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Effect of salt stress on the endogenous salicylic acid content in maize (*Zea mays* L.) plants

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ABSTRACT Two-week-old maize plants were treated with 50 or 100 mM NaCl for seven days. Leaves and roots were collected for measurements on salicylic acid and antioxidant enzyme activity on the 1st, 3rd and 7th days of treatment and after four days of recovery. The quantum yield of photosystem II decreased after 7 days in maize plants treated with 100 mM NaCl. There were no changes in the catalase and ascorbate peroxidase activity. The glutathione-S-transferase, glutathione reductase and guaiacol peroxidase activities increased. There were no changes in the level of endogenous free and bound salicylic acid. The free o-hydroxy-cinnamic acid (oHCA) content increased after 7 days in the leaves, while the bound oHCA level increased after 4 days of recovery. It has been concluded that oHCA may play an important role in stress processes.
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KEY WORDS

salt stress
antioxidant enzymes
salicylic acid
Zea mays L.

Salt (NaCl) stress is among the factors most limiting to plant productivity. Plants exposed to salt stress adapt their metabolism in order to cope with the changed environment. Survival under these stressful conditions depends on the plant's ability to perceive the stimulus, generate and transmit signals and instigate biochemical changes that adjust the metabolism accordingly (Hasegawa et al. 2000). Salicylic acid (SA) plays an important role in the defence response to pathogen attack in many plant species. (Shirasu et al. 1997). Several studies also support a major role of SA in modulating the plant response to several abiotic stresses (Yalpani et al. 1994; Senaratna et al. 2000). Treating mustard seedlings with exogenous SA improved their thermotolerance and heat acclimation (Dat et al. 1998). In maize plants, pre-treatment with SA induced the production of antioxidant enzymes, which in turn increased chilling tolerance (Janda et al. 1999).

In the present study the effects of salt stress on the oxidative stress and on the levels of endogenous salicylic acid and its precursors were investigated.

Materials and Methods

Two-week-old maize plants growing in hydroponic solution in a plant growth chamber were treated with 50 or 100 mM NaCl for seven days. Leaves and roots were collected for measurements on salicylic acid and antioxidant enzyme activity on the 1st, 3rd and 7th days of treatment and after four days of recovery.

Salicylic acid was measured according to Meuwly and Métraux (1993) and enzyme activities according to Ádám et al. (1995) and Janda et al. (2003).

The chlorophyll fluorescence was determined using a pulse amplitude modulated fluorometer (PAM-2000, Walz, Effeltrich, Germany) according to Janda et al. (1994).

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Results and Discussion

The quantum yield of photosystem II decreased after 7 days in maize plants treated with 100 mM NaCl. There were no changes in the catalase and ascorbate peroxidase activities. The glutathione-S-transferase activity increased in the leaves from the 7th day but did not change in the roots. The glutathione reductase (GR) activity increased in leaves treated with 100mM NaCl after one day but in the roots only after the four-day recovery. The guaiacol peroxidase activity increased only after four days of recovery in the roots, while there were no changes in the leaves. Several reports show that elevated levels of GSH are associated with increased oxidative stress tolerance. Thus, transgenic plants overexpressing glutathione reductase had both elevated levels of GSH and increased tolerance to oxidative stress in the leaves (Broadbent et al. 1995). In the present case there was increased GR activity, but no changes were found in the peroxidase activity in the leaves. The GR enzyme may have been able to decrease the oxidative stress in maize plants.

There were no changes in the level of endogenous free and bound salicylic acid after the treatment. The free o-hydroxy-cinnamic acid (oHCA) content increased in the leaves during the treatment in the case of 100 mM NaCl, being most pronounced after 4 days of recovery, while the bound oHCA level increased only after 4 days of recovery. SA is one of various agents that have been proposed as signal transduces in plant responses to salt stress (Molina et al. 2002). It was found that SA accumulation was below the threshold required for PR1 induction, a frequently used marker for SA accumulation (Borsani et al. 2001). This suggests that SA induction is not a basic requirement, but that the present of endogenous

SA amplifies the effect of the initial levels of reactive oxygen species. There are no data on the role of the oHCA during salt stress, but this elevated oHCA level suggests that oHCA may also play an important role in stress processes.

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