*J. Agric. Sci. Mansoura Univ., 28(8): 6271 - 6287, 2003*

# EFFECT OF SOME SODIUM SALTS ON THE GROWTH, MINERAL COMPOSITION AND ORGANIC CONTENT OF SOME GRAPE ROOTSTOCKS
## III. THE ORGANIC CONTENT

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## ABSTRACT

The present investigation was carried out during 2000 and 2001 growing seasons in order to study the effect of sodium chloride and sodium carbonate treatments on organic content of four grapevine cultivars (commonly used as rootstocks) namely, Harmony, 1103 Paulsen, Dogridge and Thompson seedless.

**The main results can be summarized in the following points:**

**A. Effect of salinity treatments**

1- Total chlorophyll content significantly decreased in the leaves with different sodium chloride and sodium carbonate treatments as compared with the control in both seasons.
2- Total phenols content significantly decreased in the leaves with salinity treatments, in the first season, while it increased in the second one.
3- Both 3000 ppm sodium chloride and 750 ppm sodium carbonate treatments significantly decreased root total sugars than the other treatments.
4- Plants treated with 1500 ppm sodium carbonate had significantly higher root reducing sugars than the other treatments, except the control.
5- In the first season, no significant differences among the studied treatments were recorded with respect to leaf starch content. In the second season, 1500 ppm sodium carbonate treatment significantly increased leaf starch content than the other treatments, except the control. The plants treated with 750 ppm sodium carbonate had significantly higher root starch content than the other treatments.
6- No significant differences were found among the studied treatments with respect to leaf C/N ratio, in the first season. In the second season, 1500 ppm sodium carbonate had significantly higher leaf C/N ratio than the other treatments. Sodium carbonate treatments significantly increased root C/N ratio than the control which had significantly higher value than sodium chloride treatments.

**B. Effect of rootstocks**

1- In both seasons, Thompson seedless had significantly higher leaf reducing sugars and lower non – reducing sugars. However, the roots had higher reducing sugars and lower C/N ratio.
2- The leaves of Dogridge had significantly low phenols in both seasons and reducing sugars, in the second season. And their roots contained significantly low total and non – reducing sugars.
3- The leaves of Harmony contained significantly high non – reducing sugars. In the meantime, their roots had significantly high phenols, total and non – reducing sugars, and low starch and total carbohydrates contents.
4- 1103 Paulsen leaves contained significantly high phenols content, whereas the roots had high starch, total carbohydrates and C/N ratio and low phenols content, however.

## INTRODUCTION

Grape is one of the most important fruit crops in Egypt. The total area of grapevines in Egypt reached 148406 feddans producing about 1078912 tons of fruits according to the statistics of the Ministry of Agriculture and Land Reclamation, Cairo, 2001. A large part of new lands area suffers from increasing salinity. Rootstock variations considered as an important factor affecting that salt tolerance of fruit crops. *Vitis vinifera* varieties are moderately tolerant to salinity ( i.e. high total salts). However, injury may result from excessive intake of chloride. Certain rootstocks reduce the accumulation of chloride in the scion variety (Sauer, 1968 and Bernstein *et al.*, 1969). It is evident that high salt concentrations in the soil cause growth inhibition in most plants, but saline conditions affect plant growth in a variety of ways. Salinity can cause: (1) a decrease in water uptake in the plants, (2) the accumulation of ions to toxic levels, and (3) reduces nutrient availability (Flowers *et al.*, 1977).

Importance of carbonate and bicarbonate in irrigation water is due to precipitation of calcium and magnesium, if they were in higher concentrations than these cations. Therefore, sodium carbonate is formed causing black alkaline soils. Absorbing high concentrations of chloride and sodium ions by plants causes crumbling of the new growing leaves, chlorosis, leaf burn, defoliation, shoot dieback and finally plant death. Salt tolerance can be expressed by relative growth at certain levels of soluble salts. With a 0.7-0.8 % water- soluble salt content in the soil, the plants were unthrifty with thin shoots, short internodes and small leaves (Martynenko *et al.*, 1973).

The objective of the present investigation was to study the response of four grapevine rootstocks namely, Harmony, Dogridge, 1103 Paulsen and Thompson seedless to different sodium chloride and sodium carbonate treatments in the irrigation water.

## MATERIALS AND METHODS

This study was conducted during the growing seasons of 2000 and 2001 in a greenhouse at the Agricultural Experiment Station of Alexandria University. This experiment aimed to study the influence of sodium salts, i.e sodium chloride and sodium carbonate on organic content of four grapevine rootstocks namely, Harmony (*Vitis champini* x 1613), 1103 Paulsen (*Vitis berlandieri x Vitis rupestris*), Dogridge (*Vitis champini*) and Thompson seedless (*Vitis vinifera*). The experimental plants of the four cultivars were one - year- old and planted in mid February in clay pots filled with sand, previously leached for salt removal. One plant was planted in each pot. All plants were irrigated with tap water every two days before starting irrigation with solutions of the different salt treatments in July 2000 and May 2001 until October of both seasons.

The sodium (Na) was applied through irrigation water as sodium chloride (NaCl) and sodium carbonate ($Na_2CO_3$). From each salt, two salinity concentrations were tested against the control (tap water without adding salts) namely, 1500, 3000 ppm for NaCl and 750, 1500 ppm for $Na_2CO_3$. Each treatment was replicated four times with three plants in each replicate.

The plants were irrigated with salt solutions every two days and the pots were leached with tap water three times monthly to avoid salt accumulation in the root zone. One litre of 1000 ppm Crystalone solution was added to each pot weekly as a source of nutritive mineral salts from starting treatments until the end of each season.

Total leaf chlorophyll content was determined in fresh leaf samples according to the method described by Yadava (1986) using a minolta SPAD chlorophyllmeter model. Five readings were taken for each plant at the end of both seasons. The results were expressed as SPAD units. For free proline content determination, 0.1 gm of dried leaf and root materials were homogenized in 10 ml sulfosalicylic acid. The homogenate was filtrated through Whatman No. 2 filter paper. Two ml of filtrate was reacted with 2 ml acid ninhydrine and 2ml glacial acetic acid in test tube for one hour at 100 °C. The reaction was terminated in an ice bath. The reaction mixture was extracted with 4ml toluene. Mixed well vigorously with stirrer for 15-20 sec. The chromophore containing toluene was aspirated from the aqueous phase, warmed to room temperature. The optical density of solution was then measured at 520 nm using toluene for blank. The proline was detemined from standard curve according to Bates *et al.*, (1973). The data were expressed as percent on dry weight basis.

