Genetical and Physiological studies on the nature of salt tolerance in Some strawberry cultivers

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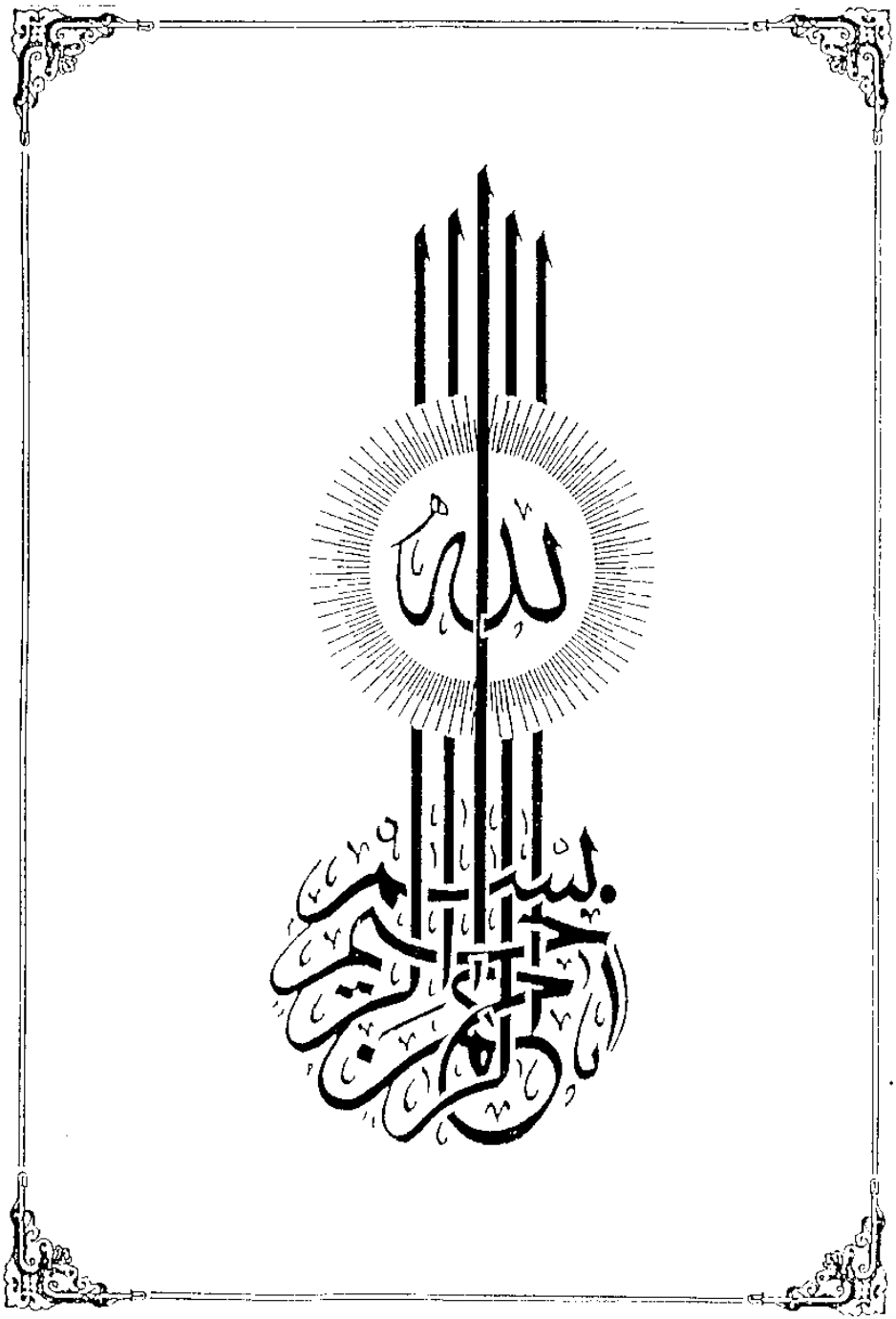

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INTRODUCTION

Strawberry is one of the declined vegetable crops in Egypt especially when compared with production in other contries. Although all production factors are available for both export and local uses, no great amounts are produced due to several reasons one of which is the very low yield obtained under local conditions. This, in turn, is attributed to several factors some of which are the used variety and salt level in growth media particularly at the new cultivated area of the A.R.E.

According to that, the present study was designed in order to investigate the behaviour followed by different cultivars of strawberry under relatively saline conditions in order to get use of such character in obtaining cultivars relatively tolerant to salinity. This was performed through genetical investigations carried out by selection of four strawberry varieties known to be recently planted in Egypt mainly for the purpose of export. The investigations also involved a study for morphological and physiological features which are related to response of plants to salinity.

