate 2%.

But the lowest value (1.16 and 1.48mg/g) was produced in I1 with the 0 (without potassium silicate spray) treatment.

4- Water management strategies to reduce water input:

Data in Table 12 revealed that the total water used, water saved, and water productivity in both seasons.

The irrigation every 4-day (I1) received the highest amounts of water throughout the season (13200 and 13460m3/ha).

While the lowest amounts were received by irrigation as I4 treatment (9310 and 9628.7 m3/ha) in the 2019 and 2020 seasons, respectively.

The amount of water-saving percentage was found to be 4.47 and 5.11% with I2 treatment in the first and second seasons, respectively, at the same time, the water-saving percentage under I3 treatment was 19.99 and 19.60% with prolonged irrigation interval followed by I4 treatment compared with irrigation every 4-day treatment in the 2019 and 2020 season, respectively.

The irrigation I3 treatment recorded the highest value of water productivity (0.91 and 0.97kg/m3) followed by irrigation as I2 treatment in the first and second seasons, respectively.

The irrigation I2 treatment gave high grain yield and low water inputs in these treatments. These results are in line with the findings of El-Refaee, (2012), Pandey *et al*. (2014) and Gewaily *et al*. (2019).

Table 12.Total water used, water saved, and water productivity as affected by irrigation regimes.

Treatment	**Total water use (m^3/ha)**			**Grain yield (t/ha)**			**Water saved (%)**			**Water productivity**		
	2019	**2020**	**Mean**	**2019**	**2020**	**Mean**	**2019**	**2020**	**Mean**	**2019**	**2020**	**Mean**
I1	13200	13460	13330	10.96	11.58	11.27	-	-	-	0.830	0.860	0.845
I2	12610	12773	12691	10.74	11.36	11.05	4.47	5.11	4.79	0.852	0.889	0.871
I3	10562	10629	10595	9.56	10.32	9.94	19.99	19.60	19.79	0.905	0.971	0.938
I4	9310	9628	9469	7.16	7.99	7.58	29.47	28.90	29.19	0.769	0.830	0.799

Irrigation every 4-day (I1), alternate 4-day on and 4- (I2), 6- (I3) and 8- (I4) day off.

Regarding the effect of rice irrigation regime and potassium silicate on water productivity (Fig1) WP increased with I3 with potassium silicate rate 3%, in both seasons.

On the other hand, as for irrigation regimes, and rice genotype, water productivity was increased with I3 with Giza 178 in both seasons. However, the lowest water productivity was obtained by I4 with Egy-Kor 27 in both seasons.