For total phenols compounds determination, 0.5 gm of dried leaf and root materials were homogenized in 15 ml ethanol 95% and boiled for 15 minutes. The homogenate was filtrated through Whatman No.2 filter paper. Half ml folin – Denis reagent was added to one ml of the alcoholic extract and after 5 minutes later 7ml saturated sodium carbonate solution was added, shakd and left for half hour. Optical density was measured at 750 nm and total phenols were calculated from a standard curve of tannic acid. These data were expressed as mg / g on dry weight basis according to Cheng and Hanning (1955). For total sugars determination, 0.5 gm of dried leaf and root materials were extracted by distilled water. This operation was repeated three times. Leading was made in the extract using lead acetate to produce aflocculent precipitate. The solution was made up to volume with water, and then filtration. Deleading took place in the filtrated solution using sufficient sodium oxalate and refiltered. The insoluble residue was entered in oven – dried at 70 C° until the constant weight. Total sugars were determined according to Malik and Singh (1980). Reducing sugars and starch were determined by Dubois *et al.*, (1956). Non reducing sugars were calculated by the difference between the total sugars and the reducing sugars. Total carbohydrates were calculated as a summation of total sugars and the starch. The results were expressed as g / 100g or percent on dry weight basis. C/N ratio was calculated by dividing the total carbohydrates content on the total nitrogen content.

Soil and water samples were taken before planting, data of soil and water analysis are presented in Table (1). The data collected throughout this study were subjected to analysis using a factorial experiment in RCBD in 4 replicates. L.S.D at 0.05 compared the differences among means according to Snedecor and Cochran (1967).

Table (1): Chemical analysis of the used tap water and sand soil at planting.

| Character | Tap water | Sand soil |
|---|---|---|
| PH | 7.66 | 7.76 |
| E.C. (mmhos/ cm) | 0.39 | 0.98 |
| Soluble ions (meq/ l ) | | |
| $Ca^{++}$ | 1.07 | 1.38 |
| $Mg^{++}$ | 1.46 | 3.54 |
| $Na^{+}$ | 1.46 | 4.70 |
| $K^{+}$ | 0.11 | 0.21 |
| $H CO_3$ | 1.57 | 2.48 |
| $Cl^{-}$ | 1.48 | 3.99 |
| $SO_4^{-2}$ | 1.04 | 3.36 |

## RESULTS AND DISCUSSION

The data representing the effect of different salinity treatments on organic content in the experimental plants during 2000 and 2001 seasons, are listed in Tables (2 to 10).

### 1- Total chlorophyll content

Concerning the effect of salinity treatments on leaf chlorophyll content, irrespective the effect of rootstocks, the results in Table (2) indicated that, in both seasons, a significant reduction in total chlorophyll content in the leaves of the studied grape plants was found with different sodium chloride and sodium carbonate treatments as compared with the untreated plants. In the meantime, increasing the concentration of the studied salts in the irrigation water significantly decreased leaf total chlorophyll, in the first season, whereas in the second one the differences between the two concentrations of each salt were not statistically significant, however. Many workers pointed that total chlorophyll content depressed under saline conditions such as, Downton and Millhouse (1985); Salama *et al.*, (1992); Sivritepe and Eris (1999); and Singh *et al.*, (2000).

Table (2): Effect of sodium chloride and sodium carbonate treatments on leaf chlorophyll content (SPAD units) of grape rootstocks in 2000 and 2001 seasons.

| Treatment / Rootstock | Na Cl (ppm) | | $Na_2CO_3$ (ppm) | | Control | Average |
|---|---|---|---|---|---|---|
| | 1500 | 3000 | 750 | 1500 | | |
| 2000 | | | | | | |
| Harmony | 37.40 | 33.33 | 34.18 | 36.06 | 37.89 | 35.77 |
| Dogridge | 33.08 | 31.66 | 33.66 | 32.62 | 37.45 | 33.69 |
| 1103 Paulsen | 35.67 | 33.17 | 32.36 | 28.85 | 34.42 | 32.89 |
| Thompson seedless | 33.35 | 36.25 | 34.92 | 27.07 | 37.27 | 33.77 |
| Average | 34.88 | 33.60 | 33.78 | 31.15 | 36.76 | |
| L.S.D 0.05 | Rootst. | | Treat. | | Rootst. x Treat. | |
| | 1.03 | | 1.15 | | 2.30 | |
| 2001 | | | | | | |
| Harmony | 34.13 | 34.00 | 32.62 | 28.57 | 36.00 | 33.06 |
| Dogridge | 33.33 | 33.16 | 31.58 | 33.01 | 35.02 | 33.22 |
| 1103 Paulsen | 33.86 | 33.47 | 30.30 | 32.28 | 30.70 | 32.12 |
| Thompson seedless | 31.62 | 29.97 | 27.93 | 30.92 | 36.48 | 31.38 |
| Average | 33.24 | 32.65 | 30.61 | 31.20 | 34.55 | |
| L.S.D 0.05 | Rootst. | | Treat. | | Rootst. x Treat. | |
| | 1.14 | | 1.28 | | 2.56 | |

As for the effect of rootstocks on leaf chlorophyll content, regardless of the effect of salinity treatments, the data in Table (2) indicated that, Harmony had significantly higher leaf chlorophyll content than the other cultivars in the first season. In the second season, Harmony and Dogridge were not significantly different than that of 1103 Paulsen. The latter did not differ than Thompson seedless. Significant differences were found between Harmony and Dogridge in one side and Thompson seedless in the other. Gaser (1992) reported that the most sensitive stocks, st. George and Couderc 1202, accumulated the lowest amount of chlorophyll a, b and carotenoid. Mohamed (1996) reported that king's Ruby transplants exhibited the higher values of chlorophyll content. Although, Early Superior, Flame seedless and Thompson seedless exhibited an evident decrease in total chlorophyll, no significant differences were recorded between Thompson seedless and Flame seedless.

**2- Total phenols content**

Regarding the effect of salinity treatments on leaf phenols content, irrespective the effect of rootstocks, the results in Table (3) revealed that, in the first season, total phenols content in the leaves decreased with sodium chloride or carbonate treatments. However, the trend was reversed in leaves of the second season. Gaser (1992) reported that leaf phenolic content increased with increasing salinity.

