Plant Archives Vol. 19, Supplement 1, 2019 pp. 67-74 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

THE EFFECT OF SILICON, TILLAGE AND THE INTERACTION BETWEEN THEM ON SOME ANTIOXIDANTS AND PHYTOHORMONES DURING DROUGHT STRESS OF MAIZE (*ZEA MAYS* L.) PLANTS

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Abstract

Maize (*Zea mays* L.) is an important cereal crop all over the world and among sensitive plants to moisture exhuasion. In this research plants were exposed to (50% as a control and 75%) of moisture exhuasion so, different methods were used to evaluate maize resistance to drought stress by using silicon, tillage and wheat residues. Plant resistance to drought stress was indicated by antioxidant enzymes activity (superoxide dismutase SOD, ascorbic peroxidase APX and catalase CAT) activity and phytohormones (auxin IAA, gibberelline GA and abscisic acid ABA). SOD activity and CAT activity were increased combined with IAA decrease in stressed plants without silicon treatment. While, SOD activity and CAT activity decreased significantly with an increase in IAA concentration in plants grown in non tillage lands with wheat residues and treated with silicon. Whereas GA and ABA concentrations were increased in plants grown in tillage lands with wheat residues which treated with silicon. Finally, we concluded that spraying plants with silicon and growing them in non tillage lands with the presence of wheat residues enable the plant to overcome drought stress.

Key word : *Zea mays*, Phytohormones, antioxidents, silicon, drought stress, tillage.

Introduction

Maize or corn (*Zea mays* L.) is an essential cereal crops in food sufficiency (Bruce *et al*., 2002). So, its important to develop a resistant maize varieties against abiotic stresses such as salt stress, drought stress and heat stress. This aspirations have been realized by using different strategies like spraying plants with different materials such as salicylic acid, plants extracts, silicon or by using tillage pathways (Johnson *et al*., 2018) or by manipulation of its metabolism proteins, antioxidants compatible solutes and endogenous hormones (Farooq *et al*., 2012)

Drought stress resulted from decrease the soil water level which lead to decrease plant water absorption coincided with high level of transpiration (Bruce *et al*., 2002; Ashraf, 2010). Which affect physiological processes due to turgor loss (Farooq *et al*., 2012). In maiz water stress effect negatively on its morphological characteristics such as kernel size , tiller length, leaves number and size and biomass production (Saini and Westgate, 2000; Khan *et al*., 2001; Boyer and Westgate, 2004; Zhao *et al*., 2006; Barney *et al*., 2009; Tai *et al*., 2011).

As a result of drought, reactive oxygen species (ROS) are accumulate in the cell, they are detoxified by some group of enzymatic and non enzymatic systems such as SOD,CAT,GSH, α–tocopherol and β-carotene to maintain minimal levels of ROS (Kellôs *et al*., 2008; Taiza *et al*., 2015; Jasim *et al*., 2016).

Phytohormones are considered as one of the controlling systems responsible for plant resistance especially abscicic acid (ABA) which is well known to regulate the environmental stresses through plant developing program (Spollen *et al*., 2000; Sharp *et al*., 2000; Cheng *et al*., 2002; Chow and McCourt 2004; Christmann *et al*., 2005; Jasim *et al.,* 2013; Jasim *et al*., 2016) or by oscillation of its content within the plant (biosynthesis or degradation) (Cutler and Krochko, 1999; Zeevaart, 1999; Jasim *et al*., 2013). Wang *et al*. (2008) noticed that maize plants subjected to water stress showed an increase in ABA level within its roots, whereas Wilkinson and Davies (2010) showed that ABA level was increased within the leaves in response to drought stress by increasing stomatal closure signals to prevent water evaporation. In addition, it was observed that auxin (IAA) plays an important role in plant resistant through integration stress signals of different plant hormones and modulation of stress-induced morphological responses by modulation of redox pathways (Hirayama and Shinozaki, 2010) 0r by controlling plant growth (Rowe *et al*., 2016). Also, gibberreline (GA) found to be participated in plant resistant to water stress by its mediation by DELLA proteins (Achard *et al*., 2006; Achard *et al*., 2008; Magome *et al*., 2008). *Arabidopsis thaliana* seedlings, exposed to salinity showed a decrease in endogenous GAs (Achard *et al*., 2006; Magome *et al*., 2008), which concomitant with DELLA accumulation (Achard *et al*., 2006). Wang *et al*. (2008) reported a reduction in GA content in maize leaves.

