Impact of Grain Priming and Silicon Spraying on the Response of Barley to After Anthesis Drought Stress

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Abstract. Two field experiments were carried out in the experimental farm of Faculty of Desert and Environmental Agriculture, Fuka, Matrouh Branch, Alexandria University, Egypt, during two successive seasons 2012/2013 and 2013/2014 to study the effect of seed priming with Ascorbic and Salicylic Acids and spraying with silicon on drought tolerance of two barley cultivars, Giza 126 and Giza 2000. Six treatment were used as follows: Seed priming with Ascorbic acid (AA) and irrigation till heading (T1), seed priming with Salicylic acid (SA) and irrigation till heading (T2), seed priming with distilled water and irrigation till heading (T3), spraying with silicon and irrigation till heading (T4), dry seeds cultivation and irrigation till heading (T5) and dry seeds cultivation and all season irrigation (T6). The results indicated that post anthesis stress decreased grain yield by 17.1 % and 100-grain weight by 11.96 %, as an average of the two seasons. Hydropriming and osmopriming with salicylic acid, in addition to spraying with silicon, decreased the effect of drought and barley plants gave comparable grain yield to that of non-stress conditions. Barley cultivar Giza 126 was more tolerant to late drought compared to Giza 2000 cultivar with S values of 0.58 and 1.42, as an average of the two seasons, respectively.

Keywords: Ascorbic Acid Barley cultivars, salicylic acid, silicon, yield and its components.

Introduction

Barley (*Hordeum vulgare* L.) is one of the main cereal crops in the world as well as in Egypt (FAO, 2007). It is mainly used for animal feeding (including both grain and straw), brewing of malts and human food. Barley is a short season, early maturing grain found in widely varying environments globally. Barley plants tolerance to moderate levels of water stress is useful because of the pressure of saving irrigation water in Egypt for other non-agricultural sectors (Ouda, *et al.*, 2007).

Drought stress is one the major abiotic stress factors that affect plant growth and physiological processes related to plant development and productivity. Decrease in productivity will depend on crop stage of

growth, drought intensity and longevity. Occurrence of drought at grain development stages (post-anthesis) has more deleterious effects on barley productivity than earlier stages of growth (Haddadin *et al.*, 2013). One of the approaches to improve growth and productivity of crop plants under water deficit is the hormonal and fertilizer treatments which enable the plants to withstand unfavorable environmental conditions (Fayez and Bazaid, 2014) or exogenous use of various growth regulating substances and other chemicals that has proven worthwhile in producing drought tolerance at various growth stages in a number of plants such as seed priming, use of plant growth regulators or mineral elements. Silicon (Si) has been reported to enhance crop tolerance to various environmental stresses, especially drought, by improving the water

status of plants, through enhanced uptake and transport (Gao, *et al.*, 2006). Thus, silicon priming may be a potential source to impart drought stress tolerance in cereal crops (Ahmed, *et al.*, 2013). Salicylic acid (SA) effects on plant growth depends on the plant species, developmental stage and SA concentration applied exogenously. Growth-stimulating effects of SA have been reported in wheat (Shakirova *et al.*, 2003) and other crops. It has been suggested that the growth-promoting effects of SA could be related to improvement of photosynthesis, transpiration and stomatal conductance (Stevens *et al.*, 2006) which are all important physiologic processes that enable plants to tolerate drought conditions (Rivas-San Vicente and Plasencia, 2011). Ascorbic acid (AA) is an organic compound that plays an important role in maintaining normal growth in plants, influencing productivity (Abdel-Hameed *et al.*, 2004) through beneficial effects on morphological, physiological and reproductive characters (Amin, *et al.*, 2008) and increasing of cereal crops tolerance to drought (Bakry, *et al.*, 2013).

The main objective of the present study was to determine the effect of seed priming with each of water, ascorbic and salicylic acids and spraying with silicon on water deficit during the after synthesis and grain development stages of Egyptian barley cultivars, Giza 2000 and Giza 126.