Table (3): **Effect of sodium chloride and sodium carbonate treatments on leaf and root phenols content ( mg/g ) of grape rootstocks in 2000 and 2001 seasons.**

| Rootstock \ Treatment | Na Cl (ppm) | | $Na_2CO_3$ (ppm) | | Control | Average |
|---|---|---|---|---|---|---|
| | 1500 | 3000 | 750 | 1500 | | |
| **Leaves 2000** | | | | | | |
| Harmony | 71.22 | 75.63 | 78.32 | 90.74 | 91.93 | 81.57 |
| Dogridge | 75.25 | 90.49 | 73.89 | 62.07 | 90.43 | 78.43 |
| 1103 Paulsen | 81.78 | 94.13 | 88.62 | 111.13 | 100.28 | 95.19 |
| Thompson seedless | 80.14 | 79.98 | 96.83 | 73.49 | 97.26 | 85.54 |
| Average | 77.10 | 85.06 | 84.42 | 84.36 | 94.98 | |
| L.S.D 0.05 | Rootst. | | Treat. | | Rootst. x Treat. | |
| | 1.89 | | 2.12 | | 4.24 | |
| **Leaves 2001** | | | | | | |
| Harmony | 61.78 | 60.64 | 81.44 | 77.96 | 57.75 | 67.91 |
| Dogridge | 76.23 | 51.40 | 59.29 | 62.35 | 45.04 | 58.86 |
| 1103 Paulsen | 58.90 | 84.32 | 75.08 | 82.01 | 71.60 | 74.38 |
| Thompson seedless | 78.54 | 56.00 | 71.03 | 58.89 | 66.41 | 66.17 |
| Average | 68.86 | 63.09 | 71.71 | 70.30 | 60.20 | |
| L.S.D 0.05 | Rootst. | | Treat. | | Rootst. x Treat. | |
| | 1.72 | | 1.92 | | 3.84 | |
| **Roots 2001** | | | | | | |
| Harmony | 92.41 | 111.67 | 134.00 | 158.83 | 130.53 | 125.49 |
| Dogridge | 109.16 | 86.04 | 94.15 | 107.43 | 96.44 | 98.64 |
| 1103 Paulsen | 90.08 | 83.17 | 110.88 | 112.05 | 85.48 | 96.33 |
| Thompson seedless | 138.04 | 135.15 | 112.63 | 116.08 | 96.46 | 119.67 |
| Average | 107.42 | 104.01 | 112.92 | 123.60 | 102.23 | |
| L.S.D 0.05 | Rootst. | | Treat. | | Rootst. x Treat. | |
| | 1.84 | | 2.06 | | 4.12 | |

As for the effect of rootstocks on leaf phenols content, regardless of the effect of salinity treatments, the data in Table (3) indicated that, 1103 Paulsen had significantly higher leaf phenols content than the other cultivars, while Dogridge one had significantly the lowest value. Significant difference was also found between Harmony and Thompson seedless. Gaser (1992) found that st. George and Couderc 1202 rootstocks contained the highest amount of phenols followed by Couderc 1613 and Dogridge rootstocks, while Thompson seedless and Couderc 1616 contained low amounts.

Concerning the effect of salinity treatments on root phenols content, irrespective the effect of rootstocks, the results in Table (3) revealed that different sodium chloride and sodium carbonate treatments caused significant increase in root phenols content as compared with the control, except 3000 ppm sodium chloride treatment. Significant differences were also found among treatments. These results are supported by Shahin (1997) on grapevines.

As for the effect of rootstocks on total phenols content in root, regardless of the effect of salinity treatments, the data in Table (3) indicated that, the studied cultivars could be arranged in the following descending order: Harmony > Thompson seedless > Dogridge > 1103 Paulsen, and the differences among them were statistically significant.

**3-Proline content**

Concerning the effect of salinity treatments on leaf proline content, irrespective the effect of rootstocks, the results in Table (4) revealed that, in both seasons, different sodium chloride and sodium carbonate treatments had no significant effect on proline content in the leaves.

As for the effect of rootstocks on leaf proline content, regardless of the effect of salinity treatments, the data in Table (4) indicated that, in the first season, the studied rootstocks could be arranged in the following descending order : Dogridge > 1103 Paulsen > Harmony = Thomson seedless. In the second season, the results indicated that Dogridge had significantly lower leaf proline content than the other cultivars which contain the same proline level. Gaser (1992) reported that the most sensitive rootstocks (st. George, Couderc 1202 and Couderc 1613) tended to accumulate higher amounts of proline, while the more tolerant stocks (Couderc1616, Thompson seedless, ARG1and Dogridge) showed the lowest content of proline in the leaves.

Regarding the effect of salinity treatments on root proline content, irrespective the effect of rootstocks, the data in Table (4) revealed that, sodium chloride and sodium carbonate treatments had no significant effect on root proline content.

As for the effect of rootstocks on root proline content, regardless of the effect of salinity treatments, the results in Table (4) indicated that, there were no significant differences among the studied cultivars. Mohamed (1996) found that no significant differences were recorded between Thompson seedless and Flame seedless.

Table (4): **Effect of sodium chloride and sodium carbonate treatments on leaf and root proline content (% D.W. basis) of grape rootstocks in 2000 and 2001 seasons.**

