**STUDIES ON ALLEVIATING SALINITY STRESS DISORDERS**

**OF TWO GRAPECULTIVARS TRANSPLANTS**

**By**

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**ABSTRACT**

 This study was carried out at the Fac. of Agric., Benha Univ. during 2014 and 2015 seasons in an endeavour to alleviate the adverse impact of irrigation with high saline water solution on growth and some leaf physiological properties of Crimson seedless and Superior salt stressed grape transplants through anti-salt stress substances manipulation (BA at 25 mg/L, potassium sulphate at 300 mg/L, potassium silicate at 5 ml/L and magnetic iron at 5 g/transplant). The collected data proved that there was a significant increment including all investigated growth parameters (plant height; stem diameter; number of lateral shoots; total number of leaves/transplant, fresh and dry weight of the different plant organs, leaf and total assimilation area, total plant dry weight and top/root ratio). Hard leaf character (H.L.C.), was significantly decreased, however, the reverse was detected in both leaf water potential (L.W.P.) and leaf relative turgidity (L.R.T.) as compared with control. The maximum improvement of both investigated parameters was achieved when the transplants were sprayed with potassium silicate at 0.5% along with magnetic iron at 5 g/transplant both soil application applied twice monthly during both seasons of study.

**Key words**: Grape rooted cuttings - Crimson seedless - Superior grape - Vegetative growth – Leaf physiological properties - Potassium silicate – Salinity – Salt stress – magnetic iron – BA - Potassium sulpate

**INTRODUCTION**

 Grapes is consider one of the most important fruit crops all over the world. World cultivated area about 7.5 millions ha. produced about 67 m. tones **(FAO, 2015)**. According to the **(FAO)** 75.866 square kilometers of the world land are dedicated to grapes. Approximately 71% of world grape production is used for wine 27% as fresh fruit and 2% as dried fruits. The area dedicated to vineyard is raising by about 2%/year.

 Moreover, it is considered to be the second most important fruit crop after citrus in Egypt as its acreage, production and exportation. The harvest area estimated by 150000 feddans produced 1.07 million tons according to **Ministry of Agriculture and Land Reclamination (2002)**.

 Salinity is a major abiotic stress factor reducing growth and yield of wide varieties of crops all over the world **(Tester and Davvenport, 2003)**. The reduction in growth may be related to adverse effects of excess salts on ion homeostasis, water balance, mineral nutrition and photosynthetic carbon metabolism **(Munns, 2002)**.

 Salinity can be minimized with reclamation, water and drainage, but the cost of engineering and management is very high. Increasing costs for water and energy emphasis the need for an alternative strategy **(Shannon, 1984)**.

 As alternative strategy for overcoming the negative effects of salinity on plant growth and yield could be attempt to treat the plants with some recovering compounds as silicon and magnetic iron, where irrigation water is known to be or may become saline.

 The function of Si as a protective agent is probably one of the most important for plants. Si can reduce salinity stress and reduce transpiration in plant **(Epstein, 1994)**.Metal toxicity, salinity, drought and temperature stresses can be alleviated by Si application **(Liang *et al.*, 2007)**.

 Drought tolerance brought about by the application of “Si” may result from decreased transpiration **(Epstein, 1999)** and the presence of silicified structure in plants suggested a reduction of leaf heat-load providing an effective cooling mechanism and then improving the plant tolerance to high temperatures **(Wang *et al.*, 2005)**. The resistance to salt stress has been found to be due to the enhancement of enzymes such as superoxide dismutase (SOD) and catalase, preventing membrane oxidative damage **(Moussa, 2006)**.

 Magnetic iron is a revolution in the world of raw agriculture, as it crude and has natural prosperities and it contact with water resulted an electro magnetic field to help the passage of useful elements to the plants. As a results of chemical fertilizers misuses, the mature of the agriculture land is changed and exhausted and turned to be salted. Therefore, the alternative is to use natural element as magnetic iron.

 The main target of the present investigation is to evaluate the impact of BA, K2SO4, potassium silicate, and magnetic iron on reducing the salinity adverse in relation to growth and some leaf physiological properties of Crimson and Superior grape transplants irrigated with 9000 ppm saline solution with 12 SAR.

**MATERIALS AND METHODS**

The present investigation was carried out during two successive 2014 and 2015 experimental seasons in the Pomology nursery, Horticulture Department belonging to Experimental Station, Faculty of Agriculture, Benha University at Moshtohor region, Kalubia Governorate, Egypt. One year old grape rooted cuttings (*Vitis vinifera*) of two cultivars namely: Crimson seedless and Superior were carefully chosen as being healthy and uniform as possible in their vigour to be used as plant materials in this concern .

**Response of saline stressed grape transplants to some recovering materials:**

This experiment was outlined and designed as an attempt to decrease the depressive effect resulted by using the relative higher concentrated saline solution for irrigation transplants of Crimson and Superior grape cvs under study in this experiment.

There upon, the investigated recovering chemicals included:

1- Benzyl adenine (BA) spray at 25 mg/L.

2- Potassium sulphate spray at 300 mg/L.

3- Potassium silicate at 5 ml/L either foliar or soil (drench) application.

4- Magnetic iron at 5.0 g/transplant applied solely or combined with potassium silicate foliar applied at 5 ml/L.

