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EFFECT OF SODIUM ON CATIONIC RELATIONS IN TOMATO PLANTS

by

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SUMMARY

The effect of Na^+ on cationic relations in tomato plants and the effect of total cation concentration of Na^+ contents have been studied. Six Na^+ concentrations (0,5,10,15,20 and 30 me.l^{-1}) and four total cation concentrations (10,20,30 and 40 me.l^{-1}) were tested. The effect of Na^+ varied according the studied part of the plant. In leaves and roots the increase of Na^+ has effect on the Ca^{++} contents. In stem juice the effect of Na^+ is on the K^+ contents. Increments of total cation in nutrient solution decrease Na^+ in each studied part of the tomato plant.

INTRODUCTION.

Tomato plants cultivated by hydroponic system, tolerate high variations in the concentrations of K^+, Ca^{++} and Mg^{++} without effect on the yield . (Agüí et al, 1979).

Na^{++} has a competitive action with K^+ in the absorption when both cations are in high concentrations in nutrient solution. At low concentrations this competitive effect does not appear (Epstein, 1966). Also Na^+ in high concentrations affects Ca^{++} transport inducing "Blossom-endrot" in tomato fruits (Hayward and Long, 1943).

Irrigation water in arid and semiarid areas has variable amounts of Na^+ as NaCl or $NaHCO_3$. It may induce salinity or/and alkalinity in soil which can be mitigated by adding Ca^{++} or Mg^{++} fertilizers to the soil.

Dropping irrigation system allows Na^{++} relative control by the addition of other cations to the irrigating water.

The interaction of Na^+ with K^+, Ca^{++} and Mg^{++} in the tomato plants was studied conjointly, in order to find an equilibrated relation which allows a good growth of the plants and avoids the alkalinization of soil.

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MATERIAL AND METHODS.

Tomato plants (Lycopersicum sculentum L.) vard "Marglobe" were cultivated by hydroponic system in greenhouse.

24 treatments were made by combination of six Na^+ concentrations (0, 5,10,15,20 and 30 me.l^{-1}) and four total cation concentrations (10, 20,30 and 40 me.l^{-1}). The relations of K^+, Ca^{++} and Mg^{++} were constant (0.35 : 0.45 : 0.20 respectively) and the relative relations of anions NO_3^-, $H_2PO_4^-$ and $SO_4^=$ were constant (0.60 : 0.05 : 0.35).

Each pot had five plants., two were recollected at flowering time, two at fruiting time and the fifth one was picked two weeks later for determination of growth.

Na^+, K^+, Ca^{++} and Mg^{++} in leaves, roots and stem juice were determined at flowering time and fruiting time. Samples of leaves and roots were dried and grinded and mineralized by wet system with nitric and perchloric acid 2:1 v/v. The stem juice was processed by the same way. Na^+ and K^+ were determined by flame spectrofotometry and Ca^{++} and Mg^{++} by atomic absorption spectrofotometry.

RESULTS.

Figs. 1 and 3 show the relationship of Na, K, Ca and Mg in leaves, roots and stem juice. These graphics are made in % of me. of the cation (Na^+, K^+, Ca^{++} or Mg^{++}) in relation to the total cation content ($Na^++K^++Ca^{++}+Mg^{++}$). For leaves and roots, graphics are made on the basis of me/100 g of dry weight, and for stem jüice, on the basis of me.l^{-1}.

In general, the content of Na^+ in leaves, roots and stem juice increases when Na^+ concentration in the nutrient solution increases, and decreases when we increase the concentrations of total cations.

The total cation content in leaves and roots is constant for the different treatments (data not showed) . Due to this,variations in the relative contents are representative of the absolute contents. The total concentrations in stem juice increases with the increase fo the cation concentration in the nutrient solution; these increments are low at flowering time and higher at fruiting time.

At flowering time, the concentration of K^+, Ca^{++} and Mg^{++} in leaves decrease lightly when Na^+ increases and at fruiting time K^+ and Mg^{++} are constant and Ca^{++} decreases with Na increase.

In root at flowering and fruiting time,the Na increase affects the Ca^{++} content only,and much more pronunciated than in leaves.

In stem jüice the effect of Na^+ concentration is on the K^+ concentration, but Na^+ does not affect K^+ content when the total cation concentration is increased. The relative (and absolute) values of $Ca^{++}$are very low.

