Influence of Salt Stress on Some Yield Components and Quality of Sunflower (*Helianthus annuus* L.) Plant

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Abstract: Two pots experiments were conducted during 2006 and 2007 seasons to study the influence of four levels of salinity (325 control, 1000, 2000 and 3000 mgl^{-1}) of sunflower (*Helianthus annuus* L.). Sunflower cultivars viz., Sakha 53 and Giza 102, were grown to maturity in a sandy soil (EC_e 2.1 dSm^{-1}). Raising the level of water salinity reduced the yield parameters including diameter of achene, number of seeds achene^{-1}, weight of 100 seeds, seed yield plant^{-1}, total oil and total protein content plant^{-1}. The differences between the two cultivars were not significant in most yield parameters during the two growing seasons (2006, 2007). However, Sakha 53 cultivar was more tolerant than Giza 102 cultivar. The higher salinity level up to 3000 mgl^{-1}, the severer was its depressive effect on the studied yield components.

Keywords: sunflower cultivars, salt stress, yield components, yield quality, salinity

INTRODUCTION

Sunflower is moderately sensitive to soil salinity, where it can tolerate salinity up to EC equals to1.7 dSm^{-1} (Allen *et al.,* 1998). Sunflower yield was reported to be greatly reduced when plants were grown under salinity conditions (Gaballah *et al.,* 2006). Increasing production of vegetable oils became a dire need in Egypt, especially because our local production will not exceed 150,000 ton in 2010, meanwhile the consumption will reach 820,000 tons (Saudy and El-Metwally, 2009).

Sunflower (*Helianthus annuus* L.), is an important member of the family Asteraceae and is one of the major oilseed crops grown for edible oil in the world. Sunflower seeds contain 40- 50% oil and 23% protein and constitute excellent source of unsaturated fats, crude protein and fiber and important nutrients like vitamin E, selenium, copper, zinc and vitamine B-complex vitamin (AfzaL *et al.,* 2010).

Dry matter yield and protein content in wheat grains were reported to be increased at a soil salinity level of 0.3 % and then decreased with increasing soil salinity up to the level of 0.9% which was depressive. However, the number of grains per spike, the weight of 1000 grains and the efficiency of grain yield production percent were generally decreased with each increase in soil salinity. (Rabie *et al.*, 1985)

Khatoon *et al.* (2000*a*) reported that the seed yield in sunflower has been found to start decreasing at salinity level beyond EC_e 2.5 dSm^{-1} and reach to 30 % losses at EC_e 11.3 dSm^{-1}.

Relative seed yield of sunflower was reported to be unaffected by soil salinity up to 4.8 dSm^{-1}. Each unit increase in salinity above 4.8 dSm^{-1} reduced yield by 5.0% (Francois 1996). Seed yield was significantly reduced by increasing level of salinity up to 14.2 dSm^{-1}. This reduction was attributed primarily to a reduction in seed number per head and secondarily to an inconsistent reduction in seed index (weight of 100 seeds) (Jabeen and Ahmed 2009). Sunflower is classified as moderately tolerant to salinity. Yield reduction was attributed primarily to a reduction in seed number per head. Oil concentration in the seed was relatively unaffected by increased soil salinity up to 10.2 dSm^{-1} (Bajehbaj 2010).

Plant height, leaf number and leaf area of sunflower were found to be decreased with an increment in salinity and had shown a reduction of 22, 9 and 37 %, respectively at EC 10 dSm^{-1} but the response of different sunflower cultivars to salinity varied (Khatoon *et al.,* 2000*b*). Similarly, salinity stress significantly decreased yield and yield component of sunflower. Chartzoulakis (2005) found that salinity stress (50 and 100m*M* NaCl) reduced the fruit weight and oil content in olive.

In the present study, the main objective was to define the influence of salt stress on some yield components including diameter of achene (cm), number of seeds achene^{-1}, weight of 100 seeds (gm) and seed yield plant^{-1} in two cultivars of sunflower plant. Some yield quality parameters were also investigated including seed oil content and protein content as well.

MATERIALS AND METHODS

Two pots experiments were performed, 2006 and 2007 seasons at the Experimental Farm of the Faculty of Agriculture, Suez Canal University, Ismailia. The objective of the study was to detect the effect of four salinity levels on some yield components. Seed yield quality was also studied sunflower cultivars Sakha 53 and Giza 102 were obtained from Oil Crops Institute Research, Agricultural Center Research, Ministry of Agriculture, Giza Egypt.

