Effect of soil salinity and mineral nutrition on some physiological aspects in cotton plant

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B. Sc (Agric), Cairo University, 1964

THESIS

Submitted in Partial Fulfilment of the Requirements for the Degree of

Master of Science

in

Plant Physiology

Plant Pathology Department

Faculty of Agriculture

Ain Shams University

1973

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Committee in charge

Date / / 1973

A C K N O W L E D G E M E N T

This investigation was carried out under the supervision of Dr. M. El-Kadi, Professor and Head of the Agricultural Botany Department, Faculty of Agriculture, Shebin-El-Kom and Dr. A.I. Gabr, Associate Professor of Plant Physiology, Faculty of Agriculture, Ain Shams University. The author wishes to express his sincere appreciation and gratitude to them for their fruitful assistance and encouragement throughout this work.

The author is greatly indebted to Dr. A. Raafat, Professor of Plant Physiology, Faculty of Agriculture, Ain Shams University and Dr. M.T. El-Saidi, Research Associate Professor in the National Research Centre, Cairo, for their guidance and kind help that made this work possible.

Thanks are also due to all members of the Botany Department, Faculty of Agriculture, Ain Shams University and the National Research Centre, for their assistance.

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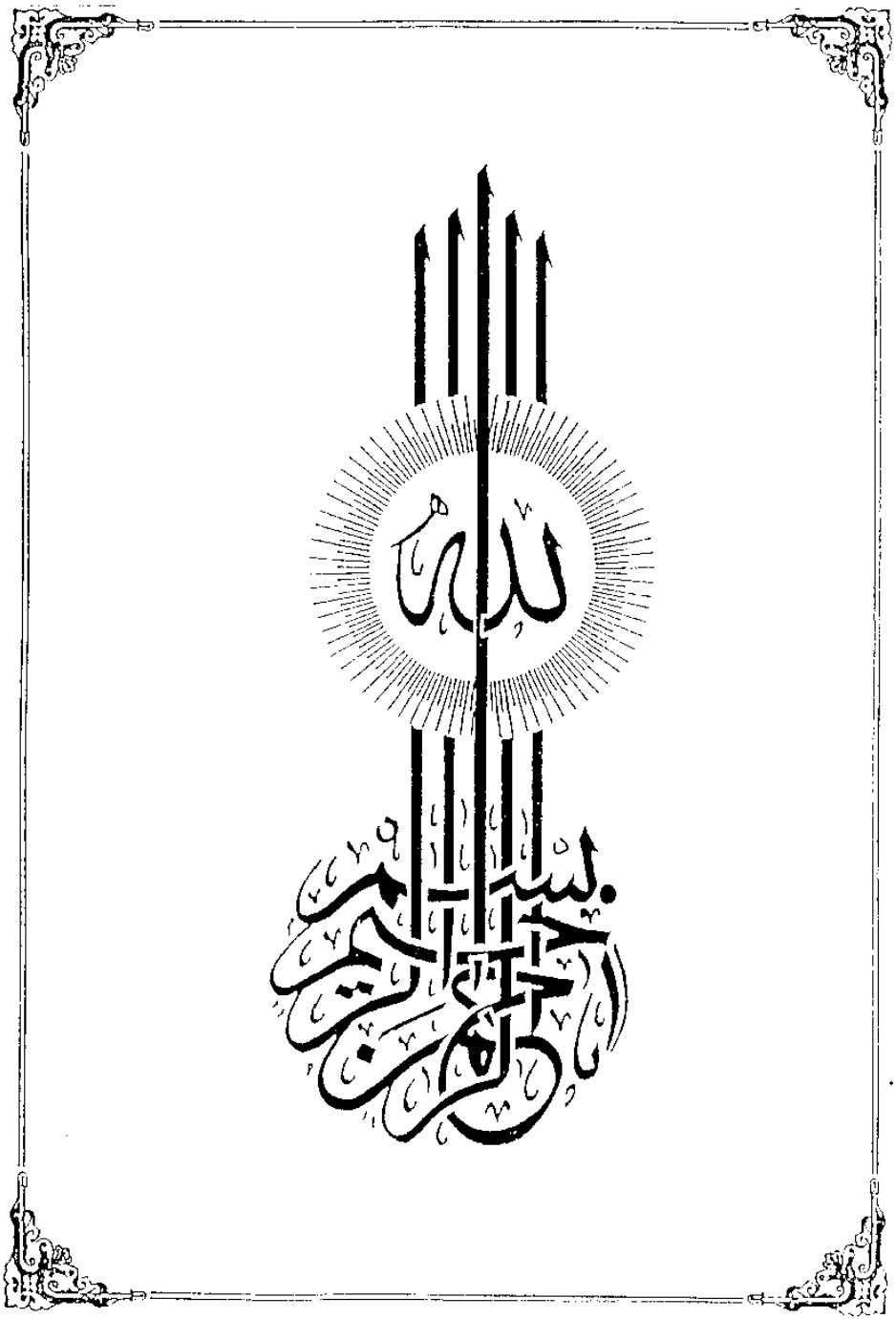

