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# Effect of foliar application of potassium silicate and α-tocopherol on mitigating the adverse impacts of low temperature and salinity stresses on young mango trees

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## ABSTRACT:

The investigation was conducted during two successive seasons (2019 /2020 and 2020/2021) on two young mango trees cvs. "Sediek" and "Ewais" to determine the impact of foliar spray with different levels of silicone which applied in form of potassium silicate **"**25% $SiO_2$+10% $k_2O$**"** (0.0%, 0.1% and 0.2%) and α-tocopherol "vitamin E" (0 ppm, 200 ppm and 400 ppm) alone or combined, to mitigate the harmful effect of low temperature and negative effect of soil salinity on young mango trees. growth characteristics (tree height, leaf area and shoot length) for trees of Sediek and Ewais mango cvs. negatively influenced by abiotic stresses. Meanwhile, foliar application of potassium silicate "P.S." and/or *α*-tocopherol "α-Toc." alone or in combination significantly improved the morphological and physiological characteristics compared with control. The foliar application of tocopherol alone was more noticeable compared to sprayed with potassium silicate alone particularly at the higher rates as it maintained the growth and plant performance under abiotic stresses.

Abiotic stresses, including salinity, cold caused adverse effects on (RWC) and (MSI) of young mango trees under study. On the other hand, foliar application of P.S. and *α-Toc.* alone or together enhanced significantly these parameters.

Negative relationship was detected among free proline content in leaves of young mango trees grown under adverse environmental conditions and foliar application of potassium silicate and *α-tocopherol* singular or together.

**Keywords:** Abiotic stress, potassium silicate **"P.S."**, α-tocopherol **"α-Toc."** salinity stress, low temperatures, Morphological and physiological characteristics, Sediek and Ewais mango.

## 1. INTRODUCTION:

Abiotic stresses like low temperature and salinity negatively influence tree growth and stimulates the activated oxidative anions in the plant tissues and cells **(Sadiq et al., 2019).** Climatic changes have a greater impact on the growth and productivity of fruit trees than any other factor that affects them. Multiple types of abiotic stress lead to decrease growth and development of plants by producing a great amount of reactive oxygen species that cause serious injury to numerous molecules, cell structures and membranes as well as photosynthetic systems and causing cell death.

The growth, development and productivity of fruit trees are greatly influenced by temperature changes such as low temperature. Under Fayoum conditions, in the winter temperature can drop to $5^{℃}$ or even lower (Central Lab. for Agricultural Climate).

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**Nene et al., (1996)** reported that the optimum temperature differs from species to another and among cultivars. Also, the optimum temperature for mango trees ranges from 24-$26^{oc}$, while the minimum temperature is 10-$12^{oc}$. Bellow those degrees, trees exhibit chilling injury **(Farooq and Aaxam, 2002).**

Mango is categorized as very salt sensitive especially at younger ages **(Srivastavtav et al., 2007).** Mango is more sensitive to the salinity of soil, they are not able to grow under salinity conditions above 1 $dSm^{-1}$ **(Maas, 1986; Gupta and Sen, 2003).** On mango trees **(Jindal et al., 1976)** found that salinity conditions led to scorched leaf tips and leaf curling. In severe cases, growth is inhibited and defoliation of the leaves occurs. Finally, the trees die. Under high salinity, mango production is restricted due to decreased plant growth, limited root expansion, and lower success as well as survivability **(Roy et al., 2014). Akram et al.,(2007); Pandy et al.,(2014)** on mango and **Khayyat et al., (2014)** on pomegranate. They reported that the decreasing leaf area due to increasing salt levels may be due to reducing cell content, lopsided nutrition and membrane damage.

Many metabolic activities and cell functions have been linked to visible signs like necrosis, wilting, and chlorosis due to exposure to low temperatures **(Rulland and Zachowski, 2010).** These negative influences are associated with alteration in cell membrane formation as well as lipid composition **(Matteucci et al., 2011). Jouve et al.,(2000)** demonstrated that there is evidence to show that stabilization of membrane formation and function may play a vital role in determining survival under cold conditions. Cold weather negatively affects plant growth. This fact is problematical for plants grown in regions where temperatures are consistently low. Moreover, low temperatures cause stress throughout the winter season, even in tropical and subtropical regions **(Sadiq et al., 2019).**

Silicon plays an essential role in alleviating different biotic and abiotic stresses. This is due to its vital role on plant antioxidant systems, co-precipitation of harmful metal ions with silicon, and immobilisation of toxic metal ions in growth media **(Epstein and Bloom, 2003). Santos et al., (2014)** on mango trees and **Ma and Yamaji, (2006)** reported that silicon is linked to a multitude of functions, such as increased nutrient availability, stimulating photosynthetic processes and mechanical properties of plant parts, as well as improved tolerance to abiotic stress like salinity, water stress, elevated heat, and mineral toxicities

Tocopherols are lipophilic molecules and antioxidant affiliated to vitamin E family. Green photosynthetic organisms create them naturally **(Falk and Munné-Bosch, 2010).** Photosynthetic organisms are considered the only sources for the production of tocopherol **(Maeda and DellaPenna, 2007).**

All types of tocopherols play a crucial role in improving plant growth, delaying senescence, and preventing leaf abscission, as well as in different metabolic processes **(Desel et al., 2007; Arrom and Munné-Bosch, 2010).**

## 2. MATERPALS AND METHODS

The investigation was conducted during two successive seasons (2019 /2020 and 2020/2021) on two young mango cultivars namely, “Sediek” and “Ewais” to determine the effect of foliar spray with different levels of silicone which applied in form of potassium silicate **“**25% $SiO_2$+10% $k_2O$**.”** (0.0%, 0.1% and 0.2%) and α-tocopherol “vitamin E” (0 ppm, 200 ppm and 400 ppm), to mitigate the harmful effect of low, temperature and negative impact of soil salinity on young mango trees. The trees were about 2 years old at the beginning of study, planted at 5*6 m apart, each cultivar was grafting on Sukkary rootstock "tolerant to salinity" **(Omaima et al., 2011 and Zeinab Abo-Rekab (2014)** and grown on a sandy loam (newly reclaimed lands) at the experimental farm of the Fac. of Agric.at Demo, Fayoum, Egypt. The initial physical and chemical characteristics of the soil were determined according to **Page et. al., (1982),** the results are shown in Tables (1&2). Soil salinity was 4.55dSm$^{-1}$. Weakly air temperature from December till March for Fayoum Governorate during 2019, 2020 and 2021 years are presented in Table (3).

