# TRIALS FOR ALLEVIATING THE ADVERSE EFFECTS OF SOIL AND WATER SALINITY ON FRUITING OF EWAISE MANGO TREES

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## ABSTRACT

During 2016 and 2017 seasons, five martials namely ABA, Chitosan, Salicylic acid, Mannitol and Selenium each at 100 ppm were tested for their beneficial effects on counteracting the inferior effects of salinity on fruiting of Ewaise mango trees grown under soil and irrigation water salinity (salinity of soil and irrigation water were 4.69 dsm and 3.13 dsm ppm, respectively). The selected trees received three sprays at growth start, just after fruit setting and one month later.

Subjecting the trees to the five materials namely ABA, Chitosan, Salicylic acid, Mannitol and Selenium each at 100 ppm was accompanied with enhancing all growth aspects, tree nutritional status, yield and quality parameters relative to the trees grown under salinity stress alone. The best materials, in ascending order, responsible for reducing the adverse effect of salinity were ABA, Mannitol, Salicylic acid, Selenium and Chitosan.

For alleviating the unsuitable effects of salinity on fruiting of Ewaise Mango trees grown under soil stress, it is recommended to spray chitosan or selenium each at 100 ppm three times at growth start, just after fruit setting and one month later.

**Keywords**: ABA, Chitosan, Salicylic acid, Mannitol, Selenium, Soil and water salinity, Ewaise mango trees, alleviating, Growth, Yield and fruit quality.

## INTRODUCTION

Salinity caused by soil and water irrigation saline conditions is a serious problem faces the world. Each year more lands become non- productive **(Fairbairn *et al*., 2000)**. The most effective mean to solve the problem of salt-stressed is to use some materials such as absicic acid, mannitol, chitosan, selenium and salicylic acid.

Salinity in the soil and irrigation water had an obvious depression on growth, tree nutritional status, yield and fruit quality of different fruit crops **(Ali-Mervat *et al*., 2013; Ibrahiem and Al- Wasfy, 2014; Taha- Nevine and Sherif-Hanna, 2015 and El- Hanafy, 2017)**. The results of **Abdel- Kader *et al*., (2002) and El- Sabagh *et al*., (2011)** emphasized the adverse effects of salinity on growth and fruiting of fruit crops.

Previous studies showed that using selenium **(Gad El-Kareem, *et al*., 2014; Uwakiem, 2015; Akl *et al*., 2017 a and 2017 b Abo El- Fadle, 2017 and El- Hanafy, 2017)**, salicylic acid **(Delaney, 2004**; **Ahmed, 2011; El- Khawaga, 2013; Amiri *et al*., 2014; Mohamed-Attiat, 2016; Abd El-Rady, 2015 and El-Sayed- Eman, 2017),** chitosan **(Hadwiger, 2013; Mohamed, 2014; El-Eleryan-**

**Eman, 2015; Ali *et al*, 2017 and Khafagy, 2018)**; ABA **(Taylor *et al*., 2000; Taiz and Zeiger, 2002; Tutega, 2007 and Gill and Titeja, 2010)** and mannitol **(Cha-Mm *et al*., 2010; Gill and Titeja, 2010 and Kaya *et al*., 2013)** had an obvious promotion on alleviating the adverse effects of soil and water salinity on growth and fruiting of fruit crops.

The target of this study was elucidating the beneficial effects of using chitosan, selenium, salicylic acid, ABA and mannitol on alleviating the adverse effects of salinity on growth and fruiting of Ewaise Mango trees.

## MATERIALS AND METHODS

This investigation was carried during 2016 and 2017 seasons on uniform in vigour and regular bearing eighteen 8- years old Ewaise mango trees onto seedling rootstock. The trees are grown in a private mango orchard located at West Samalout district, Minia Governorate. The selected trees are planted at 6x6 meters apart. The investigated trees were irrigated through drip irrigation system. The soil texture is sandy. Salinity of soil and irrigation water was 4.69 ds/m and 3.13 ds/m, respectively. The trees received the common horticultural practices that already applied in the orchard. Table (1) shows the analysis of the soil in the tested location according to **Wilde *et al*., (1985).**

**Table (1): Analysis of the tested soil**

| Constituents | Values |
|---|---|
| Particle size distribution | |
| Sand % | 78.0 |
| Slit % | 9.9 |
| Clay % | 12.1 |
| Texture % | Sandy |
| pH (1:2.5 extract) | 7.5 |
| E.C. (1 : 2.5 extract) ppm | 4.69 |
| O.M. % | 0.14 |
| $CaCO_3$ % | 2.25 |
| Total N% | 0.009 |
| Available P (Olsen method, ppm) | 2.1 |
| Available K (ammonium acetate, ppm) | 15.5 |
| EDTA extractable micronutrients (ppm): | |
| Fe | 1.0 |
| Mn | 0.9 |
| Zn | 0.7 |
| Cu | 0.3 |

Under this study the trees were subjected to the following six treatments.