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2.1. Effect of salinity on growth

Many investigations have been carried out dealing with the effect of salinity on growth. Bernstien and Pearson (1956) suggested that excessive sodium accumulation by roots might affect its known fuction particulary water absorption. Dry weight as a percentage of fresh material tended to increase as growth was decreased. Similar results were obtained by Harward et al. (1956) who found that addition of (Cl) generally resulted in decreases in the percent dry matter content of the plant tops.

Osawa (1961) treated several vegetable crops, including strawberries, with sodium chloride solution of various concentrations variable between 1000 and 16,000 ppm. Results showed that with increasing concentration the plants became dwarfed, lateral shoots restricted and there were reductions in fresh and dry weights of tops. Other studies were carried out by Osawa (1962) who grew strawberry plants in sand culture using Hoagland's solution with NaCl added at various concentrations. Salt tolerance was evaluated in term of the concentration of NaCl in the solution which corresponded to 50% reduction in fresh weight of the aerial or edible portions of the vegetable. Results showed that dry weight of the tops was decreased at high salt concentration in fruition vegetables, but did not vary so much

[illegible] ... [illegible] were confirmed by Robins [illegible] (19[illegible]) who used Colorado river water containing high salinity, [illegible] 4.5% Cl, to irrigate plots of sugar cane. A linear negative response of stalk length to salinity was observed, a 50% reduction in growth rate being associated with a soil sample having a conductivity reading of 3.3 m.mohos.

Several studies were carried out on the effect of salinity on leaf area which was considered to be an expression for growth of plants. Nieman (1964) reported that areal growth of leaves was primarily through an increase in cell number and cell enlargment mainly contributing to growth in thickness. The number of cells per unit leaf area tended to remain constant in both the control and stunted leaves of plants grown in saline nutrient solution; stunted leaves were, however, smaller due to their fewer cells. In fact, results showed that salinity suppressed cell enlargement and cell division proportionately. Meriri and Poljkoff-Mayber (1970) grew bean plants under various fluctuating regions of salinity. In all experiments growth was retarded, retardation being dependent on the rate of salinization, the ultimate level of salinity and the duration of exposure to saline condition.

One of the main physiological features usually affected by salinity is the succulence of leaves. Repp. et al. (1959) reported an increase in the leaf succulence of plants grown in salty soils. They added that salt induced succulence could

[illegible] of plant.

Wasiel and Bernstein (1959) mentioned that with increasing the salt concentration of NaCl solution there was an increase in the water content of sugar beet although no such phenomenon was observed in forage beet. These data were confirmed by Janes (1970) who found a great response to the water potential gradient, and not the actual potential, in leaves of pepper plants. The resistance to water flow through the plants (R) was estimated by dividing the differance between the water potential of the growth medium and those of the leaves by the rate of transpiration. There was an increasing in (R) as the rate of traspiration decreased.

Runners of strawberry is considered to be a unique feature affected by salinity in vegetable crops. Kramer (1963) mentioned that runner production was reduced by application of either Chloride or Na to a greater extent than by sulphates, runner weight was less affected by levels of Na than by those of Chloride or Sulphate.

Several studies have been performed on the symptoms of salt injury of plants grown under saline conditions.

[illegible] nutrient solution was [illegible] in determining the growth of Lassen and Shasta varieties of strawberries grown in sandculture. High concentrations of Cl and, to some extent, Na in the substrate caused marginal scorch on mature leaves; accumulation of Na in leaves, however, was slower than that of Cl. Other studies on grapes were carrid by Ehlig (1960) who grew several varieties in sand culture with a nutrient solution to which was added 1-atm mixed chlorides, 2-atm mixed chlorides, 2 atm $CaCl_2$, 2 atm $Na_2SO_4 \cdot 2$ NaCl, or no salt. Chloride accumulation from high chloride treatments also caused certain burns on leaf blades of all varieties. Injury developed very rapidly at temperatures above 100°F, but very slowly below 99°F. Results also showed that some varieties were much more sensitive to chloride than others as the formers accumulated two to three times faster than the latters. Kohl et al. (1960) presented evidence that Lilium longiflorum var. Coft was relatively tolerant during the prefrosting period. Plants were relatively sensitive to sodium and calcium chlorides during the frosting period whose plants accumulated little amounts of minerals. Saline injury was found to occur as leaf necrosis, reduced height and flower blasting.

Osawa (1961) mentioned that several vegetable crops, including strawberry, were differently affected with high

occurred in tomatoes and peppers at 16,000 ppm, in cucumber and snap beans at 3000 ppm and in strawberries at 2000-4000 ppm; broad beans did not develop specific symptoms. Similar results were obtained by Kramer (1963) who showed that some leaf injury was observed with increasing levels of chloride application.