Consequently, the salinity stressed transplants of both grape cultivars, which irrigated with higher saline concentration (9000 ppm) and SAR (12) that prepared after **Sharaf *et al.* (1985)** as shown in **Table (1)** were subjected to the following recovering treatments:

1- Irrigation with 9000 ppm saline solution of SAR 12 plus tap water spray twice weekly as control.

2- Irrigation with 9000 ppm saline solution of SAR 12 plus BA spray at 25 mg/L twice monthly.

3- Irrigation with 9000 ppm saline solution of SAR 12 plus potassium sulphate spray at 300 mg/L twice monthly.

4- Irrigation with 9000 ppm saline solution of SAR 12 plus potassium silicate spray at 5 ml/L twice monthly.

5- Irrigation with 9000 ppm saline solution of SAR 12 plus potassium silicate as soil drench at 5 ml/L plus water spray each applied twice monthly.

6- Irrigation with 9000 ppm saline solution of SAR 12 plus magnetic iron as soil added at 5 g/transplant plus water spray each applied twice monthly.

7- Irrigation with 9000 ppm saline solution of SAR 12 plus potassium silicate foliar spray at 5 ml/L + magnetic iron soil added at 5 g/transplant each applied twice weekly.

**Table (1): Preparation of used saline solutions (9000 ppm and SAR 12).**

|  |
| --- |
| **Salt added per liter\*** |
| **CaCl2** | **MgSO4** | **KCl** | **K2SO4** | **Na2SO4** | **NaCl** | **SAR\*\*** | **Cl:SO4 meq./L** |
| **gm** | **meq.** | **gm** | **meq.** | **gm** | **meq.** | **gm** | **meq.** | **gm** | **meq.** | **gm** | **meq.** |
| **2.05** | **36.94** | **2.00** | **33.33** | **-** | **-** | **0.40** | **4.60** | **2.20** | **30.99** | **2.35** | **40.17** | **12** | **1.1** |

**\* Salts added in grams were estimated as anydrous form**

**\*\* SAR = Meq**

**Experiment layout:**

Accordingly, two simple experiments were conducted (an experiment devoted for each grape cultivar), whereas the complete randomized block design was used for arranging the differential investigated recovering treatments. Herein, each treatment was replicated five times and every replicate was represented by two grape transplants. So, 70 salt stressed transplants of each grape cultivar subjected to irrigation with saline solution (9000 ppm) of the SAR (12) were needed for investigating the aforesaid recovering treatments. Seventy, salt stressed transplants of each cultivar were classified according to their vigour into five categories each included 14 transplants plus two additional ones, so a reserve would be available in this regard. Seven investigated recovering treatments were arranged within transplants of each category at the rate of 2 transplants per every recovering treatment. The salt stressed transplants (irrigated with 9000 ppm saline solution of SAR 12 were subjected to the corresponding recovering treatment from April 15th till September 15th 2014 and 2015 years during 1st and 2nd seasons, respectively.

 Methodology as has been followed in this investigation is determined as follows:

After the experiments had been terminated on mid September of 2014 and 2015 years during two seasons, the response to the differential investigated (saline solutions & recovering treatments) was evaluated through determining the changes in the following measurements.

**Vegetative growth measurements:**

 As the experiment was terminated during each season 14 growth measurements (plant height, stem thickness, No. of both lateral shoots and leaves/plant, average leaf area, total assimilation area/plant, fresh and dry weights of three plant organs (leaves, shoots and roots), total plant weight and top/root ratio in response to recovering treatments were evaluated.

**Leaf physiological properties:**

The following three leaf physiological characteristics of both grape cvs. transplants under study in response to the differential investigated treatments (saline solutions and recovering treatments) were determined.

**Hard leaf character (H.L.C.):**

It was determined according to the following equation:





 The method was suggested by **Youssef (1990), Hassan (1998) and Laz (1999)**.

**Leaf water potential (L.W.P.):**



The method followed and the equation used for calculations L.W.P. have been suggested by **Halma (1934)** and confirmed by **Wilson *et al.* (1953) and Peynado and Young (1968).**

**Leaf relative turgidity (R.R.T.):**

Discs of about 1.0 cm in diameter were removed from each leaf sample to determine their fresh weight immediately then placed in closed containers (Petri dishes) until they become constant in weight (after 24 hours) at room temperature 20°C ±2 in shade. The discs were surface dried with plotting paper and weighed for their turgid weight. Dry weight of each 10.0 discs was determined after 24 hours. Leaf relative turgidity was estimated according to the following equation after **Halma (1934)** and followed by **Elmistron and Hillyer (1937); Mohamed (1993), Nomir (1994) and Osman (2005).**



**Statistical analysis:**

All data obtained during both seasons of the present investigation were subjected to analysis of variance and significant difference among means were determined according to **Sendecor and Cochran (1972)**. In addition, significant difference among means were distinguished according to the Duncan`s multiple range **Duncan (1955).** Whereas capital letters were used for differentiating between values of the effect of investigated recovering treatments.

**RESULTS AND DISCUSSION**

**1. Vegetative growth:**

Effect of some anti-salt stress compounds on recovering from salt stress symptom of Crimson and Superior grape transplants.