Tillage is defined as a mechanical manipulation treatment for the soil which is used to enhance plant production by changing soil characteristics such as soil water conservation, soil temperature, in filtration and water evaporation process (1,3). Also, it increase water use efficiency and nutrient management practices and water availability (Hatfield *et al*., 2001; Mwehia, 2015).

Silicon is nonessential element for plants, but it play an important role in plant growth and development. Silicon application cause an increase in plant parameters such as photosynthetic rate, leaf water status and osmotic adjustment. Drought stress resistant in maize can be controlled by silicon application by improving photosynthetic rate, osmotic adjustment, decrease water loose and lowered water transpiration lead to plant growth and yield (Amin *et al*., 2016)

Wheat straw is an important product used in many agricultural sustainability because it contain an important elements such as cellulosic fibers, hemicelluloses, proteins, lignin and ash, N-heterocycles, fatty acids, phenols, lignins, carbohydrates, steroids and amino acids (Khan and Mubeen, 2012; Schnitzer *et al*., 2014)

Materials and Methods

Field experiment was carried out during the summer season of 2016 in Kut city located southwest of Baghdad at latitude 45-49 and length 32.3, in loam-silt-clay soil in order to determine the role of wheat crop residues and tillage system in reducing water stress on maize crop. Split-split plot arrangement at randomized complete block design with three replications was used. The wheat residue process consisted on the main plots, which included four treatments a tillage without wheat residue (control), tillage with a wheat residue, non-tillage with wheat residue and no-tillage without wheat residue. While the moisture exhaustion treatments were dissolved in the sub-plots which were 50% (as control), and 75% exhaustion from the prepared water. Silicon treatments were consisted in sub- plots which were control and treatments with silicon spraying at 18^{th} leaves stage.

The experimental field was selected from a field planted with wheat crop cv. Ebaa 99 for the winter season 2015-2016 as a homogeneous piece of wheat residue at a height of 30-35 cm. The amount of wheat residue was calculated in the experimental units by dropping a wooden box with a square meter area in four random areas within the field before tillage. The wheat residue was then collected to determine the amount of wheat residue in the unit area. After preparing the field, seeds of corn (Alfurat hybrid) were planted at 27/7/2016 by laying 3 seeds in each hill (25 cm apart) on line (75 cm apart) and then subsided into one plant per hill after one month of planting. Fertilizers were added as recommend to the maize. The irrigation process was carried out by a flexible 2-inch plastic pipe network attached to a water-fed pump that was calibrated before each irrigation to control the addition of calculated water based on the depletion of the water content specified in the control treatment (tillage and no residue). In order to determine the irrigation dates and their quantities, the moisture was measured by the weight method before each irrigation to determine the specific irrigation time for each treatment.

Results

Table (1) illustrated a significant decrease in SOD activity in plants treated with Si to be (15.6) unit compared with untreated plants which its SOD activity was (44.3) unit. While there was no significant effect of tillage or moisture exhaustion.

The dual interaction demonstrated that SOD activity increased significantly in plants without Si which exposed to moisture exhaustion for 14 days, while the plants treated with Si showed a significant decrease in SOD activity both for un stressed and for plants exposed to water exhaustion to reach up to (13.8) unit.

In addition SOD activity was decreased significantly in plants grown in wheat residue-tillage + Si treatment (11.9) unit. While tillage + moisture exhaustion had no effect on SOD activity.

The triple interaction showed that SOD activity increased significantly in plants with the treatment of (14 days of stress without Si in non tillage land with wheat residue) which was **(63.4)** unit. While the enzyme activity decreased significantly when the plants treated with (14 days of stress with Si in non tillage land with wheat residue) which was (7.9) unit.

Table 1 : The effect of silicon, tillage and moisture exhaustion and the interaction between them on SOD activity.

