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Response of peanut (*Arachis hypogaea* L.) to potassium, silicon, and selenium foliar application under water stress conditions

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ABSTRACT

With water resources becoming more limited in arid and semi-arid regions, water-saving strategies are needed to reduce agricultural water use. A field experiment was carried out at EL-Bostan Agricultural Farm, Faculty of Agriculture, Damanhur University, EL-Behira Governorate, Egypt, during two successive summer seasons 2020 and 2021 to investigate the effect of foliar application of potassium, silicon, and selenium on some growth characteristics, chemical properties, yield, and some related traits of the peanut crop (Arachis hypogea L.) under water deficit conditions. A split-plot design was used; three depletion ratios (50, 60, and 70%) of available water were applied in the main plots, while four spray treatments (tap water (as control), 2% K2SO4, 2 mM Si as Na2O3Si.9H2O, and 30 g Se/ha as Na2SeO4) were laid in the subplots. The findings revealed that increasing the depletion percentage from 50% to 70% resulted in a significant decrease in all traits except the shelling percentage. Potassium foliar application produced the highest plant height and the number of branches per plant, whereas silicon treatment resulted in the highest pod yield per plant, seed yield per plant, shelling percentage, 100-pod weight, 100-seed weight, and pod yield. Treatment with selenium led to high chlorophyll contents. The interaction between the two studied factors showed that irrigation after a 50% depletion ratio with potassium foliar application recorded significant values of the plant height and number of branches. The highest content of chlorophyll was achieved when the crop was treated with selenium under irrigation after depleting 70% of the available soil moisture content. The highest values of pod yield per plant, seed yield per plant, and pod yield (ard/fed) were observed when the peanut was irrigated after a 50% depletion ratio with silicon foliar application. The best shelling percentage was achieved with potassium under a 70% depletion ratio. The treatment with silicon under a 60% depletion ratio recorded the heaviest 100-pod weight and 100-seed weight. When peanut plants are subjected to water stress, treatment with silicon, potassium, or selenium reduces crop losses and increases plant tolerance to stressful water conditions.

Keywords: Peanut, potassium, silicon, selenium, depletion ratio, foliar application, yield components

INTRODUCTION

Egypt is currently under the threshold of water poverty and it is regarded as an arid and semi-arid region. Water-saving approaches, such as deficit irrigation, are sustainable practices to optimize agricultural water use, improve water-use efficiency, and optimize crop yield. The practice of deficit irrigation, however, necessitates an improved understanding of the response of crops to limited water (Liu *et al.,* 2018). Peanut (*Arachis hypogea* L.) is one of the most important oil crops in the world, its seeds are rich in edible oil (48-50%) which contains useful vitamins and healthy unsaturated fatty acids in addition to protein (26 – 28 %), carbohydrates (20%), high concentration of minerals, and fibers (5%), according to Fageria *et al.,* (1997). Peanut crop is cultivated in over 100 countries with over 95% of cultivated area in Asia and Africa (Variath and Janila, 2017). In Egypt, a peanut is not used to obtain oil but to get cash by exporting them. So farmers considered it a great cash crop, especially in newly reclaimed soils. Peanut grows up in Egypt in sandy soils during the summer season which is characterized by high temperature and the presence of water deficit problems and increasing evapotranspiration with low water holding capacity. Its water requirements are about 3500 m3 during the season (Anonymous 2016). Reducing water affect growth, yield, yield components and quality characteristics of peanut, so increasing plant tolerance to water shortage is one of the most strategies that we can do to alleviate crop loss. It could be happening by using some important elements such as Potassium (K), Silicon (Si) and Selenium (Se). Potassium (K) is not a part of the chemical structure of plants but it plays significant role in plant development (Prajapati and Modi, 2012). Potassium activates about 60 different enzymes involved in plant growth. The amount of K present in the cell determines how many of the enzymes can be activated and the rates at which chemical reactions can proceed. Thus, the rate of a given reaction is controlled by the rate at which K enters the cell Van Brunt and Sultenfuss, (1998). The proper functioning of stomata is essential for photosynthesis, water and nutrient transport, and plant cooling. When the water supply is short, K is pumped out of the guard cells, the pores close tightly to prevent loss of water and minimize drought stress to the plant (Thomas and Thomas 2009). Accumulation of K in plant roots produces a gradient of osmotic pressure that draws water into the roots. Potassium plays a vital role in the Photosynthesis process through the activation of enzymes, also it helps in the transport of sugar that is produced from Photosynthesis to all parts of the plant for utilization and storage (Prajapati and Modi 2012).

