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# EFFECT OF SALINITY ON GERMINATION AND GROWTH OF ALFALFA, SUNFLOWER AND SORGHUM

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**Abstract**

The effect of different levels of salinities on germination and growth of alfalfa (*Medicago sativa*), sunflower (*Helianthus annuus*) and sorghum (*Sorghum bicolor*) plants was studied. NaCl and $CaCl_2$ (1:1 w/w) @ 1000, 3000, 5000 and 7000 ppm in Hoagland solution were used. During germination stage, sunflower tolerated salinity upto 5000 ppm and alfalfa and sorghum upto 3000 ppm. During growth stage, dry matter, leaf area and pigment fractions in alfalfa and sunflower increased at low levels of salinity but decreased at higher levels. In sorghum plants growth parameters decreased at all the salinity levels.

## Introduction

Saline soils are widespread in many parts of the world. In Saudi Arabia some areas of agricultural land have become saline particularly in situations with inadequate drainage, low rainfall, poor irrigation management and irrigation with saline water. The major inhibitory effect of salinity on plant growth has been attributed to (1) osmotic effects of water availability, (2) the toxic effect of the ions and (3) nutritional imbalance caused by such ions (Gupta, 1977). Adverse effects of salt stress on seed germination, seedling growth as well as some physiological activities of a number of cultivated plant species have been extensively investigated (Zidan, 1979; Shah *et al.*, 1987; Hamada, 1990). Generally, the trends and magnitude of these changes varied according to the level of salinization treatment as well as the plant type used. This variation in plant response and the need to select some of our economic plants for cultivation in saline soils necessitated a series of investigations to test their ability to tolerate salinity.

The aim of the present investigation was to provide information on the effect of salinity on germination and growth of three economic plants under sandy soil conditions.

## Materials and Methods

The effect of salinity on seed germination and growth of alfalfa (*Medicago sativa*), sunflower (*Helianthus annuus*) and sorghum (*Sorghum bicolor*) were studied. Saline solutions containing NaCl and $CaCl_2$ (1:1, w/w) were applied at concentrations of 1000, 3000, 5000 and 7000 ppm in 1/10 strength Hoagland solution (Hoagland & Arnon, 1950). Twenty five seeds of the test species were pretreated with 10% clorox (0.52% sodium hypochlorite) for 4 min and then germinated in Petri dishes at 25°C. Three replicate Petri dishes were prepared from each treatment. Seeds were considered to be germinated after the radicle emerged from the testa.

In another experiment, seeds of alfalfa and sunflower and grains of sorghum were germinated in moist vermiculite until emergence of the primary leaves when equal number of seedlings were transplanted into 30 cm diameter pots, containing 2 Kg air-dried sandy soil (1:1, w/w). The pots were placed in trays containing Hoagland solution. The plants were grown under such control solution for 10 days where the pots in each of the test species were divided into five groups of three pots each. The pots were watered with saline solutions to field capacity twice per week, alternating the appropriate solution with a comparable watering regime. Controlled environment growth chambers were used at 25±2°C (day/night) on a 14-h day, photosynthetic photon-flux density of 600-700 umol $m^{-2}$ $S^{-1}$, and 60-70% R.H. Plants for all the treatments were harvested after 30 days.

Leaf area was measured by portable Area Meter Li-3000. Total photosynthetic pigments were determined colorimetrically (Metzner *et al.*, 1965). Shoots (leaves plus stem) and roots of test species were harvested separately and weighed. They were then oven dried at 70°C to constant weight.

There were 3 replicates of each treatment and the data were statistically analyzed to calculate the least significant difference (L.S.D).