Silicon	Moisture exhaustion	Tillage with a wheat residue: No-tillage without wheat residue	tillage without wheat residue	Non-tillage with wheat residue	tillage with a wheat residue	Si + Moisture exhaustion
Without Si	7 day	34.5	34.7	37.4	35.5	35.5
	14 day	57.5	35.7	63.4	55.6	52.1
Spraying Si	7 day	12.9	14.5	15.9	26.9	17.15
	14 day	**12.2**	**24.8**	**7.9**	**10.2**	**13.8**
Mean of tillage with a wheat residue		**29.3**	**27.4**	**31.2**	**32.0**	
$LSD_{(0.05)}$	**Si*M.E*Tillage with a wheat residue=20.28 Si*Moisture exhaustion=10.14 Tillage with a wheat residue=10.14**					
Si+tillage with a wheat residue						**Mean of Si**
Without Si		**46.0**	**35.2**	**50.4**	**45.5**	**44.3**
Spraying Si		**12.5**	**19.6**	**11.9**	**18.5**	**15.6**
$LSD_{(0.05)}$	**Si*tillage with a wheat residue= 14.34 Si= 7.17**					
Moisture exhaustion + tillage with a wheat residue						**Mean of Moisture exhaustion**
7 day		**23.7**	**24.6**	**26.6**	**31.2**	**26.5**
14 day		**34.9**	**30.2**	**35.7**	**32.9**	**33.4**
$LSD_{(0.05)}$	**Moisture exhaustion*tillage with a wheat residue= 14.34 Moisture exhaustion=7.17**					

Table (2) showed that there is a significant decrease in SOD activity in plants treated with Si to be (31.4) unit compared with untreated plants which was SOD activity (38.8) unit. While there was no significant effect of tillage or moisture exhaustion. But the dual interaction showed that APX increased significantly in stressed plants grown in tillage land with a wheat residue.

The triple interaction showed that there was no significant effect of almost treatments except of (7 days+ Si + no tillage without wheat residue) which increased significantly to be (17×10^{-4}) unit compared with the control (37.7×10^{-4}) unit.

Table 2: The effect of silicon, tillage and moisture exhaustion and the interaction between them on APX ($\times10^{-4}$) activity.

Silicon	Moisture exhaustion	Tillage with a wheat residue: No-tillage without wheat residue	tillage without wheat residue	Non-tillage with wheat residue	tillage with a wheat residue	Si + Moisture exhaustion
Without Si	7 day	37.7	39.0	38.5	38.2	38.4
	14 day	38.8	39.8	38.5	39.9	39.2
Spraying Si	7 day	17.0	40.0	39.7	27.8	31.1
	14 day	39.9	25.0	21.3	40.5	31.7
Mean of tillage with a wheat residue		33.4	36.0	34.5	36.6	
LSD$_{(0.05)}$	Si*M.E*Tillage with a wheat residue=15.16* 10^{-4} Si*Moisture exhaustion= 7.58* 10^{-4} Tillage with a wheat residue= 7.58* 10^{-4}					
Si+tillage with a wheat residue						**Mean of Si**
Without Si		38.3	39.4	38.5	39.0	38.8
Spraying Si		28.5	32.5	30.5	34.2	31.4
LSD$_{(0.05)}$	Si*tillage with a wheat residue=10.72* 10^{-4} Si= 5.36* 10^{-4}					
Moisture exhaustion + tillage with a wheat residue						**Mean of Moisture exhaustion**
7 day		27.4	39.5	39.1	33.0	34.7
14 day		39.3	32.4	29.9	40.2	35.4
LSD$_{(0.05)}$	Moisture exhaustion*tillage with a wheat residue= 10.72* 10^{-4} Moisture exhaustion= 5.36 * 10^{-4}					

Whereas, a significant decrease in CAT activity was shown in table (3). The first one was when the plants treated with Si. CAT activity was (1.96) unit compared with the control (2.61) unit. The second decrease was in stressed plants treated with Si and grown in tillage land with wheat residue which was (0.7) unit in compatible with the control (3.09) unit. In contrast CAT activity increased significantly in unstressed plants grown in till aged land without wheat residue (3.67) unit.

The triple interaction showed that CAT activity was decreased significantly in almost treatments treated with Si, but the lowest one was in stressed plants treated with Si in non tillage land with wheat residue.

Table 3 : The effect of silicon, tillage and moisture exhaustion and the interaction between them on CAT activity