Materials and Methods

Two field experiments were conducted during 2012/2013 and 2013/2014 winter seasons at Fuka Research Station, Faculty of Desert and Environmental Agriculture, Matrouh Governorate (North West Coast of Egypt, N= 31° 04', E= 27° 54'), Alexandria University to study the effect of seed priming with water, Ascorbic and Salicylic acids and spraying with silicon on drought tolerance of two Egyptian barley cultivars. Six treatments

were used as follows: Seed priming with Ascorbic acid (AA) and irrigation till heading (T1). Seed priming with Salicylic acid (SA) and irrigation till heading (T2). Seed priming with distilled water and irrigation till heading (T3). Spraying with silicon and irrigation till heading (T4). Dry seeds cultivation and irrigation till heading (T5) and Control: Dry seeds cultivation and all season irrigation (T6).

Seed priming with ascorbic or salicylic acids was performed by soaking seeds of barley varieties in a concentration of 50 mg/liter of either substances for 10 hours then sown directly (T₁ and T₂). Similarly, seed priming with distilled water was performed by soaking seeds in distilled water for 10 hours then sown directly (T₃). Spraying with silicon (T₄) was applied twice at 50 and 80 days from sowing with a concentration 0.4 gm/liter of sodium meta silicate (Si= 28.09 %).

The experimental site soil had the following properties: texture= sandy (calcareous), pH= 8.33, total organic matter= 0.68 %, EC= 3.35 dS/m as an average of the two seasons. Each experiment was laid out in a split plot design of four replications. The main plots were devoted to the following two barley (*Hordeum vulgare*) cultivars, namely; Giza 2000 and Giza 126. The sub plots were occupied by the six treatments.

Sub plot size was 5.4 m² (6 rows X 0.2 m between rows X 3.0 m row length). Seeding rate for the two cultivars was 96 kg/ha. Nitrogen fertilizer was applied as ammonium nitrate (33.5 % N) at the rate of 96 kg N/ha. Phosphorus fertilizer was applied as calcium monophosphate (15.5 % P₂O₅), during land preparation, at the rate of 37 kg P₂O₅ /ha. Potassium fertilizer was added as potassium sulphate (48% K₂O) at the rate of 60 K₂O/ha. All other practices, such as pest control, were applied as recommended for barley production

in the region. Sowing date was November 25nd in the two seasons.

The following characters were measured, or computed, in the two seasons:

- 1) Whole plants dry weight was calculated at 48, 65 and 80 days after sowing (DAS), by oven-drying of plants taken from a random sample (0.06 m²) taken from each sub plot. Relative growth rate (RGR, g/g/day) was calculated for the periods 48-65 and 65-80 days, according to Hunt (1990).
- 2) Leaf area index (LAI), was calculated at 65 DAS, according to Sestak *et al.*, (1971), using leaf area meter, model no. Li 3000 C.
- 3) Grains dry weight development (GDWD, g/plant), was measured at 111, 125 and 139 DAS. Ten random spikes from Barley plants from each sub-plot were taken and grains were separated and weighed. Grains were then oven-dried at 70°C till constant weight. Dry weight of grains was expressed as g/spike.
- 4) At harvest, number of spikes/m² (NS/m²), number of grains/spike, NG/S, average of 10 random spikes) and 100-grain weight (100 GW, average of two random 100-grains samples) were calculated from each sub-plot. Grain yield (GY) was calculated from harvesting and threshing of the four inner rows, from each sub-plot, and weight of grains was converted to tons/ha. Harvest index (HI) was calculated as: HI= Grain yield/ biological yield (Beadle, 1993).
- 5) Drought susceptibility index (DSI), according to Fischer and Maurer (1978), as follows:

$$DSI = 1 - \frac{Y_s}{Y_w} / 1 - \frac{\bar{Y}_s}{\bar{Y}_w}$$

Where, Y_s: Yield under stress condition.

Y_w: Yield under all season irrigation.

$\bar{Y}_s$: Mean of genotypes or treatment under stress condition.

$\bar{Y}_w$: Mean of genotypes or treatment under all season irrigation.

$(1 - \frac{\bar{Y}_s}{\bar{Y}_w})$ = Environmental stress intensity.

