# EFFECT OF SOME GROWTH RETARDANTS ON PHYSIOLOGICAL PROCESSES OF SOME PLANTS UNDER DIFFERENT LEVELS OF WATER SUPPLY

By

**SALAH EL-DIN ABDEL-SADEK KANDIL**

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Approved by ______________________

A. T. Gabr

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# I. INTRODUCTION

Cotton and maize, two of the most important field crops grown in A.R.E., are often badly damaged due to exposure to drought conditions. Some growth-retarding chemicals have been tested in the literature to improve drought tolerance of various plants. In this area of research, there are certain reports regarding Cycocel "CCC" (2-chloroethyltrimethyl ammonium chloride), though relatively little attention has been paid to the responses in case of either cotton or maize, that needed much more work. On the other hand, there appeared recently certain information, though scanty and fragmentry, on another substance : Ancymidol "El-531" ($\alpha$-cyclopropyl-$\alpha$-(4-methoxyphenyl)-5-pyrimidinemethanol). The preliminary reports in this regard showed that Ancymidol could modify plant growth. Accordingly, it was hoped that the present investigation could clarify to what extent could this compound as well as CCC be efficient for both cotton and maize to tolerate if grown at soil moisture levels other than the optimal one.

The present work dealt , as well, with changes in certain processes in plants under such conditions. The purpose was to find out which aspect of metabolism could be regarded to be comparatively much more responsible for the changes in drought tolerance in response to the growth substances. Such information might be of certain use in the development of drought-resistant plant strains or management practices to alleviate water stress.

## II. REVIEW OF LITERATURE

The present work is mainly concerned with some effects exhibited due to interactions between irrigation levels and certain growth retardants, namely Ancymidol and CCC on cotton and maize plants. The study of responses to modifying the level of irrigation has covered in literature a wide range of plant genera. In the field of growth retardants, more attention has been paid in literature to CCC rather than to Ancymidol. Hence, it was thought preferable to restrict the present review to maize and/or cotton plants, according to the aspect studied, when dealing with the responses to changes in levels of either irrigation or CCC, but to extend it to cover different plant genera when considering the effects of Ancymidol. Even when regarding the responses to Ancymidol, there is an apparent lack of information in the area of either yield or water relations and biochemical studies, compared with that of growth. Consequently, when presenting the review concerned with the former area, only the studies dealing with CCC were shown.

## 1. Growth and Yield Studies :

### A. Growth Studies :

#### 1. Effects of different water regimes on plant growth :

##### a) Studies on cotton :

As early as 1934, Crowther, on cotton indicated that plant height, number of nodes and internode length increased by increasing the amount of irrigation water. It was reported that the amount of irrigation water was responsible for a considerable variation in the total number of flowers produced by the plant, and the number of flowers per plant increased with heavier application of water. In 1936, he stated that heavier irrigation had no effect on total bolls picked per plant.

Harris and Hawkins (1942) reported that holding the water during the fruiting period of cotton might decrease the vegetative growth and stimulate fruiting.

Bert _et al_. (1955) pointed out that later irrigation of cotton usually causes undesirable vegetative growth.

Scarsbrook _et al_. (1959) showed that plant height of cotton was increased by both nitrogen and irrigation.

Lodging of both main and lateral branches was a serious problem where the highest rates of moisture and nitrogen were used. It was most severe before the bolls opened. The plants tended to straighten up after the bolls began to open.

Abdel-Raheem (1960) indicated that increasing the amount of irrigation water increased significantly the plant height of cotton at the end of the season, number of nodes, length of internode, length of sympodium, number of flowers and number of open bolls per plant.

El-Saidi (1964) found that water deficits in meristematic regions reduced growth in cotton. He indicated that plants which were subjected to only a slight moisture stress failed to attain the amount of growth of the control. In some cases, if plants which suffer from water deficits were not in critical period (flowering and boll formation) they might surpass the control after receiving water. If plants in critical period were exposed to shortage conditions of water supply, the growth would never approach the control levels after recovering from drought.

Bruce and Romkens (1965) cultivated cotton under several regimes of soil moisture stress imposed during three stages of growth. They found that square initiation was directly related to rate of plant height, increased during the four weeks after first flowering which itself was progressively reduced by increasing moisture stress during that period.

Kumar and Raheja (1969) indicated that growth characters of cotton plants (plant height, number of leaves/plant, number of nodes/plant and plant dry matter) were decreased by increase in soil moisture tension.

Raafat _et al_. (1970) studied the effect of different conditions of water supply during different developmental stages on the growth of cotton plants. They reported that water stress at any of the studied developmental stages caused a decrease in plant height, dry weight of stems and leaves. Upon rewatering, the rate of stem elongation generally increased, whereas the dry weight tended to be still decreased in most cases. Excessive irrigation at any developmental stage, except the budding one, caused, in general, an increase in plant height and dry weight of stems. High moisture level at the budding stage, however, decreased the plant height and dry weight of stems. The dry weight of leaves was not markedly affected at any of the studied stages, at conditions of excessive irrigation.

Marani and Amirav (1971) subjected cotton plants to various moisture-stress and irrigation treatments at different stages of development. They noticed that moisture stress at the beginning of flowering reduced growth rate and numbers of flowers and bolls. Moisture stress during the later part of the flowering period reduced percentage of boll retention, boll number and weight. Stress during boll development had similar effects and accelerated maturity.