| Treatment / Rootstock | Na Cl (ppm) | | $Na_2CO_3$ (ppm) | | Control | Average |
|---|---|---|---|---|---|---|
| | 1500 | 3000 | 750 | 1500 | | |
| **Leaves 2000** | | | | | | |
| Harmony | 0.04 | 0.04 | 0.03 | 0.04 | 0.04 | 0.04 |
| Dogndge | 0.07 | 0.10 | 0.09 | 0.07 | 0.09 | 0.08 |
| 1103 Paulsen | 0.05 | 0.04 | 0.08 | 0.05 | 0.04 | 0.05 |
| Thompson seedless | 0.04 | 0.05 | 0.03 | 0.04 | 0.05 | 0.04 |
| Average | 0.05 | 0.06 | 0.06 | 0.05 | 0.06 | |
| L.S.D 0.05 | Rootst. | | Treat. | | Rootst. x Treat. | |
| | 0.01 | | N.S | | 0.02 | |
| **Leaves 2001** | | | | | | |
| Harmony | 0.07 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 |
| Dogridge | 0.04 | 0.04 | 0.05 | 0.04 | 0.04 | 0.04 |
| 1103 Paulsen | 0.07 | 0.05 | 0.07 | 0.06 | 0.05 | 0.06 |
| Thompson seedless | 0.06 | 0.05 | 0.07 | 0.06 | 0.07 | 0.06 |
| Average | 0.06 | 0.05 | 0.06 | 0.06 | 0.06 | |
| L.S.D 0.05 | Rootst. | | Treat. | | Rootst. x Treat. | |
| | 0.01 | | N.S | | N.S | |
| **Roots 2001** | | | | | | |
| Harmony | 0.06 | 0.08 | 0.07 | 0.05 | 0.05 | 0.06 |
| Dogridge | 0.08 | 0.08 | 0.09 | 0.08 | 0.07 | 0.08 |
| 1103 Paulsen | 0.08 | 0.09 | 0.05 | 0.06 | 0.11 | 0.08 |
| Thompson seedless | 0.08 | 0.08 | 0.06 | 0.05 | 0.07 | 0.07 |
| Average | 0.08 | 0.08 | 0.07 | 0.06 | 0.08 | |
| L.S.D 0.05 | Rootst. | | Treat. | | Rootst. x Treat. | |
| | N.S | | N.S | | N.S | |

## 4. Total carbohydrates content

Regarding the effect of salinity treatments on leaf carbohydrates content, irrespective the effect of rootstocks, the data in Table (5) showed that, in the first season, the different sodium chloride and sodium carbonate treatments had no marked effect on leaf carbohydrates content. In the second season, the plants treated with 1500 ppm sodium carbonate had significantly higher leaf carbohydrates content as compared with the other treatments. Likewise, untreated plants (control) had significantly higher leaf total carbohydrates than the rest treatments. Significant difference was also found between 1500 ppm sodium chloride and 750 ppm sodium carbonate treatments. Abou- Rayya *et al.*, (1988) reported that total carbohydrates content was not affected by saline conditions. However, Gaser (1992) found that leaf carbohydrates content decreased with rising salinity.

As for the effect of rootstocks on leaf carbohydrates content, regardless of the effect of salinity treatments, the results in Table (5) indicated that, the only significant difference was found between 1103 Paulsen and Dogridge, in the first season. In the second season, it was indicated that the studied rootstocks could be arranged in the following descending order Dogridge > Thompson seedless > Harmony > 1103 Paulsen and the differences among them were significant. Gaser (1992) reported that st. George (the most sensitive rootstock) tended to accumulate the lowest amount of carbohydrates followed by Couderc 1202, Couderc 1613 and Dogridge, while Thompson seedless, Couderc 1616 and ARG1 seemed to contain carbohydrates in higher amounts.

**Table (5): Effect of sodium chloride and sodium carbonate treatments on leaf and root total carbohydrates content ( % D.W. basis ) of grape rootstocks in 2000 and 2001 seasons.**

| Treatment / Rootstock | Na Cl (ppm) 1500 | Na Cl (ppm) 3000 | $Na_2CO_3$ (ppm) 750 | $Na_2CO_3$ (ppm) 1500 | Control | Average |
|---|---|---|---|---|---|---|
| **Leaves 2000** | | | | | | |
| Harmony | 13.16 | 13.05 | 13.43 | 13.78 | 14.03 | 13.49 |
| Dogridge | 13.70 | 13.45 | 13.48 | 12.00 | 12.36 | 13.00 |
| 1103 Paulsen | 14.34 | 13.94 | 13.41 | 12.63 | 15.20 | 13.90 |
| Thompson seedless | 13.60 | 14.16 | 13.33 | 14.51 | 12.50 | 13.62 |
| Average | 13.70 | 13.65 | 13.41 | 13.23 | 13.52 | |
| L.S.D 0.05 | Rootst. | | Treat. | | Rootst. x Treat. | |
| | 0.63 | | N.S | | 1.40 | |
| **Leaves 2001** | | | | | | |
| Harmony | 13.66 | 13.93 | 14.45 | 14.44 | 13.80 | 14.06 |
| Dogridge | 17.90 | 17.99 | 18.15 | 18.76 | 21.33 | 18.83 |
| 1103 Paulsen | 11.29 | 11.97 | 14.09 | 13.52 | 12.55 | 12.68 |
| Thompson seedless | 18.07 | 18.88 | 16.38 | 20.28 | 17.39 | 18.20 |
| Average | 15.23 | 15.69 | 15.77 | 16.75 | 16.27 | |
| L.S.D 0.05 | Rootst. | | Treat. | | Rootst. x Treat. | |
| | 0.43 | | 0.48 | | 0.96 | |
| **Roots 2001** | | | | | | |
| Harmony | 24.32 | 18.47 | 34.56 | 30.18 | 21.28 | 25.76 |
| Dogridge | 19.75 | 19.64 | 35.06 | 29.84 | 38.28 | 28.51 |
| 1103 Paulsen | 44.26 | 46.66 | 46.03 | 35.26 | 50.49 | 44.54 |
| Thompson seedless | 31.30 | 25.84 | 32.42 | 28.42 | 28.07 | 29.21 |
| Average | 29.91 | 27.65 | 37.02 | 30.93 | 34.53 | |
| L.S.D 0.05 | Rootst. | | Treat. | | Rootst. x Treat. | |
| | 1.09 | | 1.22 | | 2.45 | |

Regarding the effect of salinity treatments on root carbohydrates content, irrespective the effect of rootstocks, the data in Table (5) revealed that the different sodium chloride and sodium carbonate treatments caused a significant decrease in root total carbohydrates as compared with control, except 750 ppm sodium carbonate. This trend is supported by Youssif (1998) on grapevines.

As for the effect of rootstocks on root carbohydrates content, regardless of the effect of salinity treatments, the results in Table (5) indicated that 1103 Paulsen had significantly higher root total carbohydrates than the other cultivars, whereas Harmony one contained significantly the lowest value. No significant differences were found between Dogridge and Thompson seedless, however. Mohamed (1996) reported that king's Ruby was the highest one in root carbohydrates content compared to other varieties i, e. Thompson seedless, Early Superior and Flame seedless.