FIG. 1

Cationic relations in leaves

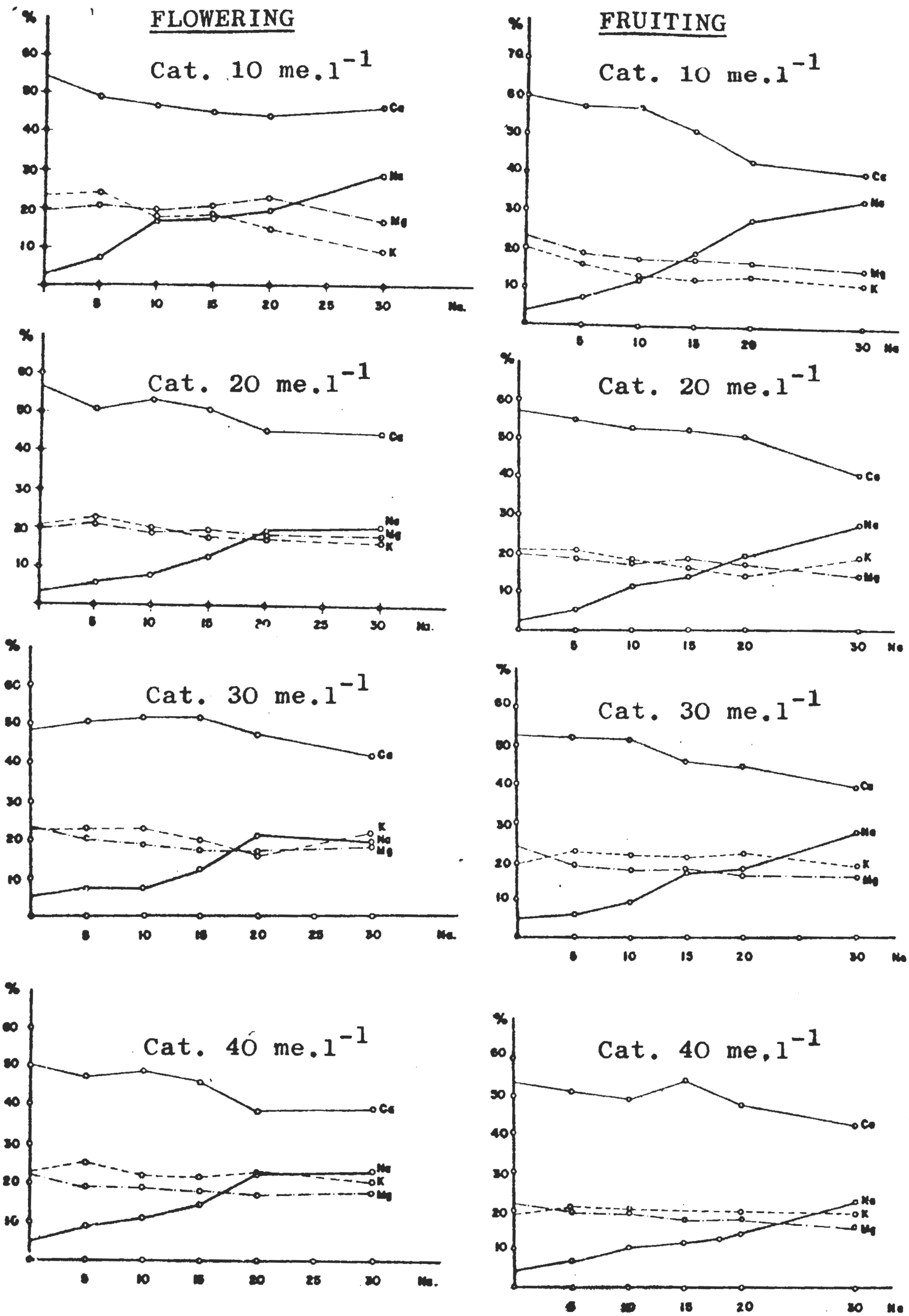


FIG. 2