C O N T E N T S

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I. INTRODUCTION

Cotton is one of the most important field crops grown in Egypt. It occupies about one third of the total cultivated area every year. Nowadays, the tendency in our country is to spread irrigated cultivations as well as to cultivate more areas of newly reclaimed lands. It is common knowledge that a potential if not an actual limiting factor for the productivity of irrigated crops, is the excessive accumulation of soluble salts in the rhizosphere. Observations, so far, demonstrated reduction in both quantity and quality of crops grown in saline soils. Under such conditions, the use of special practices to minimize salinity effects is very important.

A possible approach to improve cotton yield under salinity conditions, is through the selection of the proper rate of plant nutrients. One of the facts known in this regard, is that crops which are grown upon salinized soil show a high requirement for nitrogen; the latter is besides readily washed out from such soils when watering is practised. A liberal supply of nitrogen fertilizers under saline conditions, is therefore necessary.

Concerning the combined effect of salinity and nitrogen

fertilization on cotton plants, data available in literature are conspicuously deficient; though it should be recognized that a great deal of investigations has been focused on the effect exerted by the same two factors separately.

This work was designed to investigate the response of cotton plants grown at different salinity levels to various doses of nitrogen fertilizer. As criteria for such response, certain physiological and chemical aspects as well as the yield of plants were studied.

II. REVIEW OF LITERATURE

Literature dealing with the physiological responses of different crops to changes in the level of either salinity or soil nitrogen content are voluminous, but those concerning cotton only will be reviewed herein.

A) Effect of salinity on some physiological and chemical aspects as well as yield in cotton plants :

1- Growth, development and yield :

Eaton (1942) showed that the vegetative growth of cotton plants was reduced relatively more by increased concentrations of chloride and sulphate salts than was yield of seed cotton, but the differences were not great with chloride salts.

Simonsen (1946) carried out some experiments on cotton plants using 3 soil types. Based on 5 years observations, it was concluded that the plants grow normally when the soil content of the soil is < 1.5 g. per kg. (on dry basis). Where the NaCl is extremely high, cotton plants may grow but the plants are very short, have sparse foliage and do not flower.

According to Hayward and Wadleigh (1949), the root elongation of cotton stopped when the total soil moisture stress in a saline soil reached about 15 atm. In addition, it was indicated that there may be differences in the vegetative and fruiting responses of cotton to increased levels of salinity. These differences may be related to variations in water regime, to climatic factors, or to the variety of cotton.

Aleksandrova (1954) showed that, on meadow soils of different degrees of salinity with a high water table, a high degree of salinity decreased yield of cotton and quality of the fibre.