Klepper et al. (1973) subjected cotton plants 70-day-old to a 26-day drying period. They found that the rate of growth in height and stem diameter decreased greatly after 17 days, although 35 % of the root system was in soil wetter than-1 bar and the plant was absorbing water to a potential of -3 to -5 bars. Initially there were more roots in the upper than in the lower layers of the soil, but roots at the top died and new roots developed at lower levels as drying proceeded.

Silva (1973) showed that drought reduced plant height of cotton, leaf size and number, and doubled the leaf abscission percentage.

Kochetkov (1976), on cotton, reported that soil moisture deficiency inhibited growth and boll weight and increased shedding of squares, flower buds and young bolls; excessive soil moisture also increased physiological shedding.

Moursi *et al*. (1978) indicated that there was a depression in the plant height, number of leaves, branches, number of flowering buds and number of bolls with irrigation of cotton plant after an increasing depression of available moisture of soil. Hence irrigating cotton plants after a depletion of 10 % of available soil moisture in pots produced the tallest plants and the greatest number of vegetative and reproductive parts.

Hussein *et al*. (1980) studied the influence of different irrigation intervals (6, 10, 14 and 18 days) at the beginning of different stages of growth (20, 40, 60 and 80 days after sowing). They reported that decreasing the irrigation interval from 18 to 6 days caused a significant increase in stem height. Irrigation every 14 days increased number of leaves, flowering buds, number of sympodia and bolls per plant as compared with 6, 10 and 18 days irrigation intervals. Increasing the irrigation interval did not affect number of branches per plant. Number of leaves increased significantly as the exposing to water regime started from 20 days after sowing as compared with other stages under study. The highest length of the main stem was obtained when the plants were irrigated every 10 days and the regime beginning 20 days after sowing (after seedling stage). On the other hand, the lowest length of the main stem was obtained when the plants were irrigated every 6 days and the regime beginning at 80 days from sowing (starting of flowering stage).

b) Studies on Maize :

May and Milthorpe (1962) on maize, showed that water stress led to a reduction in total growth of different organs differently. There was normally an increase in the ratio of root to top growth and a decrease in the proportion of lateral roots to total root length. The ratio of leaf to stem was decreased. The growth of organs was influenced during the period of soil water stress in the following order of decreasing severity : Leaves > stems > roots. On restoration of full water supply, the situation was reversed.

Coligado *et al.* (1963) indicated that drought retarded corn growth at the seedling stage but the plants were able to recover as they were given sufficient moisture throughout the growing period.

Rowe and Andrew (1964) subjected corn plants to specific periods of moisture stress early in development, the timing and length of which were based on emerged-leaf number. It appeared that plant height and root weight were reduced by all treatments.

Birke (1965) observed that maize plants at the 3rd leaf stage on loamy sand began to show reduced growth when soil moisture content declined to below 5 % by weight (corresponding to 42 % of the total and 33 % of the available moisture when based on minimum water capacity).

Vaclavik (1968) conducted some experiments in which maize was grown (a) from sowing or (b) from the 4-6-leaf stage, at 30 or 40, 60 and 90 % soil water-retaining capacities. It was revealed that in case of (a) the initial differences in net assimilation rate (NAR) between treatments decreased during growth. On the other hand, in case of (b), NAR fell steadily throughout growth, with no marked differences in NAR between plants at the 2 highest moisture levels. However, in case of the plants grown at the 40 % moisture level, NAR was initially fairly low and began to rise steeply for 7 days at the 4-6-leaf stage. It then declined, but remained higher than that of plants in the moisture treatments. It was considered that adaptive changes had occurred on photosynthetic tissue when plants had been subjected to moisture stress from sowing, whereas when stress was imposed later, the changes which occurred were the direct result of tissue dehydration.

Classen and Shaw (1970) grew maize plants in large buried containers and subjected them to a 4-day period of water stress at 9 different times in the season. Each component of vegetative growth was significantly influenced by one or more of the stress periods. Maximum reductions of 15-17 % in total vegetative dry matter production resulted from water deficits at 3 weeks before 75 % silking. Significant increases in stem weight followed stress at the late silking and very early ear stage.

El-Zeiny (1972) subjected maize plants grown in pots to moisture stress during different developmental stages. He noticed that all treatments that received a special water regime showed lower values for plant height, average number of green leaves per plant and dry weight of either stem and leaves than in case of normal water supply.

Soriano and Ginzo (1975) found that dry matter of maize was directly related to leaf water potential in plants subjected to stress for 0, 3 or 5 days.

Bruyn and Human (1976), with maize, showed that water stress during the first 54 days after sowing had the greatest effect on vegetative growth.

Hussein *et al.* (1980), in experiment on maize, noticed that leaf area was reduced significantly as drought increased. The plant heights decrease, however, was not significant. On the other hand, water stress did not affect dry matter of both stems and roots.

2. Effects of Ancymidol and CCC on plant growth :

1. Effects of Ancymidol on plant growth :

Leopold (1971) observed that the dwarfing effects of EL-531 (Ancymidol) on plants are generally overcome by the application of GA; this effect is illustrated with corn seedlings grown in the greenhouse, where seed treatment with talc powder containing 1 % EL-531 (Ancymidol) produced dwarf corn plants, and weekly applications of 0.2 ml of 0.1 mM GA completely restored the corn plants to normal growth.