Data were subjected to the statistical analysis according to El-Nakhlawy, (2010) using SAS ver. 9.1.3 (2007). Means were compared, using the revised least significant difference (RLSD) value at p≤0.05.

Results

Cultivars showed insignificant differences in relative growth rate (RGR) in the two periods 48-65 and 65-80 DAS. RGR values increased from 0.03 to about 0.08 g/g/day from the first to the second period in both seasons (Table 1). The same trend of data for cultivars was found for grain dry weight development (GDWD) at 111, 125 and 135 DAS, however, cultivar Giza 126 showed a slight increase over cultivar 2000 for that character in both seasons (Table 2). With regard to leaf area index (LAI), insignificant differences were found between the two cultivars, at 65 DAS, however Giza 2000 exhibited a non-significant increase over Giza 126 (Table 2). Regarding grain yield and yield components, means presented in (Tables 3 and 4) indicated insignificant differences between the two cultivars in number of spikes/m², number of grains/spike and grain yield in both seasons. However, Giza 126 was significantly superior to Giza 2000 in 100-grain weight and harvest index in the two seasons. In the present investigation, drought was imposed after heading (post-anthesis) and that may explain the insignificant differences between both cultivars, in RGR and LAI which were recorded at pre anthesis stages, in addition to NS/m². On the other hand, the severity of drought at post-anthesis stage, especially in the

first season, may have drastically affected grain formation, in both cultivars, thus exhibiting insignificant variations in NG/S and GY. Meanwhile, values of drought susceptibility index (DSI) revealed lower values for Giza 126 compared to Giza 2000 (Table 4) indicating the higher tolerance of Giza 126 to terminal drought conditions compared to Giza 2000.

Insignificant differences were found between all applied treatments for RGR at 48-65 DAS period (Table 1) however, at 65-80 DAS period, the control (T6), priming with each of AA (T1), SA (T2) and water (T3), in addition to spraying with Si (T4), gave significantly higher RGR values compared to the drought treatment (T5). The trend was similar in both seasons. Means presented in (Table 2, Fig. 1 and 2) for GDWD, at the three sampling dates, revealed that T1, T2, T3, T4 and T6 were significantly superior to T5 in both seasons. Similarly T3, T4 and T6 surpassed T1 and T2, in the two seasons, for GDWD values. LAI values, presented in (table 2), indicated that T1 gave statistically similar values for T6, and both were significantly higher than T2, T3 and T4. The significantly least values was obtained from T5 in both seasons.

Concerning grain yield and yield components (Tables 3 and 4), insignificant differences were recorded between all applied treatments for NS/m², NG/S and HI in the two seasons. However, GY showed significant variation in the two seasons, where T6 significantly surpassed T1 and T5, but was statically similar to T2, T3 and T4 in both seasons. With regard to 100-GW, T6 and T4

were significantly superior to T1 and T5, and statically similar to T2 and T3 in the first season. However, in the second season, T6 was significantly higher than T3 and T5 and statically similar to T1, T2 and T4. That variation in treatment ranking, other than T6 and T5, may be attributed to environmental conditions modifying the effect of applied treatment. DSI values for applied treatments increased in the order T2<T3<T4<T1<T5 indicating that all applied compounds and elements enhanced drought tolerance compared to drought treatment and priming with SA showed the highest tolerance to post-anthesis drought.

The interaction between barley cultivars and applied treatments (Tables 1, 2, 3 and 4) indicated significant first order interaction for RGR, GDWD, LAI and GY in both seasons, NS/m² in the second season and 100 GW in the first season. The data exhibited the significant superiority of T6 with both cultivars over T5 with both cultivars, in the two seasons. The remaining applied treatments gave intermediate values for interaction. It may be observed that the interaction resulted from the differences in magnitude (expression of character) of response of the two barley cultivars to the applied treatment. For example, GY differences (Table 4, Fig. 3), in the first season, between the two barley cultivars were 0.09, 0.06, 0.20, 0.10, 0.04 and 0.28 t/ha for T1, T2, T3, T4, T5 and T6, respectively, whereas, in the second season, GY differences reached 0.33, 0.31, 0.26, 0.01, 0.09 and 0.58 t/ha, for the respective treatments.