**1.1. Plant height (cm):**

 Concerning the effect of using some anti-salt stress substances that suggested as harmful symptoms correcting tools which emerged under irrigation with high saline water (9000 ppm) combined with 12 SAR for Crimson and Superior grape cvs.

 Data presented in Table (2), reveal that the transplants of the two grape cvs. which were sprayed with potassium silicate at the rate of 5 ml/L coupled with the addition of: magnetic iron salt added at the rate of 5 g/transplant each applied twice monthly (T7) were the tallest one as compared with the other treated transplants. Furthermore, the addition of magnetic iron at the rata of 5 g/transplant twice monthly as soil amendenent (T6) came in the second rank.

 On the other hand, the untreated transplants (control), recorded the least value of the investigated parameter.

 This result is in agreement with that reported by **Abdel-Rahman *et al.* (2009)** on Navel range trees; **Abdel-Aal and Oraby (2013)** on mango transplants and **Ali *et al.* (2013)** who reported that magnetic iron (100 and 150 kg/feddan) were very effective in stimulating shoot length and leaf area of Thomposon seedless grape vines.

**1.2. Stem diameter:**

 Table (2) reflect that the transplants which received potassium silicate at the rate of 5 ml/L twice monthly as foliar spray combined with magnetic iron at the rate of 5 g/transplant twice monthly as soil application (T7), reflected the highest value of stem diameter during both seasons of study. Meanwhile, magnetic iron at the rate of 5 g/transplant twice monthly as soil application (T6) occupied the second rank in this respect.

 On the other hand, BA spray at the rate of 25 mg/L twice monthly gave the least value of stem diameter as compared with the other investigated treatments.

 This result is standing with those reported by **Eman *et al.* (2010)** on Le-Conte pear trees and **Aly *et al.* (2015)** who mentioned that magnetic iron enhanced shoot length and shoot thickness of Valencia orange trees. Also, potassium silicate stimulated stem diameter, in this respect **Abdel-Aal and Oraby (2013)** on mango and **Moawad *et al.* (2015)** who mentioned that a mixture containing potassium silicate was able to enhance height and pseudostem diameter of grand naine banana transplants.

**Table (2): Some vegetative growth measurements (plant height and stem diameter) of saline stressed Crimson seedless and Superior grape transplants as influenced by some recovering substances applied during 2014 & 2015 experimental seasons.**

|  |  |  |
| --- | --- | --- |
| **Recovering treatments** | **Crimson seedless cv.** | **Superior cv.** |
| **Plant height (cm.)** | **Stem diameter (cm)** | **Plant height (cm.)** | **Stem diameter (cm)** |
|  | **2014 season** |
| **T1 Control (water spray)** | **32.67G** | **0.60F** | **41.34G** | **0.70F** |
| **T2 BA (spray)** | **49.44F** | **0.70F** | **54.90F** | **0.90EF** |
| **T3 K2SO4 (Spray)** | **57.72E** | **0.90E** | **83.91D** | **1.10DE** |
| **T4 K Silicate (Spray)** | **92.22C** | **1.40C** | **109.40C** | **1.50C** |
| **T5K Silicate (Soil)** | **68.67D** | **1.10D** | **67.64E** | **1.20D** |
| **T6 Magnetic iron (Soil)** | **112.10B** | **1.80B** | **128.70B** | **1.83B** |
| **T7 K Silicate + magnetic (T4 & T6)** | **131.00A** | **2.30A** | **154.00A** | **2.30A** |
|  | **2015 season** |
| **T1 Control (water spray)** | **28.49G** | **0.55F** | **36.00G** | **0.54F** |
| **T2 BA (spray)** | **42.54F** | **0.68E** | **48.00F** | **0.78E** |
| **T3 K2SO4 (Spray)** | **60.70E** | **0.84D** | **65.00E** | **0.95DE** |
| **T4 K Silicate (Spray)** | **74.81C** | **1.23C** | **93.00C** | **1.20C** |
| **T5K Silicate (Soil)** | **67.65D** | **1.13C** | **85.00D** | **1.10CD** |
| **T6 Magnetic iron (Soil)** | **90.72B** | **1.66B** | **106.00B** | **1.40B** |
| **T7 K Silicate + magnetic (T4 & T6)** | **109.10A** | **1.94A** | **128.00A** | **1.70A** |

**Means within each column followed by the same capital letter/s didn't significantly differ at 5 % level.**

**1.3. No. of lateral shoots/transplant:**

 Table (3) refers that the response of No. of lateral shoots/transplant for two grape cvs (Crimson and Superior) to the different studied treatments was an image of each other during both seasons of study, i.e. the highest values of the investigated parameter were obtained when the transplants of both grape cvs. were sprayed with potassium silicate at the rate of 5 ml/L twice monthly combined with magnetic iron at the rate of 5 g/transplant twice monthly as soil application (T7), descendly followed by adding magnetic iron at the rate of 5 g/transplant twice monthly as soil application (T6); spraying with potassium silicate at the rate of 5 ml/L twice moonthly (T4) and soil addition of potassium silicate at the rate of 5 ml/L twice monthly (T5) during both seasons of study.

 This result is in harmony with that mentioned by **El-Zaawely *et al.* (2013)** who noticed that magnetic field treatments increased number of branches per plant, number of leaves and leaf area of sweet pepper.