Silicon is known as one of the most anti-oxidant elements, many authors reported that it is not an essential element for all higher plants (Epstein, 1999), but it has beneficial effects for many plants especially when it was under stressful conditions like water stress (Liang *et al.,* 2007). Silicon can alleviate water stress effects by keeping plant leaves in an upright position which allows it to receive more light, increasing their resistance against diseases (Ma and Yamaji, 2006). Enhancing water uptake and transport, regulating stomatal behavior and transpirational water loss, accumulating solutes and osmoregulatory substances, and inducing plant defence-associated signaling events are all mechanism keys influencing Si's ability to mitigate the effects of drought stress, resulting in whole-plant water balance (Wang *et al.,* 2021). The uptake of most nutrient elements increases in response to Si application under drought stress, which enhances plant growth and improves its resistance and/or tolerance. For example, potassium in which benefits plant growth, osmotic adjustment, and drought tolerance, also Si application enhanced peanut growth by increasing nutrient uptake at various growth stages, favoring the partitioning of dry mass to pod, and allocating tissue N, P, K, Ca, and Mg to shoots and pod while decreasing toxic element uptake and accumulation (Dong *et al.,* 2018).

Like silicon, selenium is not an essential element (Terry *et al.,* 2000). Selenium enhanced the antioxidant defense system and increases the tolerance of many plants under water stress conditions (Kuznetsov *et al.,* 2003; Cunha *et al.,* 2022). Increasing Se the peanut plant could benefit human and animal health Sorensen and Nuti (2011). Because the rates required of Si and Se are so low it is difficult to apply them as a fertilizer. As a result, the use of Si and Se as dry fertilizers have not been widely adopted, foliar application of silicon and selenium-containing solutions is a viable alternative Si and Se fertilization method, particularly for intermediate and Si non-accumulator plants (Morato de Moraes *et al.,* 2020; De Souza Junior *et al.,* 2021) . In Egypt, the farmers are using it in form of sodium silicate and sodium selenite. The objectives of this study were to determine: (1) the growth and yield response of peanuts to limited water through different levels of soil moisture depletion ratio and (2) the best element of K, Si, and Se that boosts peanut tolerance for drought stress. This could provide insights to determine the potential of deficit irrigation as a strategy to reduce the water use of peanuts while maintaining yield, which in turn could contribute to water savings in water-scarce regions.

MATERIAL AND METHODS

Experimental site:

Field experiments were carried out on the farm of the faculty of agriculture, Damanhur University, El-Bostan, El-Behira Governorate, Egypt, during the two successive summer seasons of 2020 (S1) and 2021 (S2) to study the effect of Potassium (K), Silicon (Si) and Selenium (Se) foliar application on peanut (Arachis hypogea L.) yield and its related traits under water stress conditions. The main chemical and physical properties of experimental soil are presented in Table (1). Commercial cultivar Giza 6 obtained from Oil Crops Research department, Agricultural Research Center (A.R.C) was used in this investigation. All agricultural practice of peanut was done as recommended by the Ministry of Agriculture and Land Reclamation.

Table 1. Physical and chemical properties of the soil at the experimental sites

Soil analysis	First season	Second season
Sand %	93.52	93.52
Silt %	2	1
Clay %	4.48	5.48
Texture	sand	sand
EC (dSm^{-1}) (1:5)	0.506	0.473
pH	7.86	8.00
Total CO_3^{--} (%)	5.1	6.0
Organic matter %	0.41	0.16
Available N (ppm)	175	350
Available P (ppm)	0.77	0.87
Available K (ppm)	119.05	85.43

Experimental design:

The experimental factors were conducted in split-plot arrangements based on a randomized complete block design (RCBD) with three replicates as follows, three levels of depletion ratio (50, 60 and 70 % of available water) assigned in the main plots, four treatments of foliar application i.e. (tap water (as control), 2% potassium sulphate (48 % K2O), 2 mM Si as sodium metasilicate (Na2O3Si.9H2O) and 30g Se/ha as sodium selenate (Na2SeO4) were arranged in the sub plot. Foliar application treatments were applied three times, the first one was after 45 days of the sowing date, and the second and the third ones were after 50 and 65 days after sowing. Irrigation scheduling was made at three levels of soil moisture depletion (50, 60 and 70 %) using the CROPWAT model version 8.0 after feeding it with crop, soil, and weather data (FAO, 1992).

Collection data:

Yield and yield components i.e. a number of branches/plant, 100-pods weight (g), 100-seed weight(g), pod yield/plant (g), seed yield/plant (g), pods yield (ard./fed), and shelling (%) as well as chlorophyll content index (SPAD unit) as a chemical composition in addition to plant height (cm).