**5. Total sugars**

Concerning the effect of salinity treatments on leaf sugars content, irrespective the effect of rootstocks, the results in Table (6) revealed that, in both seasons, the control plants did not significantly differ in their total sugars content than that of all the studied salinity concentrations, except 750 ppm sodium carbonate treatment in the second season. Significant differences were found between 1500 and 3000 ppm sodium chloride treatments, in the first season, and between 750 ppm sodium carbonate in one side and the other treatments in the second side, in the second season. Youssif (1998) and Singh *et al.*, (2000) found that leaf total sugars increased under saline conditions.

As for the effect of rootstocks on leaf sugars content, regardless of the effect of salinity treatments, the data in Table (6) indicated that, in the first season, Harmony had significantly lower leaf total sugars than the other cultivars. In the second season, the results indicated that Harmony and 1103 Paulsen had significantly higher leaf total sugars than Thompson seedless and Dogridge. Significant difference was also found between Dogridge and Thompson seedless.

Regarding the effect of salinity treatments on root sugars content, irrespective the effect of rootstocks, the results in Table (6) indicated that, untreated plants and those subjected to 1500 ppm sodium chloride or 1500 ppm sodium carbonate had significantly higher root total sugars content than those subjected to 3000 ppm sodium chloride and 750 ppm sodium carbonate. Sourial *et al.*, (1985); Ahmed *et al.*, (1988) and Essa (1988) found that root total sugars depressed with rising salinity.

As for the effect of rootstocks on root sugars content, regardless of the effect of salinity treatments, the data in Table (6) indicated that the studied cultivars could be arranged in the following descending order with respect to root total sugars content Harmony >1103 Paulsen > Thompson seedless >Dogridge and the differences among them were significant.

**Table (6): Effect of sodium chloride and sodium carbonate treatments on leaf and root total sugars content (% D.W. basis ) of grape rootstocks in 2000 and 2001 seasons**

| Treatment / Rootstock | Na Cl (ppm) 1500 | Na Cl (ppm) 3000 | $Na_2CO_3$ (ppm) 750 | $Na_2CO_3$ (ppm) 1500 | Control | Average |
|---|---|---|---|---|---|---|
| **Leaves 2000** | | | | | | |
| Harmony | 2.57 | 2.81 | 2.84 | 3.19 | 3.44 | 2.97 |
| Dogridge | 3.47 | 3.74 | 3.80 | 3.00 | 2.65 | 3.33 |
| 1103 Paulsen | 3.05 | 3.70 | 3.34 | 3.45 | 3.90 | 3.49 |
| Thompson seedless | 3.63 | 3.57 | 3.65 | 3.28 | 3.50 | 3.53 |
| Average | 3.18 | 3.46 | 3.41 | 3.23 | 3.37 | |
| L.S.D 0.05 | Rootst. 0.22 | | Treat. 0.25 | | Rootst. x Treat. 0.49 | |
| **Leaves 2001** | | | | | | |
| Harmony | 3.07 | 2.19 | 3.15 | 2.61 | 3.03 | 2.81 |
| Dogridge | 2.37 | 2.46 | 2.97 | 1.82 | 1.47 | 2.22 |
| 1103 Paulsen | 2.20 | 2.44 | 3.32 | 3.11 | 2.67 | 2.75 |
| Thompson seedless | 2.53 | 2.65 | 2.61 | 1.93 | 2.56 | 2.46 |
| Average | 2.54 | 2.44 | 3.01 | 2.37 | 2.43 | |
| L.S.D 0.05 | Rootst. 0.20 | | Treat. 0.23 | | Rootst. x Treat. 0.46 | |
| **Roots 2001** | | | | | | |
| Harmony | 4.90 | 3.45 | 3.50 | 4.34 | 4.48 | 4.13 |
| Dogridge | 2.95 | 3.26 | 2.29 | 2.80 | 2.80 | 2.82 |
| 1103 Paulsen | 4.36 | 3.41 | 2.61 | 4.36 | 4.59 | 3.87 |
| Thompson seedless | 3.33 | 3.25 | 3.10 | 4.42 | 3.71 | 3.56 |
| Average | 3.89 | 3.34 | 2.88 | 3.98 | 3.90 | |
| L.S.D 0.05 | Rootst. 0.20 | | Treat. 0.23 | | Rootst. x Treat. N.S | |

## 6. Reducing sugars

Regarding the effect of salinity treatments on leaf reducing sugars content, irrespective the effect of rootstocks, the data in Table (7) indicated that, in the first season, 1500 ppm sodium carbonate treatment significantly increased leaf reducing sugars content as compared with those treated with 1500 ppm sodium chloride and those of the control. In the second season, 750 ppm sodium carbonate treatment significantly increased leaf reducing sugars than the other treatments. In the meantime, the two studied concentrations of sodium chloride significantly increased leaf reducing sugars as compared with 1500 ppm sodium carbonate and the control treatments.

Downton (1977); Ahmed *et al.*, (1988) and Youssif (1998) found that leaf reducing sugars increased under saline conditions compared with the control.

As for the effect of rootstocks on leaf reducing sugars content, regardless of the effect of salinity treatments, the results in Table (7) showed that, in the first season, the studied rootstocks could be arranged in the following descending order with respect to leaf reducing sugars content Thomson seedless > 1103 Paulsen > Dogridge > Harmony and the differences among them were statistically significant. In the second season, Dogridge had significantly lower leaf reducing sugars than the other cultivars.

**Table (7): Effect of sodium chloride and sodium carbonate treatments on leaf and root reducing sugars content (% D.W. basis) of grape rootstocks in 2000 and 2001 seasons.**