**1.4. No. of leaves/transplant:**

 Table (3) indicates that the behavior of the two investigated grape cvs. as related to the total No. of leaves/transplant was identical in both grape cvs., whereas the highest values of the investigated parameter in both grape cvs. were associated with the combination between spraying with potassium silicate at the rate of 5 ml/L plus adding magnetic iron as soil amendment at the rate of 5 g/transplant as each was applied twice monthly (T7). The least value was detected with BA spray transplants at the rate of 25 mg/L twice monthly.

 Similar results were also found by **Eman *et al.* (2010)** on Le-Conte pear trees; **Ismail *et al.* (2010)** on Navel orange trees and **Aly *et al.* (2015)** who indicated that magnetic iron enhanced average leaves number/shoot and leaf area of Valencia orange trees.

**Table (3): Some vegetative growth measurements (No. of laterals shoot & leaves/transplant) of saline stressed Crimson seedless and Superior grape transplants as influenced by some recovering substances applied during 2014 & 2015 experimental seasons.**

|  |  |  |
| --- | --- | --- |
| **Recovering treatments** | **Crimson seedless cv.** | **Superior cv.** |
| **No. of laterals shoot/ transplant** | **No of leaves/ transplant** | **No. of laterals shoot/ transplant** | **No of leaves/ transplant** |
| **2014 season** |
| **T1 Control (water spray)** | **1.00F** | **6.50G** | **1.00G** | **7.00G** |
| **T2 BA (spray)** | **1.00F** | **9.75F** | **2.00F** | **12.00F** |
| **T3 K2SO4 (Spray)** | **2.00E** | **13.00E** | **3.00E** | **16.00E** |
| **T4 K Silicate (Spray)** | **4.00C** | **18.25C** | **6.00C** | **23.00C** |
| **T5K Silicate (Soil)** | **3.00D** | **16.00D** | **5.00D** | **20.00D** |
| **T6 Magnetic iron (Soil)** | **5.00B** | **27.25B** | **7.00B** | **30.50B** |
| **T7 K Silicate + magnetic (T4 & T6)** | **6.00A** | **33.75A** | **8.00A** | **35.25A** |
|  | **2015 season** |
| **T1 Control (water spray)** | **1.00F** | **5.00G** | **1.00G** | **5.25G** |
| **T2 BA (spray)** | **1.00F** | **8.00F** | **2.00F** | **10.25F** |
| **T3 K2SO4 (Spray)** | **2.00E** | **12.00E** | **3.00E** | **15.00E** |
| **T4 K Silicate (Spray)** | **4.00C** | **16.00C** | **5.00C** | **21.00C** |
| **T5K Silicate (Soil)** | **3.00D** | **14.00D** | **4.00D** | **18.00D** |
| **T6 Magnetic iron (Soil)** | **5.00B** | **19.75B** | **6.00B** | **29.00B** |
| **T7 K Silicate + magnetic (T4 & T6)** | **6.00A** | **26.00A** | **7.00A** | **34.00A** |

**Means within each column followed by the same capital letter/s didn't significantly differ at 5 % level.**

**1.5. Average leaf area (cm2‑) and total assimilation area (cm2):**

 Table (4) reveals that the reaction between average leaf area (cm2) of Crimson grape transplants and the anti-salt stress investigated substances was paralleled to that recorded with total assimilation are a (cm2), i.e. the two investigated parameters have the same trend. Subsequently, the transplants which sprayed with potassium silicate at the rate of 5 ml/L combined with magnetic iron at the rate of 5 g/transplant twice monthly (T7) exhausted and reflected the highest values of both average leaf area and total assimilation area, followed by adding magnetic iron as soil application at the rate of 5 g/transplant twice monthly (T6), Spray potassium silicate at the rate of 5 ml/L fortrightly (T4) and potassium silicate as soil amendment at the rate of 5 ml/L fortrightly (T5) in descending order during 2014 and 2015 seasons.

 On the other way around, the untreated transplants (control) reflected the lowest values of both investigated parameters.

 The same finding was obtained by **Ali *et al.* (2013)** on Thompson seedless grape; **Gad El-Kareem *et al.* (2014)** on Zaghloul date palm; **Ibrahim and Al-Wasfy (2014)** on Valencia orange trees; **Mohamed *et al.* (2015)** on Succary mango trees and **Akl *et al.* (2015)** who indicated that single and combined application of potassium silicate at 0.05 to 0.2% improved average shoot length, total No. of leaves/shoot and leaf area cm2 of Manfaluty pomegranate trees.

