STUDIES IN THE WATER RELATIONS AND STOMATAL BEHAVIOUR OF SOME CROP PLANTS AND THE EFFECTS OF SOME CHEMICAL TREATMENTS

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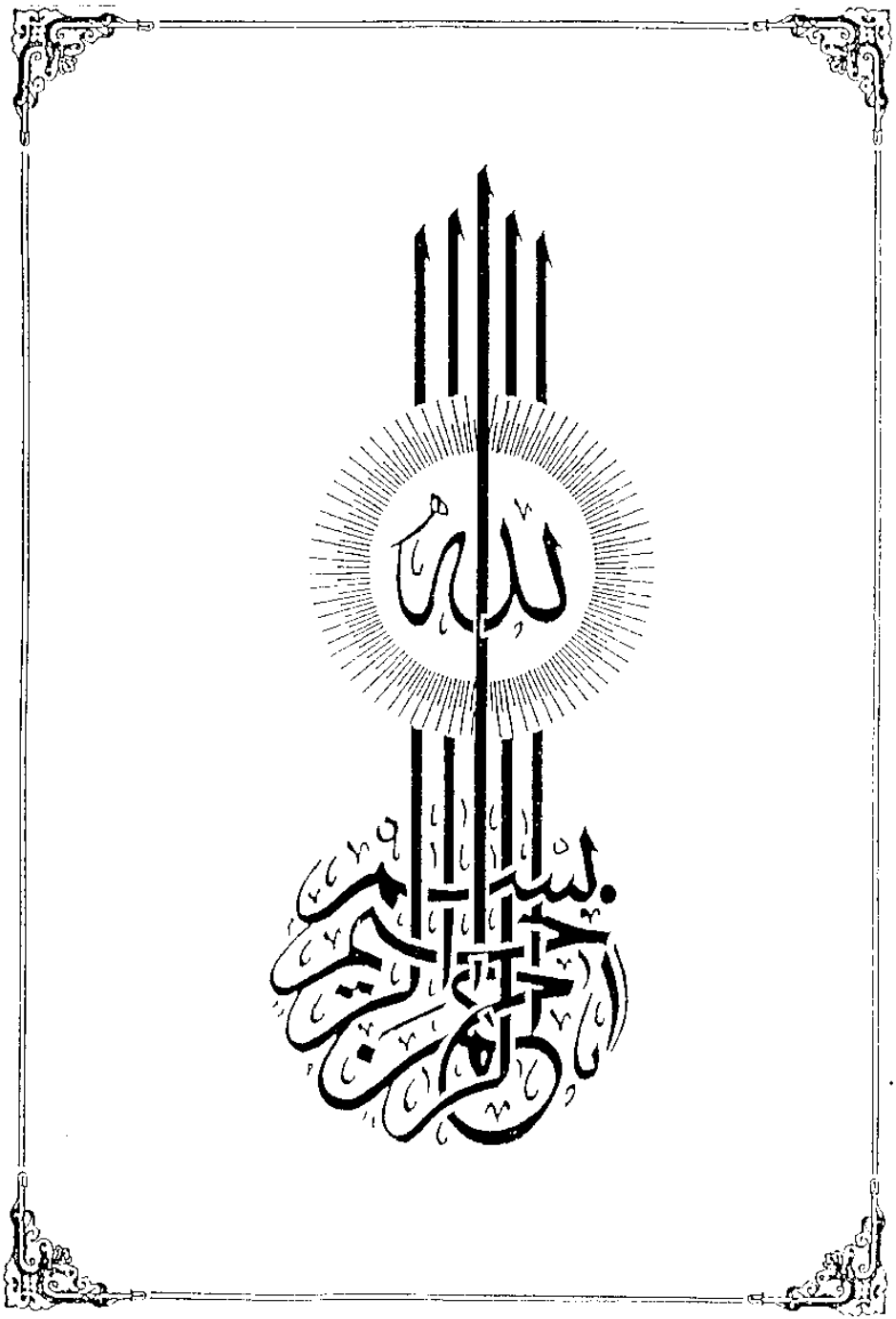

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Contents

INTRODUCTION

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Measurement of soil moisture has long been a usual routine in water relations studies of plant and soil. Soil samples taken to estimate soil moisture conditions represent an instantaneous measurement of a system that is continually changing in three dimentional space and time (Taylor, Evans and Kemper, 1961). Preferably soil water is evaluated in terms of soil water tension or soil water potential which presents the energy gradients of moisture in soil. Dependence of soil water potential upon the water content is expressed in the retention or release curve.

