The effect of different Si concentrations on antioxidative response in young maize roots.

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ABSTRACT

During our studies of drought, salt and cadmium stresses we have compared also the effect of various Si concentrations (3.5 mM, 17.5 mM and 35 mM). There is no generally accepted concentration of Si with positive effect known for various plant species. Activities of some antioxidative enzymes (ascorbate peroxidase, catalase, quaiacol peroxidase and superoxid dismutase) and root growth parameters were studied in young roots of maize *Zea mays* L. cv. NK-Alpha grown under salinity stress with and without Si treatment.

INTRODUCTION

The beneficial effect of Si on plant growth is evident mainly under stress conditions. Silicon can play a role of physical barrier, especially in case of leaves and stems, or it is also able to activate some defense mechanisms of plants. The exact roles of Si in plant metabolism are still not completely understood. Silicon application has been shown to (1) increase leaf chlorophyll content and plant metabolism, (2) enhance plant tolerance to environmental stresses such as cold, heat and drought, (3) mitigate nutrient imbalance and metal toxicity in plants and (4) reinforce cell walls, increase plant mechanical strength thereby protecting plants against pathogens and insects (Epstein,1999, Datnoff et al., 2001, Ma, 2001)
The aim of our work was to compare the effect of various Si concentration on some growth parameters and an antioxidatitve response in young maize roots, which were grown under salt stress conditions.

MATERIAL AND METHODS

Seeds of maize cv. Alpha were germinated in rolls of moist filter paper at 24 °C in the dark. Three days old seedlings were transfered to half-strength Hoagland nutrient solution with (50 mM and 200 mM) or without NaCl for 48 h, 72 h or 5 days. Silica (3.5., 17.5 and 35 mM) was applied in form of sodium silicate solution (Sigma, 27% SiO_2 dissolved in 14% NaOH), The pH of each cultivation solution was adjusted to 6.2. The nutrient solutions were replaced every other day. To measure the antioxidant enzymes activity of seminal roots of 8-day-old maize seedlings, apical segments (2cm long) were harvested, grounded with a mortar and pestle in 0.1M sodium phosphate buffer (pH 7.5) containing 1mM EDTA, filtered and centrifuged at 15 000 g for 20 min. Supernatant was used as an enzymes source.
Superoxide dismutase (SOD, EC 1.15.1.1) activity was determined by monitoring the inhibition of the reduction of NBT at 560 nm as described by Dhindsa et al. (1981). One unit of SOD was defined as the quantity of enzyme required for 50% inhibition of NBT reduction. Catalase (CAT, EC 1.11.1.6) activity was measured by following the decrease in absorbance of H_2O_2 at 240 nm (Aebi 1984), ascorbate peroxidase (APX, EC 1.11.1.11) activity similarly by following the decrease in the ascorbate concentration at 290 nm (Hossain and Asada 1984). Peroxidase (POD, EC 1.11.1.7) activity was measured according to the method of Cakmak et al.(1993). The increase of absorbance due to guaiacol oxidation was recorded at 470 nm. The protein content was determined according to Bradford (1976) using BSA as a standard.

RESULTS AND DISSCUSION

The effect of silicon (Si) on salt (NaCl) treated maize plants was studied and growth parameters of roots and shoots were compared. The positive effect of Si was found in root length, fresh and dry weight in plants cultivated 72 h in 200 mM NaCl treatment and in plants cultivated 5 days in 50mM NaCl treatment. In other cultivation times and different NaCl concentrations the differences were not significant. In growth parameters no differences were found among the three Si concentrations (3.5., 17.5 and 35 mM).

The major effect of Si on proline content in maize roots treated with salt occurred after 5 days of cultivation in solution containing 200 mM NaCl. A marked decrease occurred in this case. Similar results of proline content after Si application were found by Gunes et al. (2007) in leaves of spinach and tomato grown in sodic-B toxic soils. The differences among Si concentrations used by us were not significant.

Diverse responses of SOD, CAT, POD and APX activities with added Si under salt stress were recorded. SOD activity in the studied maize roots after short NaCl treatment in comparison with control plants decreased, but in the case of 5 days treatment a slight increase was observed. These results are in agreement with observations of Al-aghabary et al. (2004) in leaves of tomato plants. Compared with the plants treated with salt alone significantly enhanced activities of all studied enzymes were observed after Si addition. The major increase was observed in 200 mM NaCl treatment, but various Si concentrations gave no evident proof for using some of them as the best. In accordance with Liang et al. (2003) we may conclude that oxidative damage induced by salt may be alleviated by Si addition, and that among the concentrations of Si used in our experiment no substantial differences of this alleviating effect occurred.

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