Selman and Rouse (1955), as a result of an experiment carried out on cotton, showed that the addition of Na^+ to the nutrient solution increased early fruiting and boll maturity of plants grown under conditions of poor aeration, but not under conditions of good aeration. Furthermore, it was indicated that early fruiting did not affect the yield.

Shcheryakov (1956) noticed the phenomenon of cotton shalk ringing without human participation on a salty part of the field. Under such conditions, the cotton grew more thinly and was stunted. Some of the cotton plants had dry leaves. The dry plants and

[illegible] swollen. All the affected plants had coloured internodes as well as a weak root system. The saline soil appeared to be a great hindrance to the further development of the root, and it led eventually to the complete destruction of the cotton plant.

Dahnovie (1957) indicated that soil salinity could lead to stunted cotton plants with small leaf surface, short fertile branches and small bolls.

Wahhab et al. (1957) reported that there was an adverse relationship between salinity level and germination percentage of cotton.

Kovalskaia (1958) carried out some experiments on Gossypium plants grown in vessels. It was shown that when sodium chloride was added to the vessels at the early growth stage, the number of bolls was 20% lower than that of the control. The results indicated further that when the salt was given at the budding stage, boll formation was lowered by 64% compared with control. The plants were most sensitive to unfavourable conditions when at the flowering stage, but if the salt was added to the medium gradually, there was little apparent detrimental effect.

Mehta and Desai (1959) conducted some pot experiments

[illegible] species including Gossypium species. [illegible] experiments, the plants were treated with either NaCl or $CaCl_2$. It appeared that for a given salinity, a reduction in yield was greater with NaCl than with $CaCl_2$. It was further concluded that the plants of this species are very tolerant to salts.

Ivanitskaya (1961) showed, by the use of pot experiments, that SO_4 salinity had little effect on the external appearance of plants such as cotton but a corresponding degree of Cl salinity was harmful. In cotton plants, SO_4 salinity produced halo-xeromorphic anatomical characteristics, whereas Cl salinity produced halo-succulent characteristics.

Strogonov et al. (1963), in experiments with cotton plants, showed that the chloride salinity was characterized by a decrease in leaf area and a decrease in the rate of accumulation of dry substances in the root. The same authors concluded that, when using sulphate salinity, an adequate supply of water was obtained by the intensive growth of the root and the development of a water-conducting system of the root and the stem.

Gousnar and Cardenas (1968) showed that the high salinity in a fine sandy loam caused fewer epidermal cells and stomata per unit area of cotton leaves, increased surface area of epidermal cells, and increased leaf thickness.

2- Cell sap concentration and water content :

Strogonov et al. (1956) showed that high salinity reduced the moisture content of the leaves of cotton plants.

Bernstein (1961) indicated that the osmotic pressure of roots and above-ground parts of cotton increases pari passu with increases in the osmotic pressure of the medium over as a wide range of salinity as permits growth.

Strogonov et al. (1963) noticed that, when using sulphate salinity, the cotton plants were characterized by a higher content of mobile and easily exchanged water. However, the plants subjected to chloride salinity had a higher content of water which was exchangeable only with difficulty.

3- Mineral composition :

Mehta and Desai (1959), as a result of experiments carried out on cotton, indicated that the concentration of Ca^{++}, Mg^{++} and Cl increased, while that of potassium decreased upon increasing the concentration of NaCl in the root medium, yet the sum of the cation was particularly unaffected until injury point was recorded.

Strogonov (1962) showed that the relative potassium content in cotton plants was lowered when growing them on a solid substrate. A similar type of effects was exhibited under the same conditions by the total amount of either potassium or phosphorus.

Effect of soil nitrogen level on some physiological and morphological aspects as well as yield in cotton plants :

1- growth, development and yield :

As early as 1915, Balls noticed that lint percentage of cotton was decreased by nitrogen application as a result of increasing the seed weight, without a corresponding increase in the lint weight.