**Table 1. Physical properties of the soil.**

| Soil depth | Sand% | Silt% | Clay% | texture | Bulk Density (g/cm$^3$) | Filed Capacity % | Wilting Point % | Available Water % |
|---|---|---|---|---|---|---|---|---|
| 0-30 | 58.1 | 26.6 | 15.3 | Sandy | 1.44 | 22.65 | 11.00 | 11.65 |
| 30-60 | 56.3 | 29.05 | 14.65 | loam | 1.40 | 22.2 | 10.35 | 11.85 |

**Table 2. Chemical properties of the soil.**

| Soil | Cations | | | | Anions | | | ECe | |
|---|---|---|---|---|---|---|---|---|---|
| depth | $Na^+$ | $K^+$ | $Ca^{++}$ | $Mg^{++}$ | $CL^-$ | $SO_4^-$ | $HCO_3^-$ | (ds/m) | pH |
| 0-30 | 10.69 | 0.555 | 24.3 | 12.45 | 24.95 | 20.145 | 2.785 | 4.545 | 7.715 |
| 30-60 | 14.75 | 0.575 | 23.55 | 13.7 | 21.1 | 21.31 | 2.88 | 4.52 | 7.69 |

**The experiment included the following treatments:**

**1 -** Control sprayed with distilled water only.
**2 -** Sprayed with 0.1% potassium silicate **($P.S._1$)**.
**3 -** Sprayed with 0.2% potassium silicate **($P.S._2$)**.
**4 -** Sprayed with 200 ppm α-tocopherol **(α-$Toc._1$)**.
**5 -** Sprayed with 400 ppm α-tocopherol **(α-$Toc._2$)**.
**6 -** Sprayed with 0.1 potassium silicate **($P.S._1$)** + 200ppm α-tocopherol **(α-$Toc._1$)**.
**7 -** Sprayed with 0.1 potassium silicate **($P.S._1$)** + 400ppm α-tocopherol **(α-$Toc._2$)**.
**8 -** Sprayed with 0.2potassium silicate **($P.S._2$)** + 200ppm α-tocopherol **(α-$Toc._1$)**.
**9 -** Sprayed with 0.2potassium silicate **($P.S._2$)** + 400ppm α-tocopherol **(α-$Toc._2$ )**.

**Table 3. Weakly air temperature from December till March for Fayoum Governorate during 2019, 2020 and 2021 years.**

| | | 2019 | | 2020 | | 2021 | |
|---|---|---|---|---|---|---|---|
| **Month** | **Week** | **Max.** | **Min.** | **Max.** | **Min.** | **Max.** | **Min.** |
| Dec. | 1 | 21.86 | 10.95 | 22.87 | 10.59 | 20.80 | 10.01 |
| | 2 | 20.41 | 9.06 | 23.43 | 11.33 | 21.29 | 9.91 |
| | 3 | 20.98 | 7.31 | 21.89 | 10.09 | 17.74 | 7.17 |
| | 4 | 18.79 | 7.07 | 22.24 | 9.75 | 18.84 | 8.18 |
| Jan. | 1 | 17.30 | 5.31 | 16.58 | 4.75 | 21.96 | 8.99 |
| | 2 | 17.24 | 5.43 | 17.04 | 5.88 | 26.01 | 11.10 |
| | 3 | 17.92 | 4.83 | 18.99 | 7.86 | 20.56 | 8.22 |
| | 4 | 20.46 | 6.21 | 18.22 | 5.14 | 19.10 | 5.15 |
| Feb. | 1 | 22.20 | 6.61 | 19.60 | 6.03 | 21.52 | 6.95 |
| | 2 | 20.47 | 7.18 | 18.74 | 6.33 | 23.94 | 9.76 |
| | 3 | 18.71 | 6.10 | 21.89 | 7.82 | 24.54 | 9.49 |
| | 4 | 21.64 | 7.14 | 19.00 | 7.58 | 17.26 | 4.88 |
| Mar. | 1 | 20.38 | 7.23 | 22.40 | 8.31 | 21.79 | 8.18 |
| | 2 | 23.40 | 7.42 | 26.82 | 9.61 | 22.15 | 6.84 |
| | 3 | 23.18 | 8.41 | 24.24 | 11.50 | 26.68 | 10.31 |
| | 4 | 26.06 | 10.72 | 22.11 | 7.42 | 27.51 | 12.86 |

The experiment was designed as factorial experiment in complete randomized blocks design. Each treatment was replicated three times (two trees/replicate for each cultivar). Both potassium silicate and α-tocopherol were sprayed on young mango trees for four times in winter season (on the first of December, 1st of January, 1st of February and then on the first of March). All treatments received usual practices as recommended by Ministry of Agriculture, Egypt.

**Studied parameters.**

**3.1: Vegetative growth parameters.** The following characteristics were measured by the end of April of each season:

**3.1.1: Tree height (cm)**. The height (cm) from the soil surface to the highest growing point of the main stem was measured using the measuring tape.

**3.1.2: Leaf area (cm$^2$)**. Samples of ten mature and fully expanded leaves per replicate in each treatment were picked to estimate leaf area using digital Planimeter "Planix 7, Tamaya, Japan".

**3.1.3: Shoot length.** Shoot length was determined during April of each season. Four shoots (one years old) on each tree per replicate representing the tree directions (North- South- West and East) were tagged to determine shoot length (cm).

**3.2: physiological characteristics**

At the ends of April of each season, ten fully-expanded leaves were used for estimation of leaf relative water content and membrane stability index. After removing the midrib, the leaves were prepared according to the following techniques:

**3.2.1: Relative water content (RWC).**

Relative water content of leaves was estimated according to **Weatherley (1950)** and modified by **Osman and Rady (2014)**. The following formula is used to determine relative water content (RWC).

**RWC (%) = [(FW-DW)/ (TW-DW)] X 100**

**Where:** FW= fresh weight DW=dry weight TW= turgid weight

**3.2.2: Membrane stability index (MSI).**

The leaf membrane stability index was estimated using the methodology of **Premchandra et al. (1990)** which was modified by **Sairam (1994).** The formula for calculating MSI is

$$MSI = [1 - (C_1/ C_2)] \times 100.$$

**3.2.3: Leaf chlorophyll content.**

One mature leaf/plant was takin to determine SPAD chlorophyll index using a chlorophyll meter (SPAD-502, Minolta, Japan).