Statistical analysis

The gathered data were subjected to the proper statistical analysis of the variance described by Gomez and Gomez (1984). Statistical Analysis System version 9.1 (The SAS 2002) program was used. To compare the treatment means using the least significant differences (LSD) at the 0.05 level of probability was used.

RESULTS

Data presented in **Table (2)** showed that increasing depletion ratio significantly decreased peanut plant height in both studied seasons. The decreased percentages of plant height due to increasing depletion ratio were (8.4 and 22.8 %) and (5.9 and 17.6 %) under 60 % and 70 % depletion ratios, in the first and second seasons, respectively. Data also showed no significant differences between 50% and 60% depletion ratios in the first season and between 60 % and 70 % depletion ratios in the second season in the number of branches per plant. In general, increasing the depletion ratio significantly decreased the number of branches per plant in both seasons. Concerning chlorophyll content observed that drought stress imposed at the vegetative stage significantly decreased chlorophyll content, 60% depletion ratio resulted in high chlorophyll content than 50 and 70% depletion ratios.

Foliar application of potassium, silicon, and selenium significantly increased peanut plant height, number of branches/plant, and chlorophyll content index compared to the control (spraying with water) in both seasons, potassium application was the highest effect on peanut plant height in both seasons. No significant differences were found between potassium, silicon, and selenium on number of branches per plant in both seasons, foliar elements have the following order effect on chlorophyll content index: Se > Si > K > control.

The effect of the interaction between depletion ratio and foliar applications was significant on plant height, number of branches and chlorophyll content (SPAD) during both seasons except number of branches in the second season. The highest plants were observed when peanuts were irrigated after 50% of depletion under foliar application of potassium, while, the largest numbers of branches were recorded at irrigation after a depletion rate of 60% with the treatment of silicon, also, the treatment with selenium under irrigation after depletion of 70% of the available water recorded the highest values of chlorophyll content.

Table 2. Effect of depletion ratio, foliar application of potassium, silicon and /or selenium and their interaction on plant height, number of branches/plant and chlorophyll content of peanut plant during 2020 and 2021 summer seasons.

Treatment		Plant height (cm)			No. of branches			Chlorophyll content (SPAD)	
		S1	S2		S1	S2		S1	S2
Depletion ratio									
50		24.03 a*	23.80 a		4.65 a	4.56 a		31.20 c	34.25 c
60		22.02 b	22.40 b		4.57 a	4.46 b		34.37 a	37.52 a
70		18.55 c	19.62 c		4.41 b	4.42 b		31.82 b	34.83 b
LSD		0.53	0.49		0.09	0.10		0.10	0.15
Foliar application									
Control		20.07 c	20.56 d		4.38 b	4.38 b		29.74 d	33.01 d
K		23.14 a	23.76 a		4.59 a	4.49 a		31.11 c	34.43 c
Si		21.31 b	21.29 c		4.57 a	4.53 a		32.15 b	35.23 b
Se		21.60 b	22.16 b		4.62 a	4.51 a		36.85 a	39.45 a
LSD		0.62	0.48		0.07	0.08		0.24	0.15
Interaction									
50	**Control**	22.49 c	23.16 b		4.51 cd	4.43 a		24.31 i	27.34 i
	K	26.11 a	25.18 a		4.66 b	4.54 a		33.43 e	36.63 e
	Si	23.84 b	23.39 b		4.82 a	4.74 a		30.53 f	34.33 f
	Se	23.67 b	23.46 b		4.58 bc	4.54 a		36.54 c	38.70 c
60	**Control**	19.90 d	20.55 d		4.45 d	4.37 a		37.46 b	40.54 b
	K	23.93 b	24.59 a		4.64 b	4.47 a		29.3 g	33.28 g
	Si	21.95 c	21.44 c		4.47 cd	4.42 a		35.35 d	38.17 d
	Se	22.27 c	23.03 b		4.68 b	4.55 a		35.35 d	38.08 d
70	**Control**	17.81 e	17.95 f		4.18 de	4.35 a		27. 43 h	31.15 h
	K	19.38 d	21.51 c		4.45 d	4.45 a		30. 60 f	33.39 g
	Si	18.13 e	19.03 e		4.41 d	4.42 a		30.56 f	33.20 g
	Se	18.85 de	19.97 d		4.57 bc	4.45 a		38.66 a	41.58 a
LSD		1.08	0.83		0.11	NS		0.41	0.26

* Means within the same column followed by the same letter(s) are not significantly different according to LSD at 0.05 level of probability.