**Table 1. Effect of various levels of saline solution containing NaCl and $CaCl_2$ on the germination of alfalfa, sunflower and sorghum seeds.**

| Saline solution (ppm) | Time (h) 24 | 48 | 72 | 96 |
|---|---|---|---|---|
| | | **Alfalta** | | |
| 0 | 46 | 67 | 100 | 100 |
| 1000 | 46 | 58 | 80* | 100 |
| 3000 | 31* | 56* | 75* | 100 |
| 5000 | 26* | 48* | 68* | 86* |
| 7000 | 23* | 40* | 52* | 67* |
| L.S.D. at 5% | 6.4 | 10.2 | 14.6 | 11.1 |
| | | **Sunflower** | | |
| 0 | 22 | 58 | 91 | 100 |
| 1000 | 18 | 52 | 88 | 100 |
| 3000 | 15* | 48* | 88 | 100 |
| 5000 | 10* | 48* | 87 | 100 |
| 7000 | 8* | 35* | 73* | 85* |
| L.S.D. at 5% | 4.3 | 9.2 | 11.2 | 12.4 |
| | | **Sorghum** | | |
| 0 | 25 | 68 | 100 | 100 |
| 1000 | 25 | 61 | 100 | 100 |
| 3000 | 21* | 55 | 87* | 100 |
| 5000 | 20* | 43* | 60* | 85* |
| 7000 | 12* | 25* | 50* | 63* |
| L.S.D. at 5% | 3.9 | 14.5 | 10.0 | 10.2 |

*Sifnificant differences as compared with control. Data expressed as % of control.

**Table 2. Effect of various levels of saline solution containing NaCl and $CaCl_2$ on dry matter (g/plant) and leaf area ($Cm^3$/plant) of alfalfa, sunflower and sorghum plants.**

| Saline solution (ppm) | Dry matter Shoot | Root | Shoot/root ratio | Leaf area |
|---|---|---|---|---|
| | | **Alfalfa** | | |
| 0 | 0.86 | 0.48 | 1.79 | 12.90 |
| 1000 | 0.98 | 0.63 | 1.86 | 14.14 |
| 3000 | 0.93 | 0.54 | 1.72 | 13.68 |
| 5000 | 0.75* | 0.47 | 1.59* | 10.11 |
| 7000 | 0.63* | 0.42 | 1.50* | 9.22* |
| L.S.D. at 5% | 0.13 | 0.07 | 0.18 | 2.55 |
| | | **Sunflower** | | |
| 0 | 1.60 | 0.87 | 1.83 | 22.2 |
| 1000 | 1.75 | 0.93 | 1.88 | 23.4 |
| 3000 | 1.68 | 0.89 | 1.88 | 24.7 |
| 5000 | 1.41 | 0.80 | 1.76 | 20.9 |
| 7000 | 1.33* | 0.80* | 1.65* | 18.4* |
| L.S.D. at 5% | 0.20 | 0.15 | 0.15 | 4.2 |
| | | **Sorghum** | | |
| 0 | 0.80 | 0.60 | 1.33 | 39.3 |
| 1000 | 0.86 | 0.63 | 1.36 | 41.8 |
| 3000 | 0.70* | 0.51* | 1.37 | 33.7* |
| 5000 | 0.56* | 0.43* | 1.30 | 30.9* |
| 7000 | 0.51* | 0.40* | 1.27 | 21.5* |
| L.S.D. at 5% | 0.08 | 0.05 | 0.11 | 5.3 |

*Significant differences as compared with control.

## Results and Discussion

Final germination of sunflower seeds was found to be unaffected upto 5000 ppm of salinity. In alfalfa and sorghum, no significant effect of salinity was recorded upto 3000 ppm followed by considerable reduction in rate of germination and final germination percentage. Heikal *et al.*, (1982) demonstrated that the decrease in final germination percentage was always associated with a decrease in water absorption. However, Chatterton & Mckell (1969) have shown that salinity may affect germination in at least two ways.

i) by decreasing the rate of water uptake due to osmotic effects.
ii) by the toxic effect of ions of the salinizing agents.