**3.2.4: Chlorophyll fluorescence.** Chlorophyll fluorescence was measured at the ends of April and October in the two studied seasons by a portable fluorimeter (Handy PEA, Hansatech Instruments Ltd, Kings Lynn, UK). One fully mature leaf per plant was taken to determine the fluorescence measurements as reported by **Maxwell and Johanson (2000).**

**3.2.5: Leaf biochemical analysis.**

At the ends of April in the two studied seasons, representative leaf samples consisting of 25 mature leaves were taken. Then it was dried in an electric oven at 70 $^{o}$ C to a constant weight. Dry leaves were ground and stored in airtight bags for the following determinations **(Demirer et al., 2007).**

**3.2.5.1: Total carbohydrate (mg/100gD.W.).** Was determined according to the method described by **Herbert et al., (1971).**

**3.2.5.2: Free proline** (mg /g of leaf DW). was estimated according to the method described by **(Bates et al.,1973).**

**3.2.5.3: Total phenols:** Phenols content was estimated according the method as mentioned by **Ainsworth and Gillwespie, (2007)** and expressed as mg $g^{-1}$DW**.**

**3.3: Statistical analysis.**

ANOVA analysis of data was conducted using GenStat statistical package (VSN International Ltd, Oxford, UK). Means multiple comparisons were conducted using new LSD test at p = 0.5. Statistical analysis of the data was carried out according to **Snedecor and Cochran (1994)**.

## 3. RESULTS AND DISCUSSION:

**4.1: Effect of foliar application of potassium silicate (P.S.) and α-tocopherol (α-Toc.) on growth parameters: -**

**4.1.1: Tree height (cm).**

It is obvious from the obtained data in Table (4) that the tree heights of Sediek and Ewais mango cvs. were negatively affected by abiotic stresses like low temperatures in the winter and soil salinity. In the first season, the lowest value of the tree height was 130.67 cm were detected by young mango trees grown under abiotic stresses conditions (control) without spraying by either potassium silicate and/or α-tocopherol.

Regarding the spraying with P.S. or α-Toc. individually on tree height, the obtained data indicated beneficial influence of spraying with α-tocopherol alone than spraying with potassium silicate individually.

As for the effect of foliar application of potassium silicate and/or *α*-tocopherol alone or in combination, results show that the tree height increased by increasing application rate for each of P.S. and α-Toc. in the two studied seasons. Consequently, the highest values of the tree height (160.67cm) in the 1$^{st}$ season were achieved by tree sprayed with 0.2% Potassium silicate plus 400 ppm α-tocopherol. Meanwhile, foliar application by the lower levels of P.S. (0.1%) or α-Toc (200ppm) alone showed lower values of tree height. The other treatments gave intermediate values in this respect (table,4). This trend was true in the second season. The differences between cultivars were significant in both seasons.

**4.1.2. Leaf area (cm$^2$).**

The present data clearly show that leaf area was significantly enhanced by external application of potassium silicate and *α*-tocopherol alone or combined

**Table 4. Effect of foliar application of potassium silicate and $\alpha$-tocopherol on tree height of Sediek and Ewais mango cvs. grown under abiotic stresses during 2019 /2020 and 2020 /2021 seasons.**

| Cultivars / Treatments | Tree height (cm) | | | | | |
|---|---|---|---|---|---|---|
| | April 2020 | | | April 2021 | | |
| | Sediek | Ewais | Mean | Sediek | Ewais | Mean |
| **Control** | 127.67 | 123.67 | **130.67** | 160.17 | 150.00 | **155.09** |
| **P.S.$_1$** | 156.00 | 133.67 | **144.84** | 180.33 | 155.67 | **168.00** |
| **P.S.$_2$** | 156.00 | 142.33 | **149.17** | 180.44 | 158.55 | **169.50** |
| **$\alpha$-Toc.$_1$** | 150.00 | 143.33 | **146.67** | 175.41 | 162.45 | **168.93** |
| **$\alpha$-Toc.2** | 158.33 | 156.33 | **157.33** | 178.67 | 180.67 | **179.67** |
| **P.S.$_1$+ $\alpha$-Toc.$_1$** | 146.00 | 140.67 | **143.34** | 186.22 | 165.33 | **175.78** |
| **P.S.$_1$+ $\alpha$-Toc.2** | 149.00 | 143.00 | **146.00** | 182.45 | 171.67 | **177.06** |
| **P.S.$_2$+ $\alpha$-Toc.$_1$** | 151.00 | 142.67 | **146.54** | 183.33 | 166.33 | **174.83** |
| **P.S.$_{2+}$ $\alpha$-Toc.2** | 164.00 | 157.33 | **160.67** | 185.33 | 181.41 | **183.37** |
| **Mean** | **152.79** | **141.38** | | **179.15** | **165.79** | |
| **New LSD 5%** | C =9.82 | T =N.S. | CT= N.S. | C = 7.99 | T = N.S. | T=23.97 |

**Table 5. Effect of foliar application of potassium silicate and $\alpha$-tocopherol on Leaf area of Sediek and Ewais mango cvs. grown under abiotic stresses during 2019 /2020 and 2020 /2021 seasons.**

| Cultivars / Treatments | Leaf area ( $cm^2$) | | | | | |
|---|---|---|---|---|---|---|
| | April 2020 | | | April 2021 | | |
| | Sediek | Ewais | Mean | Sediek | Ewais | Mean |
| **Control** | 29.51 | 30.1 | **29.81** | 35.39 | 36.84 | **36.12** |
| **P.S.$_1$** | 34.57 | 36.34 | **35.46** | 40.36 | 41.73 | **41.05** |
| **P.S.$_2$** | 35.79 | 41.09 | **38.44** | 41.36 | 45.39 | **43.38** |
| **$\alpha$-Toc.$_1$** | 32.25 | 40.99 | **36.62** | 42.15 | 40.97 | **41.56** |
| **$\alpha$-Toc.2** | 35.13 | 41.24 | **38.19** | 42.27 | 45.42 | **43.85** |
| **P.S.$_1$+ $\alpha$-Toc.$_1$** | 34.86 | 45.55 | **40.21** | 39.03 | 39.68 | **39.36** |
| **P.S.$_1$+ $\alpha$-Toc.2** | 38.19 | 43.92 | **41.06** | 42.61 | 40.8 | **41.71** |
| **P.S.$_2$+ $\alpha$-Toc.$_1$** | 38.9 | 43.42 | **41.16** | 38.62 | 44.07 | **41.35** |
| **P.S.$_{2+}$ $\alpha$-Toc.2** | 40.36 | 45.23 | **42.80** | 42.51 | 45.42 | **43.97** |
| **Mean** | **35.51** | **40.88** | | **40.48** | **42.26** | |
| **New LSD 5%** | C=2.10 | T= 4.47 | CT=6.32 | C = 1.32 | T =2.81 | CT= N.S. |

(table, 5). Spraying $\alpha$-tocopherol alone gave the largest leaf area compared with spraying with potassium silicate alone at the two levels of treatments.