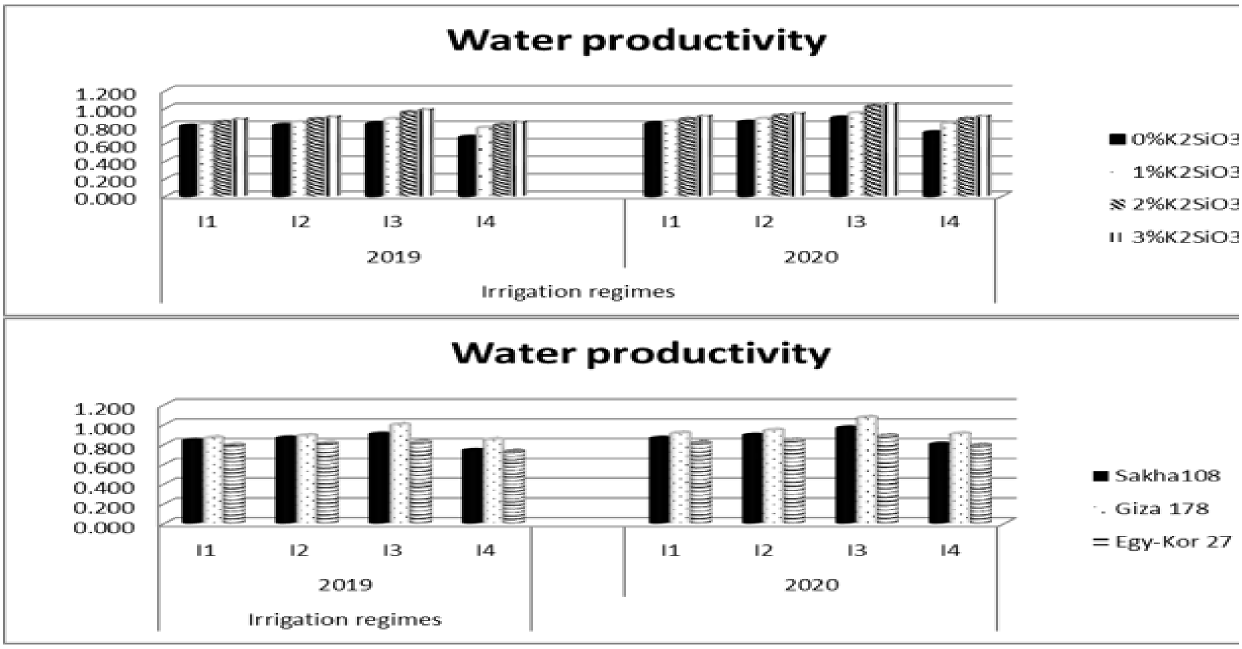

Fig .1.Water productivity (kg/m^3) affected by the interaction between the study factors.
Irrigation every 4-day (I1), alternate 4-day on and 4- (I2), 6- (I3) and 8- (I4) day off.

CONCLUSION

Under the same conditions, it is possible to cultivate Giza 178 rice cultivar and alternate irrigation as 4-day on + 4-day off with spray 2 % of potassium silicate for the highest grain yield and acceptable water productivity.

REFERENCES

Aarekar, S.A., Pawar, R.B., Kulkarni, R.V. and Pharande, A.L., 2014. Effect of silicon on yield, nutrients uptake by paddy plant and soil properties. Journal of Agriculture Research and Technology, 39(2): 328-331.

Abu El-Azm N.A.I. and Youssef S.M.S. 2015.Spraying potassium silicate and sugar beet molasses on tomato plants minimizes transpiration, relieves drought stress, and rationalizes water use. Middle East Journal of Agriculture Research, 4(4): 1047-1064.

Abuzeed, A.M., Ragab, M.E., Abd Elhady, S.A. and El-Sharkawy, Z.A., 2018. Effect of irrigation levels and foliar spraying with seaweed extract, potassium silicate and abscisic acid on growth, corm yield and quality of taro. Arab Universities Journal of Agricultural Sciences, 26(Special issue) :2275-2285.

Ahmad, A., Afzal, M., Ahmad, A.U.H. and Tahir, M., 2013. Effect of foliar application of silicon on yield and quality of rice (Oryza sativa L.). Cercetari Agronomic in Moldova, 46(3):21-28.

Alhassan, I., Saddiq, A.M., Ibrahim, A. and Mustapha, Y., 2016. Effects of irrigation frequency and nitrogen fertilizer application on yield and water use efficiency of lowland rice (Oryza sativa L.) in Northeastern Nigeria. MAYFEB Journal of Agricultural Science, 4(1):20-27.

Coskun, D., Britto, D.T., Huynh, W.Q. and Kronzucker, H.J., 2016. The role of silicon in higher plants under salinity and drought stress. Frontiers in plant Science, 7:1072.

Dai, W.M., Zhang, K.Q., Duan, B.W., Sun, C.X., Zheng, K.L., Cai, R., and Zhuang, J.Y., 2005. Rapid determination of silicon content in rice. Journal of Rice Science12(2):145-7.

De Oliveira, J.R., Koetz, M., Bonfim-Silva, E.M. and da Silva, T.J.A., 2016. Production and accumulation of silicon (Si) in rice plants under silicate fertilization and soil water tensions. Australian Journal of Crop Science, 10(2):244-250.

Deshmukh, R.K.; Ma, J.F.; B élanger, R.R. Editorial, 2017. Role of silicon in plants. Front. Plant Science, 8:1858.

