

PHYSIOLOGICAL STUDIES ON SALT TOLERANCE OF TWO BANANA CULTIVARS

1- Effect of salt concentration, sodium adsorption ratio (SAR) and chloride level in irrigation water on growth and chemical constituents

By

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ABSTRACT

The present study was conducted during 2006 and 2007 experimental seasons to investigate the salinity tolerance of banana plants through studying the response of some vegetative growth and chemical constituents to the specific and interaction effects of four evaluated factors i.e., a) banana cv. (Williams & Grand Nain); b) salinity concentration (2000 & 3000 ppm), c) SAR (3 & 6) and d) Cl:SO₄ ratio (low & high).

Data obtained revealed that all evaluated growth measurements (pseudostem height & circumference); (number of leaves & area); fresh and dry weights of differential above and underground plant organs, as well as leaves senescent rate responded significantly as they exhibiting a negative relationship to level of salinity, SAR and Cl:SO₄ ratio except senescent rate which followed a conflicted trend.

Nevertheless, all chemical constituents under study i.e., foliar photosynthetic pigments (chlo. A & B and carotines); proline and mineral nutrients (N, P, K, Ca, Mg, Fe, Mn and Zn) were significantly influenced. Whereas photosynthetic pigments and some nutrients (N, P, K, Mg, Fe, Mn and Zn) followed the same trend previously detected with growth

measurements, however proline and both (Ca & Na) followed an opposite direction (similar to that found with senescent rate of leaves) regarding their response to level of salinity conc., SAR and Cl:SO₄ ratio. Besides, in most cases Grand Nain plants showed significantly higher values of both vegetative growth and chemical composition except senescent rate and leaf (Ca & Na) content, where the reverse was true with Williams cv.

INTRODUCTION

Banana (*Musa spp.*) is a tropical plant and considered as a one of the most popular fruit in Egypt for its high nutritive value and palatability for the Egyptian consumer. Also from the economical point of view, banana growers get relatively higher and fast net return from their orchard due to the rapid life cycle of banana plant. The over all average of banana in Egypt progressively developed through the former decade which reached about 28750 and 58607 Fed. in 1986 and 1999, respectively (Ministry of Agriculture, A.R.E., 1999). This average mainly concentrated in the delta and the Nile valley 32841 Fed. as there is an ample water supply, which is need to have good production.

The efficient use and preservation of water resources in Egypt i.e., River Nile, underground (well water) reuse of agriculture drainage are the critical challenge that certainly determine the future of agriculture development. So, the shortage in available fresh water supply needed to meet the extensions especially plantation of such crops having higher water requirements like as banana leads to consideration of reuse other resources like as waste water and well or sea water after mixing with fresh water that can be reutilized in irrigation purpose for the newly established banana orchards in reclaimed lands which reached 20752 Fe (1999).

Guide lines of interpretation of water quality for irrigation water indicated that there was no problem when the EC of the irrigation water was < 0.75 mmhos/cm and severe problems took place when EC was > 3.0 mmhos/cm (Ayers, 1977; Gupta, 1979 and Russell, 1982). Many authors were interested in exploring the mechanism of salt injury in different plants. Bernstein (1975) and Miller *et al.* (1990) they explained the adverse effects of salinity on plants growth in the following two topics:

- 1- The increase in the osmotic potential of the soil, which certainly result in reduction in the availability of water to the plant.
- 2- The specific toxic effect of some ions, such as Cl^- , Na^+ and especially in the certain sensitive crops, consequently caused a disturbance in the normal metabolism of plants.

Several authors pointed out that most of salt injuries are due to the three salinity aspects i.e. concentration and specific cations/anions particularly Na^+/Cl^- , respectively. Ivonova and Ivanova (1977) on peach found that NaCl inhibited tree growth more than salt Na_2SO_4 . Moreover, most fruit crops are sensitive, chloride and sodium ion injuries may be the dominant factors in reducing fruit crops growth (Leon, 1980). Hartz (1984) found that salinity can prevent water uptake even when the soil is at field capacity. Fenn *et al.* (1968) showed that chlorides were more toxic than sulphates in the mechanism of plant injury, in case of specific ion toxicities, may involve an injury to plant regulatory system accumulation of Cl^- or Na^+ ions in the plant causing excessive water loss and leaf injury symptoms similar to those of drought. In addition, Gomes *et al.* (2001); Mohamed (2001), Abo El-Ez (2003), Carmo *et al.* (2003) and Gomez *et al.* (2004) on some banana cultivars demonstrated the effect of salinity on both vegetative and chemical properties.