Table 1. Mean values for relative growth rate (g/g/day) at 48-65 and 65-80 days in 2012/13 and 2013/14 seasons.

character Treatments		Relative growth rate (RGR)			
		2012/ 2013		2013/ 2014	
		48-65 days	65-80 day	48-65 days	65-80 day
Cultivars	Giza 2000	0.03 a *	0.08 a	0.03 a	0.09 a
	Giza 126	0.03 a	0.08 a	0.03 a	0.08 a
Alleviation treatments	T1	0.03 a	0.08 a	0.03 a	0.09 a
	T2	0.03 a	0.09 a	0.03 a	0.09 a
	T3	0.03 a	0.07 ab	0.03 a	0.08 a
	T4	0.03 a	0.08 a	0.03 a	0.08 a
	T5	0.02 a	0.06 b	0.02 a	0.06 b
	T6	0.04 a	0.09 a	0.04 a	0.09 a
Interaction					
Giza 2000	T1	0.04	0.08	0.04	0.10
	T2	0.03	0.08	0.03	0.10
	T3	0.02	0.08	0.02	0.09
	T4	0.03	0.09	0.03	0.09
	T5	0.03	0.06	0.03	0.07
	T6	0.02	0.09	0.02	0.11
Giza 126	T1	0.02	0.07	0.02	0.09
	T2	0.03	0.08	0.03	0.09
	T3	0.03	0.07	0.03	0.08
	T4	0.05	0.08	0.04	0.07
	T5	0.02	0.05	0.02	0.05
	T6	0.02	0.09	0.02	0.10
RLSD _{0.05} ⁽¹⁾		NS	0.024	NS	0.035
RLSD _{0.05} ⁽²⁾		NS	0.035	NS	0.036

(1) Revised least significant difference between treatments at the same cultivar.

(2) Revised least significant difference between cultivars at the same treatment.

*Means followed by the same letter(s) are not significantly different at $p \leq 0.05$.

Table 2. Mean values for leaf area index and grains dry weight development at 111, 125 and 139 days in 2012/13 and 2013/14 seasons.

Characters Treatments		Leaf area index (LAI)		Grains dry weight development (GDWD) (g/ spike)					
		2012/ 2013	2013/ 2014	2012/ 2013			2013/ 2014		
				111 day	125 day	139 day	111 day	125 day	139 day
Cultivars	Giza 2000	1.93 a	3.62 a	3.79 a	4.11 b	5.16 b	4.63 a	5.15 b	6.37 b
	Giza 126	1.86 a	3.48 a	3.91 a	5.58 a	6.23 a	4.77 a	6.97 a	7.70 a
Alleviation treatments	T1	2.27 a	4.24 a	3.72 b	4.32 d	5.18 d	4.53 b	5.39 d	6.40 d
	T2	1.61 cd	3.00 cd	3.61 b	4.73 c	5.46 c	4.40 b	5.91 c	6.75 c
	T3	1.90 b	3.54 b	4.23 a	5.16 b	6.32 a	5.20 a	6.45 b	7.80 a
	T4	1.72 bc	3.22 bc	4.20 a	5.11 b	5.97 b	5.05 a	6.39 b	7.37 b
	T5	1.43 d	2.66 d	3.01 c	3.80 e	4.78 e	3.66 c	4.75 e	5.91 e
	T6	2.46 a	4.61 a	4.30 a	5.96 a	6.47 a	5.25 a	7.45 a	7.99 a
Interaction									
Giza 2000	T1	2.12	3.96	4.08	4.21	5.20	4.97	5.27	7.34
	T2	1.54	2.88	3.52	4.16	5.01	4.29	5.20	6.19
	T3	1.67	3.04	4.19	4.40	5.94	5.12	5.50	6.42
	T4	1.63	2.89	3.36	3.49	4.38	4.09	4.37	5.41
	T5	1.31	2.44	3.16	3.30	4.33	3.85	4.20	5.34
	T6	2.34	4.83	4.33	5.07	6.11	5.34	6.33	7.54
Giza 126	T1	2.59	4.53	4.32	6.01	6.74	5.07	6.63	8.25
	T2	1.54	3.13	4.15	5.30	6.68	4.97	7.41	7.31
	T3	1.90	4.04	4.07	5.92	6.04	5.27	7.51	8.33
	T4	2.16	3.55	3.69	5.14	5.92	4.51	6.42	7.46
	T5	1.54	2.87	2.85	4.24	5.19	3.48	5.30	6.41
	T6	2.42	4.83	4.45	6.85	6.83	5.43	8.57	8.44
RLSD _{0.05} ⁽¹⁾		0.27	0.27	0.51	0.23	0.37	0.54	0.29	0.45
RLSD _{0.05} ⁽²⁾		0.19	0.19	0.37	0.21	0.53	0.56	0.30	0.47

