MORPHOLOGICAL AND PHYSIOLOGICAL CHANGES DURING DROUGHT IN CRITICAL PERIODS & THEIR EFFECTS ON MAIZE YIELD

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C O N T E N T S

I. INTRODUCTION

Water plays a vital role in modern agriculture. It is essential to ration the use of land and water resources.

Yield potential is a complex phenomena which is governed by edaphic, climatic factors, crop characteristics, irrigation management and other agricultural practices. Water stress could be created by either water deficit 'through skipping an irrigation'; shortage of available water supply and/or presence of soluble salt (s).

The need to study soil moisture stress on cereals particularly maize as one of the most important cereal crop, in Egypt, is of great importance. Recently, the formidable problematic features faced the agricultural development are confined with the efficient use of arable lands and the water resources. In this concern, studies on plant adaptation to the stress causes by shortage of available soil water should be encouraged.

In Egypt maize plant subjected to drought stress during different stages of growth as a result of distinguished system of irrigation and/or lacking of water at the end of canals of irrigation during summer season.

It is of interest to find out the best way of increasing productivety of maize by water management as well as exposing grains to γ-rays to eliminate the effect of soil moisture stress.

Therefore this study was performed to investigate the mechanism of environmental stress on the morphology, physiology, yield and yield components of maize.

II. REVIEW OF LITERATURE

This study could be divided into two groups, the first one concerns the effect of water stress and the second concerns the effect of gamma rays on the different characters of maize.

I. Effect of water stress:

A- On yield and yield components:

B- On growth

C- On physiological characters (Water status, osmotic pressure of cell sap and net assimilation rate).

D- On chemical contents (Sugar content, pigments content and mineral content).

E- Water use efficiency.

II. Effect of gamma rays

A- On yield and yield components

B- On growth

C- On chemical contents (sugar content-pigments content-mineral content).

I.A. Effect of water stress on yield and yield components:

It is well known that the final yield of a crop is the integrated result of a number of interrelated effects on different physiological processes. Wáter stress can affect the processes of photosynthesis and respiration; it can affect growth, which provides synthetic tissue; and it can affect reproduction, which provides the sink for the storage of photosynthates.

The influence of water stress on yield and its components can be quite marked and it is greatly affected by the time at which a plant was stressed. In other words, in determinate species such as corn there is some evidence for a marked critical period. Miller and Duley (1925) were the first investigators studying the effects of soil moisture stress at different growth stages of maize. They found that the greatest reduction in yield of ears was due to moisture stress during the third 30-days period after tasseling; early moisture stress had no effect on yield. In this respect, the effect of moisture stress on vegetative growth and grain yield in corn (Zea mays L.) depends on the degree of stress and on the stage of growth at which stress occurs (Samerhalder, 1962) and (Sionit and Kramer,1977). Stress in corn during silking stage was more harmful to grain yield than stress during any other growth stage (Denmead and Shaw, 1960). In addition, (Gardner, et al., 1981) reported that yield reduction was greatest when stress occurred during the pollination or grain filling periods. They also added, stress during vegetative growth stage only had the least damaging effects on yield while stress during both the grain filling and pollination stages had the greatest limiting effect on yield.

Data of (Denmead and Shaw 1960; Miller and Duley 1925, and Robins and Domingo 1953), have shown the tasseling-silking period to be most critical. According to (Robins and Domingo 1953) depletion of moisture to the wilting percentage for one to two days during the tasseling period resulted in grain yield reduction as much as a 22%; depletion to the wilting point for 6 to 8 days gave a yield reduction of about 50%. Similarly, (Denmead and Shaw 1960), under field trials, noted that stress induced 51% reduction. The stress periods in their investigation, were obtained by 2 or 3 wetting-drying cycles equivalent to about 7 days of stress. The 25% reduction resulting from stress imposed during the vegetative growth stage and they attributed such reduction to a direct reduction in leaf area. Although stress during ear formation resulted in 21% reduction, it was largely due to a reduction in the photosynthate produced.

A significant grain yield reduction (12-15%) was observed after stress during the vegetative period at early ear shoot and ovule development in 1966 growing season; a 23% grain yield reduction was associated with stress at 75% silking in 1965 season(Claassen and Shaw 1970). They also noted that in the 3rd week period after silking, water deficits consistently reduced yield approximately 30% in both years. In addition, significant reductions in kernel numbers were associated with yield reductions from stress before or during silking and pollination; besides kernel weights were signfficantly reduced by stress during or after silking. On the other side, studies carried out by the same outhers, indicated that the 4-days stress during vegetative growth did not influence leaf area development enough to reduce significantly subsequent grain yield. However, stress imposed during vegetative growth of corn influenced yield by reducing the active leaf area of the plants (Denmead and Shaw, 1960).

A highly significant yield reduction was obtained when the available soil moisture was depleted about 20 days earlier or about four weeks after tasseling (Robins and Domingo, 1953). They also came to the conclusion that the duration of such water deficit and the time at which such water deficit occurs are also of great importance. They also attributed the yield reduction, was due in part, to a reduction in fertilization and in part to reduced ear size. Severe early drought resulted in stunted size and delayed silking with many partially or completely barren plants. However, drought following fertilization was observed to shorten the ears by drying back from the tip and to reduce the kernel size due to destruction of productive tissue (Kiesselbach 1950). Imposing water stress prier to tassel emergence, i.e., the period prior to tassling that male meiosis occurs, reduced grain yield and the reduction in the yield may be due to the disruption of pollen formation and induced male sterility (Denmead and Shaw, 1960).

Mass and Downey (1971) found that water stress severely reduced the number of grains per cob and as a consequence of this the total grain weight was also much less. Irrigation maize plants after depletion of increasing amounts of available water decreased the ears and straw yield and sink capacity, i.e., ear weight, ear length, ear diameter, weight of 100 kernels and number of kernels per row (Ashoub, 1977). Exposing wheat plants to high moisture stress depressed the number of spikes per plant, number of spikelets per the main spike, number of grains per the main spike, total number of florets per the main spike, fertility %, 1000 kernels weight, grain yield and straw yield (Moursi et al., 1983c).

Crop salt tolerance has usually been established as the yield decrease produced by a given level of soluble salts in the root medium as compared with yield under non-saline conditions (Allison, 1964) and (Bernstein, 1974). Salinity causes the plant to developless, thus significantly affecting its yield (Maas and Hoffman,1977) (Mercado, 1970) and (Patel and Wallace, 1976). Grain yield and straw yield of wheat and barley were significantly dropped with increasing salt concentrations of irrigation water (Soliman et al., 1978).

I.B. Effect of water stress on growth:

Deleterious effect of water stress on plant growth have been reported by several investigators. In this respect, water stress could affect one or more of the following parameters which in turn affect plant growth and development:

a) Decreased photosynthesis (Brix, 1962 and Hsiao 1973).

b) Decreased turgor which inhibitis cell expansion or cell enlargement (Ordin, 1960 and Boyer,1968).

c) Effects of water stress on metabolism (Barnett and Naylor 1966).

d) Inhibition of floral induction (Aspinall and Husain, 1970).

e) Inhibition of gametogenesis in cereals (Skazkin and Lukomskaya, 1962).

Regarding turgor, it is worthy to mention that