The highest significant values of leaf area were 42.80 and 43.97 $cm^2$ during 2020 and 2021 seasons, respectively, were found on mango trees sprayed with the higher level of potassium silicate plus α-tocopherol together, on the other hand, the lowest significant values were detected by mango trees grown under abiotic stresses (control), which were sprayed with distilled water only. Meanwhile, the other treatments gave intermediate values in this respect. This trend was detected in the two studied seasons.

Trees of Ewais cultivar grown under abiotic stresses and treated with foliar applied by potassium silicate and $\alpha$-tocopherol alone or in combination produced the largest leaf area compared with the trees of Sediek cv. grown under the same conditions during the two studied seasons. The differences between the two studied cvs. were significant in both the first and second seasons.

**4.1.3. Shoot length (cm).**

Results clearly indicate that yang mango trees grown under environmental stresses had the lowest significant values of shoot length (table, 6). This may be due to the adverse influence of climatic challenges and/or soil salinity stresses, which led to decreased growth and development of trees by producing a great number of reactive oxygen species that cause serious injury to numerous molecules, cell structures and membranes as well as photosynthetic systems and cause cell death.

The obtained results showed that shoot length increased significantly by increasing the application rate of P.S. or α-Toc. compared with control trees (table,6). In addition, yang mango trees sprayed with a higher concentration of P.S. (0.2%) plus α–Toc. (400 ppm) gave the highest significant values of shoot length 21.20 cm, followed in descending order by those sprayed with 0.1% P.S.+ 400 ppm α–Toc., 0.2% potassium silicate + 200 ppm α -tocopherol, and then by 0.1% P.S. + 200 ppm α-Toc., respectively. No significant differences were detected in the interaction among foliar application treatments and cultivars. This trend was found in the second season. Significant differences were observed between the two studied cultivars.

From the above mentioned results, it could be concluded that the growth characteristics like tree height, leaf area and shoot length for trees of Sediek and Ewais mange cvs. were negatively influenced by abiotic stresses. This may be due to the severity of winter and/or soil salinity which might have restricted physiological and biochemical processes like nutrient metabolism, ion uptake, carbohydrate assimilation and growth promoters, which reduce plant growth and development.

In this regard, **Ahmed et al., (2013**) on Hindybisinara mango cv. and **Moawed et al. (2015)** on sukkary mango cv. found that the leaf area, and shoot length

**Table 6. Effect of foliar application of potassium silicate and *α*-tocopherol on Shoot length of Sediek and Ewais mango cvs. grown under abiotic stresses during 2019 /2020 and 2020 /2021 seasons**.

| Cultivars / Treatments | Shoot length (cm). | | | | | |
|---|---|---|---|---|---|---|
| | April 2020 | | | April 2021 | | |
| | Sediek | Ewais | Mean | Sediek | Ewais | Mean |
| **Control** | 16.37 | 12.02 | **14.20** | 42.54 | 28.60 | 35.57 |
| **P.S.$_1$** | 20.00 | 13.96 | **16.98** | 50.24 | 33.00 | 41.62 |
| **P.S.$_2$** | 21.33 | 14.26 | **17.80** | 50.96 | 43.64 | 47.30 |
| ***α*-Toc.$_1$** | 18.08 | 16.08 | **17.08** | 44.74 | 40.70 | 42.72 |
| ***α*-Toc.2** | 18.33 | 15.87 | **17.10** | 46.56 | 45.10 | 45.83 |
| **P.S.$_1$+ *α*-Toc.$_1$** | 20.09 | 15.12 | **17.61** | 47.66 | 31.54 | 39.60 |
| **P.S.$_1$+ *α*-Toc.2** | 20.08 | 17.36 | **18.72** | 48.40 | 46.94 | 47.67 |
| **P.S.$_2$+ *α*-Toc.$_1$** | 18.67 | 16.88 | **17.78** | 44.74 | 35.94 | 40.34 |
| **P.S.$_{2+}$ *α*-Toc.2** | 21.21 | 21.19 | **21.20** | 58.30 | 51.34 | 54.82 |
| **Mean** | **19.35** | **15.86** | | 48.24 | 39.64 | |
| **New LSD 5%** | **C = 1.28** | **T = 2.71** | **CT= N.S.** | **C = N.S.** | **T=8.00** | **CT= N.S.** |

increased significantly by increasing the application rate of silicon compared with control.**Farooq et al.,(2019) and Schaffer et al.,(1994)** reported that environmental factors outside of the conventional location for optimum mango growth may cause stresses, resulting in physiological changes like decreased growth or possibly persistent tree damage. Many metabolic activities and cell functions have been linked to visible signs like necrosis, wilting, and chlorosis due to exposure to low temperatures **(Rulland and Zachowski, 2010).** These negative influences are associated with alterations in cell membrane formation as well as lipid composition **(Matteucci et al.,2011**).

In different fruit crops, increasing salinity in the root zone by more than 2 $dSm^{-1}$ impairs vegetative growth. Salinity affects tree growth by decreasing shoot and internode growth, disrupting leaf initiation and expansion, and accelerating leaf senescence and abscission (**Ebert, 2000**).

Meanwhile, foliar application of P.S. and/or α-Toc. alone or in combination stimulated vegetative growth on mango trees. This may be due to the positive impact of silicone on vegetative growth of plant especially under adverse conditions by improving nutrient uptake, mechanical properties of the plant parts and stimulating active roots. Also, silicon and -tocopherol inhibits oxidative degradation by enhancing the activity of antioxidant enzymes that reduce reactive oxygen species caused by stress conditions and toxic metals.

Furthermore, tocopherols play a vital role in stimulating plant growth, delaying senescence, and preventing leaf abscission, improving metabolic processes, eliminating free radicals and reducing membrane lipid peroxidation. **El-Quesni et al. (2009**) on *Hibiscus rosa-sinensis* and **Soltani et al., (2012)** on Calendula officinalis plants, reported that the application of alpha tocopherol enhanced growth parameters such as plant height, leaf area.

**4.2. Effect Exogenous applications of potassium silicate and/ or *α*-tocopherol on physiological responses: -**

**4.2.1. Relative water content (RWC):**

Young mango trees exposed to adverse environmental conditions including cold or salinity stresses had the lowest significant values of relative water content (table,7). On the other hand, foliar application of potassium silicate and *α*-tocopherol alone or together enhanced significantly RWC of young mango trees under the same conditions. Consequently, in the first season values of RWC were 71.48 and 72.82 for trees sprayed by potassium silicate at levels 0.1 and 0.2 %, respectively. Moreover, relative water content for trees treated with 200 ppm *α*-tocopherol was 69.66, while it was 70.51 for trees sprayed by 400 ppm α-tocopherol. This trend was the same in the 2nd season.