Silicon	Moisture exhaustion	Tillage with a wheat residue: No-tillage without wheat residue	tillage without wheat residue	Non-tillage with wheat residue	tillage with a wheat residue	Si + Moisture exhaustion
Without Si	7 day	3.30	3.59	2.60	1.76	2.81
	14 day	2.89	2.76	2.81	2.15	2.41
Spraying Si	7 day	2.83	3.76	1.11	1.93	2.65
	14 day	1.64	1.78	0.29	1.36	1.27
Mean of tillage with a wheat residue		2.66	2.97	1.70	1.80	
LSD$_{(0.05)}$	Si*M.E*Tillage with a wheat residue= 1.37 Si*Moisture exhaustion= 0.67 Tillage with a wheat residue= 0.67					
Si+tillage with a wheat residue						**Mean of Si**
Without Si		3.09	3.17	2.71	1.95	2.73
Spraying Si		2.23	2.77	0.70	1.65	1.84
LSD$_{(0.05)}$	Si*tillage with a wheat residue= 0.97 Si= 0.48					
Moisture exhaustion + tillage with a wheat residue						**Mean of Moisture exhaustion**
7 day		2.07	3.67	1.86	1.85	2.61
14 day		2.26	2.27	1.55	1.75	1.96
LSD$_{(0.05)}$	Moisture exhaustion*tillage with a wheat residue= 0.97 Moisture exhaustion= 0.48					

Table (4) showed that IAA concentration was increased significantly up to (4.90×10^{-4}) Mm when the plants treated with Si compared with untreated plants (2.60×10^{-4}) Mm. A similar increase in IAA concentration was observed in plants grown in non tillage land with wheat residue (4.69×10^{-4}) Mm. whereas, there was no significantly in IAA concentration when the plants exposed to moisture exhaustion stress.

The dual effect showed that plants treated with Si increased significantly both in unstressed and stressed plants compared with untreated plants with Si. The increase was observed in pants grown in tillaged plants with and without wheat residue. Whereas, only stressed plants which grown in non tillaged land with wheat residue showed a significant increase in IAA concentration.

The triple interaction showed that IAA concentration was increased significantly in almost treatments treated with Si, but the higher one was in stressed plants treated with Si in non tillaged land with wheat residue.

Table 4 : The effect of silicon, tillage and moisture exhaustion and the interaction between them on IAA ($\times10^{-4}$) concentration.

Silicon	Moisture exhaustion	Tillage with a wheat residue: No-tillage without wheat residue	tillage without wheat residue	Non-tillage with wheat residue	tillage with a wheat residue	Si + Moisture exhaustion
Without Si	7 day	1.18	2.30	4.80	2.70	2.74
	14 day	3.13	1.91	2.57	2.23	2.46
Spraying Si	7 day	4.10	5.16	3.53	4.20	4.25
	14 day	4.14	5.83	7.88	4.39	5.56
Mean of tillage with a wheat residue		3.14	3.80	4.69	3.38	
LSD(0.05)	Si*M.E*Tillage with a wheat residue=2.7* 10^{-4} Si*Moisture exhaustion=1.35* 10^{-4} Tillage with a wheat residue= 135* 10^{-4}					
Si+tillage with a wheat residue						**Mean of Si**
Without Si		2.16	2.10	3.68	2.47	2.60
Spraying Si		4.12	5.49	5.71	4.29	4.90
LSD(0.05)	Si*tillage with a wheat residue= 1.91* 10^{-4} Si= 0.95* 10^{-4}					
Moisture exhaustion + tillage with a wheat residue						**Mean of Moisture exhaustion**
7 day		2.64	3.73	4.16	3.45	3.50
14 day		3.63	3.87	5.23	3.31	4.01
LSD(0.05)	Moisture exhaustion*tillage with a wheat residue= 1.91* 10^{-4} Moisture exhaustion= 0.95* 10^{-4}					

Table 5 : The effect of silicon, tillage and moisture exhaustion and the interaction between them on GA3 ($\times10^{-4}$) concentration

Silicon	Moisture exhaustion	Tillage with a wheat residue: No-tillage without wheat residue	tillage without wheat residue	Non-tillage with wheat residue	tillage with a wheat residue	Si + Moisture exhaustion
Without Si	7 day	10.19	8.19	10.03	9.06	9.37
	14 day	10.01	13.31	10.92	11.96	11.55
Spraying Si	7 day	26.23	24.54	20.72	25.84	24.33
	14 day	23.48	26.54	26.23	28.26	26.13
Mean of tillage with a wheat residue		17.48	18.14	16.97	18.78	
LSD(0.05)	Si*M.E*Tillage with a wheat residue= 8.2* 10^{-4} Si*Moisture exhaustion= 4.1* 10^{-4} Tillage with a wheat residue= 4.1* 10^{-4}					
Si+tillage with a wheat residue						**Mean of Si**
Without Si		10.10	10.75	10.47	10.51	10.46
Spraying Si		24.85	25.54	23.48	27.05	25.23
LSD(0.05)	Si*tillage with a wheat residue= 5.8* 10^{-4} Si= 2.9* 10^{-4}					
Moisture exhaustion + tillage with a wheat residue						**Mean of Moisture exhaustion**
7 day		18.21	16.36	15.38	17.45	16.85
14 day		16.74	19.93	18.57	20.11	18.84
LSD(0.05)	Moisture exhaustion*tillage with a wheat residue= 5.8* 10^{-4} Moisture exhaustion= 2.9* 10^{-4}					