1) Control
2) Spraying absicic acid (ABA) at 100 ppm.
3) Spraying mannitol sugar alcohol at 100 ppm.
4) Spraying salicylic acid at 100 ppm.

5) Spraying selenium at 100 ppm.
6) Spraying chitosan at 100 ppm.

Each treatment was replicated three times, one tree per each. The five materials (ABA, mannitol, SA, selenium and chitosan) were sprayed three times at growth start (4$^{th}$ week of Feb.); just after fruit setting (1$^{st}$ week of April) and at one month later (1$^{st}$ week of May). Salicylic acid was solubilized in few drops of Ethyl alcohol. Chitosan was prepared by using 0.6% acetic acid and adding 25% glycerol as plasticizer and the pH of water was adjusted to 5.6 using 1.0 N sodium hydroxide **(Abdalla and Haggag-Waffa, 2010)**. Triton B as a wetting agent was added to all spraying solutions and control trees at 0.05% and spraying was carried out till runoff.

This study was statistically analyzed using randomized complete block design (RCBD), where the experiment included six treatments. Each treatment was replicated three times one tree per each.

**During both seasons, the following parameters were recorded:**

**1-** Vegetative growth characteristics namely shoot length (cm), number of leaves/ shoot and leaf area (cm$^2$) in the spring growth cycle, in the twenty leaves below panicles **(Summer, 1985)** using the following formula as reported by **(Ahmed and Morsy, 1999)**.

Leaf area= (maximum length x maximum width) 0.7- 1.06

**2-** Percentages of N, P and K **(Cottenie *et al.*, 1982)** on dry weight basis of the leaves.

**3-** Percentages of initial fruit setting and fruit retention.

**4-** Yield per tree expressed in weight (kg.) and number of fruits per tree.

**5-** Fruit quality characteristics namely average fruit weight (g), T.S.S. %, total and reducing sugars % **(Lane and Eynon, 1965 and A.O.A.C, 2000)**, total acidity % (as g citric acid/100 g juice) and vitamin C content (as mg/100 ml juice) **(A.O.A.C, 2000**).

All the obtained data were tabulated and subjected to the proper statistical analysis according to **Mead *et al,* 1993**) and the different treatment means were compared using new L.D.S. at 5%.

## RESULTS AND DISCUSSION

### 1- Vegetative growth characteristics:

It is revealed from the obtained data in Table (2) that treating Ewaise mango trees grown under saline conditions three times with chitosan, selenium (Se); salicylic acid (SA); mannitol and absicic acid (ABA) each at 100 ppm was significantly responsible for stimulating shoot length, number of leaves/shoot and leaf area relative to the trees that growing under salinity stress. Significant differences on these growth aspects were observed among the five materials (chitosan, selenium; salicylic acid; mannitol and absicic acid). The promotion on these growth aspects was significantly associated with using ABA, mannitol, SA, Se and chitosan each at 100 ppm, in ascending order. Treating the trees three times with chitosan or Se each at 100 pm significantly maximized these growth aspects in

the trees growing under saline conditions. Subjecting the trees to salinity caused by soil (4.69 ds/m) and irrigation water (3.13 ds/m) without any treatment gave the lowest values. The maximum values of shoot length **(14.1 & 14.3 cm)**, number of leaves/shoot **(16.0 & 17.0)** and leaf area **(82.9 and 83.7 cm$^2$)** were recorded on the trees under salt conditions and treated with chitosan at 100 ppm during both seasons, respectively. These results were true during both seasons.

**2- Percentages of N, P and K:**

Data in Table (2) clearly show that Percentages of N, P and K in the leaves were significantly increased due to treating the trees with any one of the five materials (chitosan, selenium; salicylic acid; mannitol and absicic acid) each at 100 ppm relative to the control treatment (trees under salinity stress). There was a significant promotion on these nutrients with using chitosan, Se, SA, mannitol and ABA, in descending order. Varying anti-salinity materials had significant differences on these nutrients. The highest values of N **(2.16 & 2.17 %),** P **(0.251 & 0.248%)** and K **(1.56 & 1.51 %)** were recorded on the trees growing under saline soil and treated with chitosan at 100 ppm during both seasons, respectively. Similar results were announced during both seasons.