Thus the present study was devoted to study the specific and interaction effects of banana cv., salinity concentration, SAR, Cl:SO₄ ratio and their combinations on growth and chemical compositions of two banana cultivars (Williams & Grand Nain).

MATERIAL AND METHODS

The present investigation was carried out during two successive seasons of 2006 and 2007 in greenhouse belonging to the Horticulture Research Station, El-Kanater, Kalubia, Governorate, Egypt. Three months old, uniform and healthy suckers (plants) of two banana cultivars (Williams and Grand Nain) were used as plant materials for this study.

On March 15th for both seasons suckers of two banana cultivars were transplanted individually i.e. each was planted in 35 cm in diameter pots (plastic bags) filled with 10 kg clay and sand mixture at 2:1 ratio (by volume). Irrigation was carried out twice weekly by adding one litter of tap water for each pot until investigated treatments of this study were started in both experimental seasons. Each pot (plant) was supplied with (NH₄)₂SO₄, K₂SO₄ and P₂O₅ applied every other two weeks at the rate of (1.7,1.2 and 0.6 gm/pot for 1st, 2nd and 3rd fertilizers, respectively, from April 1st until mid-September. However, irrigation with different saline solution was started two weeks later i.e., on April 1st and continued until October 1st.

Effect of different saline solutions on two banana cultivars.

In this regard eight solutions represented the different possible combinations between the following four investigated factors i.e., a) two banana cultivars (Williams and Garnd Nain), b) two saline concentrations (2000 and 3000 ppm), c) two SAR (3 & 6) and d) two Cl:SO₄ ratios (low & high), were prepared as shown in Table (1), besides tap water irrigation as control were investigated.

Thus; nine investigated treatments were as follows:

- 1- Tap water "control".
- 2- 2000 ppm saline solution with SAR 3 and low Cl:SO₄ ratio.
- 3- 2000 ppm saline solution with SAR 3 and high Cl:SO₄ ratio.
- 4- 2000 ppm saline solution with SAR 6 and low Cl:SO₄ ratio.
- 5- 2000 ppm saline solution with SAR 6 and high Cl:SO₄ ratio.
- 6- 3000 ppm saline solution with SAR 3 and low Cl:SO₄ ratio.
- 7- 3000 ppm saline solution with SAR 3 and high Cl:SO₄ ratio.
- 8- 3000 ppm saline solution with SAR 6 and low Cl:SO₄ ratio.
- 9- 3000 ppm saline solution with SAR 6 and high Cl:SO₄ ratio.

The complete randomized block design with five replications was devoted for arranging the above mentioned investigated treatments, whereas each replicate was represented by two plants.

1. Growth measurements:

On October 1st during both experimental seasons whereas the experiment was terminated the following morphological measurements were recorded:

1. Pseudostem length and circumference (cm).
2. Leaves measurements [total number, senescent rate of leaves (yellowish : total) and average area].
3. Fresh and dry weight of plant organs (leaves, pseudostem, corms and roots)

In each season the aforesaid growth measurements (except leaf area) were determined for every individual plant, then an average of two plants represented the same replicate was estimated. However, leaf area was determined in collected adequate samples from each plant. These samples were washed several times with distilled water, then, oven dried at 70°C till

a constant weight for the dry matter estimation. Meanwhile, dried leaves were finally ground with stainless steel knife mill and stored in small light bags for N; P; K; Ca; Mg; Fe; Zn; and Mn determination.

2. Chemical analysis:

In this regard leaf photosynthetic pigments (chlorophyll A , B and carotenoids) and leaf (proline), as well as leaf mineral composition in response to various investigated treatments were concerned.

2.1. Photosynthetic pigments (foliar pigments)

Leaf photosynthetic pigments (chlorophyll A & B and carotenoids compounds) were extracted by pure acetone and determined colorimetrically in each sampled leaves levels, at the optical densities of (662, 644 and 440 mm for chlorophyll A, B and carotenoides compounds, respectively, according to Nornal (1982) using the following equations:

$$\text{Chl. A} = (9.784 \times E_{664}) - (0.99 \times E_{644}) = \text{mg/L.}$$

$$\text{Chl. B} = (21.426 \times E_{644}) - (4.650 \times E_{663}) = \text{mg/L.}$$

$$\text{Carotenoides} = (4.685 \times E_{440}) - 0.268 (\text{chl. A} + \text{chl. B}) = \text{mg/L.}$$

2.2. Estimation of proline content:

The proline was determined in fresh leaves according to the methods described by (Batels *et al.*, 1973) and confirmed by Draz, (1986).