Table (5) showed that IAA concentration was increased significantly up to (25.23×10^{-4}) Mm when the plants treated with Si compared with untreated plants (10.46×10^{-4}) Mm. While there is no significantly in GA concentration in plants grown in non tillaged land with wheat residue. Also, there was no significantly in GA concentration when the plants exposed to moisture exhaustion stress.

The dual effect showed that plants treated with Si increased significantly both in unstressed and stressed plants compared with untreated plants with Si. And there was an increase in GA concentration of plants treated with Si and grown in tillaged and with and without wheat residue. Whereas, there was no significantly between stressed and unstressed plants grown in tillaged and non tillaged land with and without wheat residue.

The triple interaction showed that GA concentration was increased significantly in all treatments treated with Si both to stressed and unstressed plants grown in grown in tillaged and non tillaged land with and without wheat residue.

Table (6) showed that ABA concentration was increased significantly up to (115.2×10^{-4}) Mm when the plants treated with Si compared with untreated plants (42.8×10^{-4}) Mm. While, there is no significantly in ABA concentration in plants grown in tillaged and non tillaged land with and without wheat residue. Also,, there was no significantly in ABA concentration when the plants exposed to moisture exhaustion stress.

The dual effect showed that plants treated with Si increased significantly both in unstressed and stressed plants compared with untreated plants with Si. And there was an increase in ABA concentration of plants treated with Si and grown in tillaged land with and without wheat residue. Whereas, there was no significantly between stressed and unstressed plants grown in tillaged and non tillaged land with and without wheat residue.

The triple interaction showed that ABA concentration was increased significantly in all treatments treated with Si both to stressed and unstressed plants grown in grown in tillaged and non tillaged land with and without wheat residue.

Table 6 : The effect of silicon, tillage and moisture exhaustion and the interaction between them on ABA ($\times 10^{-4}$) concentration

Silicon	**Moisture exhaustion**	**Tillage with a wheat residue**				**Si + Moisture exhaustion**
		No-tillage without wheat residue	**tillage without wheat residue**	**Non-tillage with wheat residue**	**tillage with a wheat residue**	
Without Si	7 day	49.1	52.8	34.4	33.3	42.4
	14 day	45.9	58.7	32.7	35.3	43.2
Spraying Si	7 day	125.8	112.8	87.4	114.1	110.0
	14 day	116.2	112.6	113.9	138.8	120.4
Mean of tillage with a wheat residue		84.3	84.2	67.1	80.4	
$LSD_{(0.05)}$	Si*M.E*Tillage with a wheat residue= 43.23* 10 Si*Moisture exhaustion= 21.6* 10^{-4} Tillage with a wheat residue=21.6* 10^{-4}					
Si+tillage with a wheat residue						**Mean of Si**
Without Si		47.5	55.7	33.5	34.3	42.8
Spraying Si		121.0	112.7	100.6	126.4	115.2
$LSD_{(0.05)}$	Si*tillage with a wheat residue= 30.56* 10^{-4} Si= 15.28* 10^{-4}					
Moisture exhaustion + tillage with a wheat residue						**Mean of Moisture exhaustion**
7 day		87.5	82.8	60.9	73.7	76.2
14 day		81.1	85.7	73.3	87.0	81.8
$LSD_{(0.05)}$	Moisture exhaustion*tillage with a wheat residue=30.56* 10^{-4} Moisture exhaustion=15.28* 10^{-4}					

Discussion

Drought stress is the main problem in a warm countries suffering from high water evaporation during hot seasons. So, it was necessary to overcome this problem by using different procedures and treatments.