**Table (2): Effect of spraying ABA, mannitol, SA, selenium and chitosan on some growth aspects and percentages of N, P and K in the leaves of Ewaise mango trees during 2016 and 2017 seasons.**

| Treatment | Main shoot length (cm.) | | No. of leaves/shoot | | Leaf area (cm.)$^2$ | | Leaf N % | | Leaf P % | | Leaf K % | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 |
| Control | 9.1 | 9.3 | 5.0 | 6.0 | 69.9 | 70.1 | 1.61 | 1.64 | 0.191 | 0.194 | 1.04 | 1.11 |
| ABA at 100 ppm | 9.7 | 9.9 | 7.0 | 8.0 | 71.5 | 72.0 | 1.71 | 1.72 | 0.200 | 0.204 | 1.14 | 1.17 |
| Mannitol at 100 ppm | 10.4 | 10.6 | 9.0 | 10.0 | 73.3 | 73.9 | 1.84 | 1.82 | 0.210 | 0.215 | 1.25 | 1.24 |
| SA at 100 ppm | 11.2 | 11.3 | 11.0 | 12.0 | 75.9 | 76.5 | 1.95 | 1.99 | 0.222 | 0.226 | 1.36 | 1.33 |
| Selenium at 100 ppm | 13.0 | 13.3 | 14.0 | 14.0 | 79.9 | 80.5 | 2.06 | 2.11 | 0.231 | 0.239 | 1.49 | 1.42 |
| Chitosan at 100 ppm | 14.1 | 14.3 | 16.0 | 17.0 | 82.9 | 83.7 | 2.16 | 2.17 | 0.251 | 0.248 | 1.56 | 1.51 |
| New L.S.D. at 5% | 0.4 | 0.5 | 1.0 | 1.0 | 1.2 | 1.4 | 0.06 | 0.08 | 0.006 | 0.007 | 0.04 | 0.05 |

**SA = Salicylic acid**

**3- Percentages of initial fruit setting and fruit retention.**

Data in Table (3) reasonably indicate that percentages of initial fruit setting and fruit retention were significantly improved due to treating the trees of Ewaise mango under salinity stress to any one of the five materials (chitosan, selenium; salicylic acid; mannitol and absicic acid) each at 100 ppm compared to those trees left without any treatment. The best materials in alleviating the adverse effects of salinity were chitosan, Se, SA, mannitol and ABA, in descending order. Treating the trees three times with chitosan at 100 ppm gave the maximum values of initial fruit setting **(4.1 % & 3.9 %)** and fruit retention **(1.9 % & 1.8%)** during both seasons, respectively. The lowest values were recorded on untreated trees growing under salinity conditions. These results were true during both seasons.

**4- Yield/tree.**

Data in Table (3) indicate that yield/tree expressed in weight (kg) and number of fruits/tree was significantly improved in response to treating the trees growing under salinity soil with any one of the five materials (chitosan, selenium;

salicylic acid; mannitol and absicic acid) each at 100 ppm compared to the check treatment that growing under salinity conditions. Yield/tree was significantly varied according to the types of anti-salinity agents. The promotion effect on the yield was significantly attributed to using chitosan, Se, SA, mannitol and ABA, in descending order. The maximum yield **(57.3 & 58.4 kg)** during both seasons, respectively, respectively was observed on the trees sprayed with chitosan followed by Se in which the trees produced **53.2 & 53.5 kg** during both seasons. The trees treated with SA, mannitol and AbA produced **49.9 & 46.0 and 43.3 kg** in the first season and **50.1 & 46.4 and 43.8** kg in the second season, respectively. Growing the trees under salinity stress alone (without any treatment) gave the lowest values of yield (**40.2 & 40.4 kg)** during both seasons, respectively. The percentage of increment on the yield due to application of chitosan, Se, SA, mannitol and ABA over the control treatments reached **42.5, 32., 24.1, 14.4 and 7.7 %** in the first season and reached **44.6, 32.4, 24.0, 14.9 and 8.4 %** in the second season, respectively. These results were true during both seasons.

**5- Physical and chemical characteristics of the fruits:**

Data in Tables (3 & 4) clearly show that spraying any one of the five materials (chitosan, selenium, salicylic acid, mannitol and absicic acid) each at 100 ppm significantly improved fruit quality in terms of increasing fruit weight, T.S.S%, total and reducing sugars% and vitamin C content and decreasing total acidity % relative to the control trees that subjected to salinity stress without treatments. The promotion on both physical and chemical characteristics of the fruits was significantly related to the application of chitosan, Se, SA, mannitol and ABA each at 100 ppm, in descending order. Significant differences on these quality parameters were observed among the five materials (chitosan, selenium, salicylic acid, mannitol and absicic acid). The best results were obtained due to treating the trees with chitosan at 100 ppm. Unfavourable effects on fruit quality were recorded on the trees growing under salinity stress conditions alone (the control trees). The results were true during both seasons.