2.3. Leaf mineral determination:

From each dried leaf sample 0.2 g was digested using perchloric acid and sulphoric acid mixture (1:1) (Piper, 1950) for the following mineral analysis:

1. Total nitrogen by semi micro-Kiel Dahl method as out lined by (Pregl, 1945).
2. Phosphorus using spekol spectrophotometer at 88.2 U.V. according to method described by (Murphy and Riely, 1962).

3. Potassium and Sodium were estimated photometrically using the methods recommended by (Brown and Lilleland, 1964).
4. Calcium, magnesium, iron, zinc and manganese were determined using atomic absorption spectrophotometer "Perkin Elmer 3300" after (Chapman and Pratt, 1961).

3. Statistical analysis:

All data of the present investigation were subjected to analysis of variance and significant difference among means were determined according to (Snedecor and Cochran, 1972). In addition significant difference among means were distinguished according to the Duncan's multiple test range (Duncan, 1955) whereas, capital and small letters were used for differentiating the values of specific and interaction effects of investigated factors, respectively.

RESULTS AND DISCUSSION

Data obtained concerning the response of vegetative growth and chemical composition of banana suckers to specific and interaction effects of the investigated four factors i.e., banana cultivars; salinity concentration; SAR and Cl:SO₄ ratio of saline solutions used for irrigation are presented in Tables (2, 3, 4, 5, 6, 7, 8 and 9).

1. Vegetative growth measurements:

1.1. Pseudostem length and circumference:

A- Specific effect:

Concerning the specific effect of cultivar, Table (2) displays that both pseudostem measurements followed to great extent the same trend, where Grand Nain cv. exceeded significantly Williams cv. during both seasons.

As for the specific effect of salinity concentration, it was quite evident as shown from Table (2) that both investigated levels (2000 & 3000 ppm) reduced statistically both pseudostem parameters as compared to control (tap water irrigation). Herein, the severest reduction was always in concomitant to the 3000 ppm irrigated plants, descendingly followed by those subjected to 2000 ppm and tap water from statistical point of view. Nevertheless, the specific effect of two other investigated factors i.e. SAR (3 & 6) and Cl:SC₄ ratio (low & high) reflected also an obvious variance. Hence, a significant negative relationship between either SAR or Cl:SO₄ levels from one hand and values of both pseudostem parameters from the other was obviously detected during both seasons.

B- Interaction effect:

Data obtained revealed that each investigated factor reflected directly its own specific effect on interaction effect of their combinations. Herein, the most depressive effect was exhibited by the 3000 ppm saline solution of SAR 6 and higher Cl:SO₄ ratio, regardless of banana cultivar, where the least values of both pseudostem parameters were detected during two seasons. On the contrary, the lightest reduction below control (tap water irrigation) was statistically in closed relationship to the Grand Nain suckers irrigated with 2000 ppm saline solution of SAR 3 and lower Cl:SO₄ ratio, for two pseudostem parameters which in most cases did not statistically vary than control during both seasons. In addition other investigated combinations were in between the aforesaid two extremes.

1.2. Leaves measurements (total number/plant; senescent rate yellowish : total" and average leaf area):

A- Specific effect:

Referring the specific effect of cultivar, Table (3) displays that the response of 3 leaves measurements did not follow the same trend. Anyhow, two banana cultivars had approximately the same number of total leaves per plant. However, for two other leaves parameters, two conflicted trends were detected. Whereas Wilhams cv. showed significantly higher rate of senescent leaves (yellowish : total number), but the reverse was true with average leaf area since Grand Nain surpassed statistically Williams cv. during both seasons.

As for the specific effect of three other investigated factors (salinity concentration, SAR and Cl:SO₄ ratios) Table (3) declares that both total number of leaves/plant and average leaf area followed the same trend, whereas a negative linear relationship between values of three investigated factors (concentration, SAR and Cl:SO₄) from one hand and both concerned leaves measurements (number & area) from the other were detected during two seasons. On the contrary with the senescent rate of leaves the trend of response took the other way around (positive relationship).