| Treatment / Rootstock | Na Cl (ppm) | | $Na_2CO_3$ (ppm) | | Control | Average |
|---|---|---|---|---|---|---|
| | 1500 | 3000 | 750 | 1500 | | |
| **Leaves 2000** | | | | | | |
| Harmony | 1.11 | 1.26 | 1.32 | 1.55 | 1.46 | 1.34 |
| Dogridge | 1.56 | 2.06 | 2.21 | 1.72 | 1.37 | 1.78 |
| 1103 Paulsen | 1.97 | 2.28 | 1.87 | 2.18 | 3.29 | 2.32 |
| Thompson seedless | 2.93 | 2.60 | 3.24 | 3.36 | 1.76 | 2.78 |
| Average | 1.89 | 2.05 | 2.16 | 2.20 | 1.97 | |
| L.S.D 0.05 | Rootst. | | Treat. | | Rootst. x Treat. | |
| | 0.19 | | 0.22 | | 0.43 | |
| **Leaves 2001** | | | | | | |
| Harmony | 1.86 | 1.64 | 1.69 | 1.24 | 1.45 | 1.58 |
| Dogridge | 1.58 | 1.53 | 1.77 | 0.93 | 0.95 | 1.35 |
| 1103 Paulsen | 1.32 | 1.48 | 1.96 | 1.60 | 1.51 | 1.57 |
| Thompson seedless | 1.55 | 1.69 | 1.90 | 1.65 | 1.41 | 1.64 |
| Average | 1.58 | 1.59 | 1.83 | 1.36 | 1.33 | |
| L.S.D 0.05 | Rootst. | | Treat. | | Rootst. x Treat. | |
| | 0.18 | | 0.20 | | 0.40 | |
| **Roots 2001** | | | | | | |
| Harmony | 1.16 | 1.05 | 1.03 | 1.17 | 1.09 | 1.10 |
| Dogridge | 1.17 | 1.13 | 1.05 | 1.06 | 1.32 | 1.15 |
| 1103 Paulsen | 0.99 | 0.98 | 1.28 | 1.00 | 0.95 | 1.04 |
| Thompson seedless | 1.14 | 1.13 | 1.24 | 2.52 | 1.56 | 1.52 |
| Average | 1.12 | 1.07 | 1.15 | 1.44 | 1.23 | |
| L.S.D 0.05 | Rootst. | | Treat. | | Rootst. x Treat. | |
| | 0.23 | | 0.26 | | 0.51 | |

Concerning the effect of salinity treatments on root reducing sugars content, irrespective the effect of rootstocks, the results in Table (7) revealed that the plants treated with 1500 ppm sodium carbonate had significantly higher leaf reducing sugars content than the other treatments, except the control. Essa (1988) found that reducing sugars decreased in roots of salt-treated plants.

As for the effect of rootstocks on root reducing sugars content, regardless of the effect of salinity treatments, the data in Table (7) indicated that, Thompson seedless had significantly higher root reducing sugars content than the other cultivars.

## 7. Non – reducing sugars

Concerning the effect of salinity treatments on leaf non – reducing sugars content, irrespective the effect of rootstocks, the results in Table (8) indicated that, in the first season, untreated plants and those subjected to 3000 ppm sodium chloride had significantly higher leaf non - reducing sugars content than those treated with 1500 ppm sodium carbonate. In the second season, the plants treated with 750 ppm sodium carbonate had significantly higher leaf non - reducing sugars than the other treatments, except the control. Youssif (1998) found that leaf non- reducing sugars content increased under saline conditions.

**Table (8): Effect of sodium chloride and sodium carbonate treatments on leaf and root non- reducing sugars content ( % D.W. basis ) of grape rootstocks in 2000 and 2001 seasons.**

| Treatment / Rootstock | Na Cl (ppm) | | $Na_2CO_3$ (ppm) | | Control | Average |
|---|---|---|---|---|---|---|
| | 1500 | 3000 | 750 | 1500 | | |
| **Leaves 2000** | | | | | | |
| Harmony | 1.45 | 1.55 | 1.52 | 1.64 | 1.99 | 1.63 |
| Dogridge | 1.90 | 1.69 | 1.56 | 1.28 | 1.28 | 1.54 |
| 1103 Paulsen | 1.08 | 1.42 | 1.47 | 1.27 | 0.61 | 1.17 |
| Thompson seedless | 0.69 | 0.99 | 0.38 | 0.26 | 1.74 | 0.81 |
| Average | 1.28 | 1.41 | 1.23 | 1.11 | 1.41 | |
| L.S.D 0.05 | Rootst. | | Treat. | | Rootst. x Treat. | |
| | 0.18 | | 0.20 | | 0.39 | |
| **Leaves 2001** | | | | | | |
| Harmony | 1.21 | 0.82 | 1.46 | 1.37 | 1.58 | 1.29 |
| Dogridge | 0.79 | 0.93 | 1.20 | 0.89 | 0.52 | 0.87 |
| 1103 Paulsen | 0.88 | 0.97 | 1.37 | 1.50 | 1.16 | 1.18 |
| Thompson seedless | 0.98 | 0.95 | 0.71 | 0.28 | 1.15 | 0.81 |
| Average | 0.97 | 0.92 | 1.19 | 1.01 | 1.10 | |
| L.S.D 0.05 | Rootst. | | Treat. | | Rootst. x Treat. | |
| | 0.15 | | 0.17 | | 0.33 | |
| **Roots 2001** | | | | | | |
| Harmony | 3.74 | 2.40 | 2.47 | 3.16 | 3.39 | 3.03 |
| Dogridge | 1.78 | 2.13 | 1.24 | 1.74 | 1.48 | 1.67 |
| 1103 Paulsen | 3.38 | 2.43 | 1.32 | 3.36 | 3.63 | 2.82 |
| Thompson seedless | 2.19 | 2.12 | 1.86 | 1.90 | 2.15 | 2.04 |
| Average | 2.77 | 2.27 | 1.72 | 2.54 | 2.66 | |
| L.S.D 0.05 | Rootst. | | Treat. | | Rootst. x Treat. | |
| | 0.35 | | 0.39 | | 0.78 | |

As for the effect of rootstocks on leaf non – reducing sugars content, regardless of the effect of salinity treatments, the data in Table (8) indicated that, in the first season, Harmony and Dogridge had significantly higher leaf non - reducing sugars content than 1103 Paulsen and Thompson seedless. Significant difference was also found between 1103 Paulsen and Thompson seedless. In the second season, it was found that Harmony and 1103 Paulsen had significantly higher leaf non- reducing sugars content than Dogridge and Thompson seedless.

Regarding the effect of salinity treatments on root non- reducing sugars content, irrespective the effect of rootstocks, the results in Table (8) revealed that, the untreated plants and those subjected to 1500 ppm sodium chloride had significantly higher root non - reducing sugars content than those treated with either 3000 ppm sodium chloride or 750 ppm sodium carbonate. Downton (1977) and Sourial *et al.*,(1985) reported that salinity led to an increase in root non- reducing sugars. Conversely, Essa (1988) on Roumi Red grape, reported that non- reducing sugars level in plants was decreased under salt stress when compared with the control.

As for the effect of rootstocks on root non-reducing sugars content, regardless of the effect of salinity treatments, the data in Table (8) indicated that, the studied rootstocks could be arranged in the following descending order with respect to root non-reducing sugars content Harmony > 1103 Paulsen > Thompson seedless > Dogridge. Harmony and 1103 Paulsen had significantly higher root non- reducing sugars content than Dogridge and Thompson seedless.

