

## Effect of silicon calcium, boron on Proline and relative water contents in Apple leaves

Qusay T. Salim<sup>1, a</sup>, Ahmed T. Joody<sup>1</sup>

<sup>2</sup>Collage of Agriculture, University of Baghdad, Iraq  
[qusaytariq@gmail.com](mailto:qusaytariq@gmail.com)

**Abstract.** Four concentration of potassium silicate in combined with three concentration of calcium, boron mixture were studied to determine the effect of silicon, calcium and boron sprayed on the relative water content and the concentration of proline acid in the leaves of the apple trees. The results showed that calcium, silicon and boron had a significant effect by increasing the leaf water content and decreasing the concentration of proline. The treatment S2C1 gave the highest water content, were S3C3 gave the highest decrease in proline's concentration.

**Keywords:** copper Oxide; PLD; heterostructure; detector parameters

### 1. Introduction

Silicon is classified as one of the beneficial elements for the plant and effecting on the growth in two directions. It first enters the structure of the cellular walls and accumulates under the cuticle layer in the leaves. It accumulates in the intercellular spaces forming a silicon body called phytoliths. Here silicon acts as a support for the structure of the plant [1-5]. The second trend is the physiological effect of the silicon, since it works to improve the antioxidant enzymes activity and build non-enzymatic antioxidants in the environmental stress conditions [6, 7]. In addition, it works on regulates the absorption of nutrient elements, the movement of water within the plant [8].

Silicon deposits in cellular walls act as impediments to the movement of heavy elements within the plant [9]. It also prevents the accumulation of sodium in cells [10] also the silicon promote plant defense system by increasing the production of and PR-1 proteins [11] and promotes the accumulation of phenolic compounds [12]. Calcium has various structural and phylogenetic functions within the plant. It enters the structure of cellular walls. It works as a link between the components of the wall, pectin and poly glycerides [13]. Calcium also plays a key role in the stability and permeability of plasma membranes. It is important to note its role in the transmission of signals inside the plant, especially the thermal and water conditions [14], also calcium regulate the ion pump in cell [15].

Boron is one of the non-moving elements within the plant. Boric acid is a plant-derived image. It has been shown to be important for plant growth since 1910 [16]. The importance of boron lied in cells building and physiological role by interacting with calcium in the cell walls structure [17]. It has a fundamental role in cell division in vegetative growth, Its lack causes the failure of plant growth, as well as boron formation a complexes with sugary compounds and facilitates their movement within the plant, also boron regulate the plant hormones [18], and increases the yield by controlling the evolution of the Pollution tube [19].



## 2. Experimental work

The experiment was carried out in an apple orchard of Anna class which is grafted with quince plant at age of 4 years old. The orchard is located in the faculty of agricultural engineering in the University of Baghdad in Baghdad city and consists of three lines, each line includes 15 trees, the distance between the lines is 4 m and the distance between each tree and another is 2.5 m.

The experiment includes two factors, factor (S) which stands for the trees that are sprayed with  $K_2SiO_3$  as a source of silicon (26.5%  $Si_2O$  and 12.65%  $K_2O$ ) in four concentrations (0, 2, 4 and 6 ml  $L^{-1}$ ). While factor (C) represents the trees that are sprayed with a mixture containing calcium Ca-EDTA (9.7% Ca) and boron with  $H_3BO_3$  (17 % B) in 3 concentrations (0, 0.5 g  $L^{-1}$  Ca-EDTA + 10 mg  $L^{-1}$  B, and 1 g  $L^{-1}$  Ca-EDTA + 20 mg  $L^{-1}$  B). All the treatments applied on the 1st of April, 1st of May, and 1st of June 2017.

