# THE ROLE OF ENDOGENOUS GROWTH HORMONES DURING WATER STRESS AND SALINITY STRESS


By

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B.Sc. ( Agric. ) Ain Shams University , 1980


# THESIS

SUBMITTED TO THE

CRADUATE DIVISION

IN PARTIAL FULFILMENT

OF THE REQUIREMENTS

FOR THE DEGREE OF MASTER OF

AGRICULTURAL SCIENCE

IN

Plant Physiology


AIN SHAMS UNIVERSITY

FACULTY OF AGRICULTURE

Dept. of Agricultural Botany

and Plant Pathology


1987

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بسم الله الرحمن الرحيم

# ACKNOWLEDGEMENT

The writer wishes to express his sincere thanks and deep gratitude to Prof. Dr. Aly Raafat Prof. of Plant physiology, Prof. Dr. Hamed M. El-Antably, Prof of plant physiology and Chairman of the Agricultural Botany and Plant Pathology Department and Prof. Dr. Moustafa A. Amer Prof. of Plant Physiology for their supervision and fruitful assistance that made this work possible.

Sincere thanks are also due to Dr. S. A. Habib associate Prof. of Agric. Botany and Dr. M. A. Bondok Lecturer in the same department for their continuous aid at various stages of this research.

Thanks are also extended for all members of the Agric. Botany and Plant Pathology Department for their kindness, cooperation and help during the preparation of this work.

C O N T E N T S

# INTRODUCTION

Both salinity and water deficit (water stress) are related phenomena and represent two of the most important environmental stresses influencing the productivity of agricultural systems around the world.

Drought is an inevitable and recurring feature of world agriculture and, despite our improved ability to predict their onset and modify their impact, drought remains the single most important factor affecting world food security and the condition and stability of the land resource from which that food is derived. The decade of the 1980's, like the 1970's, has begun with drought, but the problem has been more widespread and serious, particularly in the developing world, where drought has hastened the collapse of many fragile and unstable food production systems (McWilliam, 1986).

Salinity, like drought, remains as one of the world's oldest and most serious environmental problems. Mistakes made by the Sumerians in the Tigris and Euphrates basin of Mesopotamia over 4000 years ago are being repeated today in almost every major irrigation development in the world. It is claimed that mismanaged irrigation systems and the resulting salinity is undermining to varying degrees the productivity of at least one-third of $230 \times 10^6$ ha of the world's irrigated land (Reeve and Fireman, 1967). Excessive irrigation and inadequate drainage are the principal causes of this build-up of salinity. Some of the most serious of these problems occur in semi-arid regions associated with the great river systems of Asia, the Tigris and Euphrates, other rivers and associated irrigation systems where salinity is a constant threat include the Colorado in the south-west of the U.S.A., the Nile in Egypt and the Murray Darling catchment in Australia.

The distribution of vegetation over the surface of the earth is controlled by the availability of water more than by any other single factor. Moreover, environmental water deficit reduces plant growth by modifying the physiological processes and conditions which control growth. Plant growth is, therefore controlled by plant water stress (Kramer, 1965) which is caused by either excessive loss of water, inadequate absorption, or both.

Tomato, Lycopersicon esculentum Mill, is one of the most important vegetable crops grown in Egypt. This crop is produced for local consumption as well as for exportation. According to the annual statistical Hand Book of Egypt, (1985) a total area of about 321085 feddans was cultivated by tomato in 1984.

Regarding this fact, this investigation was carried out to study the possible improvement of plant tolerance to water stress and salinity, using foliar application of some plant growth regulators, namely, abscisic acid 'ABA' and

Gibberellic acid "$GA_3$",and to study changes in endogenous gibberellin-like substances inhibitors, auxins and cytokinin activities in relation to plant growth and development parameters for tomato plants subjected to either water stress or salinity conditions.

## REVIEW OF LITERATURE

### 1. Effect of water stress and salinity on plant growth:

#### Effect of water stress:

A large number of studies have been devoted to investigate the harmful effects of water stress on plant growth.

Berényi (1970) reported that earlier irrigation to maintain the soil moisture capacity above 60% reduced the dry matter content of tomatoes cv. Kecskeméti Konzerv, and the differences between the dry matter content of irrigated and unirrigated crops were smaller in 2 wet than in 2 dry years.

Sakr (1972) mentioned that the low water supply (45% of water holding capacity of the soil used) decreased stem height of broad bean plants. However the high water supply (75% WHC) increased this character.

Milovidova (1975) found that tomato plants on plots maintained at 80% field water capacity (FWC) during the growing period yielded appreciably more than plants at 60% FWC. Increasing the FWC from 60 to 70-80% during the 2nd half of the growing period could not compensate, in terms of yield, for the insufficient water supply during the 1st half of the growing period.