A physiological approach of evaluation of water conditions in soil could be achieved by determination of stomatal movements in the plant. It has been reported that stomata close under the influence of soil water stresses when their water balance becomes negative stomatal closure under conditions of moisture deficits has been recorded by many investigators, of whom may be mentioned, Hammouda (1954), Oppenheimer and Elze (1941), and Heath (1959).

Alvim (1965) has introduced a new type of porometer which proved suitable and practical for field studies. One of the aims of the present investigation is to elucidate stomatal behaviour responses to water stresses in some crop plants i.e. cotton, maize, broad beans and wheat, under field conditions in Egypt taking advantage of Alvim's porometer It will be realized that this new type of porometer could be adjusted to the tested plants and satisfactorily adopted to indicate irrigation need in the different crop plants. As a result of progressive drying of the soil, there occures a decline in plant water potential. Stomatal control of transpiration leads to a diurnal pattern of change in the internal water deficit. Under extreme conditions of high evaporation or reduced water supply, steepeness of the water potential gradient through the plant is associated with a reduction of the water potential of the leaf to a value inducing a further degree of stomatal closure.

In the present investigation some trials on the effects of certain chemicals on stomatal aperture have been made.

Concerning the effects of natural growth regulators on plant transpiration and stomatal behaviour there were

also some studies by some investigators for example, Player (1950) who found that sprays of IAA reduced the transpiration rate of Castor bean plants. Sitnikova (1966) studied the effects of spraying plants with G.A, IAA and mixtures of both, and Allerup (1964) has stated that adding 10^{-3}M concentration of IAA resulted in almost immediate transient increases in transpiration. Crafts and Yamaguchi (1960), Kozinka (1967), Friesen and Dew (1967) tried the effect of 2 methoxy-3,6-dichloro benzoic acid. TIBA (tri-iodobenzoic acid) which seems to be scarcely tested by other investigators was tried in the present investigation.

In recent years, the effects of some herbicides, plant hormones and other chemical substances on stomatal aperture and transpiration have received an increasing amount of interest and are now becoming a subject of wide interest and discussion among several investigators. In the present investigation the effects on stomatal behaviour of certain growth regulators, IAA, TIBA, and certain herbicides, 2, 4:D amine, dalapon, eptam, linuron, simazine, and treflan were elucidated.

2,4,D a selective post-emergence herbicide used in cereals had been tried by some investigators among them may be mentioned Brown (1946) who reported a reduced transpiration rate in beans treated with 0.1%, Ferri and Lex (1948) who reported stomatal closure in Tropaeolum majus after application of 2,4:D and Player (1950) who found transpiration reduction in Castor bean plants. Bradbury and Ennis (1952) reported stomatal closure by 2,4:D on both root and leaf application. Kasperik (1955) found that sensitive plants to 2,4:D as Vicia faba or Sinapis alba showed greatly reduced transpiration, the hormone interfering with stomatal mechanism while no change in transpiration was found in the resistant plant Avena sativa.

Rao and Soundarapandion (1963) applying 2,4:D at 1.3 gm/pot as a foliage Spray to Trianthema portulacastrum found that the treated plants showed a uniformly higher rate of transpiration, also it was found that the gross amount of water transpired by the treated plants was also much higher compared with untreated plants. Gill (1968) postulated that 2,4:D enhanced transpiration at 5 p.p.m. but caused a significant reduction at 500 p.p.m.
Also it had been reported by Wiese, Army and Thormas (1966) that nonlethal dosages of 2,4:D reduced transpiration

rapidly. Striking reduction in transpiration intensity has been also reported in 4 to 5 week old pea seedlings following the application of 10^{-2} M 2,4:D, (Kozinka V, 1966). Morariu and Parascan (1962) found that 2,4,D reduced the transpiration of 2 year old seedlings of Pinus nigra. Smith and Buchholtz (1964) postulated that the main effect of 2,4:D was most likely upon stomata. The effect of 2,4:D has been also pointed out by Mansfield (1967) and Ebert and Muller (1968).