The soil used was uniformally packed in pots each of 30 cm height and 25 cm diameter at a rate of 15 kg soil pot^{-1} and used as experimental units. The soil in each pot was thoroughly mixed with farm yard manure (FYM) at a rat of 100 g. Sunflower seeds were sown on 15th of April (2006 , 2007) at a rate of 5 seeds pot^{-1}. N-fertilizer was added as ammonium nitrate (33.5 N), at a rate of 10 g pot^{-1} in two equal split dressings, after 15 and 45 days from sowing. All pots received superphosphate (15.5% P_2O_5) at a rate of 5 g pot^{-1}, before sowing. Potassium sulfate (48 % K_2O) was applied at a rate of 5 g pot^{-1} in two equal split dressings after sowing and after 20 days from sowing. The experimental design was a split with three replicates.

Achene yield and yield components (diameter of achene (cm), number of seeds achene^{-1}, weight of 100 seeds (gm) and seed yield plant^{-1}) were recorded. The seeds were analyzed for N content (Winkleman *et al.*, 1986), and oil content was determined by Soxhlet apparatus by taking random seed samples of each treatment and genotype. The protein content was calculated using the relationship: %N x 6.25 = % protein.

Data were statistically analyzed according to procedures outlined by Snedecor and Conchran (1982).

RESULTES AND DISCUSSION

Diameter of Achene:

With concern to plant cultivar, Figure 1 shows that the variance between Sakha 53 cultivar and Giza 102 cultivar in diameter of achene was not significant in both seasons.

Regarding the salinity treatments, the control treatment significantly increased the diameter of achene as compared with the other salinity treatments, but the difference between 1000 and 2000 mg salt^{-1} treatments was not significant in the first season. In the second season the control and 1000 mg salt^{-1} treatments significantly increased the diameter of achene as compared with 2000 or 3000 mg salt^{-1} treatments with significant difference between the last two treatments.

Number of Seeds Achene^{-1}:

In relation to the cultivar action, Figure 1 reveals that the difference between Sakha 53 cultivar and Giza102 cultivar was not significant for the number of seeds achene^{-1} in the first season, but in the second season Sakha 53, significantly excelled the other cultivar. These results are in harmony with those obtained by Rabie *et al.* (1985) with wheat plant. The control and 1000 mgl^{-1} treatments significantly exceeded number of seeds achene^{-1} as compared with 2000 or 3000 mg salt^{-1} treatments with no significant difference between the two last treatments in the first season. However, in the second season, the control treatment significantly increased the number of seeds achene^{-1} as compared with other salinity treatments i.e. 1000, 2000 and 3000 mg salt^{-1}, but the variance between 2000 and 3000 mg salt^{-1} treatments was not significant.

Francois (1996) indicated that the relative sunflower yield reduction was attributed primarily to a reduction in seed number per head.

Weight of 100 Seeds:

Regarding the cultivar effect, It is clearly shown in Figure 2 that the difference between Sakha 53 and Giza102 cultivars in weight of 100 seeds was not significant in both seasons. Similar trends were obtained by Rabie *et al.*, (1985) with wheat plant and Francois (1996) with sunflower.

Respecting the salinity effect, the control and 1000 mgl^{-1} treatments significantly increased the weight of 100 seeds as compared with 2000 and 3000 mgl^{-1} treatments with no significant difference between the last two treatments in the first season. In the second season, similar trend was observed.