B- Interaction effect:

Table (3) shows a considerable variances in three leaves measurements, whereas specific effect of each investigated factor was directly reflected on their interaction effect. Herein, the severest reduction in both average leaf area and total number of leaves/plant associated with the greatest rate of senescent leaves was significantly in closed relationship with such combinations representative of the irrigated Williams and Grand Nain banana plants (especially former cultivar) irrigated with 3000 ppm

saline solution of SAR (6) and higher Cl:SO₄ ratio during two seasons of study. On the contrary, the lightest influence than control was markedly coupled with the irrigated Williams and Grand Nain banana plants (especially later cultivar) with 2000 ppm solution of SAR 3 and lower Cl:SO₄ ratio. In addition, other combinations were in between.

1.3. Fresh and dry weight of aboveground (aerial) and underground organs:

1.3.1. Aboveground organs (pseudostem & leaves):

A- Specific effect:

In this respect fresh and dry weights of both pseudostem and leaves in response to four investigated factors were the two aboveground organs concerned as shown in Table (4). Two organs followed the same trend, whereas Grand Nain cv. showed heavier weight than Williams cv. Moreover, with increasing level of salinity concentration of the saline solution and/or any of its SAR/Cl:SO₄ ratio weight values (fresh & dry) of both leaves and pseudostem were significantly decreased.

B- Interaction effect:

Table (4) shows that the specific effect of the four investigated factors (banana cv., saline concentration, SAR and Cl:SO₄ ratio) were reflected on interaction effect of their combinations. Anyhow, the severest depressive effect on fresh and dry weights of the aboveground plant organs (leaves & pseudostem) was significantly exhibited by the 3000 ppm of either lower or higher SAR and Cl:SO₄ ratio, regardless of banana cultivar during two seasons (2006 & 2007). However, in most cases irrigated Williams plants with 3000 ppm saline solutions of SAR 6 and higher Cl:SO₄ ratio tended to have the lightest (fresh and dry) weights of two aerial plant organs), but differences is significantly absent as compared to three other combinations of 3000 ppm of SAR. Such trend was true during

both 2006 & 2007 seasons except with leaves fresh weight. On the contrary, the least reduction in fresh and dry weights of leaves and pseudostem exhibited by irrigation with saline solutions as compared to control (tap water irrigation) was always in significant concomitant to Grand Nain plants irrigated with 2000 ppm saline solution of SAR 3 and lower Cl:SO₄. In addition, other combinations were in between.

1.3.2. Underground organs:

In this regard true stem (corm) and roots were the two underground organs investigated regarding the response of their fresh and dry weights to specific and interaction effects of four factors as shown from tabulated data in Table (5).

A- Specific effect:

Both underground organs (corm & roots) followed the same trend previously detected with the aboveground organs regarding the response to specific effect of four investigated factors (banana cultivar, salinity concentration, SAR and Cl:SO₄ ratio).

B- Interaction effect:

It is quite evident that the trend of response was so firm and to great extent and coincident with the above mentioned one for the aerial plant organs.

The present results regarding the reduction in investigated vegetative growth (leaves, pseudostem, corms and roots) exhibited by saline solutions may be due to the absorption of particular ions to toxic accumulation level, that decrease the essential nutrients and consequently induced a drastic changes in the ion relationship of plants (Wadleigh and Gaash, 1963). Moreover, the application of saline solution may lead to the suggestion that salinity induced earliness of plant senescence as a result of the

accumulation of some ions (Na and/or Cl) to reach toxic levels that may adoptive mechanism of banana to retranslocate excess amount of Na and/or Cl out of younger leaves to the older ones to put them away from the physiologically active tissues (Winter, 1982). Besides, the reduction in growth caused by water stress composed mainly of tension or osmotic components (Hayward and Bernsteen, 1958), who suggested also that salinity like drought may reduce water potential and pressure potential (turgar pressure).

In addition, the depressive effect of increasing salt concentration, SAR and/or Cl:SO₄ ratio on plant height, fresh and dry weights of plants may be due to the disturbance in metabolic pathway of plants as a result of salts on enzymatic activities (Strogonov, 1964) or to the adverse effect of Na and Cl ions on metabolism or disturbed water relations (Delane *et al.*, 1982).