(1) Revised least significant difference between treatments at the same cultivar.

(2) Revised least significant difference between cultivars at the same treatment.

*Means followed by the same letter(s) are not significantly different at $p \leq 0.05$.

Table 3. Mean values for number of spikes/m², number of grains/spikes and 100-grain weight in 2012/13 and 2013/14 seasons.

Characters Treatments		NS/ m2		NG/ S		100 GW (gm)	
		12/13	13/14	12/13	13/14	12/13	13/14
Cultivars	Giza 2000	272.25 a	287.25 a	47.0 a	52.14 a	3.78 b	3.34 b
	Giza 126	343.50 a	295.00 a	51.8 a	53.16 a	4.29 a	4.10 a
Alleviation treatments	T1	323.00 a	275.00 a	50.9 a	52.84 a	3.87 b	3.76 ab
	T2	285.50 a	302.00 a	49.8 a	53.18 a	3.94 b	3.80 ab
	T3	308.75 a	305.00 a	50.4 a	52.30 a	4.08 b	3.52 b
	T4	307.75 a	307.50 a	49.6 a	52.56 a	4.21 a	3.73 ab
	T5	226.50 a	238.75 a	44.2 a	50.80 a	3.87 b	3.46 b
	T6	395.75 a	318.75 a	51.5 a	54.23 a	4.25 a	4.07 a
Interaction							
Giza 2000	T1	320.75	303.75	48.6	53.48	3.87	4.04
	T2	258.25	295.00	36.6	54.75	4.18	3.53
	T3	275.00	301.25	47.9	51.80	4.17	2.76
	T4	187.50	255.00	46.5	51.60	4.38	3.38
	T5	112.50	233.75	48.9	50.00	4.51	3.26
	T6	458.25	315.00	53.7	51.23	4.65	3.10
Giza 126	T1	340.50	315.00	53.2	54.98	3.85	4.10
	T2	312.50	300.00	51.8	51.60	3.70	4.08
	T3	340.50	313.75	53.0	52.80	3.35	4.16
	T4	312.50	295.00	52.7	53.53	3.77	4.08
	T5	297.00	243.75	50.8	51.60	3.97	3.78
	T6	479.00	322.50	49.4	54.45	3.98	4.42
RLSD 0.05 (1)		NS	2.46	NS	NS	0.49	NS
RLSD 0.05 (2)		NS	2.41	NS	NS	0.09	NS

(1) Revised least significant difference between treatments at the same cultivar.

(2) Revised least significant difference between treatments at the same cultivar.

*Means followed by the same letter(s) are not significantly different at $p \leq 0.05$.

Table 4. Mean values for grain yield, harvest index and drought susceptibility index in 2012/13 and 2013/14 seasons.