**8. Starch content**

Regarding the effect of salinity treatments on leaf starch content, irrespective the effect of rootstocks, the data in Table (9) indicated that, in the first season, the differences among the studied treatments were not significant. In the second season, the plants treated with 1500 ppm sodium carbonate had significantly higher leaf starch content than those treated with the two sodium chloride concentrations or 750 ppm sodium carbonate. Downton (1977) found that leaf starch content markedly decreased with increasing salinity of irrigation water.

As for the effect of rootstocks on leaf starch content, regardless of the effect of salinity treatments, the results in Table (9) indicated that, there were no significant differences among the studied cultivars, in the first season. However in the second season, the data showed that Dogridge and Thompson seedless had significantly higher leaf starch content than Harmony and 1103 Paulsen. Significant difference was also found between the latter two cultivars.

Concerning the effect of salinity treatments on root starch content, irrespective the effect of rootstocks, the results in Table (9) indicated that, the plants treated with 750 ppm sodium carbonate had significantly higher root starch content than the other treatments. In the meantime, untreated plants had significantly higher root starch value than the rest treatments. Significant difference was also found between 3000 ppm sodium chloride and 1500 ppm sodium carbonate treatments. Youssif (1998) reported that root starch content reduced with salt stress.

As for the effect of rootstocks on root starch content, regardless of the effect of salinity treatments, the data in Table (9) indicated that 1103 Paulsen had significantly higher root starch content than Dogridge and Thompson seedless. The latter two cultivars had significantly higher root starch content than Harmony.

**Table (9): Effect of sodium chloride and sodium carbonate treatments on leaf and root starch content ( % D.W. basis ) of grape rootstocks in 2000 and 2001 seasons.**

| Treatment / Rootstock | Na Cl (ppm) | | $Na_2CO_3$ (ppm) | | Control | Average |
|---|---|---|---|---|---|---|
| | 1500 | 3000 | 750 | 1500 | | |
| **Leaves 2000** | | | | | | |
| Harmony | 10.59 | 10.24 | 10.59 | 10.59 | 10.59 | 10.52 |
| Dogridge | 10.24 | 9.71 | 9.71 | 9.00 | 9.71 | 9.67 |
| 1103 Paulsen | 11.30 | 11.24 | 11.07 | 9.18 | 11.30 | 10.82 |
| Thompson seedless | 9.97 | 10.59 | 9.72 | 11.12 | 9.00 | 10.08 |
| Average | 10.53 | 10.45 | 10.27 | 9.97 | 10.15 | |
| L.S.D 0.05 | Rootst. | | Treat. | | Rootst. x Treat. | |
| | N.S | | N.S | | N.S | |
| **Leaves 2001** | | | | | | |
| Harmony | 10.59 | 11.47 | 11.30 | 11.83 | 10.77 | 11.19 |
| Dogridge | 15.53 | 15.53 | 15.18 | 16.94 | 19.86 | 16.61 |
| 1103 Paulsen | 9.07 | 9.53 | 10.77 | 10.42 | 9.89 | 9.94 |
| Thompson seedless | 15.53 | 16.24 | 13.77 | 18.36 | 14.83 | 15.75 |
| Average | 12.68 | 13.19 | 12.76 | 14.39 | 13.84 | |
| L.S.D 0.05 | Rootst. | | Treat. | | Rootst. x Treat. | |
| | 1.03 | | 1.15 | | 2.31 | |
| **Roots 2001** | | | | | | |
| Harmony | 19.27 | 15.03 | 31.07 | 25.84 | 16.80 | 21.60 |
| Dogridge | 16.80 | 16.38 | 32.76 | 27.04 | 35.48 | 25.69 |
| 1103 Paulsen | 39.89 | 43.25 | 43.43 | 30.89 | 45.90 | 40.67 |
| Thompson seedless | 27.98 | 22.59 | 28.95 | 24.01 | 24.36 | 25.58 |
| Average | 25.99 | 24.31 | 34.05 | 26.95 | 30.64 | |
| L.S.D 0.05 | Rootst. | | Treat. | | Rootst. x Treat. | |
| | 1.62 | | 1.81 | | 3.63 | |

## 9. C/N ratio

Concerning the effect of salinity treatments on leaf C/N ratio, irrespective the effect of rootstocks, the results in Table (10) indicated that, in the first season, the C/N ratio in leaves was not affected by the studied treatments. In the second season, the plants treated with 1500 ppm sodium carbonate had significantly higher leaf C/N ratio than the other treatments. Downton (1985) and Stevens *et al.*, (1996) found that leaf nitrogen content was not affected by rising salinity in the irrigation water. Besides, Abou-Rayya *et al.*, (1988) found that leaf total carbohyrates were not affected by rising salinity up to 2000 ppm.

As for the effect of rootstocks on leaf C/N ratio, regardless of the effect of salinity treatments, the data in Table (10) indicated that, in the first season, 1103 Paulsen had significantly higher leaf C/N ratio than Harmony and Thompson seedless. The latter two rootstocks had significantly higher value than Dogridge. In the second season, Dogridge and Thompson seedless had significantly higher leaf C / N ratio than 1103 Paulsen, which had significantly higher level than Harmony.

Regarding the effect of salinity treatments on root C/N ratio, irrespective the effect of rootstocks, the results in Table (10) indicated that, 750 ppm sodium carbonate treatment had significantly higher value than the other treatments. Significant difference was also found between 750 and 1500 ppm sodium carbonate treatments. In the meantime, the plants treated with the two studied concentrations of sodium chloride had significantly lower root C/N ratio than the control. Gaser (1992) and Youssif (1998) found that root nitrogen and total carbohydrates decreased with rising salinity.

As for the effect of rootstocks on root C/N ratio, regardless of the effect of salinity treatments, the data in Table (10) indicated that the studied rootstocks could be arranged in the following descending order with respect to root C/N ratio 1103 Paulsen > Harmony > Dogridge > Thompson seedless. Significant differences were found among them, except between Harmony and Dogridge.