Dry matters of shoot and root decreased significantly in response to salinity (Table 2). Low salinity levels (1000-3000 ppm) stimulated the production of dry matter in alfalfa and sunflower plants (Table 2). In sorghum plants the growth was increased at a salinity

**Table 3. Effect of various levels of saline solution containing NaCl and $CaCl_2$ on chlorophyll, carotenoid and total pigment (mg/g dry weight)**

| Saline solution (ppm) | Chlorophyll a | Chlorophyll b | Carotenoid | Total pigment | Chl.a/b |
|---|---|---|---|---|---|
| | | **Alfalta** | | | |
| 0 | 6.95 | 3.76 | 2.28 | 12.99 | 1.85 |
| 1000 | 7.53 | 3.95 | 2.59* | 14.07 | 1.91 |
| 3000 | 7.15 | 3.86 | 2.39 | 13.40 | 1.85 |
| 5000 | 6.20* | 3.14* | 2.00* | 11.34* | 1.97* |
| 7000 | 5.43* | 2.85* | 1.88* | 10.16* | 1.91 |
| L.S.D. at 5% | 0.72 | 0.51 | 0.25 | 1.30 | 0.07 |
| | | **Sunflower** | | | |
| 0 | 5.95 | 3.31 | 2.15 | 11.31 | 1.80 |
| 1000 | 6.62 | 3.52 | 2.19 | 12.33 | 1.88* |
| 3000 | 6.27 | 3.48 | 2.30 | 12.05 | 1.80 |
| 5000 | 5.84 | 3.10 | 2.10 | 11.04 | 1.88* |
| 7000 | 5.82 | 3.20 | 2.10 | 11.12 | 1.82 |
| L.S.D. at 5% | 0.83 | 0.64 | 0.35 | 1.50 | 0.06 |
| | | **Sorghum** | | | |
| 0 | 5.10 | 2.88 | 1.85 | 9.83 | 1.77 |
| 1000 | 5.53 | 3.05 | 2.13 | 10.61 | 1.81 |
| 3000 | 4.98 | 2.70 | 1.65* | 9.33 | 1.84* |
| 5000 | 4.01* | 2.55* | 1.23* | 7.79* | 1.67* |
| 7000 | 3.67* | 2.30* | 0.95* | 6.92* | 1.59* |
| L.S.D. at 5% | 0.85 | 0.23 | 0.28 | 1.80 | 0.07 |

*Significant differences as compared with control.

level of 1000 ppm alone. Similar effect of salinity on growth have been reported on maize (Lopez, 1972) and barley (Iyenger *et al.*, 1989). Das & Melhrotra (1971) reported that 8000 ppm salinity was critical in some cereals where at 10,000 ppm, the growth of these cereals was completely checked after the addition of a second salt treatment. Dry matter of shoots were more severely affected by salinity as compared to the roots, except in sorghum plants. This can be seen from the reduced values of shoot/root of salinized plants as also reported by Zidan (1979) and Hamada (1990).

The reduction in leaf area (Table 2) of all three plants at high salinity levels (5000 and 7000 ppm) is in accordance with the results obtained by Heikal (1975) where reduction in leaf area of salinized plants has been attributed to suppressed cell division. Similarly Nieman (1965) showed that the salt-stunted bean leaves had smaller leaf area because of fewer cells.

The biosynthesis of pigment fractions (Chlorophyll $\alpha$, chlorophyll ß and carotenoids) was substantially affected with increase in salinity levels (Table 3). Salts in concentrations of 1000 ppm and 3000 ppm had stimulatory effects on the biosynthesis of pigments in sunflower and alfalfa leaves. However, in case of sorghum leaves, level of 1000 ppm had stimulatory effect on pigments biosynthesis. On the other hand, in all the test species pigment fractions decreased at high salinity levels (5000 and 7000 ppm) except in alfalfa at 5000 ppm. Consequently the rate of transformation of chlorophyll $\alpha$ to chlorophyll ß was considerably affected as evident similar to then reported by from the values of a/b ratios (Table 3). These results are generally in accordance with those obtained by other workers including Zidan (1979) and Hamada (1990). Strogonov (1962) proposed that the reduction in pigment content is probably due to the inhibiotry effect of the accumulated ions of various salts on the biosynthesis of the different pigment fractions. From indirect evidence Strogonov *et al.*, (1970) concluded that salinity affects the strength of the forces bringing the complex of pigment protein-lipid, in chloroplast structure. On the bases of the results presented, sunflower plants could be rated as salt-tolerant plants as compared to alfalfa and sorghum.

It may also be concluded that the response of different species to the influence of salts depends on the degree of salt tolerance of these species and on the degree of salinization of substrate.

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