Duncan, D. B., 1955. Multiple range and multiple F. test. Biometrics, 11: 1-24.

El-Habet, H. B. (2021). Role of silica in mitigation of Cd, Pb and Cr toxicities in rice under irrigation with drainage water in the Egypt Nile delta. Irrigation and Drainage, 70(1): 52-69.

El-Refaee, I.S., 2012. Effect of application of rice straw compost and NPK fertilizers under some irrigation regimes on grain yield and water productivity of EHR1 hybrid rice cultivar. Journal of Plant Production, 3(3), :445-462.

El-Sheery, I., 2017. Effectiveness of potassium silicate in suppression white rot disease and enhancement physiological resistance of onion plants, and its role on the soil microbial community. Middle East J, 6(2):376-394.

Gaballah, M.M., Ghoneim, A.M., Ghazy, M.I., Mohammed, H.M., Sakran, R.M., Rehman, H.U. and Shamsudin, N.A.A., 2021. Root traits responses to irrigation intervals in rice (Oryza sativa). International Journal of Agriculture and Biology, 26 (1): 22-30.

Gewaily, E.E., Mohammed, A.T. and Abd El-Rahem, W.T., 2019. Effect of different irrigation regimes on productivity and cooking quality of some rice varieties. World Journal of Agricultural Sciences, 15(5):341-354.

Gomez, K.A. and Gomez, A.A., 1984. Statistical procedures for agricultural research. John Wiley and Sons.

Graham-Acquaah, S., Siebenmorgen, T.J., Reba, M.L., Massey, J.H., Mauromoustakos, A., Adviento-Borbe, A., January, R., Burgos, R. and Baltz-Gray, J., 2019. Impact of alternative irrigation practices on rice quality. Cereal Chemistry, 96(5):815-823.

Hameed, F., Xu, J., Rahim, S.F., Wei, Q., Khalil, R. and Liao, Q., 2019. Optimizing nitrogen options for improving nitrogen use efficiency of rice under different water regimes. Agronomy, 9(1):39.

Hossain, M.Z., Sikder, S., Husna, A., Sultana, S., Akhter, S., Alim, A. and Joardar, J.C., 2020. Influence of water stress on morphology, physiology and yield contributing characteristics of rice. SAARC Journal of Agriculture, 18(1):61-71.

Jawahar, S. and Vaiyapuri, V., 2010. Effect of sulphur and silicon fertilization on growth and yield of rice. International Journal of Current Research, 9(1):36-8.

Juliano, B.O. 1971. A simplified assay for milled rice amylose. Cereal Sci. Today (16): 334-360.

Khan, R., A.H., Gurmani, A.H., Gurmani, A.R. and Zia, M.S., 2006. Effect of boron application on rice yield under wheat rice system. International Journal of Agriculture and Biology, 8(6):805-808.

Kobua, C.K., Jou, Y.T. and Wang, Y.M., 2021. Advantages of amending chemical fertilizer with plant-growth-promoting rhizobacteria under alternate wetting drying rice cultivation. Agriculture, 11(7): 605.

Kumar, K.A. and Rajitha, G., 2019. Alternate Wetting and Drying (AWD) Irrigation-A Smart Water Saving Technology for Rice: A Review. International Journal of Current Microbiology and Applied Sciences, 8(3):2561-2571.

Laane, H.M., 2018. The effects of foliar sprays with different silicon compounds. Plants, 7(2):45.

Li, T., Angeles, O., Marcaida, M., Manalo, E., Manalili, M.P., Radanielson, A. and Mohanty, S., 2017. From ORYZA2000 to ORYZA (v3): An improved simulation model for rice in drought and nitrogen-deficient environments. Agricultural and forest meteorology, 237:246-256.

Mancosu, N., Snyder, R.L., Kyriakakis, G. and Spano, D., 2015. Water scarcity and future challenges for food production. Water, 7(3):975-992.

