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CULTIVATING TOMATO UNDER WATER AND SALINE STRESS

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INTRODUCTION

Although the effect of water stress and saline stress have been widely studied in tomato plants growing under semi-arid environments, little is known about the interactive effects of the nitrogen supplied during episodes of water stress or about the effect of the application of amino acids in tomato cultivated using saline water.

Losses due to blossom-end rot (BER) are common in the tomato plantations where waters with a high salt content are used. It seems that BER (Figure 1) is related not only with one factor but by interactions between water availability, salinity and nutrient ratios in the root zone, air humidity, and inadequate xylem tissue development in the fruit when the plant is exposed to increased salinity. The appearance of BER is related to a decrease in the absorption and translocation of calcium (Ca), due, among other factors, to excessive salinity in the soil solution. The incidence of this disorder is greater as the Ca content in the solution decreases. However, BER is common in highly saline conditions even when the Ca needs of the plants are totally provided for, and the application of Ca at the beginning of cultivation (Franco *et al*., 1994) or the increasing of the level of irrigation (Franco *et al*., 1999) do not completely eliminate the disorder.

On the other hand, products containing amino acids and low molecular weight peptides, called protein hydrolysates, used to complement fertilisation with mineral elements to regulate the plant water balance, have been effective in order to correct BER. Amino acids can play an important role in the osmotic adjustment of the plant in saline cultivation conditions. Proline, particularly, has been mentioned as cytosolute in the adaptation of some plants to osmotic stress (García *et al*., 2006).

The aim of the four studies summarised in this paper was to study the effects of mineral nutrition and the amino acids inclusion in irrigation solutions on the cultivation of tomato under water and saline stress.

REDUCTION OF BLOSSOM-END ROT UNDER SALINE CONDITIONS

Fig. 1. Blossom-end rot develops on tomato fruit of a plant cultivated under saline conditions

Experiments were conducted to investigate the effects of a protein hydrolysate, applied by means of fertigation (Franco *et al*., 1994) and the effects of water stress (Franco *et al*., 1999) on the mineral content, free amino acid levels and incidence of BER in tomato cultivated using saline water.

The addition of Ca (gypsum) to the substrate proved to be effective as a method of controlling BER only to a certain degree, succeeding in the best of cases to reduce by 50% the incidence of the disorder. The application of a protein hydrolyzate by fertigation improved the reduction of BER, with a total absence of affected fruits in some cases. The addition of the hydrolyzate increased the total content of amino acids in the fruit, mainly proline and alanine. A highly significant correlation was found between the reduction of BER and the joint content of Ca and proline in the fruit (Franco *et al*., 1994).

When plants were cultivated under water stress

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using saline water, yield per plant was higher and fewer fruit were affected by BER in the treatment involving the higher level of irrigation. The macronutrient leaf and fruit content hardly showed any difference, only the N concentration in fruit being significantly affected in the water stressed plants, in which the levels were higher. The Ca concentration in the style portion of mature fruit, which is related with the incidence of BER, was not significantly affected by the level of irrigation. As regards micronutrients, only the Fe (in leaf and fruit of the first truss), Cu (in leaf of the first truss), Zn (in leaf and fruit of the first truss, and leaf of the fifth truss) and Mn (in leaf of the first truss) concentrations differed significantly. The total free amino acid leaf content was not affected by irrigation treatments. However, the total free amino acid content of fruit, significantly those of the first truss, was higher in the less irrigated treatment. The amino acids: aspartic acid (only from the first truss), glutamic acid, proline and alanine had high concentrations in the fruit of the less irrigated plants, while the γ-aminobutyric acid and phenylalanine (only from the fifth truss) levels were higher in fruit of the more irrigated plants (Franco *et al*., 1999).

MODERATING WATER STRESS BY APPLICATION OF AMINO ACIDS AND NITROGEN

The effects on the growth of tomato plants of adding amino acids and antibiotics to nutritive solution were studied (García *et al*., 2006). It is clear that the amino acids added to the hydroponic medium encouraged micro-organism competition for the nitrogen in the nutrient solution. Absolute and relative growth rates of plants demonstrated the negative effect of the antibiotics added to nutritive solutions, that can not be mitigated by the presence of the amino acids.

An experiment studied the effect of different doses of nitrogen on the water stress of tomato plants grown in a sandy soil and exposed to long-term water stress. Treatments consisted of a daily application of 80% (stressed) or 100% (unstressed) of the water evapotranspired the previous day of Hoagland's solution (N1 treatment), Hoagland's solution + 40 mM NO_3^- (N2 treatment) of Hoagland's solution + 80 mM NO_3^- (N3 treatment), these last applications every three days (a total of seven applications in the course of the experiment). The leaf fresh weight at full turgor/leaf dry weight ratio increased in plants of the stressed N1 and N3 treatments with no significant difference between them at the end of the experiment. However, the N2 dose produced a significant increase in well-watered plants but not in stressed plants. Leaf surface area was greater in control plants than in stressed N2 plants, while the opposite was true in the case of stressed N1 and N3 plants both at the beginning and end of the experiment, although the difference between the stressed plants and the control were not significant. Leaf water potential was greatly reduced in stressed N2 plants but was unaltered in their well-watered counterparts. The significant increase in relative water content at turgor loss point (around 3%) and cell membrane rigidity (more than 125% increase in bulk modulus of elasticity) clearly pointed to the osmotic adjustment of stressed N2 plants, confirming that this N dose moderated the effects of the water stress occurring in N2 plants (García *et al*., 2007).

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