The present results are in general agreement with the findings of Gomes *et al.* (2001), Mohamed (2001), Abo El-Ez (2003), Carmo *et al.* (2003) and Gomes *et al.* (2004), on some banana cvs. demonstrated the effect of salinity on vegetative growth.

II- Chemical constituents:

In this respect leaf photosynthetic pigments (chlorophyll A, B and carotein), proline and some mineral elements (N, P, K, Ca, Mg, Na, Fe, Mn and Zn) were the investigated chemical constituents regarding their response to specific and interaction effects of four studied factors:

II.1. Leaf photosynthetic pigments and proline contents:

Data of both 2006 and 2007 seasons are presented in Table (6).

A. Specific effect:

It is quite clear as shown from data in Table (6) that all 3 photosynthetic pigments and proline responded specifically to four investigated factors from one hand, however, they followed two conflicted trends from the other, Herein, Grand Nain plants leaves were significantly richer in there chlorophyll a, b and carotenoids contents, but the reverse was true for leaf proline content whereas its leaves were the poorest as compared to control.

In addition, 3 pigments (chlorophyll a, b and carotenoids compounds) reduced significantly by increasing level of either salt concentration, SAR or Cl:SO₄ ratios of saline solutions. However, the trend took the other way around with proline content.

B. Interaction effect

Table (6) reveals obviously that each investigated factor reflected directly its own effect on their different combinations. Herein, the least values of there photosynthetic pigments associated with the greatest proline value were significantly in closed relationship to the 3000 ppm of SAR 6 and either lower or higher Cl:SO₄ ratio irrigated plants, regardless of banana cultivar. Such trend was generally true during both seasons with few exceptions pointed out that two cultivars exchanged their situation. In other words irrigated Williams suckers with 3000 ppm saline solution of SAR 6 and higher Cl:SO₄ ratio were relatively the most sensitive to saline stress as their leaf 3 photosynthetic pigments and proline contents were concerned during both seasons except chlorophyll A & B content during 2nd season, where those of Grand Nain were relatively the inferior. On the contrary, both Williams and Grand Nain plants subjected to the 2000 ppm saline solution of SAR 3 and lower Cl:SO₄ ratio showed not only the least variance i.e. reduction in their leaf chlorophyll (A & B) and carotenoids

compound associated with the least increase in proline content but also they were not significantly vary from statistically point of view. In addition other combinations were in between.

These results are in general agreement with the earlier findings of Poljakoff and Gali (1975), Patel *et al.* (1984), Kabeel (1985), Omar (1996) and Ali (2005) regarding the reduction on chlorophyll content. Moreover, findings of Nieves *et al.* (1991) and Gaser (1992) gave support to the detected trend of proline response to salinity.

II.2. Leaf mineral composition:

The response of leaf N, P, K, Mg, Ca, Na, Fe, Mn and Zn contents to the specific and interaction effects of investigated four factors (banana cv.; salinity concentration; SAR and Cl:SO₄ ratio and their combinations were concerned.

II.2:1. Macro nutrient elements:

Data obtained regarding the macro nutrient elements (N, P, K, Ca, and Mg) besides Na during both 2006 & 2007 seasons are presented in table (7) and (8).

A. Specific effect:

As for the specific effect of cultivar, table (7) and (8) display a considerable variations varied from one nutrient element to another. Anyhow, Grand Nain leaves were significantly richer in their P, K, and Mg content, while the reverse was true with both Ca and Na content. On the other hand two banana cultivars were equally similar in their leaves N content from statistical point of view.

Nevertheless, the trend of response to specific effect of salt concentration was firmer and showed two conflicted patterns. Herein, N, P, K, and Mg were significantly in negative relationship to salt concentration. However, both Ca and Na followed an opposite trend.

Referring the specific effect of SAR and Cl:SO₄ ratio, it is quite evident that both followed typically the same trend which was to great extend coincident with that previously detected with salinity concentration. Anyhow, the higher SAR or Cl:SO₄ ratio was the least leaf N, P, K, and Mg content associated with the highest Ca and Na leaf content.

B. Interaction effect:

Each investigated factor reflected its own specific effect on the differential investigated combinations. Hence, the greatest interaction effect on leaf macro nutrient elements contents i.e. the least N, P, K, and Mg% associated with the highest Ca and Na content was allows in significant concentration to the four combinations representative of plants with 3000 ppm of SAR and lower or higher Cl:SO₄ ratio, regardless of banana cultivar. However, such trend in most cases was true during two seasons, but those irrigated with 3000 ppm of SAR 6 and higher Cl:SO₄ ratio tended to be relatively more depressed, especially Williams suckers.