**Table (4): Some vegetative growth measurements (average leaf area and total assimilation area) of saline stressed Crimson seedless and Superior grape transplants as influenced by some recovering substances applied during 2014 & 2015 experimental seasons.**

|  |  |  |
| --- | --- | --- |
| **Recovering treatments** | **Crimson seedless cv.** | **Superior cv.** |
| **Average leaf area (cm2)** | **Total assimilation area (cm2)** | **Average leaf area (cm2)** | **Total assimilation area (cm2)** |
| **2014 season** |
| **T1 Control (water spray)** | **17.24G** | **112.0G** | **21.55G** | **161.0G** |
| **T2 BA (spray)** | **19.81F** | **193.0F** | **24.76F** | **297.0F** |
| **T3 K2SO4 (Spray)** | **23.57E** | **307.0E** | **29.44E** | **471.0E** |
| **T4 K Silicate (Spray)** | **31.44C** | **576.0C** | **39.46C** | **932.0C** |
| **T5K Silicate (Soil)** | **30.04D** | **481.0D** | **37.55D** | **751.0D** |
| **T6 Magnetic iron (Soil)** | **37.39B** | **1018.0B** | **46.74B** | **1402.0B** |
| **T7 K Silicate + magnetic (T4 & T6)** | **41.33A** | **1468.0A** | **51.68A** | **1808.0A** |
|  | **2015 season** |
| **T1 Control (water spray)** | **15.34G** | **77.0G** | **20.33G** | **107.0G** |
| **T2 BA (spray)** | **17.13F** | **141.0F** | **23.65F** | **243.0F** |
| **T3 K2SO4 (Spray)** | **21.21E** | **255.0E** | **28.47E** | **427.0E** |
| **T4 K Silicate (Spray)** | **28.34C** | **454.0C** | **38.64C** | **811.0C** |
| **T5K Silicate (Soil)** | **25.57D** | **359.0D** | **34.78D** | **626.0D** |
| **T6 Magnetic iron (Soil)** | **35.46B** | **700.0B** | **48.22B** | **1329.0B** |
| **T7 K Silicate + magnetic (T4 & T6)** | **39.32A** | **1023.0A** | **50.63A** | **1721.0A** |

**Means within each column followed by the same capital letter/s didn't significantly differ at 5 % level.**

**1.6. Root fresh and dry weights (g):**

 Table (5) reveals that Crimson and Superior grape transplants which were sprayed with potassium silicate at 5 ml/L fortnightly combined with the addition of magnetic iron at 5 g/transplant twice monthly as soil amendment (T7) reflected the highest values of root fresh and dry weights as compared with the other investigated recovering substances.

 Soil addition of magnetic iron at the rate of 5 g/transplant twice monthly (T6) came in the second rank in this respect followed by spraying with potassium silicate at the rate of 5 ml/L twice monthly (T4) which arranged as the third order. The control (untreated transplants) was the inferior one in this respect during both seasons of study.

 Similar result was found by **Matichenkov *et al.* (1999)** on grapefruit seedlings and **Matichenkov *et al.* (2001)** whoindicate that Si nutrition was responsible for a significant increase in dry and green mass of Valencia and grape fruit root transplants.

**Table (5): Some vegetative growth measurements (root fresh and dry weights) of saline stressed Crimson seedless and Superior grape transplants as influenced by some recovering substances applied during 2014 & 2015 experimental seasons.**

|  |  |  |
| --- | --- | --- |
| **Recovering treatments** | **Crimson seedless cv.** | **Superior cv.** |
| **Root fresh weight (g)** | **Root dry weight (g)** | **Root fresh weight (g)** | **Root dry weight (g)** |
| **2014 season** |
| **T1 Control (water spray)** | **10.19G** | **2.36G** | **12.52G** | **2.73G** |
| **T2 BA (spray)** | **11.65F** | **3.43F** | **14.26F** | **4.40F** |
| **T3 K2SO4 (Spray)** | **13.18E** | **5.25E** | **17.65E** | **7.28E** |
| **T4 K Silicate (Spray)** | **20.24C** | **9.83C** | **35.51C** | **11.12C** |
| **T5K Silicate (Soil)** | **18.18D** | **7.91D** | **33.50D** | **8.45D** |
| **T6 Magnetic iron (Soil)** | **27.66B** | **13.15B** | **56.24B** | **21.36B** |
| **T7 K Silicate + magnetic (T4 & T6)** | **35.83A** | **15.26A** | **63.40A** | **28.43A** |
|  | **2015 season** |
| **T1 Control (water spray)** | **9.34G** | **2.14G** | **11.71G** | **2.15G** |
| **T2 BA (spray)** | **11.57F** | **3.53F** | **13.54F** | **3.43F** |
| **T3 K2SO4 (Spray)** | **14.68E** | **4.92E** | **18.10E** | **5.56E** |
| **T4 K Silicate (Spray)** | **18.70C** | **7.93C** | **32.35C** | **10.43C** |
| **T5K Silicate (Soil)** | **16.42D** | **6.83D** | **31.26D** | **9.52D** |
| **T6 Magnetic iron (Soil)** | **23.25B** | **9.18B** | **49.61B** | **18.62B** |
| **T7 K Silicate + magnetic (T4 & T6)** | **31.63A** | **12.66A** | **58.35A** | **21.60A** |

**Means within each column followed by the same capital letter/s didn't significantly differ at 5 % level.**

 Meanwhile, **Esitkea (2003)** indicated that magnetic field application increased fresh and dry root weights of strawberry as compared with control. Also, in this respect, **Abdel-Aal and Oraby (2013)** declared that treated mango transplants with silicon at 150 mg/kg soil increased fresh and dry weights of shoots and roots.

**1.7. Leaves fresh and dry weights (g):**

 Table (6) clears that the behavior of both leaves fresh and dry weight of the two grape cvs. Crimson and Superior cvs. was an image of each other, as both achieved the highest values when the transplants were sprayed with potassium silicate at the rate of 5 ml/L fortnightly coupled with the addition of magnetic iron at the rate of 5 g/transplant twice monthly as soil application (T7) followed by magnetic iron addition at the rate of 5 g/transplant twice monthly alone (T6).