According to Table 3, the depletion ratio significantly affected pod yield/plant, seed yield/plant, and shelling percentage. A depletion ratio of 50% produced the highest values of the traits, 48.68 and 52.37g for pod yield per plant, 25.90 and 25.77g for seed yield per plant and 53.20 and 49.24 for shelling percentage during the 2020 and 2021 seasons, respectively. While ratios of 60% and 70% resulted in lower values for previous traits. Water stress caused significant reductions in peanut pod yield/plant, seed yield/plant, and shelling percentage. As for the effect of foliar application on pod yield per plant, seed yield per plant, and shelling percentage, silicon treatment exhibited the best values compared to the other treatments, it reflects the important role of silicon on plants. From Table 3, foliar application with silicon under 50% of depletion ratio gave the highest values of pod yield per plant (51.24 and 54.66) during the two seasons. The highest seed yield of the plant was obtained from silicon foliar application treatment with irrigation when 50% of the available water was depleted in the first season and 60% depleted in the second season, while, the potassium treatment and irrigation after 70% depleted water exhibited the highest percentages of shelling.

Table 3. Effect of depletion ratio, foliar application of potassium, silicon and /or selenium and their interaction on pod yield /plant, 100-pod weight, and shelling of peanut plant in the two-growing season.

Treatment	Pod yield /plant (g)			Seed yield /plant (g)			Shelling (%)	
	S1	S2		S1	S2		S1	S2
Depletion ratio								
50	48.68 a*	52.37 a		25.90 a*	25.77 a		53.20 a	49.24 a
60	46.44 b	50.70 b		24.06 b	25.09 a		51.91 b	49.50 a
70	42.68 c	42.26 c		20.99 c	22.50 b		49.16 c	53.28 a
LSD	0.89	1.57		0.22	0.83		0.92	NS
Foliar application								
Control	42.32 d	44.28 c		21.51 d	22.28 d		50.64 b	50.47 a
K	46.51 c	48.84 b		24.34 b	25.20 b		52.49 a	51.97 a
Si	47.90 a	51.09 a		25.61 a	25.75 a		53.45 a	50.57 a
Se	47.01 b	49.57 b		23.14 c	24.58 c		49.12 c	49.68 a
LSD	0.47	1.23		0.39	0.43		1.16	NS

Table 3 contionued									
Interaction									
50	**Control**	46.10 f	50.80 c		24.36 de	25.65 b		52.84 c	50.49 b-e
	K	50.06 b	52.09 bc		26.61 b	25.75 b		53.15 c	49.46 b-e
	Si	51.24 a	54.66 a		27.34 a	25.96 b		53.36 bc	47.50 e
	Se	47.34 de	51.92 bc		25.30 c	25.70 b		53.44 bc	49.50 b-e
60	**Control**	41.98 h	45.35 de		22.50 h	22.10 d		53.61 abc	48.74 de
	K	48.14 d	51.86 bc		23.44 fg	25.36 b		48.69 e	48.94 cde
	Si	46.54 ef	52.10 bc		25.77 c	26.83 a		55.37 ab	51.57 bcd
	Se	49.07 c	53.48 ab		24.51 d	26.05 b		49.96 de	48.72 de
70	**Control**	38.86 i	36.68 g		17.66 j	19.09 e		45.46 f	52.17 bc
	K	41.33 h	42.55 f		22.98 gh	24.47 c		55.61 a	57.52 a
	Si	45.92 f	46.49 d		23.7 ef	24.45 c		51.62 cd	52.63 b
	Se	44.60 g	43.30 ef		19.59 i	21.97 d		43.39 f	50.81 bcd
LSD		0.81	2.13		0.68	0.75		2.01	3.25

***** Means within the same column followed by the same letter(s) are not significantly different according to LSD at 0.05 level of probability.

The data in **Table (4)** referred to the presence of a significant effect of depletion ratio on 100-pod weight (g), 100-seed weight (g), and pod yield (ard./fed). 60% of the depletion ratio exhibited the highest values of 100-pod weight (in the first season) and 100- seed weight in the two seasons, while, the best values of 100- pod weight (in the second season) and pod yield (ard./fed) were recorded with 50% 0f depletion ratio, irrigation at a 70% depletion ratio resulted in a decrease in yield and its components. High significant differences were found between foliar application treatments, silicon foliar application is considered the best among the rest as it achieved the highest values of all studied traits.

Concerning the interaction between depletion ratio and foliar application the data showed that the highest values of 100- pod weight (220.33 and 170.49 g) and 100- seed weight (95.57 and 84.86 g) were found when peanut crop was irrigated at 60% of depletion ratio with silicon foliar application during the two seasons 2020 and 2021, respectively. Also, pod yield (ard./fed) was the best with silicon foliar application under 50% of depletion ratio.

Table 4. Effect of depletion ratio, foliar application of potassium, silicon, and/or selenium, and their interaction on seed yield (g/plant), 100-seed weight, and pod yield (ard. /fed) of peanut plant in the two-growing season.