Today, we use silicon and tillage pathways with and without wheat residue to overcome drought stress. The results showed that the single interaction of non tillaged lands cause a significant decrease in CAT activity and an increase in IAA concentration (Table 3,4)which leads to increase plant resistant to drought stress by preventing soil water evaporation (Imran *et al.*, 2013)causing adecrease in IAA degradation and ABA accumulation (Pirasteh-Anosheh *et al.*, 2013). Also, non tillaged lands maintain SOD and APX activity (Table 1,2), it lead us to believe that the plants behave as normal plants during stresses (Abo Al-Timmen *et al.*, 2018). This result was compatible with the finding of (Khan *et al.*, 2017) who mentioned that non tillaged lands caused an increasing growth and yield parameters significantly germination count, number of fertile tillers, spikelets per spike and number of grains per spike and gave maximum net income and benefit cost ratio.

Data analysis of the single interaction of silicon showed that it may be act as a protective factor to plant enzymatic system because its effect in reducing antioxidant levels(Table 1,2,3) may be by forming a complex network which is supported by an antioxidant recycling system (Taiza *et al.*, 2015) and maintain plants as control ones. These finding was compatible with (Kim *et al.*, 2014) or may be by its positive effect inregulating plant physiology and influencing IAA, GA and ABA increase (Table 4,5,6). These findings was consonant with (Jang *et al.*, 2018; Kimetal, 2014). Luyckx *et al.* (2017) showed that silicon may had a mediated action on phytohormones biosynthesis it may act on both ABA and GA biosynthesis/ homeostasis.

The dual interference between silicon and moisture exhaustion for 14 days showed that all parameters of the plants without silicon treatment did not differ significantly from control plants (non stressed plants) except a significant increase in SOD activity. But the stressed plants treated with silicon showed a significant decrease in SOD and CAT activity (Table 1,3) and a significant increase in IAA, GA and ABA concentrations.

These findings lead us to relies that silicon has a defense mechanism inside the plants indirectly may be by preventing water evaporation or by regulation of antioxidant system (Zhu, 2014). Hattori *et al.* (2005) find that silicon reducing water loss in water stressed circumstances, and it cause higher stomatal conductance, relative water contents, and water potentials of wheat and decrease water uptake (Eneji *et al.*, 2005; Pei *et al.*, 2010). It may be attributed to the deposition of silicon in the upper layer of epidermis then the leaves became thicker which prevent excessive water loss by transpiration (Hattori *et al.*, 2005). Or it may be related to the effect of silicon on anatomical changes within the plant. This suggestion is compatible with findings of (Abo Al-Timman, 2016) showing that rice husk extract which contain high level of silicon (Gilkes *et al.*, 2013) affect on physiological and anatomical characteristics of wheat seedlings. The same findings was observed in the dual interaction between silicon and tillage. A non tillaged land was the best in decreasing antioxidant activity and enhancing phytohormones concentration (Table 1,3,4,5,6,). Its seems that the plant grow well under these treatments. These findings was compatible with (Abo Al-Timmen *et al.*, 2018). Also, Liang *et al.* (2003) and Kim (2017) observed that CAT activity was decreased significantly when barley plants was treated with silicon under drought stress and the two ways of tillaging lands.

The dual interference between moisture exhaustion and tillage revealed a significant increase in APX activity of stressed plants with and without tillaging because APX is more involved in detoxification of H_2O_2 and act as a signaling molecule in plants (Cuypers *et al*., 2011). In addition, Zarei *et al*. (2012) found that the highest APX activity was observed under 10% and 20% of the PEG treatment.

In the triple interaction we concluded that the best treatment was the stressed plants treated with silicon and grown in non tillaged lands. This treatment caused a significant decrease in SOD and CAT activity and a significant increase in IAA (Table 1,3,4), probably due to the effect of tillaging pathway which prevent excessive water evaporation. This result was compatible with (Abo Al-Timmen *et al*., 2018) who found that mulching soil which prevent water evaporation caused a significant decrease in antioxidant enzymes, in addition, (Rezende *et al*., 2017) discovered that silicon caused a decrease in SOD expression of cape gooseberry plants. Or, due to the role of silicon in maintaining antioxidant systems indirectly through osmotic regulation of the cell as normal cells by forming a thick layer under epidermis which prevent water evaporation (Johnson *et al*., 2018). Or, by increasing ABA concentration which was highlighting clearly in (Table 6) especially with plants grown in tillaged lands which permits more water evaporation. This result led us to thought that silicon effect is showed up when increasing stress. The presence of sterols in wheat straw components gives the plant the opportunity to plant water stress resistance because sterols is the precursor for many hormones (Schnitzer *et al*., 2014). Or may be attributed to the role of these residues in increasing soil fertility and decrease water evaporation and provides favorable microclimate for the crop emergence (Loss *et al*., 2015).

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