# IMPROVEMENT OF TOMATO PRODUCTION UNDER THE DESERT CONDITIONS

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*By*


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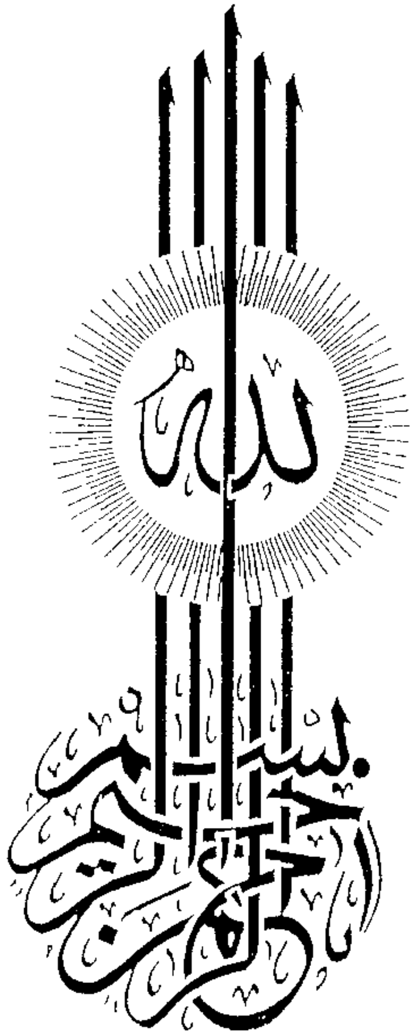
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# CONTENTS

# INTRODUCTION

# 1. INTRODUCTION

Due to the upsurge growth of population, inadequate management of most of inputs, urban encroachment on agricultural land and the consequent consistent decline of food self-sufficiency, development and expansion of irrigated land is a must. However, most of the potentially irrigable soils are mainly of sandy nature. These soils, except few areas, are in deserts and the fringes of Delta and Nile Valley.

The major problems encountered the reclamation and upgrading the productivity of sandy soils are their low intrinsic water-holding capacity, low fertility status and exchange capacity, weak structure and subsequently it is susceptible to wind erosion. Furthermore, the shortage of high quality water and hence the inevitable use of low quality water constitutes substantial constraint to achieving the optimum productivity of desert soils.

Synthetic soil conditioners, especially hydrogels, have been devised as a successful mean for rectifying and optimizing the physical environments of sandy soils towards greater crop production. Nevertheless, this conclusion is mainly arisen from experiments conducted using fresh water. Therefore, in the current work, the retainability and behaviour of two hydrogels namely Evergreen-500 and Broad leaf, in saline solutions were examined. Moreover, the effect of such substances on growth, development, and yield of tomato grown under saline irrigation water was also considered.

# REVIEW OF LITERATURE

# 2. REVIEW OF LITERATURE

It is well accepted that Nile water nowadays is not sufficient to meet the requirement of agricultural expansions in proportion to the immense increase of population. So, the use of marginal quality waters for irrigation is becoming inevitable. This situation has resulted in creation hazardous soil conditions for plant growth. Nevertheless, there are many of management practices that facilitate better and efficient use of such waters for sustainable productivity. These include; **i)** Salinity control within the permissible levels, **ii)** the choice of appropriate crop species and **iii)** optimizing the soil physical environment in order to reduce the stress level on the plant grown under given salinity conditions (**Mashali, 1990**).

In this respect, synthetic soil conditioners have been advocated as a successful mean for improving soil structure, retention and movement of soil water. Moreover, they may encourage germination and root growth. Under such conditions salinity stress could be eliminated and greater crop production could be achieved. Previous studies of the interaction between saline water irrigation and synthetic soil conditioners on soil properties, growth and chemical composition of the plant can be outlined under the following subheadings:

## 2.1. Effect of saline irrigation water on soil properties

The use of saline water for irrigation ensues a change in soil salt content, exchangeable cations, dissolution and precipitation of some chemical components, with consequent impact on soil structure and transmission of fluids in the soil.

**Thorne and Thorne (1954)** and **Kovda (1973)**, showed that the development of soil salinity was closely related to irrigation water salinity.

However, other investigators such as **Fathi *et al.*, (1976)**, **Drenge (1974)**, **Shainberg and Oster (1978)** and **Jurinak (1990)** provided more than one factor influencing salt accumulation in soil upon using poor-quality water for irrigation. These factors include soil properties, amount of irrigation water applied, climate, consumptive use of the growing plants and irrigation frequency.