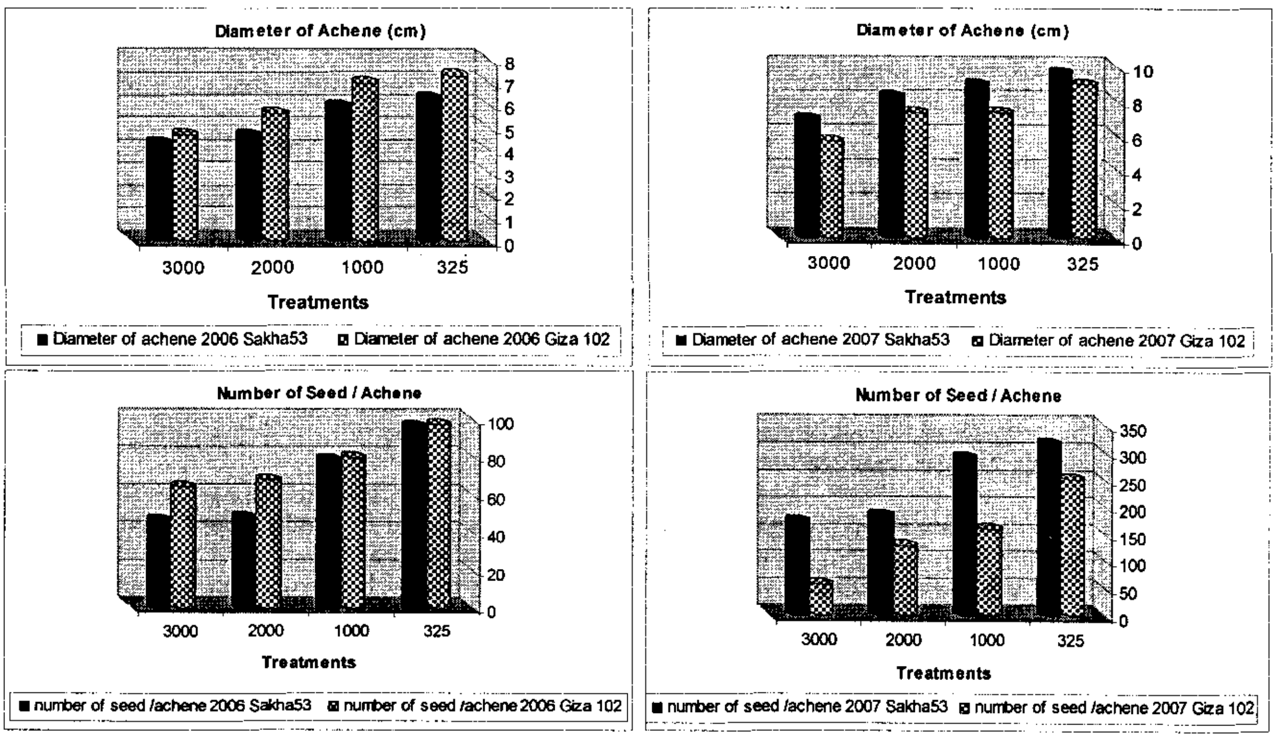

Fig. (1): Influence of irrigation water salinity (mg l^{-1}) on diameter of achene and number of seeds /achene of sunflower plant during 2006 and 2007 seasons.

Seed Yield Plant^{-1}

In relation to the cultivar action, Figure 2 reveals that the variance between Sakha53 cultivar and Giza102 cultivar was not significant for seed yield plant^{-1} in the first season, but in the second season Sakha53 proved to be superior to the other cultivar. Francois (1996) indicated that relative seed yield was unaffected by soil salinity. Each unit increase in salinity reduced sunflower yield.

There were insignificant differences between salinity treatments in the first season. In the second season the control treatment significantly increased seed yield plant^{-1} as compared with the other treatments, but the difference between 1000 and 2000 mgl^{-1} treatments was not significant. Rabie *et al*., (1985) showed that the efficiency of grain yield production percent was generally decreased with each increase in soil salinity.

Khatoon *et al.* (2000*a*) and Khatoon *et al.* (2000*b*) reported that the seed yield of sunflower has been found to start increasing with salinity decreasing.

Total Oil:

In Figure 3 the differences between Sakha 53 cv. and Giza 102 cv. were not significant regarding the total oil in 2006 and 2007 season. The results obtained by Francois (1996) indicated that oil concentration in sunflower seeds was relatively unaffected by increased soil salinity. Chartzoulakis (2005) found that salinity stress reduced the oil content in olive.

The control treatment proved to be significantly superior regarding the oil as compared with the other salinity treatments, but the variance between 1000 and 2000 mgl^{-1} treatments was not significant in 2006 season, but in 2007 season, there was insignificant differences between salinity treatments.

Total Protein:

Concerning the cultivar effect, Figure 3 reveals that the difference between Sakha 53 and Giza102 cultivars was not significant for the total protein in the first season, but in the second season, Giza102 was found to be superior to the other cultivar. Demiral *et al.,* (2005) reported that the declines in protein content in the highest salinity level, may be features of photosynthesis. They added reviewed that reduction in plant growth, suggests lower rates of protein synthesis, possibly accompanied by synthesis of stress-induced proteins in cotton.