Crowther (1934) showed that nitrogen application to cotton plants increased plant height and number of flowers. The same type of application was further noticed to decrease the lint percentage, but it increased the weight of seeds.

Reynolds et al. (1934) pointed out that nitrogen application increased the number of fruiting branches of cotton. Meanwhile, it had no significant effect on lint percentage.

Wadleigh (1944), in experiments with cotton, showed that the extent of growth of the fruiting branch, and hence the number of fruiting forms that develops, depends upon the supply of nitrogen available to the plant. In plants deprived of adequate nitrogen, he noted a marked decrease in the number of seeds that developed per boll as the fruiting season progressed, with a resulting increase in the number

of aborted embryos, or both. It seems that received adequate nitrogen, a larger number of sound seeds developed per boll. Embryo abortion obviously limits the weight of the seeds and thus affects the boll size. Wadleigh accordingly reported that nitrogen nutrition tends to increase the boll size, and that the average weight of the individual seeds tends to increase as the level of nitrogen rises. He further determined that the length of lint shows a slight tendency to increase with an increase in the level of available nitrogen. On the basis of these findings, Wadleigh concluded that there is a definite relationship between the growth of cotton plants, as indicated by vegetative vigour, and the yield of lint and seed.

Dalton et al. (1949) cited that nitrogen influences both early and late growth rates of the main stalk of cotton plants. It also influences the growth rate of its fruiting branches, the number of flowers per plant, the distribution of flowers in the 2nd to 6th week of the flowering period, the number of bolls per plant, and the yield of seed cotton. However, nitrogen does not influence the stage of development at the time of initiation of fruiting, the percentage of the flowers developing into mature bolls, or the length of the boll maturation period.

Nelson (1943) concluded that the application of

[illegible] cotton plants increased the size and [illegible] However, the same type of application led to a decrease in percentage of lint and oil content of seeds.

El-Gabaly (1952) showed that the nitrogen application increased number of bolls and cotton yield.

Anand and Kalamkar (1954) reported that the yield of cotton was increased by applying ammonium sulphate as a manure, compared with the case of unmanured soil.

Hamilton et al. (1956) showed that the yield of cotton increased linearly with increasing nitrogen and irrigation, particularly nitrogen. Furthermore, it appeared that the highest nitrogen level increased fibre diameter, but otherwise nitrogen did not affect fibre quality.

Scarsbrook et al. (1959) noticed that nitrogen fertilizer increased the height of cotton plants, weight of bolls and weight of seeds.

Abdel Shoeb (1960) carried out some experiments on cotton plants. It was indicated that the plant height became great with adding nitrogen fertilizer. Furthermore, it appeared that the application of nitrogen increased the number of flowers, the lint length and weight of 100 seeds, but it decreased the lint percentage.

Zanati (1961) concluded that the nitrogen applications

decreased the lint percentage of cotton when compared to the unfertilized plots, whereas lint length was not affected.

Dastur and Dabir (1962), in a study with cotton plants, concluded that nitrogen fertilizing increased dry weight of plants, number of bolls per plant, lint index , number of seeds per boll and yield capacity; and it, as well, promoted maturing.

Handi et al. (1962) indicated that the application of 100 - 300 kg./fed. $Ca(NO_3)_2$ to cotton plants increased yields and decreased lint percentage.

Megie (1962) concluded that nitrogen application to cotton plants depressed ginning percentage.

Sallouma (1962) conducted some experiments on cotton plants. The results indicated that there was an increase in seed cotton per plant and seed index with increase in nitrogen supply to plants. Furthermore, it appeared that nitrogen increased the number of bolls per plant; whereas heavy dose of nitrogen depressed the number of bolls. On the other hand, the author concluded that there was no relationship between the amount of nitrogen applied to the plants and the lint percentage.

Mackenzie and Van Schoik (1963) concluded that the application of nitrogen to cotton plants increased plant height and boll size.