Regarding the effect of potassium silicate combined with α-tocopherol. In the two studied seasons, mango trees sprayed with higher level of potassium silicate (0.2%) with 400 ppm *α-tocopherol* gave the highest significant values of RWC, while the lowest value in this respect was detected by tress sprayed by the lower levels of P.S. (1%) with 200ppm *α*-Toc. The other treatments gave intermediate values in this respect. Significant differences were found between the two studded cultivars in the first season only.

**4.2.2. Membrane stability index (MSI).**

Abiotic stresses, including salinity and cold temperatures caused a harmful effect on membrane stability index for mango trees under study. Therefore, young mango tress grown under the adverse conditions which were sprayed with distilled water only showed the lowest significant values of MSI (table, 8). On the other hand, sprayed with the higher levels of potassium silicate or α-tocopherol alone was superior compared to the sprayed by lower levels of P.S. or α-Toc. in this respect.

Spraying yang mango trees with potassium silicate plus α-tocopherol together led to increasing gradually membrane stability index. In the first season, MSI for trees sprayed with 0.2% P.S. plus 400ppm α-Toc. was 75.47 But, these value was 64.23 for tress treated with 0.1% P.S. plus 200ppm α-Toc. The other treatments had intermediate values in this concern. Also, the same trend was observed in the second season. No significant differences were found among the two studied cvs. through April in the second season only.

**Table 7. Effect of foliar application of potassium silicate and *α-tocopherol* on Relative water content of Sediek and Ewais mango cvs. grown under abiotic stresses during 2019 /2020 and 2020 /2021 seasons.**

| Cultivars / Treatments | Relative water content | | | | | |
|---|---|---|---|---|---|---|
| | April 2020 | | | April 2021 | | |
| | Sediek | Ewais | Mean | Sediek | Ewais | Mean |
| **Control** | 68.83 | 65.41 | **67.12** | 69.72 | 71.88 | **70.80** |
| **P.S.1** | 76.84 | 66.11 | **71.48** | 73.91 | 72.45 | **73.18** |
| **P.S.2** | 77.25 | 68.38 | **72.82** | 73.87 | 77.02 | **75.45** |
| ***α*-Toc.1** | 72.42 | 66.9 | **69.66** | 71.02 | 71.84 | **71.43** |
| ***α*-Toc.2** | 73.34 | 67.68 | **70.51** | 71.17 | 74.88 | **73.03** |
| **P.S.1+ *α*-Toc.1** | 79.6 | 66.28 | **72.94** | 71.27 | 75.55 | **73.41** |
| **P.S.1+ *α*-Toc.2** | 72.15 | 77.32 | **74.74** | 76.91 | 76.74 | **76.83** |
| **P.S.2+ *α*-Toc.1** | 71.27 | 66.46 | **68.87** | 72.78 | 76.08 | **74.43** |
| **P.S.2+ *α*-Toc.2** | 83.86 | 72.01 | **77.94** | 79.91 | 78.04 | **78.98** |
| **Mean** | **75.06** | **68.51** | | **73.40** | **74.94** | |
| **New LSD 5%** | C = 2.92 | T = 6.20 | CT= 8.77 | C= **N.S.** | T = 9.36 | CT=13.24 |

**Table 8. Effect of foliar application of potassium silicate and *α-tocopherol* on Membrane stability index of Sediek and Ewais mango cvs. grown under abiotic stresses during 2019 /2020 and 2020 /2021 seasons.**

| Cultivars / Treatments | Membrane stability index | | | | | |
|---|---|---|---|---|---|---|
| | April 2020 | | | April 2021 | | |
| | Sediek | Ewais | Mean | Sediek | Ewais | Mean |
| Control | 66.73 | 53.22 | **59.98** | 57.12 | 53.05 | **55.09** |
| P.S.1 | 74.82 | 53.92 | **64.37** | 65.24 | 56.92 | **61.08** |
| P.S.2 | 74.82 | 55.58 | **65.20** | 59.81 | 57.86 | **58.84** |
| *α*-Toc.1 | 72.22 | 57.78 | **65.00** | 62.71 | 61.58 | **62.15** |
| *α*-Toc.2 | 72.22 | 66.03 | **69.13** | 62.79 | 63.99 | **63.39** |
| P.S.1+ *α*-Toc.1 | 63.11 | 65.35 | **64.23** | 61.13 | 64.53 | **62.83** |
| P.S.1+ *α*-Toc.2 | 69.44 | 68.24 | **68.84** | 62.20 | 66.56 | **64.38** |
| P.S.2+ *α*-Toc.1 | 76.29 | 69.10 | **72.70** | 68.50 | 60.56 | **64.53** |
| P.S.2+ *α*-Toc.2 | 79.87 | 71.07 | **75.47** | 69.12 | 68.83 | **68.98** |
| Mean | **72.17** | **62.25** | | **63.18** | **61.54** | |
| New LSD 5% | C. = 3.57 | T.= 7.57 | CT. =10.71 | **C= N.S.** | T= 4.94 | CT =6.99 |

In this concern, **Qin and Tian, (2009)** noted that silicon protects plants against abiotic stresses by inducing a natural defensive reaction as well as the production of phenolic substances that act as antioxidants. **Ma and Yamaji, (2006)** reported that silicon is linked to a multitude of functions, such as increased nutrient availability and mechanical properties of plant parts, as well as improved tolerance to abiotic stresses like salinity and elevated heat.

**Clement et al., (2002)** studied the external applied α -Toc to soybeans plants. They found that alpha tocopherol was to be helpful in removing free radicals and reducing membrane lipid peroxidation. **Maeda et al., (2006) and Matringe et al., (2008)** reported that alpha-tocopherol protects the photosynthesis membrane from photo oxidative damage at low temperatures. Tocopherol has been shown to have a role in membrane stability. Furthermore, it can scavenge or reduce reactive oxygen species to protect the membranes **(Maeda and DellaPenna, 2007).**

**4.2.3. SPAD chlorophyll.**

It is oblivious clear from the obtained results that SPAD chlorophyll was affected significantly by applications of potassium silicate and *α*-tocopherol alone or in combinations compared with control trees. Young mango trees grown under adverse environmental conditions without any treatments showed the lowest significant values of SPAD. On the other hand, values of SPAD increased by foliar applied potassium silicate or *α*-tocopherol alone especially at higher levels (table,9).