The effect of specific salt on soil salinity was also evaluated. In this respect, **Golibas *et al.*, (1974)** found that salinity build up steadily increased proportionally to the increase in NaCl and $Na_2SO_4$ concentrations in irrigation water whereas it proceeded slower when irrigation water was rich in $CaCl_2$ and $MgCl_2$.

Concerning the impact of saline water on physical properties of soils, **Abdel Salam *et al.*, (1973)**, **Khalil *et al.*, (1976)** and **Rhoades (1990)** showed that irrigation with water of low salt concentration but contains high proportions of sodium and/or magnesium salts induced the dispersion and slaking of soil structural units with subsequent pore blockage. Such effect results in a low infiltration rate, low permeability of soil to water and air and other severe tilth problems. Similar conclusions have also been reached by **Hadas and Frenkel (1982)**, **Frenkel and Meiri (1985)** and **Jurinak (1990)**.

**2.2. Effect of saline irrigation water on growth and composition of plant.**

The use of low-quality water for irrigation have two types of effects on the growing plants; general effects due to total electrolyte concentration which induces osmotic stress and specific effects due to the individual concentration of specific constituents. These effects could be summarized in the following:

### 2.2.1. Growth and yield of plant

*a) Osmotic effect*

Studies on salt effects which related to total salt concentration in the plant root media showed that these effects are generally evidenced by retarded growth with consequent low yield. In this accord, **Korkor *et al.*, (1974)** found that seed yield of cotton dropped from 2245.1 to 127.2 kg/fed as soil salinity increased from 2.69 to 12 mmhos/cm. Likewise, **Siddique and Kamar (1985)** mentioned that saline irrigation water caused a sharp decrease in the number of flowers, pods and seeds, setting of flowers into pods, 100-seeds weight of peas plants. **Zaghloul (1988)** found that Baccara Rose growth parameters, such as plant height, number of leaves, number of flowers and number of leaves on flower stem as well as fresh and dry weight of different plant organs were decreased as a result of saline irrigation water. He added that all plants irrigated by saline water having 4000 ppm were died during the experiment.

**Gale *et al.*, (1967), Shalhevet and Berstien (1968)** and **Kramer (1969)** have been concurred that the reduction in growth, fresh weight and dry matter production of plants irrigated with saline water is mainly attributed to the decrease in water uptake ensues by the osmotic potential in plant root media. Meanwhile, **Rhoades (1990)** postulated that salt stress increases the energy expended to acquire water and to make adjustments necessary to survive under such conditions.

**Shalhevet and Yaron (1973)** in their study on tomato grown in artificially salinized plots, found that the yield was reduced by 10% for every 1.5 mmhos/cm increase in ECw above 2.0 mmhos/cm. Yield reduction was the same for equal mean of soil salinities regardless of leaching and the rate of salt accumulation in the soil. In the same direction, **Mane and Magger (1986)** and **Martines *et al.*, (1987)** showed that the yield of four tomato hybrids grown under saline conditions was progressively decreased as salinity increased. This decrease was due to the reduction in fruit weight rather than in fruit number.

Several investigators, however, indicated that the effect of salinity may vary with growth stage of plant. Among them, **Shalhevet *et al.*, (1969)** who found that the salt tolerance of peanut during germination was much higher than during the subsequent growth. Nevertheless, **Pasternak *et al.*, (1986)** and **Abu-Awwad and Hill (1991)** pointed out that the yield of tomato irrigated from the beginning with saline water ($EC_w$ = 7.5 ds/m) was reduced by 60% relative to the control. Meanwhile, applying such water at the appearance of eleventh leaf, the reduction of yield was only 30% from the control.

Contradictory findings were arrived at by **Shalhevet and Yaron (1973)** as they pointed out that the salt tolerance of tomato during germination was similar to subsequent growth in the salinity range of their experiment; (EC of irrigation water ranged between 1.6 and 10.2 mmhos/cm).

The influence of irrigation water salinity on water consumption of plants was also considered by many researchers. Among them, **Meiri and Mayer (1970)**, and **Shalhevet and Yaron (1973)** who found that water consumption of plant irrigated with saline water was considerably lower than that of the control plants. They ascribed this behavior to the smaller area and number of leaves per plant and the subsequent lower transpiring area and lower transpiration rate in the salinity-treated plants.

Nevertheless, **Black (1960), Slatyer (1961)** and **Gale *et al.*, (1967)** showed that the reduction in transpiration and water consumption of plants grown under saline conditions are mainly due to the reduction in water content and hence the turgidity of leaf. As a result, stomatal closure, photosynthesis and transpiration would be reduced.