On the contrary the least influence was detected by those combinations representative of 2000 ppm saline solution of lower SAR and Cl:SO₄ ratio which didn't significantly differ than control (tap water irrigation) in most cases during two seasons, with a relative tendency showed that Grand Nain plants were more tolerant.

In addition, other combinations were in between the aforesaid two extremes.

II.2.2. micro nutrient elements:

Leaf Fe, Mn, and Zn contents as influenced by the investigated four factors and their combinations were the investigated four factors and their combinations were the micro nutrient elements studied.

A. Specific effect:

Table (9) display obviously that three microelements represented specifically to the four investigated factors from one hand and followed the same trend from the other. Herien, Grand Nain leaves were significantly richer in their Fe, Mn and Zn content than the other cultivar (Williams). Moreover, Fe, Mn and Zn content were significantly reduced with increasing level of any of the three investigated factors i.e. salinity concentration, SAR and Cl:SO₄ ratios.

B. Interaction effect:

It was so clear that the irrigated Williams suckers with 3000 ppm saline solution of SAR 6 and either lower or higher Cl:SO₄ ratio had statistically the poorest leaves Fe, Mn and Zn contents. Such trend was true during both seasons, especially with that combination of higher Cl:SO₄ ratio, however differences were more pronounced with both Fe and Mn than Zn content.

On the contrary, the highest leaf Fe, Mn and Zn content was significantly coupled with tap water irrigated Grand Nain plants descendingly followed by the 2000 ppm, SAR 3 and lower Cl:SO₄ ratio irrigated plants of the same cultivar which showed the least rate of reduction in their leaf Fe, Mn and Zn content.

In addition other combinations were in between with a relative tendency of variance differed from one micronutrient element to another.

These results are in general agreement with the findings of Patil and Patil (1982) on pomegranate; Sharaf *et al.* (1985) on (Guava and Olive) and some grape species); Gaser (1986) on avocado; Omar (1996) on apricot and mango seedlings and Hasan (2005) on some olive cultivars.

REFERENCES

- Abo El-EZ, A.T. (2003). Response of mycorrhizal and non-mycorrhizal banana plants (*Musa sp.*) cv. Williams to saline conditions. I. Effect of water salinity on chemical composition. *Assiut J. of Agric. Sciences*: 34(3):89-110.
- Ali, A.H.O. (2005). Physiological studies on growth and salt tolerance of some apple rootstocks. Thesis, Fac. of Agric., Benha University.
- Ayers, R.S. (1977). Quality of water for irrigation. *Proc. Amer. Soc. Civil Engineers*, 103:135-1540
- Batels, L.S., Waldren, R.P. and Teare, I.D. (1973). Rapid determination of free proline for water stress studies. *Plant and soil* 939: 205-207.
- Bernstein, L. (1975). Effect of salinity and sodality on plant growth. *Am. Rev. of phytopathology*, 13:295-311.
- Brown, J.D. and Lilleland, O. (1964). Rapid determination of potassium and sodium in plant material and soil extract by flame photometry. *Proc. Hort. Soc. Hort. Sci.*, 73:813.
- Carmo, G.A. do; Medeiros, J.F. de; Tavares, J.C.; Gheyi, H.R.; Souza, A.Mde; Palacio, E.A.de.Q. (2003). Growth in cultivars under different salinity levels of irrigation water. *Revista-Brasileira-de Fruticultura*. 25(3):513-518.
- Chapman, H.D. and P.F. Pratt (1961). *Methods of analysis for soils; plants and waters*. Div. Agric. Sci. Univ. California, Berkely PP. 309
- Delane, R. Genway, H. Munns, R. and Jame, G. (1982). Ion concentration and carbohydrate status of the elongation leaf tissue of *Hordeum vulgare* growing at high external NaCl. I- Relationship between solute concentration and growth. *J. of Exp. Botany*, 33(135): 557-573.