 On the other hand, BA spray at the rate of 25 mg/L twice monthly reflects the least improvement value of both leaves fresh and dry weights as compared with the other treatments (except the control) meanwhile, the untreated transplants (control) was the inferior one in this respect, during both seasons of study.

 This finding is in harmony with those obtained by **Ismail *et al.* (2010)** who reported that magnetitc metal compound fertilizer significantly increased total number of leaves and its dry matter % of Superior grape. Meanwhile, **Al-Wasfy (2013)** mentioned that spraying potassium silicate at 0.05-0.2% was very effective in enhancing leaves fresh and dry weights of Sakkoti date palm as well as **Abdel-Aal and Oraby (2013)** declared that mango transplants treated with silicon reflected high increment in leaves fresh and dry weights.

**Table (6): Some vegetative growth measurements (leaves fresh and dry weights) of saline stressed Crimson seedless and Superior grape transplants as influenced by some recovering substances applied during 2014 & 2015 experimental seasons.**

|  |  |  |
| --- | --- | --- |
| **Recovering treatments** | **Crimson seedless cv.**  | **Superior cv.** |
| **Leaves fresh weight (g.)** | **Leaves dry weight (g.)** | **Leaves fresh weight (g.)** | **Leaves dry weight (g.)** |
| **2014 season** |
| **T1 Control (water spray)** | **1.62G** | **0.42G** | **1.55G** | **0.38G** |
| **T2 BA (spray)** | **2.82F** | **0.71F** | **2.51F** | **0.59F** |
| **T3 K2SO4 (Spray)** | **4.51E** | **1.07E** | **3.70E** | **0.84E** |
| **T4 K Silicate (Spray)** | **7.79C** | **1.68C** | **5.83C** | **1.20C** |
| **T5K Silicate (Soil)** | **6.67D** | **1.50D** | **5.35D** | **0.98D** |
| **T6 Magnetic iron (Soil)** | **14.99B** | **2.72B** | **10.35B** | **1.70B** |
| **T7 K Silicate + magnetic (T4 & T6)** | **22.09A** | **3.57A** | **14.22A** | **2.10A** |
|  | **2015 season** |
| **T1 Control (water spray)** | **1.25G** | **0.39G** | **1.33G** | **0.37G** |
| **T2 BA (spray)** | **2.73F** | **0.67F** | **2.45F** | **0.57F** |
| **T3 K2SO4 (Spray)** | **3.96E** | **0.86E** | **3.64E** | **0.76E** |
| **T4 K Silicate (Spray)** | **6.82C** | **1.20C** | **5.93C** | **1.18C** |
| **T5K Silicate (Soil)** | **4.94D** | **0.96D** | **4.66D** | **0.95D** |
| **T6 Magnetic iron (Soil)** | **10.73B** | **1.68B** | **9.63B** | **1.73B** |
| **T7 K Silicate + magnetic (T4 & T6)** | **17.33A** | **2.32A** | **13.54A** | **2.15A** |

**Means within each column followed by the same capital letter/s didn't significantly differ at 5 % level.**

**1.8. Shoots fresh and dry weights (g):**

 Data presented in Table (7) indicate that the highest obtained values of shoots fresh and dry weight were achieved when the transplants were sprayed with potassium silicate at the rate of 5 ml/L twice monthly combined with soil applied of magnetic iron at the rate of 5 g/transplant twice monthly (T7), followed by solely magnetic iron addition at the rate of 5 g/transplant twice monthly (T6), foliar spray with potassium silicate at the rate of 5 ml/L once weekly (T4), soil application of potassium silicate at the rate of 5 ml/L once weekly (T5) and foliar spraying with potassium sulphate at the rate of 300 mg/L twice monthly, in descending order.

 Meanwhile, the least value of both fresh and dry weight were recorded with untreated transplants (control).

**Table (7): Some vegetative growth measurements (shoots fresh and dry weights) of saline stressed Crimson seedless and Superior grape transplants as influenced by some recovering substances applied during 2014 & 2015 experimental seasons.**

|  |  |  |
| --- | --- | --- |
| **Recovering treatments** | **Crimson seedless cv.** | **Superior cv.** |
| **Shoots fresh weight (g)** | **Shoots dry weight (g)** | **Shoots fresh weight (g)** | **Shoots dry weight (g)** |
| **2014 season** |
| **T1 Control (water spray)** | **4.36G** | **2.16G** | **5.65G** | **2.70G** |
| **T2 BA (spray)** | **6.16F** | **3.72F** | **8.24F** | **5.86F** |
| **T3 K2SO4 (Spray)** | **9.28E** | **5.15E** | **13.13E** | **7.33E** |
| **T4 K Silicate (Spray)** | **15.46C** | **10.45C** | **17.22C** | **13.19C** |
| **T5K Silicate (Soil)** | **13.89D** | **7.28D** | **15.41D** | **10.55D** |
| **T6 Magnetic iron (Soil)** | **17.74B** | **12.18B** | **20.24B** | **18.50B** |
| **T7 K Silicate + magnetic (T4 & T6)** | **23.65A** | **14.65A** | **28.98A** | **22.41A** |
|  | **2015 season** |
| **T1 Control (water spray)** | **3.63G** | **2.11G** | **4.59G** | **2.15G** |
| **T2 BA (spray)** | **5.83F** | **3.77F** | **6.13F** | **3.30F** |
| **T3 K2SO4 (Spray)** | **8.21E** | **6.37E** | **11.28E** | **5.46E** |
| **T4 K Silicate (Spray)** | **13.65C** | **9.44C** | **15.46C** | **8.26C** |
| **T5K Silicate (Soil)** | **11.44D** | **8.56D** | **14.53D** | **7.42D** |
| **T6 Magnetic iron (Soil)** | **14.55B** | **10.43B** | **19.63B** | **10.70B** |
| **T7 K Silicate + magnetic (T4 & T6)** | **21.62A** | **13.67A** | **28.51A** | **12.41A** |