In contrast, **Heller *et al.*, (1973)** studied the effect of irrigation and salinity on ten-year old orange orchard planted in clay soil. They found that salinity had no effect on evapotranspiration, and there was no differences, by commercial standards, in the size of the fruit resulted from various salinity treatments. In the same direction, **Abou-Awwad and Hill (1991)** found that seasonal evapotranspiration of tomato was unaffected by the irrigation water salinity.

***b) Specific ion effect***

According to **Ayers and Westcot (1985)**, specific ion toxicity results when certain ions such as sodium, chloride and boron are taken up with soil water and accumulate in the leaves to an extent that cause damage to plant. The degree of damage depends upon time, concentration, crop sensitivity and crop water use. Likewise, **Lupina (1966 and 1967)** and **Shainberg and Oster (1978)** showed that specific ion toxicity problem is different from salinity problem in that it is not caused by a water shortage. They further added that in case of specific ion toxicity, plant injury may involve injury to plant regulatory system. They believed that Na and/or Cl ions in the leaves of shrubs may affect stomatal closure and thus causing excess water loss.

**Yaron *et al.*, (1969)** pointed out that irrigation with water containing chlorides was more detrimental than with that containing nitrate at the same level of salinity. They also found a slight decrease in stem and leaf growth upon applying water containing chlorides even at 2.0 mmhos/cm total salt concentration. Meanwhile, **Bernstien (1975)** stated that specific ion toxicities are commonly associated with woody species and rarely occur among herbaceous plants. However, some annual crops which are not sensitive to Cl and Na may develop symptoms of leaf burn when sprinkled with brackish waters.

Nevertheless, **Roades (1990)** clarified that the susceptibility to foliar salt injury depends on leaf characteristics and rate of adsorption and is not generally correlated with salinity tolerance. In the same direction, **Heller *et al.*, (1973)** and **Bieloria *et al.*, (1978)** stated that specific toxic effects of Cl and Na were not found with citrus irrigated by water having 17.1 meq/L chloride.

The presence of high concentrations or activities of certain ions, especially sodium and chloride, relative to the others may cause nutritional imbalance in the growth media. In this respect, **Cramer *et al.*, (1988)** and **Lauchli and Epstein (1990)** mentioned that sodium ions have caused disturbance in calcium nutrition, which may adversely affect cell membrane function and hence plant growth. **Aslam *et al.*, (1984)** found that $Cl^-$ and $So_4^=$ diminish the rate of $NO_3^-$ absorption and the degree of inhibition approached 83% at 0.2 M NaCl.

Several workers have agreed that many of trace elements that can be absorbed by plants from soil may accumulate in plant and cause metabolic imbalance. **Page and Change (1990)** stated that many forage crops grown under saline conditions may absorb enough Se and Mo to be toxic to consumers.

### 2.2.2. Chemical composition of plant

As water is removed from the soil via plant uptake and/or evaporation, salt concentration of soil solution within the plant root-zone progressively increases. Consequently osmotic potential of soil water fall. To survive under such higher stress, plant must adjust osmotically upon build up higher internal solute concentrations. This can be achieved by absorption of ions from the medium or synthesis of organic compounds or both, (**Greenway and Munns, 1980**). Likewise, **Munns and Termaat (1986)** pointed out that plant response to saline conditions has several features. Such features embrace regulation of ions concentration in the cytoplasm and, in most cases, the production of carbohydrates to meet the demand of growth and osmotic adaptation.

**Wyn Jones and Gorhams (1983)** explained the mechanisms of plant response to salinity on the basis that salt from the medium apparently serves as an osmoticum in that large fraction of the total cell volume; the vacuole. In the cytoplasm, the function of osmoregulation is served mainly by organic solutes synthesized by the plant. In this context, **Lauchli and Epstein (1990)** mentioned that the glycophytes (non-halophytes) grown in moderate salinity media, tend to exclude salt and to sequester the absorbed ions in their roots and stems. Thus, minimizing the exposure of the leaf cells and hence the photosynthetic apparatus to salt. Consequently they are unable to absorb major quantities of external ions for osmoregulation and must synthesize organic osmolytes.

Regarding the effect of salt stress on chlorophyll content and photosynthesis rate; **Gale *et al.* (1967), Gale and Poljakoff (1970), Joshi (1976), Strack (1975), El-Sayed *et al.* (1988)** and **Sarg (1991)** concluded that salinity causes a pronounced decrease in chlorophyll content with subsequent reduction in photosynthesis efficiency in the leaves as compared to the control.

**Guerri (1985)** in his studies on tomato plant, found an appreciable fall in chlorophyll content with increasing sodium chloride concentration from 0 to 50 mole/m$^3$. Meanwhile, **Sinel Nikova *et al.*, (1988)** demonstrated that chlorophyll a and b as well as total chlorophyll content increased under