In the 1st season, the highest significant values of SPAD chlorophyll (62.70) were detected for trees sprayed with 0.2% P.S. plus 400pp α-Toc together, followed in descending order by trees sprayed by 0.2% P.S. + 200 ppm α-Toc., 0.1% Si plus400ppm α-Toc., and then by those sprayed by 0.1% P.S.+ 200ppm α-Toc., respectively. The same trend was observed in the second season. Trees of Sediek cultivar showed the highest significant values of SPAD chlorophyll compared with trees of Ewais cv. under the same conditions of the two studied seasons.

**4.2.4. photosynthetic efficiency ($F_v/F_m$).**

As shown from the obtained data (table,10) that Chlorophyll fluorescence (ratio of variable fluorescence yield "$F_v$"/maximum fluorescence yield "$F_m$") differed significantly by foliar application of potassium silicate and *α*-tocopherol alone or together. Also, spraying with *α*-tocopherol alone at 400ppm had a more pronounced effect than spraying with 0.2% potassium silicate alone.

Regarding the effect of foliar applied potassium silicate and *α*-tocopherol together. In the two studied seasons, young mango trees sprayed with the lower level of potassium silicate (0.1%) + 200ppm alpha-tocopherol gave the lowest significant values of $F_v/F_m$ . While the highest significant values of $F_v/F_m$ were attained by trees sprayed with the higher level of P.S. (0.2%) +400ppm α-Toc.

**Table 9. Effect of foliar application of potassium silicate and *α-tocopherol* on SPAD of Sediek and Ewais mango cvs. grown under abiotic stresses during 2019 /2020 and 2020 /2021 seasons.**

| Treatments \ Cultivars | SPAD | | | | | |
|---|---|---|---|---|---|---|
| | April 2020 | | | April 2021 | | |
| | Sediek | Ewais | Mean | Sediek | Ewais | Mean |
| Control | 55.60 | 51.37 | **53.49** | 54.47 | 38.43 | **46.45** |
| P.S.$_1$ | 62.97 | 51.6 | **57.29** | 63.73 | 40.67 | **52.20** |
| P.S.$_2$ | 63.83 | 51.73 | **57.78** | 59.30 | 49.67 | **54.49** |
| $\alpha$-Toc.$_1$ | 61.90 | 51.13 | **56.52** | 57.60 | 44.37 | **50.99** |
| $\alpha$-Toc.2 | 66.33 | 58.00 | **62.17** | 58.33 | 50.10 | **54.22** |
| P.S.$_1$+ $\alpha$-Toc.$_1$ | 62.37 | 55.00 | **58.69** | 58.23 | 43.50 | **50.87** |
| P.S.$_1$+ $\alpha$-Toc.2 | 64.60 | 52.83 | **58.72** | 59.23 | 45.70 | **52.47** |
| P.S.$_2$+ $\alpha$-Toc.$_1$ | 60.63 | 57.20 | **58.92** | 59.50 | 45.73 | **52.62** |
| P.S.$_{2+}$ $\alpha$-Toc.2 | 66.67 | 58.73 | **62.70** | 63.97 | 50.67 | **57.32** |
| Mean | **62.77** | **54.18** | | **59.37** | **45.43** | |
| New LSD 5% | **C = 2.18** | **T = 4.62** | **CT= N.S.** | **C = 1.56** | **T = 3.30** | **CT= N.S.** |

**Table 10. Effect of foliar application of potassium silicate and $\alpha$-tocopherol on $F_v/F_m$ of Sediek and Ewais mango cvs. grown under abiotic stresses during 2019 /2020 and 2020 /2021 seasons.**

| Treatments \ Cultivars | $F_v/F_m$ | | | | | |
|---|---|---|---|---|---|---|
| | April 2020 | | | April 2021 | | |
| | Sediek | Ewais | Mean | Sediek | Ewais | Mean |
| Control | 0.58 | 0.54 | 0.56 | 0.60 | 0.64 | 0.62 |
| P.S.$_1$ | 0.69 | 0.52 | 0.61 | 0.74 | 0.63 | 0.69 |
| P.S.$_2$ | 0.71 | 0.59 | 0.65 | 0.67 | 0.71 | 0.69 |
| $\alpha$-Toc.$_1$ | 0.67 | 0.57 | 0.62 | 0.73 | 0.69 | 0.71 |
| $\alpha$-Toc.2 | 0.72 | 0.67 | 0.70 | 0.73 | 0.74 | 0.74 |
| P.S.$_1$+ $\alpha$-Toc.$_1$ | 0.69 | 0.56 | 0.62 | 0.69 | 0.62 | 0.66 |
| P.S.$_1$+ $\alpha$-Toc.2 | 0.69 | 0.61 | 0.65 | 0.73 | 0.63 | 0.68 |
| P.S.$_2$+ $\alpha$-Toc.$_1$ | 0.69 | 0.67 | 0.68 | 0.76 | 0.68 | 0.72 |
| P.S.$_{2+}$ $\alpha$-Toc.2 | 0.72 | 0.68 | 0.70 | 0.78 | 0.76 | 0.77 |
| Mean | 0.68 | 0.60 | | 0.71 | 0.68 | |
| New LSD 5% | C = 0.034 | T = 0.076 | CT=N.S. | C = 0.019 | T = 0.040 | CT= N.S. |

(table,10). The other treatments had intermediate values in this respect. Significant differences were detected between the two studied cvs. in the first and second seasons.

These results agreed with **(Hattori et al.,2008**) under stresses conditions, they reported that the decrease in photosynthesis pigment may be due to the production of hydrolysis enzymes like chlorophyllase and ROS-induced chlorophyll degradation and cell wall disintegration.

**Matichenkov et al, (2000)** on citrus trees and **Gad EL-kareem et al., (2012)** on mango trees, reported that applying silicon to fruit trees grown under drought conditions helps to alleviate the negative impacts of drought stresses on plant growth, pigments. **Doaa-hamza and Ameer-Shalan (2020)** on mango trees El Gahrawy cv. grown under different levels of salinity, found that the spraying silicon increased chlorophyll. **Gad el-Kareem et al. (2014)** on mature date palm, **Moawed et al., (2015** on mature mango trees and **El-Gioushy, (2016)** on navel orange trees, found that total chlorophylls increased significantly by increasing application rate of silicon.