- Draz, M.Y. (1986). Response of bitter almond seedlings to different water regime. Ph.D. Thesis, Fac. of Agric., Cairo Univ., Egypt.
- Duncan, B.D. (1955). Multiple test range and multiple F tests. *Biometrics*. 11-142.
- Fenn, L. B. ; Bingham, F.T. and Oertil, J.J. (1968). On the mechanism of chloride toxicity. *Yearb. Calif. Avac. Soc.* 52: 113-16 (Hort. Abst. 39: 73-49).
- Gaser, A.A. (1986). Physiochemical studies on tolerance of avocado seedlings to salinity. M.Sc. Thesis, Fac. of Agric., Cairo Univ., Egypt.
- Gaser, A.A. (1992). Salt tolerance of some grapevine rootstocks. Ph.D. Thesis, Fac. of Agric., Cairo Univ., Egypt.
- Gomes., E.W.F.; Willadino, L.; Martins-Lss; Carmara, T. R.; Horts. W.J. (ed.); Schenk, M.K. (ed.); Burkert, A. (ed.); Classen, N. (ed.); Flessa, H. (ed.); Romheld, V. *et al.*, (2001). The effects of salinity on five banana genotypes (*Musa Spp*). Thesis International Plant Nutrilion Colloquium, -Hannover, Germany, 4100-411; 5 ref.
- Gomes., E.W.F.; Willadino, L.; Martins-Lss; Carmara, T.R.; Oliveira, E. Silva, S-de; Oliveira E Silva, S.; Carmara, T.R.; Meunier, I. M.J. (2004). Banana Diploids (AA) submitted to salt stress. Thesis, *Pesquisa- Agropecuaria-Brasiheria*, 39(6): 525-531.
- Gupta, I.C. (1979). use of saline water in agriculture. Oxford Ibh. Publ. Co. P. 2-28.
- Hasan, A.A.E.(2005). Physiological studies on the effect of salt stress on some olive cultivars. Ph.D. Thesis, Fac. of Agric. Moshtohor, Benha University.

- Hartz, T.K. (1984). Salinization A threat to valley agriculture. *J. Rio. Grande valley Hort., Soc.*, 37: 123-125.
- Hayward, H.E. and Bernstein, L. (1958). Plant growth relationships on salt affected soils. *Bot. Rev.*, 24: 584-635.
- Ivanova, A.S. and Ivanova, A.S. (1977). Correlation between growth and mineral nutrition of peach under salinity. *Soviet Plant Physiol.*, 24:492-8 (*Hort. Abst.*, 48; 151).
- Kabeel, H.I.A. (1985). Physiological studies on salt tolerance of some deciduous fruit species. M.Sc. Thesis, Fac. of Agric. Moshtohor, Zagazig Univ., Egypt.
- Leon, B. (1980). Salt tolerance of fruit crops sea plant physiologist, Retilerdi. U.S.A. Sci. and Education adms. W.D.C.
- Miller, R.W.; Donahue, R.L. and Miller J.U. (1990). *Soils an introduction to soils and plant growth*" Publishedby prentice Hall Inter. Inc. Englewood Cliffs, NewJersey, PP.308-339.
- Mohamed S. El-Deen M. (2001). Physiological studies on banana under salt stress condition, M.Sc. Thesis, Fac. of Agric., Cairo Univ., Egypt.
- Murphy, J. and Riely, J.P. (1962). A modified single dolution method for determination of phosphate in nutural water. *Anol Chem (Acta)*, 27: 31-36).
- Nieves, M.; Cerda, A. and Botella, M. (1991). Salt tolerance of lemon scions measured by leaf chloride and sodium accumulation. *J. of Plant Nutrition* 14(6): 623 636 (*Hort., Abst.*, 62: 5221).
- Nornal, R.(1982):Formulae for determination of chlorophyllous pigments extracted with N, N-Dimethylformamide. *Plant Physiology*, 69: 1371-1381.