Treatment		100-pod weight (g)			100-seed weight (g)			Pod yield (ard. /fed)	
		S1	S2		S1	S2		S1	S2
Depletion ratio									
50		166.08 b	164.80 a		84.01 b	83.82 a		19.47 a	20.94 a
60		195.33 a	163.46 b		90.28 a	83.41 a		18.57 b	20.28 b
70		140.83 c	159.95 c		76.72 c	78.20 b		17.07 c	16.90 c
LSD		1.96	1.20		0.36	0.43		0.35	0.63
Foliar application									
Control		147.33 d	155.37 c		77.01 d	78.22 c		16.92 d	17.71 c
K		167.00 c	163.98 b		85.24 b	83.29 a		18.60 c	19.53 b
Si		183.56 a	167.63 a		90.45 a	83.44 a		19.16 a	20.43 a
Se		171.78 b	163.98 b		81.97 c	82.30 b		18.80 b	19.82 b
LSD		1.50	1.22		0.42	0.92		0.18	0.49
Interaction									
50	**Control**	159.66 f	162.59 de		80.74 d	82.99 b		18.44 f	20.32 c
	K	164.66 e	167.57 b		84.85 c	86.22 a		20.02 b	20.83 bc
	Si	170.00 d	164.55 cd		90.20 b	83.24 b		20.49 a	21.86 a
	Se	170.00 d	164.50 cd		80.25 d	82.81 b		18.93 de	20.77 bc
60	**Control**	170.66 d	153.88 f		84.96 c	80.51 d		16.79 h	18.14 de
	K	190.33 c	163.19 de		95.39 a	85.26 a		19.25 d	20.74 bc
	Si	220.33 a	170.49 a		95.57 a	84.86 a		18.61 ef	20.84 bc
	Se	200.00 b	166.25 bc		85.17 c	83.00 b		19.62 c	21.39 ab
70	**Control**	111.66 h	149.63 g		65.33 f	71.14 f		15.54 i	14.67 g
	K	146.00 g	161.16 e		75.47 e	78.38 e		16.53 h	17.02f
	Si	160.33 f	167.84 b		85.58 c	82.21 bc		18.36 f	18.59 d
	Se	145.33 g	161.17 e		80.47 d	81.07 cd		17.84 g	17.32ef
LSD		2.95	2.11		0.73	1.60		0.32	0.85

* Means within the same column followed by the same letter(s) are not significantly different according to LSD at 0.05 level of probability.

DISCUSSION

Depletion ratio generally affected the growth (plant height and the number of branches) of peanuts, the reduction in plant height with high depletion percentage could be attributed to a lower crop growth rate and the decrease in relative water content. These results agree with those of Madhusudhan and Sudhakar (2014) and Mourad, (2014). It is important to note that a higher number of branches in plants is desirable because it produces a higher yield, the decrease in the number of branches due to the lack of moisture content may be due to minimizing the shoot system of peanuts under dry conditions. These results are in full agreement with those of Fatthallah and Gawish (1997) who reported that the decrease in the number of branches caused by low soil moisture levels may be due to a reduction in the uptake of nutritional elements, which resulted in deterrence in the physiological processes required for plant growth. A sufficient supply of water improves the chemical compositions of plants like chlorophyll, as demonstrated by the results, these results are in agreement with the results obtained by Madhusudhan and Sudhakar (2012), who recorded that chlorophyll content declined in all stress treatments and differed between cultivars.

The higher plants were recorded with potassium application this result is consistent with Afify *et al.,* (2019) this may be due to the role of Potassium helping to maintain sufficient rates of nitrogen fixation and N-partitioning to meet the requirement of two active sinks i.e. reproductive parts and the nodules at the same time, Furthermore, foliar potassium application increases the average diameter of the plant stem, number of leaves, and plant height (Almeida *et al.,* 2015), in addition to potassium's important role in hormone balance, affecting the increase in the concentration of oxine, an essential hormone for the growth of plants (Rubio *et al.,* 2009). The plants at the flowering stage treated with Se showed higher concentrations of chlorophylls. These results are in harmony with those reported by Matheus Luís Oliveira Cunha *et al.,* (2022). Delaying irrigation until reaching 70% of the field capacity led to a decrease in the characteristics of pod yield/plant, seed yield/plant, and shelling percentage compared with the normal irrigation (control). Drought stress limits photosynthesis due to stomatal (stomatal closure) and non-stomatal (impairments of metabolic processes) factors, resulting in less assimilate production for plant growth and yield, these results of irrigation treatments in our present study confirm the findings of previous investigators (Arunyanark *et al.,* 2009; Dinh *et al.,* 2013; Arruda *et al.,* 2015; Nassar *et al.,* 2018).