**Means within each column followed by the same capital letter/s didn't significantly differ at 5 % level.**

**1.9. Total plant dry weight (g):**

 Table (8) indicates that the highest value of total plant dry weight of both cvs. was achieved when the transplants were sprayed with potassium silicate at 5 ml/L twice monthly combined with soil addition of magnetic iron at the rate of 5 g/transplant twice monthly (T7), followed by application of magnetic iron alone as soil amendment at the rate of 5 g/transplant twice monthly (T6).

 On the other hand, the transplants of both grape cvs. which sprayed with tap water only and never received any of recovering substances (control) had the minimum value of total plant dry weight during the 1st and the 2nd seasons.

**1.10. Top/root ratio:**

 Table (8) shows that spraying with potassium sulphate at the rate of 300 mg/L twice monthly was the Superior one in this respect (T3). Foliar spray of potassium silicate at the rate of 5 ml/L twice moonthly (T4) came in the second rank for Crimsm cv. in the first season, while the addition of potassium silicate as soil amendment at the rate of 5 ml/L fortnightly standing the second one in the 2nd season for Crimson cv. as well as it considered the promised one for Superior cv. during both seasons of study.

 This result goes in line with those reported by **Ismail *et al.* (2010)**  who declared that the lower rates of magnetite significantly increased total plant dry matter % of Superior grape. Meanwhile, **Abdel-Aal and Oraby (2013)** reported that mango sprayed transplants with silicon enhanced total transplants dry weight and top/root ratio compared to untreated transplants. In this respect, **Abobatta (2015)** reported that dry weight (leaves and stem) of Valencia orange trees was improved as an impact of magnetic iron.

**Table (8): Some vegetative growth measurements (total plant dry weights & top/root ratio) of saline stressed Crimson seedless and Superior grape transplants as influenced by some recovering substances applied during 2014 & 2015 experimental seasons.**

|  |  |  |
| --- | --- | --- |
| **Recovering treatments** | **Crimson seedless cv.** | **Superior cv.** |
| **Total plant dry weight (g)** | **Top/root** **ratio** | **Total plant dry weight (g)** | **Top/root** **ratio** |
| **2014 season** |
| **T1 Control (water spray)** | **4.94G** | **1.092F** | **5.81G** | **1.133D** |
| **T2 BA (spray)** | **7.86F** | **1.290A** | **10.84F** | **1.465A** |
| **T3 K2SO4 (Spray)** | **11.47E** | **1.185C** | **15.44E** | **1.125D** |
| **T4 K Silicate (Spray)** | **21.97C** | **1.235B** | **25.51C** | **1.297C** |
| **T5K Silicate (Soil)** | **16.68D** | **1.112E** | **19.97D** | **1.365B** |
| **T6 Magnetic iron (Soil)** | **28.05B** | **1.120D** | **41.56B** | **0.945E** |
| **T7 K Silicate + magnetic (T4 & T6)** | **33.48A** | **1.192C** | **52.94A** | **0.863F** |
|  | **2015 season** |
| **T1 Control (water spray)** | **4.63G** | **1.165F** | **4.66G** | **1.175A** |
| **T2 BA (spray)** | **7.96F** | **1.263E** | **7.29F** | **1.180A** |
| **T3 K2SO4 (Spray)** | **12.14E** | **1.470A** | **11.78E** | **1.163A** |
| **T4 K Silicate (Spray)** | **18.57C** | **1.340C** | **19.87C** | **0.913B** |
| **T5K Silicate (Soil)** | **16.34D** | **1.395B** | **17.88D** | **0.880B** |
| **T6 Magnetic iron (Soil)** | **21.29B** | **1.320D** | **31.05B** | **0.668C** |
| **T7 K Silicate + magnetic (T4 & T6)** | **28.65A** | **1.263E** | **36.15A** | **0.675C** |

**Means within each column followed by the same capital letter/s didn't significantly differ at 5 % level.**

**2.2. Leaf physiological characters:**

**2.1. Hard leaf character (H.L.C.):**

 Data presented in Table (9) revealed that the highest reduction in hard leaf character in both investigated grape cvs. was recorded when the transplants of both cvs. were potassium silicate sprayed at the rate of 5 ml/L plus magnetic iron soil addition at the rate of 5 g/transplant each applied twice monthly (T7). Also, potassium silicate either added as foliar spray (T4) or as soil application (T5) at the same rate 5 ml/L twice monthly as well as magnetic iron at 5 g/transplant twice monthly (T6) shared (T7) in this respect i.e. both grape transplants were highly responded to the such treatments and recorded the minimum value of H.L.C. The highest value of H.L.C. was recorded with the untreated transplants (control)