**Table (3): Effect of spraying ABA, mannitol, SA, selenium and chitosan on the percentages of initial fruit setting and fruit retention, yield and average fruit weight of Ewaise mango trees during 2016 and 2017 seasons.**

| Treatment | Initial fruit setting% | | Fruit retention% | | No. of fruit/tree | | Yield/tree (kg) | | Av. Fruit weight (g) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 |
| **Control** | 2.0 | 1.9 | 0.7 | 0.6 | 201.0 | 203.0 | 40.2 | 40.4 | 200.0 | 199.0 |
| **ABA at 100 ppm** | 2.4 | 2.3 | 0.9 | 0.8 | 211.0 | 212.0 | 43.3 | 43.8 | 205.0 | 206.6 |
| **Mannitol at 100 ppm** | 2.8 | 2.7 | 1.2 | 1.0 | 218.0 | 220.0 | 46.0 | 46.4 | 211.0 | 210.9 |
| **SA at 100 ppm** | 3.3 | 3.1 | 1.5 | 1.3 | 230.0 | 231.0 | 49.9 | 50.1 | 216.9 | 217.0 |
| **Selenium at 100 ppm** | 3.7 | 3.5 | 1.7 | 1.5 | 240.0 | 241.0 | 53.2 | 53.5 | 222.0 | 221.9 |
| **Chitosan at 100 ppm** | 4.1 | 3.9 | 1.9 | 1.8 | 252.0 | 255.0 | 57.3 | 58.4 | 227.0 | 229.0 |
| **New L.S.D. at 5%** | **0.4** | **0.4** | **0.2** | **0.2** | **5.1** | **5.9** | **2.9** | **3.1** | **2.9** | **3.1** |

**SA = Salicylic acid**

**Table (4): Effect of spraying ABA, mannitol, SA, selenium and chitosan on some chemical characteristics of the fruits of Ewaise mango trees during 2016 and 2017 seasons.**

| Treatment | T.S.S. % | | Total sugars % | | Reducing sugars % | | Total acidity % | | Vitamin C (mg/100 mg pulp) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 |
| **Control** | 17.0 | 16.9 | 15.0 | 15.0 | 4.9 | 5.1 | 0.355 | 0.361 | 31.1 | 31.9 |
| **ABA at 100 ppm** | 17.4 | 17.5 | 15.4 | 15.6 | 5.3 | 5.5 | 0.341 | 0.360 | 33.3 | 34.3 |
| **Mannitol at 100 ppm** | 18.0 | 18.1 | 15.7 | 15.9 | 5.6 | 5.9 | 0.321 | 0.330 | 36.0 | 37.0 |
| **SA at 100 ppm** | 18.5 | 18.7 | 16.1 | 16.2 | 6.0 | 6.2 | 0.301 | 0.310 | 37.9 | 39.0 |
| **Selenium at 100 ppm** | 19.1 | 19.2 | 16.6 | 16.5 | 6.3 | 6.6 | 0.281 | 0.291 | 40.0 | 41.4 |
| **Chitosan at 100 ppm** | 19.4 | 19.5 | 16.9 | 16.8 | 6.6 | 6.9 | 0.255 | 0.261 | 42.9 | 43.9 |
| **New L.S.D. at 5%** | **0.3** | **0.2** | **0.3** | **0.2** | **0.3** | **0.3** | **0.013** | **0.015** | **1.9** | **2.0** |

SA = Salicylic acid

## DISCUSSION

The inferior effects of salinity on growth and fruiting of Ewaise mango trees might be attributed to its negative effects on cell division, plant pigments, plant metabolism, cytoplasm, respiration, photosynthesis pigments, uptake of water and nutrients **(Jacoby, 1994; Munns and Tomeat, 1986; and Tylor, 1996)**.

The beneficial effects of salicylic acid on counteracting the adverse effects of salinity on growth, nutritional status, yield and fruit quality of Ewaise mangoo trees might be attributed to its positive action on enhancing cell division and the biosynthesis of plant pigments and organic foods as well as reducing reactive oxygen species (ROS) and oxidative stress besides increasing the tolerance of trees to abiotic and biotic stresses and the defense resistance system and stimulating of antioxidant enzymes (**Raskin, 1992; Ozeker, 2005 and Joseph *et al.*, 2010)**.