The application of Si improves the yield components of peanuts (pod yield per plant, seed yield per plant, and shelling percentage) and increases its production under water-stress conditions, these results suggest that silicon application may be useful to improve the drought tolerance of peanut through the enhancement of water uptake ability. These results are in agreement with those reported by Monika Patel *et al.,* (2021) and Monika Patel *et al.,* (2022). The first irrigation treatment (50% depletion ratio) gave the highest pod yield (ard./fed.), as it recorded the highest values for the yield components(pod yield per plant, seed yield per plant,100-pod weight and 100-seed weight) compared to the rest of the treatments. These results are in full harmony with those of Songsri *et al.,* (2008), Farooq *et al.,* (2009) and Nassar *et al.,* (2018). Si's superiority over other foliar treatments (K and Se) in terms of yield could be because of Si's role in root development and water uptake under drought stress conditions (Gomaa *et al.,* 2021). Our findings are consistent with those of Kamaleshwaran *et al.,* (2022), who found that applying different levels of silicon (Si) from different sources improved groundnut yield components such as the number of pods plant^{-1}, 100 pod weight, 100 kernel weight, and shelling percentage.

CONCLUSION

Both potassium, silicon, and selenium have an important role in plant growth and productivity, especially under drought stress. Silicon is considered the best element among the other studied elements in our investigation, so we can recommend using these elements to enhance the tolerance of peanut plants under abiotic stress conditions like water stress.

REFERENCES

Afify, R. R., El-Nwehy, S. S., Bakry, A. B., & Abd El-Aziz, M. E. (2019). Response of peanut (*Arachis hypogaea* L.) crop grown on newly reclaimed sandy soil to foliar application of potassium nanofertilizer. *Middle East Journal of Applied Sciences,* 9(1), 78-85.

Almeida, H. J., Pancelli, M. A., Prado, R. M., Cavalcante, V. S., & Cruz, F. J. R. (2015). Effect of potassium on nutritional status and productivity of peanuts in succession with sugar cane. *Journal of Soil Science and Plant Nutrition,* 15(1), 1-10.

Anonymous (2016). Growing & production of peanut. *Agricultural Research Center*, Giza, Egypt.

Arruda, I. M., Moda-Cirino, V., Buratto, J. S., & Ferreira, J. M. (2015). Growth and yield of peanut cultivars and breeding lines under water deficit. *Pesquisa Agropecuária Tropical,* 45, 146-154.

Arunyanark, A., Jogloy, S., Wongkaew, S., Akkasaeng, C., Vorasoot, N., Wright, G. C., ... & Patanothai, A. (2009). Association between aflatoxin contamination and drought tolerance traits in peanut. *Field Crops Research,* 114(1), 14-22.

Cunha, M. L. O., de Oliveira, L. C. A., Silva, V. M., Montanha, G. S., & Dos Reis, A. R. (2022). Selenium increases photosynthetic capacity, daidzein biosynthesis, nodulation and yield of peanuts plants (Arachis hypogaea L.). *Plant Physiology and Biochemistry*, *190*, 231-239.

de Souza Junior, J. P., de Mello Prado, R., Soares, M. B., da Silva, J. L. F., de Farias Guedes, V. H., dos Santos Sarah, M. M., & Cazetta, J. O. (2021). Effect of different foliar silicon sources on cotton plants. *Journal of Soil Science and Plant Nutrition*, *21*, 95-103.

Dinh, H. T., Kaewpradit, W., Jogloy, S., Vorasoot, N., & Patanothai, A. (2013). Biological nitrogen fixation of peanut genotypes with different levels of drought tolerance under mid-season drought. *SABRAO Journal of Breeding and Genetics*, *45*(3), 491-503.

Dong, Z., Li, Y., Xiao, X., Chen, Y., & Shen, X. (2018). Silicon effect on growth, nutrient uptake, and yield of peanut (*Arachis hypogaea* L.) under aluminum stress. *Journal of Plant Nutrition*, *41*(15), 2001-2008.

Epstein, E. (1999). Silicon. *Annual Review of Plant Biology*, *50*(1), 641-664.

Fageria, N. K., Baligar, V. C., & Jones, C. (1997). Growth and mineral nutrition of field crop. Marcel Dakker. *Inc, New York*, *1001*.

FAO. 1992. CROPWAT: A Computer Program for Irrigation Planning & Management, by M. Smith. *FAO Irrigation and Drainage Paper* No. 46. *Rome, Italy.*

Farooq, M., Wahid, A., Kobayashi, N. S. M. A., Fujita, D. B. S. M. A., & Basra, S. M. A. (2009). Plant drought stress: effects, mechanisms and management. *Sustainable agriculture*, 153-188.