Cationic relations in roots

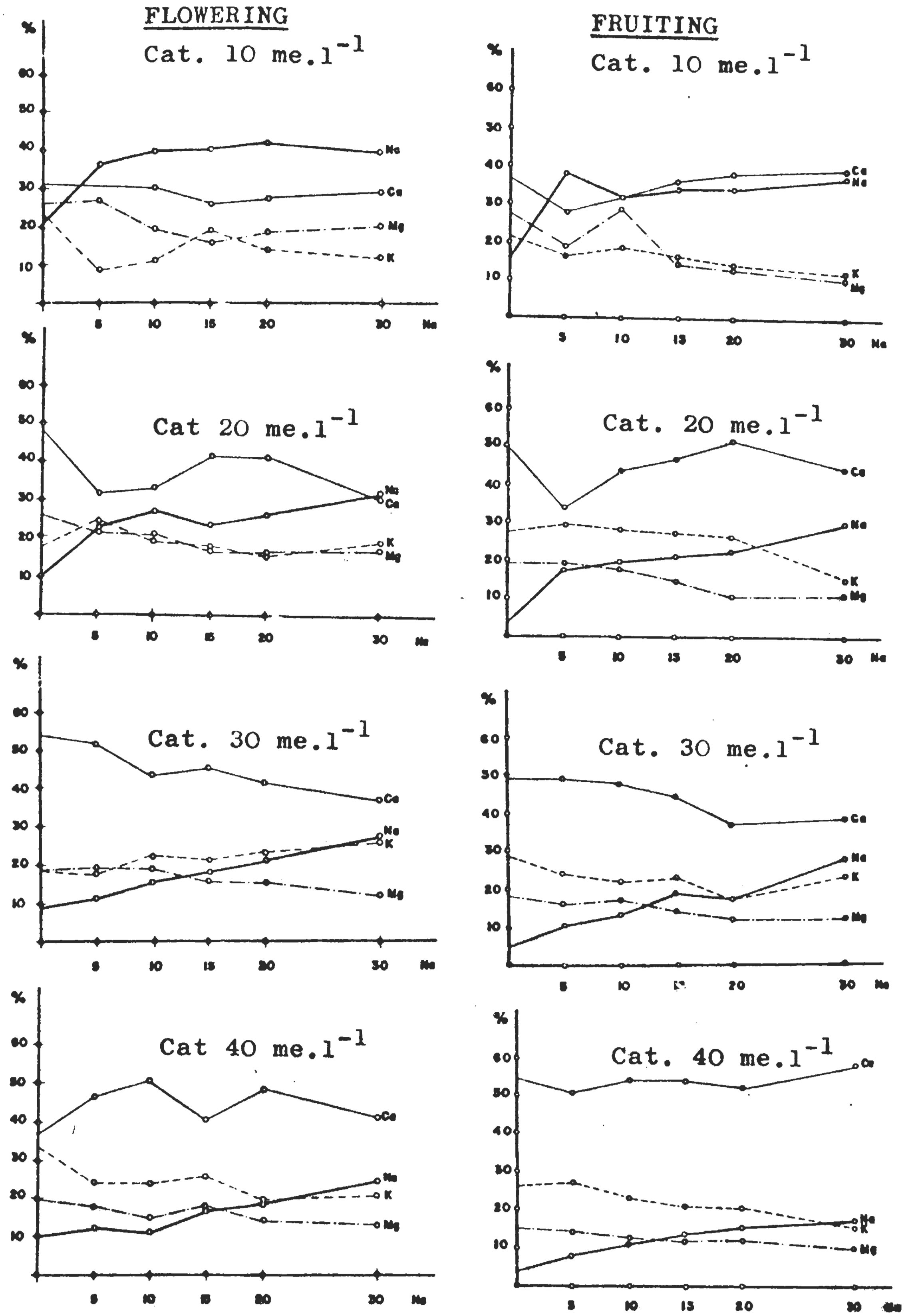
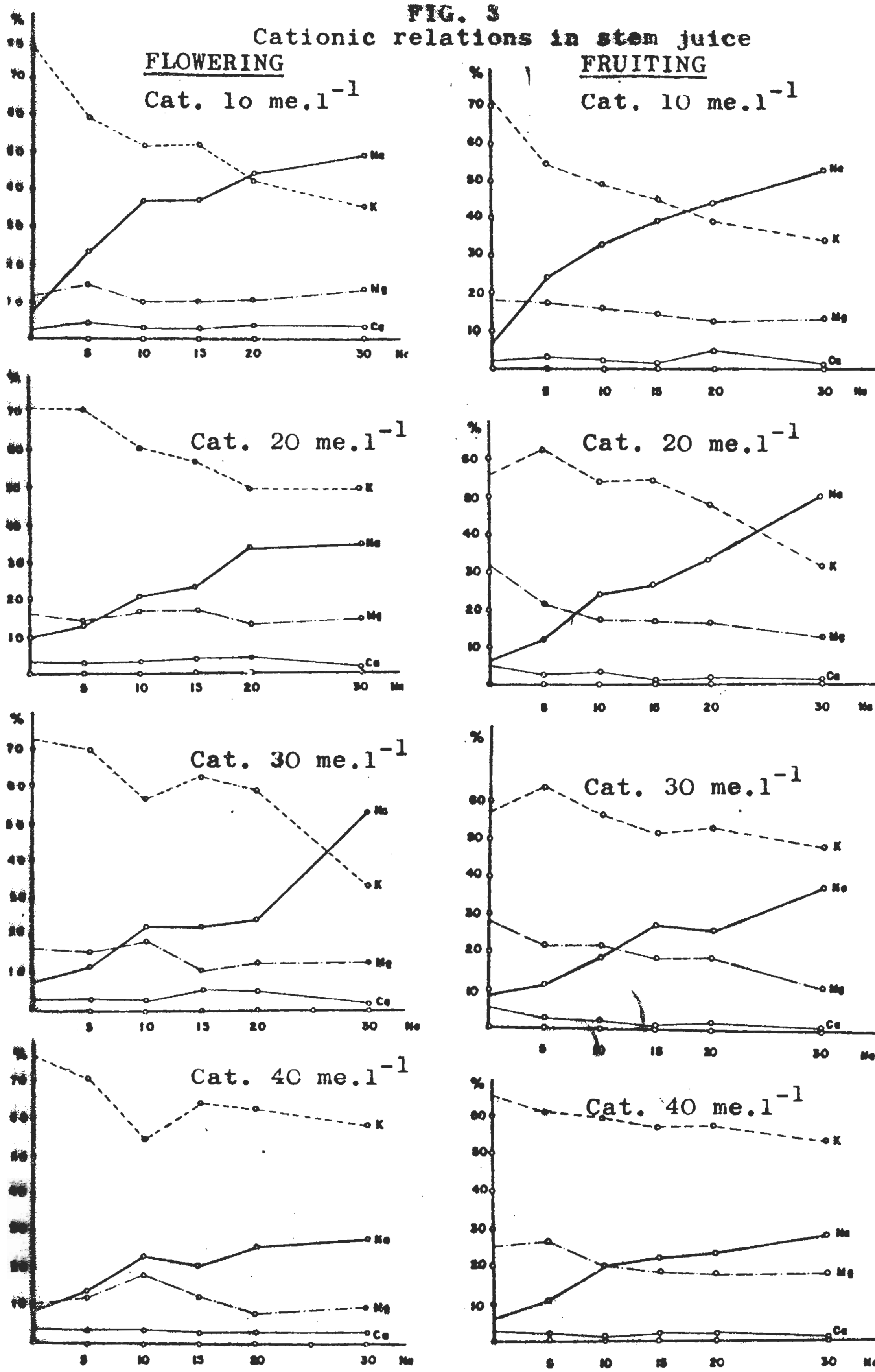