Characters Treatments		GY (ton/ ha)		HI (%)		DSI (%)	
		12/13	13/14	12/13	13/14	12/13	13/14
Cultivars	Giza 2000	1.25 a	2.59 a	15.06 b	14.94 b	0.58	0.58
	Giza 126	1.37 a	2.85 a	17.21 a	17.49 a	1.42	1.42
Alleviation treatments	T1	1.23 b	2.54 b	15.54 a	16.73 a	1.32	1.42
	T2	1.35 ab	2.79 ab	16.34 a	15.83 a	0.60	0.60
	T3	1.31 ab	2.71 ab	15.93 a	15.69 a	0.75	0.66
	T4	1.34 ab	2.77 ab	16.66 a	16.49 a	0.83	0.83
	T5	1.21 b	2.50 b	15.41 a	14.89 a	1.42	1.50
	T6	1.46 a	3.02 a	17.05 a	17.67 a	-	-
Interaction							
Giza 2000	T1	1.31	2.72	13.97	14.37	-	-
	T2	1.29	2.48	14.05	14.55	-	-
	T3	1.27	2.63	15.34	15.76	-	-
	T4	1.20	2.68	12.78	13.28	-	-
	T5	1.10	2.27	16.12	16.67	-	-
	T6	1.32	2.73	14.56	15.01	-	-
Giza 126	T1	1.40	3.05	18.62	19.10	-	-
	T2	1.35	2.79	16.60	17.10	-	-
	T3	1.47	2.89	16.72	17.22	-	-
	T4	1.30	2.69	17.62	18.10	-	-
	T5	1.14	2.36	18.15	18.67	-	-
	T6	1.60	3.31	14.53	14.78	-	-
RLSD 0.05 ⁽¹⁾		NS	0.57	0.57	NS	-	-
RLSD 0.05 ⁽²⁾		NS	0.42	0.42	NS	-	-

(1) Revised least significant difference between treatments at the same cultivar.

(2) Revised least significant difference between cultivars at the same treatment.

*Means followed by the same letter(s) are not significantly different at $p \leq 0.05$.

Fig. 1. Mean values for grains dry weight development at 111 , 125 and 139 days during 2012/2013 season.

Fig. 2. Mean values for grains dry weight development at 111 , 125 and 139 days during 2013/2014 season.

Fig. 3. Mean values for grains yield as affected by the interaction between cultivars and treatments during 2013/2014 season.

Discussion

The results obtained from the present study indicated that late drought (post-anthesis), represent by dry seed sowing and withholding irrigation at heading (T5), significantly

reduced grain yield and 100-grain weight compared to non-stress conditions (T6, irrigation all season). The reduction reached 17.1 and 11.96 % as an average of the two seasons, respectively. That reduction may have

resulted from the effect of terminal drought (during grain formation and development stages) on physiological and biochemical processes in barley plants, such as photosynthesis and metabolites transport to grains, leading to lower grain weight and reduced grain yields. Haddadin *et al.*, (2013) reported that late drought caused significant reduction in grain yield (26.1 %) compared to early drought (12.9 %). Similarly, Khalil *et al.* (2007) obtained a loss in grain yield with late drought stress (skipping the late irrigation) of about 26.0 %. Drought susceptibility index (S) values for T5, 1.42 and 1.50 in the two seasons, respectively, clearly emphasized the susceptibility of barley plants to terminal drought.

Seed priming has been practiced in many countries, including Egypt, to enhance germination and emergence of seedlings for a variety of crops (Nawaz *et al.*, 2013). Priming techniques such as hydropriming, osmopriming and hormonal priming has many advantages including rapid and uniform emergence, improved seedling growth and better stand establishment under variations in environmental conditions (Chiu and Sung, 2002). In drought-prone regions of the Mediterranean, early establishment of barley plants will permit them to benefit from favorable conditions early in the season and withstand harsher growing conditions late in the season including drought and elevated temperatures. Ascorbic acid enhance cell division and vegetative growth, especially at early stages of growth, leading to better use of available environmental conditions and enhancement of leaves growth in size (Darvishan, *et al.*, 2013 and Mohamed, 2013).

The obtained results indicated the hydropriming (T3), priming with salicylic acid (SA, T2) and spraying with silicon (Si, T4), increased barley plants to terminal drought and resulted in grain yields comparable to that of