The effect of dalapon on plant transpiration and stomatal aperture has been dealt with by some investigators, for example, Funderburk and Davis (1960), Crafts (1961) and Aberg, Borje and Johanson (1966). The last authors studying the effects of dalapon on the roots of young wheat plants and on the apical bud of cucumber seedlings found that, even when applied to the roots, dalapon first affects shoot growth of wheat plants. Wiese, Army and Thormas (1966) postulated that lethal dosages of dalapon reduced transpiration rapidly.

The effect of simazine and its analoges, commonly used as pre-emergence herbicides in maize, on stomatal behaviour was dealt with by a number of investigators

among whom are Mashtakov and Prokhorchik (1962) and Hilton et al, (1963). Atrazine had been reported to reduce the transpiration rate of tolerant and susceptible plants (Smith and Buchhaltz 1962). Gill (1968) postulated that aqueous solutions of atrazine at 5, 50 and 500 p.p.m. applied to roots reduced the transpiration rate of Cyperus esculuntus. Smith and Buchholtz (1964) stated that chlorosubstituted triazine herbicides reduced the transpiration rate, and that theapplication of Simazine 300 mg/l plus wetting agent resulted in a distinct reduction in transpiration. Recently decreased transpiration rate, caused by a simazine-induced partial closure of the stomata has been reported by Lund-Höle (1969).

In the present investigation the effect of eptam, a selective highly mobile herbicide, was tried. Sivadjian (1967) observed that the application of a 1% solution of sod. dimethyldithiocarbamate to both surfaces of a primary leaf of Phaseolus vulgaris reduced transpiration as compared to that of the opposite leaf treated with pure water and Gill (1968) noted that treatment of maize at the 3-4 leaf stage with eptam at .75 and 1.5 p.p.m. for a period of 2 weeks significantly inhibited shoot growth. Thorn and Minshall (1964) studied the effects of sod. dimethyldithiocarbamate applied to the roots of tomate and bean

plants on transpiration and stomata, and found that it markedly decreased the rate of transpiration and prevents stomatal opening.

The effect of Linuron on transpiration was noted by Freed (1952) who proposed that similar compounds - substituted ureas-affect nitrogen metabolism. Also it was reported by, (Wessles and Van der veen 1956) that photosynthesis in monuron-sprayed plants is rapidly inhibited. Minshall (1960) found that monuron reduced the transpiration rate to less than 50% that of the controls when applied at 48 ug/g fresh leaf and an internal concentration of 1-2 and 5-10 mg monuron/gm of leaf produced an increase in loss of water. Don Smith and Buchholtz (1964) found a depression in transpiration rate in Linuron treated plants, tomato and cucumber relative to the control.

The effect of treflan (trifluralin) which is a rather more recent selective herbicide used for the first time in early sixties on plant transpiration and stomatal behaviour, seems to have been untried by investigators elsewhere. In the present investigation its effect was elucidated being used as root or leaf treatment.

Recently studies have been carried out dealing with the effect of phenyl mercuric acetate on stomatal aperture or plant transpiration e.g. Smith and Buchholtz (1962). Shimshi (1963) stated that stomatal closure induced by phenyl mercuric acetate (PMA) significantly reduced transpiration while it reduced photosynthesis considerably less. Other investigations were made e.g. Slatyer and Bierhuizen (1964), Zelitch and Waggoner (1966), Sivadjian (1967) and Mansfield (1967).

In the present study the effect of cerotan (methoxyethyl mercury chloride), a mercuric fungicide of common use for seed treatments, has been investigated.

The chemicals dealt with in this present study are thus varied and comprised IAA, TIBA, which are growth regulators 2,4,D amine a herbicidal auxin, dalapon, eptam, treflan, simazine and linuron which are selective herbicides and cerotan a mercuric fungicide usually used in cultivation.

The presented section of study of effect of chemicals on stomatal behaviour consisted mainly of pot triales of foliage spray or root applications. The obtained results have led to field experimentation on two selected chemicals