Egypt. J. Agric. Res. , 77 (4) ,1999.



# EFFECT OF GROUND WATER DEPTH AND IRRIGATION WITH SALINE WATER ON SUGAR BEET II: CHEMICAL CONSTITUENTS

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(Manuscript received 20 October 1998)

***Abstract***

The effect of salt concentration in irrigation water (tap water, 2000 and 4000 ppm) and ground water table depth (40, 70 and 100 cm from the surface) with respect to their interaction on chemical composition of sugar beet (Variety; Despres Poly N) were studied.

The results indicated that lowering the ground water table up to 100 cm from the surface significantly increased total soluble solids, sucrose percentage, and potassium concentration in root as well as chlorophyll A and potassium concentration in leaves. Contrarily to this trend was observed regarding sodium concentration of roots and leaves.

Increasing the salt concentration in irrigation water up to 4000 ppm significantly increased total soluble solids in root juice, free proline concentration in leaves and sodium concentration for both leaves and roots. On the other hand, increasing concentration in both roots leaves. While, sucrose percentage, chlorophyll B and carotenoids were not affected by irrigation with saline water up to 4000 ppm.

Interaction effect of ground water depth and irrigation with saline water had no significant effect on all studied constituents of sugar beet.

## INTRODUCTION

In Egypt, the importance of sugar beet comes not only from that it is the second source for sugar production after sugar cane but also for its ability to grow well in the new reclaimed lands, which are usually suffering from salinity and poor quality of the irrigation water in addition to, the high level of water table. The effects of salinity are through osmotic inhibition, reducing nutrients uptake and toxic effect of different ions and it may be resulted a derangement on the normal metabolism of the plants. Wide variation exists between plant species in of irrigation water. For sugar crops, salinity may affect the sugar content directly and may also reduce the sugar recovery in the mill if the concentration of sodium or potassium in the juice is increased (Bernstein *et al* 1966).

Effects of salinity on growth, quality, yield and chemical composition of sugar beet were reported by many investigators such as Yassen et al (1988), Shehata et al (1994) Higazy et al (1995), El-Noemani (1996) and Mostafa (1996). They pointed out that sugar beet varieties differed in their response to salinity level. They indicated also, that grown sugar beet under saline condition resulted a change in chemical composition with noticeable in mineral balance of leaves and root of sugar beet.

Sugar beet growth, root development and nutrient uptake depended on soil conditions, Van De Goor (1979) stated that when the water table of soil is deep, it gaves the roots the opportunity to penetrate where the nutrients are available for absorption. Results of Mohamed et al (1991) and Gaber et al (1991) indicated that all studied traits of sugar beet were significantly affected by excising the water table depth up to 130 cm. Under the middle Delta Sector, El-Wakeel (1993) indicated that the reduction of the root growth, juice quality and the yield of both roots and sugar of sugar beet took place as the level of water table depth was less than 100 cm. Recently, Yacoup and Shehata (1998) reported that the sucrose percentage was highly negative correlated with water table depth, while it was positively correlated at 5% level with salinity of irrigation water.

The effect of ground water table depth and irrigation with saline water on growth and yield of sugar beet (Despres poly N variety) were reported in preceding paper by (Shehata and Yacoub, 1997). Juice quality, photosynthetic pigments, sodium and potassium concentrations as well as free proline level which determined in this paper are therefore in important to evaluate the total effects of ground water table depth and/or irrigation with saline water on sugar beet production.

## MATERIALS AND METHODS

This study was carried out in The Agricultural Research Center, Giza during the two successive seasons 1995/1996 and 1996/1997, to study the effect of ground water table depth, irrigation with saline water and their interaction on chemical composition of sugar beet. The seeds of Despres Poly N variety were sown in garbage plastic buckets 50 cm in diameter and 130 cm in height which filled with soil from the surface layer of Agricultural Research Station Farm. Normal cultural practices were carried out as usual during the two growing seasons.

Karoun Lake water was diluted to reach the concentration of 2000 and 4000 ppm in addition to tap water (260 ppm) as a control were applied regularly and uniformly for irrigation during the whole cropping period, and three water table levels at depth of 40, 70 and 100 cm from the surface were maintained using Piezometers as the method which described by Abd El-Aal (1988).