The control, 1000 and 2000 mg salt^{-1} significantly exceeded in total protein as compared with 3000 mg salt^{-1} treatment in the first season. In the second season, the control treatment significantly increased total protein as compared with the other salinity treatments, and the differences among 1000, 2000 and 3000 mgl^{-1} treatments were not significant. Goudarzi and Pakniyat (2009) reported that salt tolerant wheat cultivars producing higher protein concentration due to higher efficiency of osmotic regulation mechanism in these plants which in turn causes decreasing sodium toxicity in cytoplasm as compared to susceptible ones and the result was to prevent proteins reduction under salt stress. And showed that salinity tolerances are associated with higher accumulation of wheat protein.

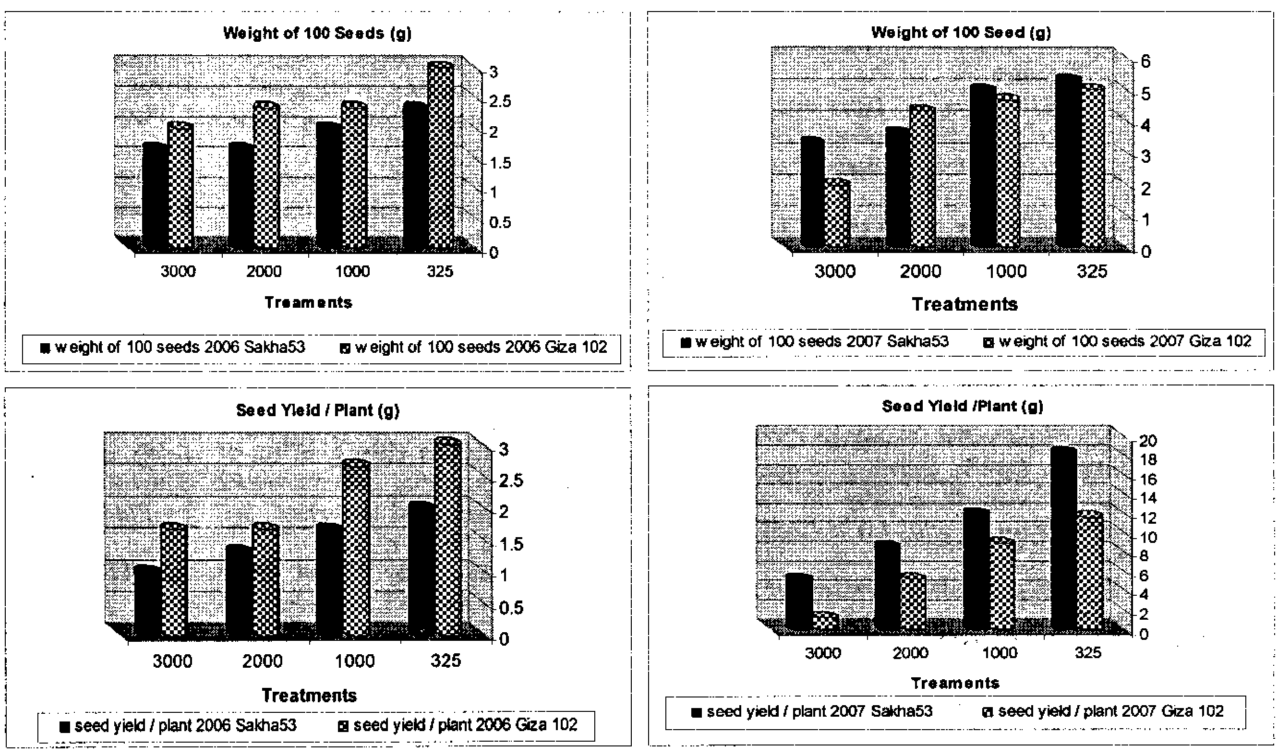

Fig. (2): Influence of irrigation water salinity (mg l^{-1}) on weight of 100 seeds and seed yield / plant of sunflower during 2006 and 2007 seasons.