FIG. 3

Cationic relations in stem juice



DISCUSSION

The radial transport of calcium in roots takes place by apoplastic way (Ferguson, 1978) and Na^+ is excreted by roots passing from the symplaste to the apoplaste (Marchner, 1974). This could produce the interaction effect between both cations, as both are retained by the negative charges of the plasmamembrane and cell walls. When the total amount of Ca^{++} increases the relation Na^+/Ca^{++} decreases, and due to this, Ca^{++} has more possibilities occuping negative positions on the membrane and cell walls. Also, monovalent cations increase sinthesis of soluble organic acid, and decrease the synthesis of insoluble organic acid. When the concentration of Na is high, the calcium precipitate is lower. This second mechanism could explain the effect of Na^+ lowing Ca^{++} concentration in leaves and roots.

The decrease of K^+ in stem juice when Na increases could be explained by an accumulation of Na in phloeme tissue produced by the excretion of Na^+ from the leaves and this can reduce the relative amount of K^+. The absolute value of K^+ decreases very little with Na^+ (data not showed).

The constant values of Mg are normal in tomato plant when the cationic relations are constant (Hernando y Cadahia, 1973). The low concentrations of Ca^{++} in the stem juice is due to that Ca^{++} is non mobile ion in the phloeme(Epstein, 1973).

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RESUMEN. EFECTO DEL SODIO SOBRE LAS RELACIONES CATIONICAS EN PLANTAS DE TOMATE.

Se estudió el efecto del Na^+ sobre las relaciones catiónicas y el efecto de la concentración total de cationes sobre el Na^+ en plantas de tomates. Seis concentraciones de Na^+ (0,5,10,15,20 y 30 me. l^{-1}) y cuatro concentraciones totales de cationes (10,20,30 y 40 me.l^{-1}).fueron probadas. El efecto del Na^+ varió de acuerdo con la parte de la planta estudiada. En hojas y raices el incremento de Na^+ tiene efecto sobre el contenido de calcio. En el jugo del tallo, el efecto del Na^+ es sobre el contenido de K^+. Los incrementos de cationes en la solución nutritiva disminuyen el Na^+ en cada una de las partes estudiadas de la planta de tomates.

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