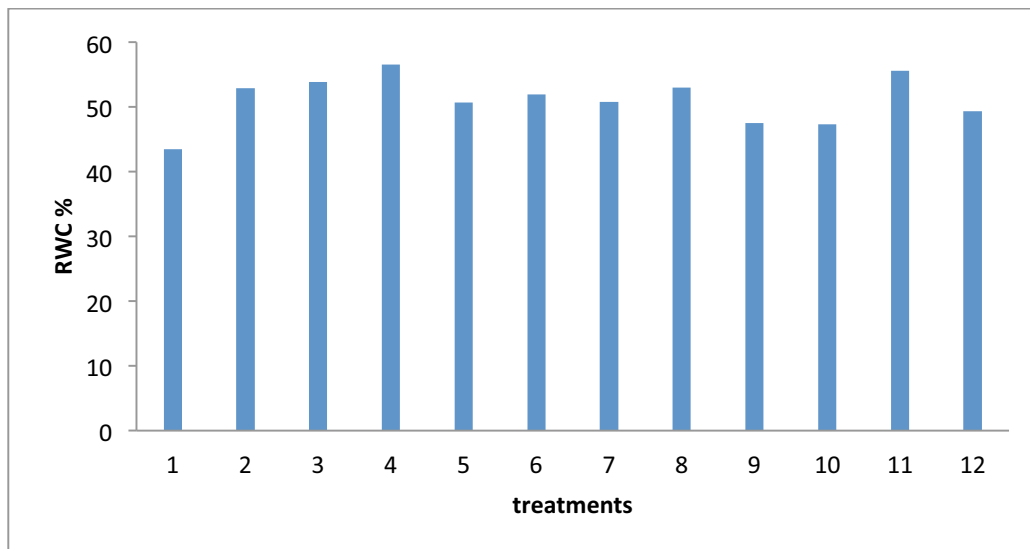
## 3. Results and discussion

### 3.1 Relative water content (RWC)

The results of Table 1. indicate that Silicon has significantly increase the Relative Water Content (RWC) in the leaves. As shown in Table 1 treatment S2 gives the highest rate of RWC as compare to the treatment S1 that are (53.07 and (50.09) respectively. There was also a significant effect of calcium and boron in the increment of the RWC, while treatment C1 gives (49.55) treatment C2 gives (53.04). Regarding the dual factors interaction, the S2C1 interference treatment gives the highest rate of relative water content which is (56.58).

**Table 1.** effect of silicon, calcium and boron on the RWC in Apple leaves (%)

S	C			Average
	1	2	3	
1	43.50	52.88	53.90	50.09
2	56.58	50.71	51.93	53.07
3	50.77	52.99	47.56	50.44
4	47.34	55.59	49.33	50.75
average	49.55	53.04	50.86	
LSD	S = 2.570	C = 2.226	S*C= 4.451	



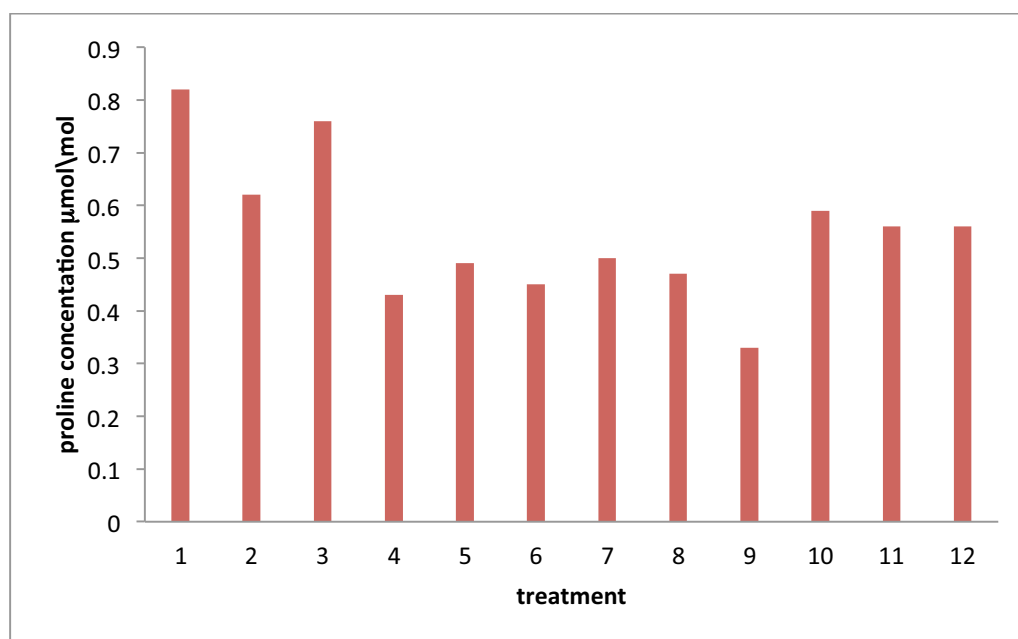
**Figure 1.** Bar chart illustration for the RWC percentage values against treatments' average