**Table (10): Effect of sodium chloride and sodium carbonate treatments on leaf and root C/N ratio content of grape rootstocks in 2000 and 2001 seasons.**

| Treatment / Rootstock | Na Cl (ppm) | | $Na_2CO_3$ (ppm) | | Control | Average |
|---|---|---|---|---|---|---|
| | 1500 | 3000 | 750 | 1500 | | |
| **Leaves 2000** | | | | | | |
| Harmony | 8.32 | 6.91 | 8.97 | 8.19 | 6.12 | 7.70 |
| Dogridge | 5.66 | 5.31 | 5.10 | 5.82 | 5.94 | 5.57 |
| 1103 Paulsen | 10.20 | 11.35 | 11.40 | 8.68 | 10.98 | 10.52 |
| Thompson seedless | 8.30 | 6.55 | 6.19 | 8.75 | 6.65 | 7.29 |
| Average | 8.12 | 7.53 | 7.92 | 7.86 | 7.42 | |
| L.S.D 0.05 | Rootst. | | Treat. | | Rootst. x Treat. | |
| | 0.50 | | N.S | | 1.12 | |
| **Leaves 2001** | | | | | | |
| Harmony | 5.70 | 5.91 | 5.50 | 5.90 | 5.70 | 5.74 |
| Dogridge | 9.54 | 8.28 | 9.10 | 10.12 | 11.04 | 9.62 |
| 1103 Paulsen | 6.31 | 6.82 | 8.50 | 8.43 | 7.72 | 7.56 |
| Thompson seedless | 10.71 | 10.10 | 9.39 | 11.35 | 8.57 | 10.02 |
| Average | 8.07 | 7.78 | 8.12 | 8.95 | 8.26 | |
| L.S.D 0.05 | Rootst. | | Treat. | | Rootst. x Treat. | |
| | 0.46 | | 0.51 | | 1.02 | |
| **Roots 2001** | | | | | | |
| Harmony | 21.87 | 17.85 | 36.39 | 32.20 | 22.97 | 26.26 |
| Dogridge | 16.73 | 19.56 | 32.58 | 30.07 | 27.27 | 25.24 |
| 1103 Paulsen | 38.36 | 38.63 | 50.40 | 40.34 | 48.15 | 43.18 |
| Thompson seedless | 22.96 | 18.54 | 23.24 | 22.95 | 18.93 | 21.32 |
| Average | 24.98 | 23.65 | 35.65 | 31.39 | 29.33 | |
| L.S.D 0.05 | Rootst. | | Treat. | | Rootst. x Treat. | |
| | 1.45 | | 1.62 | | 3.25 | |

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J. Agric. Sci. Mansoura Univ., 28(8), August, 2003

# تأثير بعض أملاح الصوديوم على النمو والتركيب المعدنى والمحتوى العضوى لبعض أصول العنب
## ٣- المحتوى العضوى

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أجرى هذا البحث خلال موسمي ٢٠٠٠، ٢٠٠١ بغرض دراسة تاثير ملحي كلوريد الصوديوم وكربونات الصوديوم على المحتوى العضوى لأوراق وجذور اربعة اصناف عنب هي هارموني، ١١٠٣ بولسن ودوج ريدج وطومسون سيدلس والمستخدمة كأصول.

**ويمكن تلخيص النتائج الرئيسية لهذه الدراسة فى النقاط التالية:**

**أ. تأثير المعاملات الملحية**

١- انخفض الكلورفيل الكلي فى الأوراق معنويا بمعاملات كلوريد الصوديوم وكربونات الصوديوم المختلفة مقارنة بالكنترول في كلا الموسمين.

٢- انخفضت الفينولات الكلية فى الأوراق معنويا بالمعاملات الملحية في الموسم الأول بينما ازدادت في الموسم الثاني.

٣- أدى استخدام المعاملتين ٣٠٠٠ جزء في المليون كلوريد صوديوم و ٧٥٠ جزء في المليون كربونات صوديوم إلى انخفاض معنوي في السكريات الكلية للجذر مقارنة بالمعاملات الأخرى.

٤- كانت النباتات المعاملة بـ ١٥٠٠ جزء في المليون كربونات صوديوم اعلى معنويا في محتوى الجذر من السكريات المختزلة مقارنة بباقي المعاملات الأخرى ما عدا الكنترول.

٥- في الموسم الأول لا يوجد فروق معنوية بين المعاملات المدروسة بالنسبة لمحتوى الورقة من النشا أما في الموسم الثاني فقد أدت المعاملة بـ ١٥٠٠ جزء في المليون كربونات صوديوم إلى زيادة معنوية في نشا الورقة مقارنة بباقي المعاملات ما عدا الكنترول. و كانت النباتات المعاملة بـ ٧٥٠ جزء في المليون كربونات صوديوم اعلى معنويا في نشا الجذر مقارنة بباقي المعاملات الأخرى.

٦- لم توجد فروق معنوية بين المعاملات المدروسة في نسبة الكربوهيدرات إلى النيتروجين في الأوراق وذلك فى الموسم الأول. أما في الموسم الثاني فقد أعطت المعاملة بـ ١٥٠٠ جزء في المليون كربونات صوديوم اعلى نسبة كربوهيدرات للنيتروجين في الورقة مقارنة بباقي المعاملات الأخرى. و أدت معاملتى كربونات الصوديوم إلى زيادة معنوية في نسبة الكربوهيدرات إلى النيتروجين في الجذر مقارنة بالكنترول الذي كان اعلى قيمة بصورة معنوية مقارنة بمعاملتى كلوريد الصوديوم.

**ب. تأثير الأصول**

١- في كلا الموسمين كان الأصل طومسون سيدلس اعلى معنويا في محتوى الورقة من السكريات المختزلة واقل في السكريات الغير مختزلة. بينما كانت جذوره اعلى في السكريات المختزلة واقل في نسبة الكربوهيدرات إلى النيتروجين.

٢- كانت أوراق الأصل دوج ريدج اقل معنويا في الفينولات في كلا الموسمين والسكريات المختزلة في الموسم الثاني. أما جذوره فقد احتوت اقل سكريات كلية وغير مختزلة.

٣- احتوت أوراق الأصل الهارموني اعلى سكريات غير مختزلة أما جذوره كانت اعلى معنويا في الفينولات والسكريات الكلية والغير مختزلة واقل في النشا والكربوهيدرات الكلية.

٤- احتوت أوراق الأصل ١١٠٣ بولسن اعلى فينولات بصورة معنوية بينما جذوره كانت اعلى في النشا والكربوهيدرات الكلية ونسبة الكربوهيدرات إلى النيتروجين واقل في الفينولات.