**2.2. Leaf relative turgidity:**

 Table (9) displays that the trend of response was too firm to be identical with both grape cvs. and during the two studied seasons. The greatest value of leaf relative turgidity was in closed relationship to potassium silicate sprayed transplants at the rate of 5 ml/L connected with magnetic iron at the rate of 5 g/transplant each applied twice monthly (T7) followed by soil magnetic iron addition alone at the rate of 5 g/transplant twice monthly (T6), sprayed potassium silicate at the rate of 5 ml/L twice monthly (T4) and soil addition of potassium silicate at the rate of 5 ml/L fortnightly (T5) in descending order during both seasons of study (control). Meanwhile, the reverse was true with untreated salt stressed transplants, which reflect the lowest leaf relative turgidity value.

**2.3. Leaf water potential:**

 Table (9) reveals that potassium silicate foliar spray at 5 ml/L fortnightly combined with magnetic iron at 5 g/transplant twice monthly as soil application (T7) was the Superior one in this respect as it maximized the leaf water potential of Crimson transplants followed by magnetic iron alone as soil application at 5 g/transplant twice monthly (T6); potassium silicate foliar spray at 5 ml/L twice monthly (T4) and potassium silicate as soil amendment at 5 ml/L twice weekly (T5) in descending order.

 On the other way around, the minimum value of L.W.P. was detected with untreated salt stressed transplants (control), followed by BA foliar spray at 25 mg/L twice monthly (T2) and potassium sulphate foliar spray at 300 mg/L twice monthly (T3) in ascending order during both seasons of study.

**Table (9): Hard leaf character, leaf relative turgidity and leaf water potential of saline stressed Crimson seedless and Superior grape transplants as influenced by some recovering substances applied during 2014 & 2015 experimental seasons.**

|  |  |  |
| --- | --- | --- |
| **Recovering treatments** | **Crimson seedless cv.** | **Superior cv.** |
| **Hard leaf character** | **Leaf relative turgidity** | **Leaf water potential** | **Hard leaf character** | **Leaf relative turgidity** | **Leaf water potential** |
| **2014 season** |
| **T1 Control (water spray)** | **0.389A** | **3.88G** | **73.41G** | **0.242A** | **4.54G** | **74.71E** |
| **T2 BA (spray)** | **0.366A** | **6.76F** | **75.06F** | **0.197B** | **7.100F** | **76.72D** |
| **T3 K2SO4 (Spray)** | **0.343AB** | **7.57E** | **76.91D** | **0.177C** | **9.25E** | **77.19D** |
| **T4 K Silicate (Spray)** | **0.292CD** | **12.60C** | **78.42C** | **0.133D** | **13.49C** | **79.40C** |
| **T5K Silicate (Soil)** | **0.313BC** | **9.13D** | **77.42D** | **0.134D** | **11.57D** | **81.31B** |
| **T6 Magnetic iron (Soil)** | **0.267CD** | **15.18B** | **81.86B** | **0.121DE** | **16.38B** | **83.58A** |
| **T7 K Silicate + magnetic (T4 & T6)** | **0.244D** | **18.72A** | **83.84A** | **0.116E** | **19.23A** | **85.23A** |
|  | **2015 season** |
| **T1 Control (water spray)** | **0.510A** | **3.47G** | **69.19G** | **0.356A** | **3.26F** | **72.56F** |
| **T2 BA (spray)** | **0.478A** | **5.63F** | **75.48F** | **0.237B** | **5.70E** | **76.79E** |
| **T3 K2SO4 (Spray)** | **0.340B** | **6.37E** | **78.32E** | **0.179C** | **8.61D** | **78.34D** |
| **T4 K Silicate (Spray)** | **0.265C** | **10.64C** | **82.41C** | **0.145DE** | **11.82C** | **80.09C** |
| **T5K Silicate (Soil)** | **0.269C** | **8.35D** | **80.58D** | **0.152D** | **9.57D** | **79.62CD** |
| **T6 Magnetic iron (Soil)** | **0.240C** | **13.64B** | **84.33B** | **0.130E** | **13.67B** | **82.01B** |
| **T7 K Silicate + magnetic (T4 & T6)** | **0.227C** | **17.32A** | **86.61A** | **0.125E** | **17.43A** | **84.14A** |

**Means within each column followed by the same capital letter/s didn't significantly differ at 5 % level.**

 Drought tolerance brought about by the application of “Si” may result from decreased transpiration **(Epstein, 1999)** and the presence of silicified structure in plants suggested a reduction of leaf heatload, providing plant tolerance to high temperatures **(Wang *et al.,* 2005)**. The resistance to salt stress has been found to be due to the enhancement of catalase, preventing membrane oxidative damage **(Moussa, 2006)**.

**Conclusion**

 It is recommended to treat Crimson and Superior salt stressed grape transplants with potassium silicate spray at 5 ml/L twice monthly along with magnetic iron at 5 g/transplant twice monthly to alleviate the adverse impacts of irrigation with high saline water solution.

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