At harvest time (6 months of age), root and leaves samples of sugar beet plant were taken to determine the following chemical analyses.

- Total soluble solids in root was determined by hand Refractometer and Sucrose percentage by methods of Le Docte, (1927).
- Photosynthetic pigments in leaves (chlorophyll A, B and Carotenoids) according to the method of Wattestein (1957).
- Free proline concentration in leaves was determined using the method of Bates et al (1973).
- Sodium and Potassium concentrations in root and leaves were estimated by the Flame Photometer method (Brown and Lilliand, 1964).

The obtained data were statistically analyzed of factorial experiment in completely randomized design according to Snedecor and Cochran (1967), and the treatment means were compared according to L.S.D. test 0.05 level of probability.

## RESULTS AND DISCUSSION

### Effect of ground water table depth on:

### A. Total Soluble Solids (T.S.S). and Sucrose Percentage.

Data in Table (1) hows that for both seasons a significant reduction could be observed in both TSS and Sucrose percentage at shallow ground water table compared with the deep one. Thus, result of the first season indicated that the total soluble solids were decreased by 3.9% and 5.9% at water table depth of 40 cm and 70 cm from the surface respectively, compared with that of the 100 cm water table depth. the corresponding values were 3.2% and 6.3% for the second growing season.

Sucrose percentage was decreased by 5.1% and 21.9% for the two ground water table levels (70 and 40 cm) releated to that of 100 cm depth in first season. Data of the second season indicated that sucrose percentage of plants grown under 70 cm water table depth was not differed than that grown under 100 cm while at shallow ground water table (40 cm) sucrose percentage significantly decreased by 6.3% compared with other water table depth (100 or 70 cm).

Table 1. The effect of ground water table depth on some chemical constituents of sugar beet.

| Chemical constituents | 1995/1996 | | | | 1996/1997 | | | |
|---|---|---|---|---|---|---|---|---|
| | water table depth (cm) 100 | 70 | 40 | LSD at 0.05 | water table depth (cm) 100 | 70 | 40 | LSD at 0.05 |
| Total soluble solids% | 22.18 | 21.31 | 20.86 | 0.41 | 23.97 | 23.21 | 22.47 | 0.34 |
| Sucrose% | 17.80 | 16.90 | 13.90 | 0.35 | 17.51 | 17.50 | 16.4 | 0.54 |
| Chlorophyll A mg/gdw | 6.24 | 5.14 | 4.40 | 0.62 | 4.44 | 4.28 | 3.51 | 0.22 |
| Chlorophyll B mg/gdw | 2.83 | 2.62 | 2.75 | NS | 2.38 | 2.34 | 2.91 | NS |
| Caroteniod mg/gdw | 3.09 | 3.09 | 3.08 | NS | 3.10 | 3.10 | 3.10 | NS |
| Free proline u mol/gfw | 5.22 | 4.95 | 4.02 | NS | 3.59 | 3.60 | 3.66 | NS |
| Potassum root% | 1.25 | 1.16 | 1.09 | 0.04 | 1.22 | 1.17 | 1.06 | 0.04 |
| Sodium in root% | 0.66 | 0.56 | 0.47 | 0.05 | 0.73 | 0.53 | 0.44 | 0.04 |
| Potassum leaves % | 2.80 | 2.69 | 2.39 | 0.10 | 3.58 | 3.43 | 2.99 | 0.07 |
| Sodium in leaves% | 1.48 | 1.38 | 1.31 | 0.04 | 1.46 | 1.44 | 1.40 | 0.05 |

Table 2. The effect of salinity of irrigation water on some chemical constituents of sugar beet.