non-stressed conditions (T6). However, priming with ascorbic acid (AA, T1) did not show any improvement in late drought tolerance. That implies the need for further studies to determine the suitable concentration for priming with that organic compound or investigate the possibility of exogenous application (through spraying) at specific stages to elucidate its role in drought tolerance of barley plants. Hydropriming, SA priming and Si spraying enhanced early establishment of barley plants and increased LAI values, compared to untreated plants (T5), leading to higher photosynthesis activity, better vegetative and reproductive growth and hence higher ability to tolerate adverse climatic conditions late in the season. Drought susceptibility index values for those treatments were less than unity, in the two seasons, indicating their beneficial effect in alleviation the harmful effects of terminal drought on barley plants. Similar findings were reported by Gao, *et al.*, (2006), Stevens, *et al.*, (2006), Abdulrahmani, *et al.*, (2007) Zahid, *et al.*, (2015), Jalilian, *et al.*, (2014) and El-Nakhlawy and Al-Qurashi, (2014). A cornerstone for the success of sustaining barley productivity in drought-prone regions is the choice of suitable barley variety that would perform adequately under such environmental conditions. The cultivars used in the present study, Giza 126 and Giza 2000, are both six-rowed cultivars. Variations in their response to drought conditions was evident in 100-grain weight and harvest index where Giza 126 showed significant superiority in both characters. In spite of the insignificant differences in grain yield, Giza 126 showed high tolerance to terminal drought ($S = 0.58$) compared to Giza 2000 ($S = 1.42$). Similar findings were reported by Khalil, *et al.*, (2007) who found that Giza 126 had slightly lower values for drought susceptibility index than Giza 2000. Moreover, Haddadin, *et al.*, (2013) and Haddadin (2015) reported variations

between barley cultivars in grain yield and yield components under drought conditions at different growth stages, in addition to variations in stress susceptibility index of barley varieties for different traits.

In conclusion, the results of the present study emphasized the role of seed priming (hydro and osmotic priming) in alleviating the harmful effects of post-anthesis drought conditions, especially salicylic acid and hydropriming, in addition to spraying of silicon twice, and growing of barley cultivars Giza 126 to increase potential yield of barley under drought conditions at grain formation and development stage.

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تأثير نقع الحبوب والرش بالسيليكون على استجابة الشعير للإجهاد المائي بعد طرد السنابل

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قسم المحاصيل، كلية الزراعة، * كلية الزراعة الصحراوية والبيئية، جامعة الإسكندرية، فرع مطروح، مصر

المستخلص. أجريت تجربتان حقيتان في مزرعة كلية الزراعة الصحراوية والبيئية - فوكة - فرع مطروح - جامعة الإسكندرية - مصر خلال الموسمين ٢٠١٢/٢٠١٣ و ٢٠١٣/٢٠١٤ م لدراسة تأثير نقع حبوب الشعير في حمض الأسكوربيك وحمض الساليسليك ورش النباتات بالسيليكون على تحمل صنف الشعير جيزة ١٢٦ وجيزة ٢٠٠٠ للإجهاد المائي. استخدمت ستة معاملات وهي على التوالي: نقع الحبوب في حمض الأسكوربيك والري حتى طرد السنابل (معاملة ١)، نقع الحبوب في حمض الساليسليك والري حتى طرد السنابل (معاملة ٢)، نقع الحبوب في الماء والري حتى طرد السنابل (معاملة ٣)، الرش بالسيليكون والري حتى طرد السنابل (معاملة ٤)، زراعة الحبوب جافة والري حتى طرد السنابل (معاملة ٥) وزراعة الحبوب جافة والري طول الموسم (معاملة ٦). أوضحت النتائج أن الجفاف في مرحلة بعد طرد السنابل يقلل من المحصول بنسبة ١٧,١ وكذلك وزن ١٠٠ حبة بنسبة ١١,٩٦٪ كمتوسط للموسمين. كما أن استخدام معاملات النقع في الماء والنقع في حمض الساليسليك والرش بالسيليكون يقلل من تأثير الإجهاد المائي إذ لم يكن هناك اختلافات معنوية في محصول الحبوب تحت ظروف الجفاف. أظهر الصنف جيزة ١٢٦ أكثر تحملاً للإجهاد المائي مقارنة بالصنف جيزة ٢٠٠٠ بقيمة معامل جفاف (S) ٠,٥٨، ١,٤٢ كمتوسط للموسمين.

الكلمات المفتاحية: أصناف الشعير، حمض الأسكوربيك، حمض الساليسليك، السيليكون، المحصول ومكوناته.