Fatthallah, M. A., & Gawish, R. A. (1997). Effect of taro intercropping with some vegetable crops on growth, yield and land productivity in relation to several soil moisture regimes. *Menofiya Journal of Agricultural Research (Egypt)* 22(6):1647-1675.

Gomaa, M., Fathallah Rehab, I., Kandil, E. E., & Ali, A. M. M. (2021). Using of Potassium Silicate to Alleviate Drought Stress Effect on Peanut as Grown in Sandy Soil. *Journal of the Advances in Agricultural Researches*, *26*(3), 109-119.

Gomez, K. A., & Gomez, A. A. (1984). *Statistical Procedures for Agricultural Research*. John wiley & sons.

Kamaleshwaran, R., Elayaraja, D., Dhanasekaran, K. Jawahar, S. (2022). Effect of different levels & source of silicon fertilizers on the growth & yield of groundnut in coastal saline soil. *Indian Journal of Natural Sciences,* 13(71): 39931- 39937.

Kuznetsov, V. V., Kholodova, V. P., Kuznetsov, V. V., & Yagodin, B. A. (2003, May). Selenium regulates the water status of plants exposed to drought. In *Doklady biological sciences* (Vol. 390, No. 1, pp. 266-268). New York: Consultants Bureau, c1965-1992..

Liang, Y., Sun, W., Zhu, Y. G., & Christie, P. (2007). Mechanisms of silicon-mediated alleviation of abiotic stresses in higher plants: a review. *Environmental Pollution*, *147*(2), 422-428.

Liu, R., Abdelraouf, E. A. A., Bicego, B., Joshi, V. R., & Garcia y Garcia, A. (2018). Deficit irrigation: a viable option for sustainable confection sunflower (*Helianthus annuus* L.) production in the semi-arid US. *Irrigation Science*, *36*, 319-328.

Ma, J. F., & Yamaji, N. (2006). Silicon uptake and accumulation in higher plants. *Trends in Plant Science*, *11*(8), 392-397.

Madhusudhan, K. V., & Sudhakar, C., (2012). Effect of water deficit stress on growth & chlorophyll pigments in two cultivars of groundnut. Research Paper, *Paripex - Indian Journal of Research,* 3(4): 8-9.

Madhusudhan, K. V., & Sudhakar, C. (2014). Morphological responses of a high yielding groundnut cultivar (Arachis hypogaea L. cv. K-134) under water stress. *Indian Journal of Pharmaceutical and Biological Research*, *2*(1), 35-38.

Cunha, M. L. O., de Oliveira, L. C. A., Silva, V. M., Montanha, G. S., & Dos Reis, A. R. (2022). Selenium increases photosynthetic capacity, daidzein biosynthesis, nodulation and yield of peanuts plants (*Arachis hypogaea* L.). *Plant Physiology and Biochemistry*, *190*, 231-239.

Patel, M., Fatnani, D., & Parida, A. K. (2021). Silicon-induced mitigation of drought stress in peanut genotypes (Arachis hypogaea L.) through ion homeostasis, modulations of antioxidative defense system, and metabolic regulations. *Plant Physiology and Biochemistry*, *166*, 290-313.

Patel, M., Fatnani, D., & Parida, A. K. (2022). Potassium deficiency stress tolerance in peanut (Arachis hypogaea) through ion homeostasis, activation of antioxidant defense, and metabolic dynamics: Alleviatory role of silicon supplementation. *Plant Physiology and Biochemistry*, *182*, 55-75.

Morato de Moraes, D. H., Mesquita, M., Magalhães Bueno, A., Alves Flores, R., Elias de Oliveira, H. F., Raimundo de Lima, F. S., ... & Battisti, R. (2020). Combined effects of induced water deficit and foliar application of silicon on the gas exchange of tomatoes for processing. *Agronomy*, *10*(11), 1715.

Mourad, K. A. (2014). Evaluation of some peanut genotypes (*Arachis hypogea* L.) under water stress conditions. Ph thesis, Agricultural Science, Department plant production, *Faculty of Agricultural, (Saba- Basha), Alexandria University.*

Nassar, S. M., Al-Kady, A. M. A., & El-Saka, Z. I. (2018). Effect of Drought Stress on Yield and Yield Components of 20 Peanut Genotypes Grown under Newly Reclaimed Soil. *Egyptian Journal of Agronomy*, *40*(1), 45-58.

Prajapati, K., & Modi, H. A. (2012). The importance of potassium in plant growth–a review. *Indian Journal of Plant Sciences*, 1(02-03), 177-186.