**4.2.5: Total carbohydrate%.**

It is clear from data in Table (11) that total carbohydrate for young mango trees grown under abiotic stress was affected significantly by foliar application of potassium silicate and *α*-tocopherol singular or in combination during the 1st and 2nd seasons of study. Leaves of young mango trees grown under abiotic stress without any treatments (control) had the lowest significant percent of total carbohydrate. These values were 21.96 % and 19.38% in the first and second seasons, respectively.

The obtained results showed that total carbohydrate increased by increasing application rates of potassium silicate or α -tocopherol singularly. Furthermore, the total carbohydrate of young mango trees sprayed with α -tocopherol alone was higher than that of trees sprayed with potassium silicate alone at higher level of application during the 1st and 2nd seasons (table, 11).

As for the impact of spraying with the mixture of P.S. and α-Toc. together. In the 1st season, young mango trees sprayed with the higher level of P.S. (2%) + 400ppm *α*-Toc. had the highest significant values of total carbohydrate (26.04 %). Meanwhile, total carbohydrate of trees sprayed by lower level of potassium silicate (1%) + 200 ppm *α*-tocopherol was 23.10 %, the other treatments gave intermediate values in this respect. This trend was also observed in the second season.

**4.2.6. Free proline content (mg $g^{-1}$ DW).**

In general, a negative relationship was detected among free proline content in leaves of young mango trees grown under adverse environmental conditions and foliar application of potassium silicate and *α*-tocopherol singular or together Table (12). Consequently, leaves of young mango trees exposed to abiotic stresses without any treatments had the highest significant values of free proline content. These results confirmed by **(Mervat Ali et al., 2013; Mirás-Avalos and Intrigliolo, 2017 and Asmaa Gamal,2020)** they reported that the concentration of proline in the vines was enhanced as a result of the salinity treatments.

Value of free proline was 0.95 mg $g^{-1}$ DW for tree sprayed by 0.1% P.S. while it was 0.83 mg $g^{-1}$DW for tree sprayed by 0.2% P.S. In addition, free proline content was 1.00 mg $g^{-1}$ DW for trees sprayed with 200pp *α*-Toc. and was 0.91 mg $g^{-1}$ DW for trees sprayed with 400 pp *α*-Toc. in the first season. It could be noted that effect of spraying with potassium silicate alone was more noticeable compared with sprayed with *α*-tocopherol alone especially at higher levels. Also, the decrease in free proline by foliar application of α-Toc. may be due to the essential role of Toc. in minimizing the adverse effects of abiotic stresses.

Trees sprayed with 0.1% P.S. + 200ppm *α*-Toc. showed the highest value of free proline content (0.82 mg $g^{-1}$ DW). This value declined significantly up to 0.59 mg $g^{-1}$ DW for trees sprayed with higher level of potassium silicate (0.20%) plus *α*-tocopherol (400ppm) together in the first season, respectively. The same trend was true for the second season. Leaves of Sediek cv. had the higher significant value of free proline content compared with leaves of Ewais cv.

**4.3.7. Total Phenols content (mg $g^{-1}$ DW).**

Phenol content differed significantly by external application of potassium silicate and α-tocopherol separately or together, as demonstrated by the obtained results. The lowest significant values of phenols (1.15 mg $g^{-1}$ DW) were detected by untreated trees. In addition, phenols content was raised by increasing the application rate of potassium silicate alone or -tocopherol alone. This trend was true in the two studied seasons (table,13).

In the first season, young mango trees sprayed with a higher concentration of P.S. (0.2%) plus α-Toc.(400 ppm) in combination gave the highest significant values of phenols content (1.61 mg $g^{-1}$ DW) followed in the second order by those treated with 0.2% P.S. plus 200 ppm α-Toc., 0.1% P.S. plus 400 ppm α-Toc., and 0.1% P.S. plus 200 ppm α-Toc., and 0.1% P.S. plus 200 ppm α-Toc., respectively. Significant differences were found between these treatments and the control. The

**Table 11. Effect of foliar application of potassium silicate and *α*-tocopherol on Total carbohydrate of Sediek and Ewais mango cvs. grown under abiotic stresses during 2019 /2020 and 2020 /2021 seasons.**

| Cultivars / Treatments | Total carbohydrate (%) | | | | | |
|---|---|---|---|---|---|---|
| | April 2020 | | | April 2021 | | |
| | Sediek | Ewais | Mean | Sediek | Ewais | Mean |
| Control | 20.75 | 23.16 | **21.96** | 19.04 | 19.71 | **19.38** |
| P.S.1 | 21.76 | 24.57 | **23.17** | 22.76 | 20.09 | **21.43** |
| P.S.2 | 22.2 | 25.03 | **23.62** | 20.86 | 20.20 | **20.53** |
| *α*-Toc.1 | 23.33 | 25.5 | **24.42** | 20.39 | 22.91 | **21.65** |
| *α*-Toc.2 | 23.41 | 25.74 | **24.58** | 23.55 | 23.90 | **23.73** |
| P.S.1+ *α*-Toc.1 | 22.52 | 23.68 | **23.10** | 24.47 | 24.98 | **24.73** |
| P.S.1+ *α*-Toc.2 | 23.09 | 23.11 | **23.10** | 24.49 | 26.02 | **25.26** |
| P.S.2+ *α*-Toc.1 | 23.15 | 25.66 | **24.41** | 24.99 | 25.63 | **25.31** |
| P.S.2+ *α*-Toc.2 | 25.95 | 26.13 | **26.04** | 24.23 | 26.80 | **25.52** |
| Mean | **22.91** | **24.73** | | **22.75** | **23.36** | |
| New LSD 5% | C =0.81 | T =1.72 | CT= NS | C = NS | T = 2.34 | CT=3.32 |

**Table 12. Effect of foliar application of potassium silicate and *α-tocopherol* on Free proline of Sediek and Ewais mango cvs. grown under abiotic stresses during 2019 /2020 and 2020 /2021 seasons.**

| Cultivars / Treatments | Free proline (mg $g^{-1}$ DW) | | | | | |
|---|---|---|---|---|---|---|
| | April 2020 | | | April 2021 | | |
| | Sediek | Ewais | Mean | Sediek | Ewais | Mean |
| Control | 1.37 | 1.16 | 1.27 | 1.79 | 1.71 | 1.75 |
| P.S.1 | 1.10 | 0.79 | 0.95 | 1.72 | 1.55 | 1.64 |
| P.S.2 | 1.05 | 0.61 | 0.83 | 1.64 | 1.09 | 1.37 |
| *α*-Toc.1 | 1.15 | 0.84 | 1.00 | 1.68 | 1.37 | 1.53 |
| *α*-Toc.2 | 1.02 | 0.79 | 0.91 | 1.65 | 1.31 | 1.48 |
| P.S.1+ *α*-Toc.1 | 0.94 | 0.70 | 0.82 | 1.55 | 1.21 | 1.38 |
| P.S.1+ *α*-Toc.2 | 0.73 | 0.58 | 0.66 | 1.55 | 1.07 | 1.31 |
| P.S.2+ *α*-Toc.1 | 0.81 | 0.49 | 0.65 | 1.6 | 0.61 | 1.11 |
| P.S.2+ *α*-Toc.2 | 0.72 | 0.45 | 0.59 | 1.26 | 0.45 | 0.86 |
| Mean | 0.99 | 0.71 | | 1.60 | 1.15 | |
| **New LSD 5%** | **C = 0.05** | **T = 0.11** | **CT= N.S.** | **C = 0.07** | **T = 0.14** | **CT= 0.20** |