- Omar, T.A.M. (1996). Physiological studies on tolerance of apricot and mango seedlings to salinity. M.Sc. Thesis, Fac. of Agric. Moshtohor., Zagazig Univ., Egypt.
- Poljakoff, A.M. and Gale, J. (1975): Plants in saline environments. Springer verlag. Berlin Heidelberg New York.
- Patil, P.K. and Patil, V.K. (1982): Effect of soil E.S.P. on the growth and chemical composition of pomegranate (*punica granatum*). Progressive Hort. 14(1): 1-5.
- Patil, P.K. and Patil, V.K. and Ghonsikar, C. P. (1984). Salinity studies on growth and nutritional status of guava (*Psidium guajava*). Int. J. Trop. Agric., 2: 334 -337.
- Piper, C.S. (1950). Soil and plant analysis. Inter., Publ. Inc. New York. pp. 368.
- Pregel, F. (1945). Quantitative organic micro-analysis 4th Ed. J & A Churvhill, Ltd. London.
- Russell, R.S. (1982): Plant root systems. Mc. Graw-Hill Book Co. New York, P. 99.
- Sharaf, M.M.; Abd El-Aziz, A.Z.; Khamis, M.A. and S.A. El-Shazly, (1985). Effect of different salinity levels in leaf mineral composition of European and American grape plants. Annals of Agric. Sci. Moshtohor, 23.
- Snedecor, G.W. and Cochran, W.G. (1972): Statistical Methods. 6th ed. The Iowa state. Univ. Press, Amer, Iowa, U.S.A. PP. 593.
- Strogonov, R.J. (1964): Principles of salt mobility and reactivity in soil systems. Soil science society of American Madison, 1: 123-140.
- Winter, E. (1982). Tolerance of *Trifolium alexandrinum* L. II- Ion balance in relation to its salt tolerance. Aust. J. Plant Physiol., 9: 227-237.

دراسات فسيولوجية على تحمل نباتات صنفين من الموز للملوحة

١- تأثير التركيز ونسبة كل من الصوديوم المدمص والكلوريد على النمو الخضري والمحتوى

الكيمائى

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أجريت هذه الدراسة خلال موسمى ٢٠٠٦، ٢٠٠٧ لدراسة مدى تحمل نباتات الموز الحديثة للملوحة من خلال تقييم استجابة بعض من قياساتها الخضرية والمحتوى الكيمائى للتأثير النوعى لأربعة عوامل مختبرة هى:

أ- صنف الموز (جراند نان، ويليامز)،

ب- تركيز ملوحة ماء الرى (٢٠٠٠، ٣٠٠٠ جزء فى المليون)،

ج- مستوى الصوديوم المدمص (٣، ٦).

د- نسبة الكلوريدات إلى الكبريتات (منخفضة، عالية) والتفاعل بينهما.

وقد أظهرت النتائج المتحصل عليها أن القياسات الخضرية (ارتفاع ومحيط الساق الكاذب)، (عدد الأوراق ومساحة الورقة)، الوزن الطازج والجاف لأجزاء النبات المختلفة (فوق أو تحت الأرض) وكذلك معدل شيخوخة الأوراق تأثرت معنويا بالعوامل المختبرة حيث كان هناك علاقة عكسية (سلبية، بين مستوى تركيز الأملاح ونسبة كل من الصوديوم المدمص والكلوريدات إلى الكبريتات ما عدا نسبة شيخوخة الأوراق التى سلكت اتجاهها مضادا (علاقة طردية).

أما عن المحتوى الكيمائى والذى شمل صبغات التمثيل الضوئى بالورقة (كلوروفيل أ، ب، الكاروتين) الحمض الأمينى برولين والصوديوم المدمص وبعض العناصر الغذائية (N, P, K, Ca, Mg, Na, Fe, Mn, Zn) فقد استجابت أيضا معنويا لأى من العوامل المختبرة وسلكت اتجاهين متضادين الأول تمثل فى أن جميع صبغات التمثيل الضوئى وبعض العناصر المعدنية (N, P, K, Mg, Fe, Mn, Zn) قد سلكت نفس الاتجاه الذى أظهرته قياسات النمو الخضري (علاقة عكسية بين محتوى كل عنصر ومستوى كل من تركيز الملوحة والصوديوم المدمص ونسبة الكلوريدات إلى الكبريتات أما الاتجاه الآخر وهو مضاد للأول ويمثل محتوى الأوراق من كل من الحمض الأمينى برولين والكالسيوم والصوديوم فقد أظهر علاقة طردية مثل الذى أظهرته نسبة شيخوخة الأوراق (من حيث تأثير مستوى كل من تركيز الملوحة، الصوديوم المدمص ونسبة الكلوريدات إلى الكبريتات، وعلى الجانب الآخر فإن نباتات الجرانند نان تميزت بارتفاع قيم قياساتها الخضرية والمحتوى الكيمائى عن نظراتها للصنف ويليامز ما عدا نسبة شيخوخة الأوراق ومحتواها من البرولين والكالسيوم والصوديوم فكان العكسى صحيحا.