Rubio, V., Bustos, R., Irigoyen, M. L., Cardona-López, X., Rojas-Triana, M., & Paz-Ares, J. (2009). Plant hormones and nutrient signaling. *Plant Molecular Biology*, *69*, 361-373.

SAS. (2002). By SAS institute INC., Cary, NC, USA. SAS (r) *proprietary software version* 9.00.

Songsri, P., Jogloy, S., Vorasoot, N., Akkasaeng, C., Patanothai, A., & Holbrook, C. C. (2008). Root distribution of drought‐resistant peanut genotypes in response to drought. *Journal of Agronomy and Crop Science*, *194*(2), 92-103.

Terry, N., Zayed, A. M., De Souza, M. P., & Tarun, A. S. (2000). Selenium in higher plants. *Annual review of plant biology*, *51*(1), 401-432.

Van Brunt, J. M., & Sultenfuss, J. H. (1998). Better crops with plant food. Potassium: *Functions of Potassium,* 82(3), 4-5.

Variath, M. T., & Janila, P. (2017). Economic and academic importance of peanut. *The Peanut Genome*, 7-26.

Wang, M., Wang, R., Mur, L. A. J., Ruan, J., Shen, Q., & Guo, S. (2021). Functions of silicon in plant drought stress responses. *Horticulture Research*, *8*.

إستجابة الفول السودانى للرش الورقى بالبوتاسيوم والسيليكون والسيلينيوم تحت ظروف الإجهاد المائي

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مع تزايد محدودية الموارد المائية في المناطق القاحلة وشبه القاحلة ، هناك حاجة إلى استراتيجيات لتوفير المياه للحد من استخدام المياه في الزراعة. أجريت تجربة حقلية بمزرعة البستان الزراعية ، كلية الزراعة ، جامعة دمنهور ، محافظة البحيرة ، مصر خلال موسمي صيفي متتالين 2020 و 2021 لبحث تأثير الرش الورقي للبوتاسيوم والسيليكون والسيلينيوم على بعض صفات النمو والخصائص الكيميائية والمحصول ومكوناته لمحصول الفول السوداني تحت ظروف العجز المائي. تم استخدام تصميم القطعة المنقسمة ، حيث تم استخدام ثلاث نسب استنفاد (50 ، 60 ، و 70٪) من الماء المتاح في قطع الأراضي الرئيسية، بينما تم استخدام أربع معالجات بالرش (ماء الصنبور (كنترول) ، 2 % كبريتات البوتاسيوم، 2 مليمول سيليكون كميتاسليكات الصوديوم، 30جم سيلينيوم كسيلينات الصوديوم) في قطع فرعية. أظهرت النتائج أن زيادة نسبة الإستنفاذ من 50٪ إلى 70٪ أدى إلى انخفاض معنوي في جميع الصفات باستثناء نسبة التصافي. الإضافة الورقية للبوتاسيوم أعطت أعلى ارتفاع للنبات وعدد الأفرع/نبات، بينما أدت المعاملة بالسيليكون إلى أعلى محصول قرون/نبات ، ومحصول البذور/نبات ، ونسبة التصافي، ووزن الـ 100 قرن، ووزن الـ 100 بذرة ، ومحصول القرون. أدت المعاملة بالسيلينيوم إلى ارتفاع محتوى الكلوروفيل. أظهر التفاعل بين العاملين المدروسين أن الري بعد استنفاذ بنسبة 50٪ مع المعاملة بالبوتاسيوم سجل قيم معنوية لارتفاع النبات وعدد الأفرع. تم الحصول على أعلى محتوى من الكلوروفيل عند المعاملة بالسيلينيوم تحت الري بعد استنفاد 70٪ من الماء المتاح. ولوحظت أعلى قيم لمحصول القرون/نبات ، ومحصول البذور/نبات ، ومحصول القرون (أردب/فدان) عندم ري الفول السوداني بعد استنفاذ 50٪ من الماء المتاح والرش بالسيليكون. تم الحصول على أفضل نسبة تصافي باستخدام البوتاسيوم تحت نسبة استنفاذ 70٪. سجلت المعاملة بالسيليكون تحت نسبة استنفاد 60٪ أثقل وزن 100 قرنة ووزن 100 بذرة. عندما تتعرض نباتات الفول السوداني للإجهاد المائي، فإن المعاملة بالسيليكون أو البوتاسيوم أو السيلينيوم تقلل من الفقد في المحصول وتزيد من تحمل النبات لظروف الإجهاد المائي.

الكلمات المفتاحية: الفول السوداني، البوتاسيوم ، السليكون، السيلينيوم، نسبة الاستنفاذ، الرش الورقى، مكونات المحصول