| Chemical constituents | 1995/1996 | | | | 1996/1997 | | | |
|---|---|---|---|---|---|---|---|---|
| | Salinity level | | | | Salinity level | | | |
| | Tap water | 2000 ppm | 4000 ppm | LSD at 0.05 | Tap water | 2000 ppm | 4000 ppm | LSD at 0.05 |
| Total soluble solids% | 21.00 | 21.51 | 21.83 | 0.41 | 22.48 | 23.20 | 23.96 | 0.34 |
| Sucrose% | 16.30 | 16.17 | 16.07 | NS | 17.31 | 17.20 | 16.93 | NS |
| Chlorophyll A mg/gdw | 5.90 | 5.16 | 4.63 | 0.62 | 4.63 | 4.24 | 3.36 | 0.22 |
| Chlorophyll B mg/gdw | 2.75 | 2.66 | 2.66 | NS | 2.37 | 2.34 | 2.31 | NS |
| Careteniod mg/gdw | 3.09 | 3.08 | 3.09 | NS | 3.10 | 3.11 | 3.10 | NS |
| Free proline u mol/gfw | 3.64 | 5.02 | 6.37 | 0.30 | 3.35 | 3.61 | 3.90 | 0.09 |
| Potassum in root% | 1.25 | 1.18 | 1.08 | 0.04 | 1.23 | 1.15 | 1.02 | 0.04 |
| Sodium in root% | 0.44 | 0.55 | 0.70 | 0.05 | 0.42 | 0.53 | 0.64 | 0.04 |
| Potassum in leaves % | 2.87 | 2.64 | 2.36 | 0.10 | 3.57 | 3.36 | 3.07 | 0.07 |
| Sodium in leaves% | 1.19 | 1.38 | 1.60 | 0.04 | 1.25 | 1.42 | 1.64 | 0.06 |

comparsion with that of tap water treatment for the first and second growing seasons respectively. While, corresponding increases in TSS were 3.20% and 6.58% under highest salinity level (4000 ppm). Saline irrigation water slightly decreased sucrose percentage of sugar beet root. This decrease did not reach to the significant level for the two growing seasons.

These results are in agreat accordance with those of Higazy et al (1994) and Shehata et al (1995). On the other hand, El-Noemani (1996) found that TSS and sucrose percentage of sugar beet root significantly increased by increasing salt concentration of irrigation water up to 6000 ppm.

## B. Photosynthetic Pigments

Data presented in Table (2) shows that the saline irrigation water caused a significant decrease in chlorophyll A compared to irrigation by tap water. While, chloropyhll B and carotenoids concentration were not significant decrease in chlorophyll A compared to irrigation by tap water. While, chloropyll B and carotenoids concentration were not significantly affected. Similar results were obtained by Shehata (1989). While, Mostafa (1996) and El-Noemani (1996) concluated that all studied photosynthetic pigments i.e. chlorophyll A, B, (A,B). carotenoids, chl A/b and A+B/carotenoids ratio were signficantly decreased by increasing salinity level of irrigation water up to 6000 ppm. They added that sugar beet varieties differed in their response to salinity with respect to the concentration of leaf photosynthetic pigments.

## C. Free Proline concentration:

It is clear from data in Table (2) that increasing salinity level of irrigation water caused a gradual and significant increase in concentration of free proline in sugar beet leaves. In the first season the increase reached to 37.9% and 75% at the 2000 and 4000 ppm as compared with that of control (tap water) respectively. Similar results were obtained for the second seasons.

Under low soil water potential, induced under saline condition, the water uptake was limited, one way to overcome this problem, is by increasing the concentration of cellular osmotic components. If the high salt content of the cells is localized in the vacuole, anther osmotic components would be aaccumulate in the cytoplasm to achive the low osmotic potential of the whole cells. Stewart and Lee (1974) indicated that the proline which increased proportionately faster than other amino acid in plants is considered main one of the substances inducing osmotic adjustment under salinity condition.

These results are in full agreement with those published by many researchers such as Shehata (1989), Higazy et al (1994), El-Noemani (1996) and Mostafa (1996). Who reported that proline concentration was higher in the leaves of all tested varieties of sugar beet under salinity stress. While, the rate of accumulation of free proline varied widely in different varieties of sugar beet grown under the same level of salinity stress. Hansen and Hitz (1982) confirmed that proline is considered as an important amino acid which serves as an osmoprotectant in many plant families.

## D. Potassium, Sodium Concentration

Data of Table (2) indicates that increasing salt concentration of irrigation water significantly decreased K concentration in root and leaves. At higher salinity level (4000 ppm) K concentration in leaves decreased by 17..8% and 14% for the first and second seasons respectively. While, the corresponding values for K-root concentration were 13.6 and 17.1% Salem (1981) elucidated that K-concentration is closely depressed by raising salinity, particular Na+ in the root media because its integers with cation uptake.