### 3.2 Proline ( $m\ mol/mol$ )

The results of Table 2 indicate that Silicon has significantly decreased the Proline in the leaves. As shown in Table 2 treatment S3 gives the lowest rate of the Proline as compared to the treatment S1 that are (0.43) and (0.73) respectively. There was also significant effect of calcium and boron in the decrement of the Proline, while treatment C2 gives (0.56) treatment C1 gives (0.59). Regarding the dual factors interaction, the S3C3 interference treatment gives the lowest rate of Proline which is (0.33).

**Table 2.** effect of silicon, calcium, Boron on proline concentration in Apple leaves

S	C			Average
	1	2	3	
1	0.82	0.62	0.76	0.73
2	0.43	0.49	0.45	0.45
3	0.50	0.47	0.33	0.43
4	0.59	0.66	0.72	0.66
average	0.59	0.56	0.56	
LSD	S = 0.043		C = 0.037	
	S*C=0.043			



**Figure 2.** Bar chart illustration for the proline concentration values against treatments' average

The Improvement in the water condition of the plant represented by the (RWC), and the decrement in the concentration of the Proline (due to Silicon effect) might be caused by the effect of Silicon in increasing the absorption of Calcium in the plant cells which leads to improving membrane stability, and permeability of the plant cells.

Or might be due to the Silicon effect in increasing Potassium absorption which leads to improving the osmosis conditions of plant cells. Knowing that the improvement in absorbing these two elements (Calcium and Potassium) is due to the Silicon effect in improving the effectiveness of the (H<sup>+</sup>-ATPase) enzyme [20, 21] as well as regulating the transpiration [22].

Furthermore, Silicon plays vital role in improving the effectiveness of antioxidant enzymes and building non-enzymatic antioxidants [20]. In addition to its role in providing further mechanical support for the plant towards external influences due to its participation in the composition of the cellular walls which increases its strength [23].

Regarding the effect of calcium and boron in increasing the relative water content and lowering the proline. These two elements have structural and physiological effect within the plant, as they participate in the structure of the cellular walls by composing complexes with the cellulosic compounds, hemicellulose, pectin and lacquin [17].

Moreover, Calcium plays key role in the stability and permeability of plasma membranes, and in the transmission of signals within the plant, especially in the cases of thermal and water environmental stress [16]. Also, it has a regulatory role similar to hormonal effect as it regulates the work of ionic pumps. The work of the pumps and your fluid controls the absorption and movement of ions within plant cells and thus controls the cell osmosis and thus the amount of water in the cells [24].

#### 4. Conclusion

In conclusion for this study several significant outcomes can be drawn clearly. First of all Silicon element has absorbed effectively through plant leaves and its effect is shown clearly by increasing the RWC and the decreasing the Proline concentration. This leads to improvement in the overall status of the plant against environmental conditions. Similar results are acquired with Calcium and Boron elements

this can be related to the physiological and structural rules for these elements in strengthening the plant cells.

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