Mikhael, B.B., Awad-Allah, M.M.A. and Gewaily, E.E., 2018. Effect of irrigation intervals and silicon sources on the productivity of broadcast-seeded Sakha 107 rice cultivar. Journal of Plant Production, 9(12):1055-1062

Mitani, N. and Ma, J.F., 2005. Uptake system of silicon in different plant species. Journal of experimental botany, 56(414):1255-1261.

Pandey, A., Kumar, A., Pandey, D.S. and Thongbam, P.D., 2014. Rice quality under water stress. Indian Journal of Advances in Plant Research, 1(2): 23-26.

Patil, A.A., Durgude, A.G., Pharande, A.L., Kadlag, A.D. and Nimbalkar, C.A., 2017. Effect of calcium silicate as a silicon source on growth and yield of rice plants. International Journal of Chemical Studies, 5(6):54-59.

Siddiqui, H., Yusuf, M., Faraz, A., Faizan, M., Sami, F. and Hayat, S., 2018. Epibrassinolide supplemented with silicon enhances the photosynthetic efficiency of Brassica junco under salt stress. South African Journal of Botany, 118:120-128.

Wissa, M.T., 2017. Impact of potassium silicate compound as foliar application on the growth, yield and grains quality of Giza 179 rice cultivar. Journal of Plant Production, 8(11):1077-1083.

Zanão Júnior, L.A., Fontes, R.L.F., Neves, J.C.L., Korndörfer, G.H. and Ávila, V.T.D., 2010. Rice grown in nutrient solution with doses of manganese and silicon. Revista Brasileira de Ciência do Solo, 34:1629-1639.

تأثير سلكيات البوتاسيوم لتحمل نقص الماء لبعض الطرز الوراثية لمحصول الارز

حسناء عبد الحميد غازي

قسم بحوث الأرز – معهد بحوث المحاصيل الحقلية - مركز البحوث الزراعية – سخا - كفر الشيخ – مصر

أجريت تجربتان حقليتان في المزرعة البحثية بمحطة البحوث الزراعية بسخا - كفر الشيخ – مصر، خلال موسمي 2019 و 2020 م بهدف دراسة تأثير أنظمة الري المختلفة وسلكيات البوتاسيوم على النمو ومحصول الحبوب وإنتاجية المياه لبعض الطرز الوراثية للأرز. نفذت التجارب بتصميم الشرائح المتعامدة بثلاث مكررات. تحتوي الشرائح الرأسية على ا ربع معاملات الري وهى التناوب الري كل 4 ايام والتناوب في الري كل 4 ترطيب و4 و6 و8 ايام تجفيف. في حين أحتوا ت الشرائح الأفقية من أربع معدل رش سلكيات البوتاسيوم (0 (بدون رش سلكيات البوتاسيوم) ، 1 و 2 و 3%). وفي الوقت نفسه ، تألفت الشرائح الشقية على التركيب الوراثي للأرز ، وهي سخا 108 ، وجيزة 178 ، وكوريا27. أظهرت النتائج الرئيسية انخفاضًا معنويًا في خصائص النمو ومحصول الحبوب ومكوناتها مع زيادة فترات مناوبات الري من الري كل 4 ايام (I1) إلى (I4). سجلت سلكيات البوتاسيوم بنسبة 3٪ يليها 2% بدون فروق معنوية قيم عالية للصفات المدروسة. وسجل جيزة 178 أعلى قيم للصفات المدروسة باستثناء طول الدالية ووزن الدالية ووزن 1000 حبة والتي سجلت أعلى قيمة مع سخا 108. استهلكت الري كل 4 ايام أعلى كمية من مياه الري المستخدمة. بينما تلقت I4 أقل كمية مياه ري مستخدمة. أعطت معاملة I3 أعلى إنتاجية للمياه مقارنة بجميع المعاملات. توصى الدراسة : بشكل عام ، وفي ظل نفس الظروف ، يمكن زراعة صنف أرز جيزة 178 والتناوب 4 ايام ترطيب و 4أيام تجفيف (I2) برش سلكيات البوتاسيوم بنسبة 2٪ للحصول على أعلى محصول حبوب وأفضل إنتاجية مياه.