Concerning sodium concentration, data in Table (2) clearly indicates that saline irrigation for sugar beet caused a significant increase for sodium concentration in both root and leaves compared to unsaline plants irrigation. In first seasons, sodium concentration in leaves and root of plants irrigated with higher salinity level (4000 ppm) amounted to 1.34 and 1.59 times compared to tap water. Approximatly the same values were obtained for the second season (1.3 for root and 1.52 for leaves). Incresing sodium concentration in both and root of sugar beet with saline irrigation was quite expected, since sodium is the dominant element of salts in saline irrigation water. In this respect, it is worth to mentiond that sodium concentration in sugar beet juice extraction is considere one of the main impurities which decreased as sodium concentration in juice increased, in addition that sodium had highly important role in sugar industry since sugar recovery depends mainly on this term.

These results in agreement with those obtained by Shehata (1989), Shehata et al (1994) and Mostafa (1996). They found that the salinity had a depressive effect on potassium concentration of sugar beet. On the other hand, salinity markedly increased sodium accumulation in root and leaves of sugar beet plant.

### Interaction Effect of water Table Depth and Irrigation with saline water on Sugar Beet.

Statistical analyses of data for the two seasons indicated that the interaction effect between water table depth and salinity level of irrigation water had a insignificant influence on all studied chemical constituent of sugar beet. This may be attributed to that the two factors (ground water table depth and salt concentration of irrigation water) acted indepenently.

From the above mentioned results, it is clearly observed that increasing salt concentration of irrigation water and/or high ground water table depth results a noticeable disturbance in chemical composition of sugar beet which greatly disturbed the metabolic and physiological activities of plants are helpful in understanding why the growth, quality and yield of sugar beet Despres Poly N variety were depressed under such conditions as concluded by Shehata and Yacoub (1997). They mentioned that the all studied criteria of sugar beet growth were significantly decreased at high ground water table depth (40 cm from surface) with high salt concentration of irrigation water (4000 ppm) while the best results were obtained when ground water table depth increased up to 100 cm from surface and irrigation by non saline water.

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# دراسة تأثير عمق مستوى الماء الأرضى مع الرى بماء مالح على بنجر السكر ٢ - التركيب الكيماوى لبنجر السكر

منى مكرم شحاته

معهد بحوث المحاصيل السكرية - مركز البحوث الزراعية - مصر.

أجرى هذا البحث بمزرعة مركز البحوث الزراعية لدراسة تأثير تركيزين لملوحة ماء الرى ٢٠٠٠ - ٤٠٠٠ جزء فى المليون بالاضافة لماء الصنبور كمقارنة وايضا تأثير عمق مستوى الماء الارضى (١٠٠ - ٧٠ - ٤٠ سم من سطح التربة) على التركيب الكيماوى (بعض المكونات الكيميائية) لنبات بنجر السكر صنف ديسبريس بولى N .

تشير النتائج الى ان زيادة عمق مستوى الماء الارضى الى ١٠٠ سم أدى الى زيادة معنوية لنسبة المواد الصلبة الذائبة والنسبة المئوية للسكروز وكلوروفيل أ كذلك تركيز عنصر البوتاسيوم للاوراق والجذور وعلى العكس نقص تركيز عنصر الصوديوم معنويا فى الاوراق والجذور.

كما أدى زيادة تركيز الاملاح لماء الرى حتى ٤٠٠٠ جزء فى المليون الى زيادة معنوية فى نسبة المواد الصلبة الذائبة فى العصير وتركيز البرولين الحر للاوراق وتركيز عنصر الصوديوم فى الاوراق والجذور و على عكس ذلك انخفض معنويا كلوروفيل أ وتركيز البوتاسيوم فى كلا الجذر والاوراق بينما لم يتاثر كل من النسبة المئوية للسكروز وكلوروفيل ب والكاروتينويدات باستخدام الماء المالح فى رى بنجر السكر.

لم يكن للتفاعل المشترك بين مستوى الماء الارضى وتركيز الاملاح لماء الرى تأثير على كل الصفات التى تم دراستها.