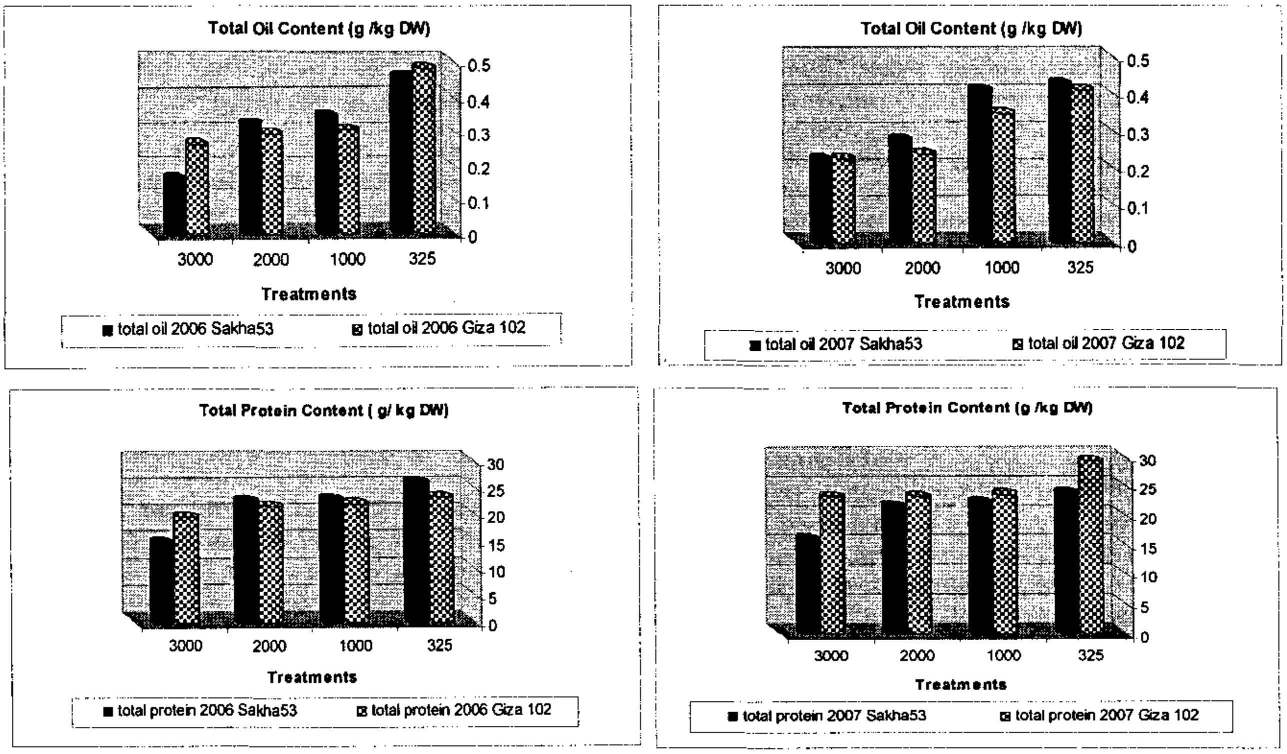

Fig. (3): Influence of irrigation water salinity (mg l^{-1}) on total oil content and total protein content of sunflower plant during 2006 and 2007 seasons.

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تأثير الاجهاد الملحى على بعض مكونات المحصول ونوعيته لنبات عباد الشمس

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اجريت تجربتين اصص خلال موسمى ٢٠٠٦و ٢٠٠٧ لمعرفة لدراسة تأثير اربعة معاملات من مستويات الملوحة (٣٢٥كنترول، ١٠٠٠، ٢٠٠٠ ، ٣٠٠٠ ملجم/لتر) على مكونات محصول عباد الشمس ونوعيته وذلك لصنفين زراعيين هما (سخا٥٣ وجيزة١٠٢) حيث تم زراعتهما في أرض رملية حتي الحصاد وكان صنف سخا ٥٣ أكثر تحملا لظروف الملوحة من جيزة ١٠٢. تسببت المعاملة بمستويات الملوحة المختلفة وخاصة المستوى الاعلى (٣٠٠٠ ملجم / لتر) فى نقص القياسات المحصولية والمتضمنة: قطر النورة- عدد البذور/ النورة- وزن ١٠٠ بذرة- وزن المحصول/ نبات- محتوى الزيت الكلى- محتوى البروتين الكلى. توجد اختلافات ليست معنوية بين الاصناف محل الدراسة فى معظم القياسات المحصولية اثناء موسمين النمو٢٠٠٦ و ٢٠٠٧.ولكن صنف سخا ٥٣ كان اكثر تحملا للظروف البيئية من صنف جيزة ١٠٢.