Shul'gina and Bondarenko (1977) found that the best results, with regard to the production of standard tomato seedlings, were obtained on straw soil substrate maintained at 55-60% of field capacity. Lowering the moisture level to 40-45% or too high moisture level retarded seedling growth.

Gamayun (1980) obtained maximal leaf and shoot growth in tomato plants cv. Biruintsa irrigated throughout the growing season at 80% field capacity.

El-Saeid (1981) found that the plant height of Phaseolus vulgaris L. was increased as the percentage of field capacity was increased from 54 to 90%.

Dell'Amico and Jerez (1982) found that plant height of tomato plants increased as the level of soil moisture increased.

Abou-Hadid (1984) stated that drought reduced tomato growth gradually. Plants nearly ceased to increase in height under drought.

Taha et al. (1984) found that fresh and dry weight of tomato seedlings were decreased with decreasing the available soil moisture.

Effect of salinity:

It is a general fact that the presence of excessive amount of salt in the soil or root medium than those required for normal plant functions usually results in some decrement in growth.

Bernstein and Pearson (1954) mentioned that tomato plants grown under saline conditions can survive under high osmotic pressure up to 12 atm. for a day or two and that no growth was observed if the osmotic pressure was maintained continuously.

Ashby and Beadle (1957) reported that tomato grew less to much less with added salts.

Shalaby (1970) found that the height of tomato plants (Lycopersicon esculentum) was decreased with increasing NaCl in root medium. Higher levels of NaCl ( 0.15 and 0.20 M) were lethal and survival did not extend more than 6 weeks from salt application.

Uprety and Sarin (1975) reported that the height of pea plants was significantly decreased under saline conditions.

Ahmed (1975) stated that the fresh and dry weights of tomato shoot decreased with increasing NaCl concentration (from 0 to 0.2 M) of the culture solutions.

Moskaleva and Sinel'nikova (1976) added NaCl to the nutrient solution for tomato raised to sand culture and found that salinity reduced seedling growth.

Salama et al. (1981) studied the effect of soil salinity on growth of tomato plants. They found that the 2 higher salinity levels (3 and 7 bars) produced a reduction in growth as compared with the control plants (0.3 bar).

Kwon and Lee (1982) mentioned that seedling growth of Mansudaehyung tomato was inhibited by soaking in 0.5-5.0% salt solutions whereas the growth of Yellow Tiny Tim was promoted by soaking in 0.5 or 1.0% salt solutions.

Hasson and Poljakoff-Mayber (1983) found that shoot growth of pea plants (Pisum sativum L.) was inhibited by salinity treatment (192 mM NaCl).

Papadopoulos and Rendig (1983), using different nutrient saline solutions with electrical conductivities (EC) of 2, 3, 4 or 5 dS/m, found that the shoot weights of tomato plants cv. VF 145 decreased markedly with increasing salinity.

Abdalla (1985) reported that plant height of pea plants was statistically reduced under NaCl or $CaCl_2$ salinity conditions.

Papadopoulos et al. (1985) used the cv. VF 145 of tomato plants to determine the effects of uniform (U) and non-uniform (N-U) salinity distribution on root growth. The plants were grown using a technique by which the root system was divided and each of 4 quadrants was allowed to grow in a separate compartment. Nutrient solutions differing in salinity levels (1, 4, 7 or 10 dS/m; N-U treatment) were applied to the 4 compartments, or all 4 received a nutrient solution otherwise similar but with a salinity of 5.5 dS/m (U treatment). Yields of shoots and roots were lower for plant grown with the U than the N-U treatment. With N-U salt distribution, about 62 and 8% (by weight) of the total root system were found in the compartments irrigated with nutrient solutions having initial salinities of 1 and 10 dS/m, respectively.

## 2. Effect of water stress and salinity on the plant anatomical structures:

### Effect of water stress:

There is a paucity of information on effects of water stress on the internal morphology (anatomy) of plants.

Kramer (1964) reported that water stress can reduce growth directly by reducing cell turgor and interfering with metaoolism and cell enlargement. Also it might reduce growth indirectly by decreasing the synthesis of auxin and slowing down this translocation to the cambium, and by reducing shoot and leaf growth and there by reducing the supply of auxin. However, water stress severe enough to reduce or stop shoot growth probably will also reduce or stop cambial activity at the same time, long before an auxin deficiency could develop. Also the effects of water stress operating through reduced auxin probably occur much more slowly than the direct effects operating through cell turgor. A severe water stress developed rapidly would operate directly, at least at first, while a stress developed slowly over a longer period might operate principally through indirect effects. Separation and evaluation of the relative of direct effects of reduced cell turgor and the indirect effects of reduced auxin supply is difficult.