**Table 13. Effect of foliar application of potassium silicate and *α-tocopherol* on total Phenols of Sediek and Ewais mango cvs. grown under abiotic stresses during 2019 /2020 and 2020 /2021 seasons.**

| Cultivars | total Phenols (mg $g^{-1}$ DW) | |
|---|---|---|
| | April 2020 | April 2021 |

| Treatments | Sediek | Ewais | Mean | Sediek | Ewais | Mean |
|---|---|---|---|---|---|---|
| **Control** | 1.21 | 1.08 | **1.15** | 1.31 | 0.69 | **1.00** |
| **P.S.1** | 1.50 | 1.12 | **1.31** | 1.51 | 0.93 | **1.22** |
| **P.S.2** | 1.58 | 1.24 | **1.41** | 1.38 | 0.96 | **1.17** |
| **$\alpha$-Toc.1** | 1.48 | 1.21 | **1.35** | 1.32 | 0.83 | **1.08** |
| **$\alpha$-Toc.2** | 1.63 | 1.37 | **1.50** | 1.45 | 0.93 | **1.19** |
| **P.S.1+ $\alpha$-Toc.1** | 1.43 | 1.22 | **1.33** | 1.54 | 0.84 | **1.19** |
| **P.S.1+ $\alpha$-Toc.2** | 1.49 | 1.22 | **1.36** | 1.63 | 0.85 | **1.24** |
| **P.S.2+ $\alpha$-Toc.1** | 1.58 | 1.49 | **1.54** | 1.63 | 1.07 | **1.35** |
| **P.S.2+ $\alpha$-Toc.2** | 1.69 | 1.52 | **1.61** | 1.69 | 1.05 | **1.37** |
| **Mean** | **1.51** | **1.27** | | **1.50** | **0.91** | |
| **New LSD 5%** | C =0.11 | T = 0.24 | CT= **N.S.** | C =0.08 | T = 0.18 | CT= **N.S.** |

same trend was found in the 2nd season. Significant differences were detected among the two studied cvs. Trees of Sediek cv. had the higher values of Phenols content compared to tree of Ewais cv.

In this respect, **Qin and Tian, (2009)** noted that silicon protects plants against abiotic stress by inducing a natural defensive reaction as well as the production of phenolic substances that act as antioxidants. **Doaa-hamza and Ameer-Shalan (2020)** studied the influence of sodium silicate (Si) on physiological responses of young mango trees cv. El Gahrawy grown under different levels of salinity. They found that the spraying of silicate increased chlorophyll, and total phenols.

**Khattab, (2007)** and **El Hariri etal., (2010)** demonstrated that alpha tocopherol application increases total phenols, which play a role in plant metabolic processes and act as a source of several ant oxidative enzymes, thereby reducing salt stress damage.

Finally: It can be concluded that cold and salinity stresses were characterized by inducing a dramatic decline of all physiological responses of young mango trees. Meanwhile, foliar application of potassium silicate and/or $\alpha$-tocopherol alone or in combination significantly improves morphological, physiological characteristics. The foliar application of tocopherol alone was more noticeable compared with spraying with potassium silicate alone particularly at the higher rates and maintained the growth and plant performance under abiotic stresses.

According to our results, we recommend foliar spray with either P.S. at 0.2% or $\alpha$-Toc. at 400pp alone or combined for four times in winter season (on the first of December, 1st of January, 1st of February and then on the first of March) to alleviate adverse effects of salinity and low temperatures on young mango trees

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# تأثير الأضافة الورقية لسليكات البوتاسيوم والألفاتوكوفيرول لتخفف الأثار السلبية لبرودة الشتاء وملوحة التربة على اشجار المانجو الصغيرة

أجرى هذا البحث خلال موسمين متتاليين 2020/2019، 2021/2020 على أشجار صنفين من اشجار المانجو الصغيره هما صنفى الصديق والعويس لدراسة تأثر الرش الورقى بمستويات مختلفة من سليكات البوتاسيوم (صفر % ، 0.1% و 0.2%) والألفــاتوكوفــيرول (صفر PPM ، 200 PPM و400 PPM) بهدف تخفيف التأثير الضار لبرودة الشتاء والتاثير السلبى لملوحة التربة على نمو أشجار المانجو الصغيرة.

**ويمكن تلخيص النتائج المتحصل عليها فيما يلى:-**

أظهرت النتائج أن مكونات النمو الخضرى مثل (إرتفاع الشجرة ، عدد الأوراق/الفرع، مساحة الورقه وطول الفرع) لأشجار كل من صنف الصديق وصنف العويس تأثرت سلبيا بالأجهادات اللاحيوية. فى حين أن الإضافات الخارجية لسليكات البوتاسوم او الألفاتوكوفيرول أظهرت تحسين معنوى الصفات المورفولجية والفسيولوجية لأشجارالمانجو تحت الدراسة .

كان الرش بالألفاتوكوفيول بمفردة أفضل من الرش بسليكات البوتاسيوم بمفردها خصوصا عند التركيزات الأعلى من الرش للمحافظه على نمو وتحسين آداء الأشجار تحت ظروف الأجهادات اللاحيوية.

**وبناء على تلك النتائج يمكن التوصية :-**

1- رش أشجار المانجو بسليكات البوتاسيوم بتركيز 0.2% بمفردها أو الرش بالألفاتكوفيرول بمفردة بتركيز 400 جزء فى المليون.

2- الرش الورقى لأشجار المانجو بسليكات البوتاسيوم بتركيز 0.2% مع بالألفاتكوفيرول بتركيز 400 جزء فى المليون معا . أربع مرات فى فصل الشتاء فى الأول من (ديسمبر، يناير، فبراير ثم مارس) لتخفيف الأثار السلبية لبروده الشتاء وملوحة التربة.