Hewitt and Furr (1966) treated seedlings of 3 citrus varieties with solution of NaCl, $CaCl_2$ or an equivalent mixture of NaCl + $CaCl_2$ each at concentration of 80 meq/l for periods of 4 to 12 weeks. Data showed that salt injuries resulted in death of some roots. A varietal difference in accumulation of Cl by the roots of different varieties was probably related to the acceptability to salt and heat injury. These results were supported with Bertolaso (1968) who also noted the salt injury in broad bean and peas.

Furr and Ream (1968) grew some varieties of date in peatmoss plus vermiculite and watered with Hoagland solution. At the 2-leaf stage salt was added to $\frac{1}{3}$ - strength Hoagland's solution at 6,000, 18000 or 42,000 ppm. Results showed that as the salt content of the substrate increased, leaf growth decreased and more Na accumulated in the tops rather than the roots. Growth depression was more closely related to the

accumulation in plants.

2.2. Effect of salinity on the chemical composition of plants

2.2.1. Carbohydrates-

Salinity may affect the carbohydrate content in plant either by direct means or indirect ones. This can be attained through several metabolic processes such as respiration, chlorophyll synthesis, absorption of water and ion balance within plant tissues. Bernstien et al. (1951) reported that the content of starch in potato tubers, opposite to percentage of soluble sugars, were slightly raised by increasing the level of salinity to 10,000 ppm. Several plants, including strawberry, were also investigated by Imazu and Osawa (1954). Plants, grown in sand culture, were treated with sodium chloride at a concentration up to 10,000 ppm. Data showed that excessive chloride appeared to interfere with carbohydrate metabolism in these plants.

Results were confirmed by Ehlig and Bernestien (195°) who grew strawberry plants in sand culture treated with 2 atomosphere of single soluble salts, 1 atomsphere mixed chlorides or no salt. Data showed that the sugar and titrable acids were increased by salinity. These data agree with the studies of Faisel and Bernstein (1959) which showed

An investigation was performed by Hiteborg and Olat (1954) who found no qualitative effect for sodium upon the carbohydrate composition of cotton plants, either in presence or absence of calcium. In the absence of calcium, sodium had a marked influnce upon carbohydrate translocation. Plants reciving sodium but no calcium lived long and, for a limited time, exhibited a carbohydrate distribution pattern more comparable to that of control plants than did these which received neither calcium, nor sodium. It was suggested that as a partial substitute for calcium, sodium has a role in maintaining carbohydrate translocation. It was further felt that sodium was able to help to maintain minus-calcium cotton plants in condition conductive to the synthesis of celluar constituents.

Kohl and Gale (1966) reported that salinized plants were less efficient in metabolizing their dry matter than the non salinized plants which possessed a higher dry weight per unit leaf area. Salinity was suggested to affect the carbohydrate contents in plants by changes in the rate of carbon fixation which was reported to be depressed with salinity.

Nitrogen content:

Nitrogen is the most needed macro essential element for plant. Therefore several investigations were carried out on the relationship between salinity and nitrogen content of plants. With several plants, including strawberry, grown in sand culture and subjected to NaCl concentrations ranging from 2,000 - 10,000 ppm, Imazu and Osawa (1954) found that salinity was unfavourable for nitrogen content of strawberry, onion and chinesis cabbage.

Koval's Kaya (1958) reported that with using tomato and cotton plants grown in either soil or sand culture treated with sodium chloride there was a harmfull effect on the colloids of protoplasm in both plants. Osawa (1962), in a study on several species of vegetable plants including strawberry, showed that the effect of NaCl on the N content varied with the species.

The relationship between salinity and nitrogen content was also studied by Bierhuized and Ploegman (1967) who grew tomatoes receiving irrigation water containing different concentration of salt. Data showed that the salt accumulation increased the foliar N of produced plants.

Phosphorus

Imaz and [illegible] grew [illegible] fistulosum and Brassica chinesis plants in sand cultures watered to NaCl concentrations variable from 2000 to [illegible] ppm. Data showed that the effect of salinity on the contents of various elements, including P, were found to be decreased in strawberry crop but slightly increased in onion. Osawa (1967) also showed the effect of NaCl on P contents to be varied with the species.

A preliminary study on the absorption of phosphate and growth of plants under saline conditions was carried out by El-Leboudi (1969). He grew tomato plants in sand cultures receiving phosphate fertilization along with different levels of sodium. Data showed that sodium as well as phosphorus was found to have a favourable influence on the yield of plants during the whole studied growth period. However, increasing the concentration of sodium above certain limits resulted in an oppsite effect. Absorption of phosphate followed a similar trend to that of plant yield. However, the so-called phosphorus utilization Quotient followed a relative different trend. It was generally decreased with raising the level of applied phosphorus in the growth media of plants under all tested treatments. On the other hand, indicated quotient was generally increased with increasing the aplication rates of sodium elements