Selenium was found by many authors to retard the reactive oxygen species (ROS) and enhance the tolerance of trees to abiotic and biotic stresses and enzymes activity **(Seppanen *et al*., 2003 and Nowak- Barbara, 2008).**

The beneficial effects of mannitol on retarding the adverse effects of salinity on growth and fruiting of Ewaise mango trees was meanly attributed to its effect on enhancing osmotic pressure of plant tissues and the biosynthesis of proline **(Cha-Mm *et al.*, 2010; Gill and Tuteja, 2010 and Kaya *et al.*, 2013)**.

According to **Swamy and Smith (1999)** absicic acid is responsible for closing stomata and preventing transpiration rate and this results in enhancing the tolerance of trees to abiotic stress.

The counteracting effect of chitosan on the adverse effects of salinity on development of the trees could be attributed to its effect in retarding the reactive oxygen species and protecting plant cells from destroying as well as its effect in increasing lignification of plant cells consequently reduced transpiration rate **(Hadwiger, 2013).**

These results regarding salicylic acid are in harmony with those obtained by **El- Khawaga, (2013); Amiri *et al*., (2014); Mohamed, (2014); Mohamed-Attiat, (2016) and El- Sayed- Eman, (2017).**

The results of selenium are in concordance with those of **Abo El- Fadle, (2014}; Gad El-Kareem, *et al*., (2014); Uwakiem, (2015); Akl *et al*., (2017 a and 2017 b) and El- Hanafy, (2017).**

Concerning the effect of chitosan **(El-Eleryan-Eman, 2013 and Khafagy, 2018)**; ABA **(Taylor and Thompson, 2000; Taiz and Zeiger, 2002; Tutega, 2007 and Gill and Titeja, 2010)** and mannitol **(Cha-Mm *et al*., 2010; Gill and Tuteja, 2010 and Kaya *et al*., 2013)** are in agreement with the present results

## CONCLUSION:

For alleviating the unsuitable effects of salinity on fruiting of Ewaise Mango trees grown under soil stress, it is recommended to spray chitosan or selenium each at 100 ppm three times at growth start, just after fruit setting and one month later.

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**محاولات لتقليل الاثر الضار لملوحة التربة ومياه الرى علي الاثمار فى أشجار المانجو العويس**

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اجريت هذه الدراسة بمزرعة خاصة بمركز سمالوط بمحافظة المنيا بـــ ج. م. ع خلال موسمى ٢٠١٦ و ٢٠١٧ حيث تم اختبار تاثير خمس مواد هى حامض الابسيسك والمانيتول والشيتوسان والسيلينيوم وحامض السلسليك بتركيز ١٠٠ جزء فى المليون لكل منهم فى تقليل الأثار الضارة لملوحة التربة ومياه الرى علي النمو والحالة الغذائية للأشجار وكمية المحصول وخصائص الجودة للثمار فى أشجار المانجو العويس النامية تحت ظروف ملوحة التربة ٤.٦٩ ديسمتر ومياه الرى ملوحتها ٣.١٣ ديسمتر. ولقد تم رش الأشجار المنتخبة لتنفيذ هذه التجربة ثلاث مرات فى بداية النمو الخضرى وبعد عقد الثمار مباشرة وبعد هذه المرحلة بشهر.

وقد ادى معاملة الأشجار بالخمس مواد (حامض الابسيسك و المانيتول والشيتوسان والسيلينيوم وحامض السلسليك بتركيز ١٠٠ جزء فى المليون لكل منهم) الى تحسين جميع الصفات الخضرية والحالة الغذائية للأشجار وكمية المحصول وخصائص الجودة للثمار وذلك بالمقارنة بتلك الأشجار النامية تحت ظروف الملوحة وبدون اى معاملة بهذه المواد ويمكن ترتيب هذه المواد بحسب تقليلها للاثار الضارة للملوحة علي النحو التالي مرتبة ترتيبا تصاعديا (حامض الأبسيسك والمانيتول وحامض السلسليك والسيلينوم والشيتوسان) .

لتقليل الأثار الضارة للملوحة علي أشجار المانجو عويس النامية تحت ملوحة التربة ومياه الرى فانه يوصى برش الشيتوسان أو السيلينيوم بتركيز ١٠٠ جزء فى المليون فى بداية النمو الخضرى وبعد عقد الثمار مباشرة وبعد هذه المرحلة بشهر.

الكلمات الدالة: حامض الابسيسك و المانيتول والشيتوسان والسيلينيوم وحامض السلسليك – أشجار المانجو العويس – ملوحة التربة ومياه الرى – تقليل الاثر الضار للملوحة – خصائص النمو – كمية المحصول – خصائص الجودة للثمار.