1. Summaries of Doctor Theses

Effects of air humidity on the growth of two cultivars differing in salt tolerance in soybean, melon and tomato under saline conditions

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The global alarm of salt-affected soils can be explained by their wide distribution on all continents, mostly located in arid and semi-arid regions. To overcome the shortage in food supply as the result of land deterioration and the progressively increasing population, the utilization of saline soils and low quality water resources for agriculture is required. However, the salinity of those saline soils and water sources typically exceeds the limit tolerated by conventional crop plants. The approach to this problem is to increase the salt tolerance of crop plants.

Increasing air humidity is one way to reduce the risks of salinity on plants by decreasing transpiration and consequently decreasing salts uptake. However, information on the effects of humidity on crop growth under saline conditions is insufficient and sometimes even contradictory. Therefore, the present research is designed to investigate the effects of increasing air humidity on plant growth and plant characteristics of salt-tolerant and salt-sensitive cultivars under salinity with the aim of improving crop growth under saline conditions.

The experiments were conducted in two environmentally controlled growth chambers set at 30 and 70% relative humidity (RH). Salt-sensitive cultivars Tachiyutaka of soybean (*Glycine max* L.), Revigal C-8 of melon (*Cucumis melo* L.) and Naomi of tomato (*Lycopersicon esculentum* Mill.), and salt-tolerant cultivars Dare (soybean), Galia (melon) and Daniela (tomato) were selected as materials for comparison. One month after germination, the plants were exposed to NaCl stress.

The results of the experiments revealed that Na^+ and Cl^- accumulation in the shoot and the saline environment in the root zone severely impaired the growth and development of the three crops. Response of osmotic adjustment under saline condition was observed in the leaves and roots of the three crops.

Cultivar variation in response to salinity in soybean, melon and tomato was observed. The variation in soybean and tomato was associated with the difference in Na^+ and/or Cl^- uptake and accumulation in leaves. However, the cultivar variation in response to salinity in melon was associated with osmotic adjustment in leaves. Characteristics in salt-tolerant cultivars such as greater root growth, higher efficiency in water absorption, better root osmotic adjustment and higher root activity were related with their salt-tolerance.

In soybean, salt-tolerant cultivar had higher transpiration rate than salt-sensitive one, but Na^+ and/or Cl^- accumulation was lower in salt-tolerant cultivar. In melon, the two contrasting cultivars had similar transpiration rates and similar Na^+ and/or Cl^- accumulation, except that salt-tolerant cultivar had higher Na^+ accumulation than salt-sensitive one at 70% RH. In tomato, the two contrasting cultivars also had similar transpiration rates, but salt-tolerant cultivar had lower Na^+ and/or Cl^- accumulation than salt-sensitive one, except that Cl^- accumulation was similar between the two cultivars at 70% RH. Increasing air humidity decreased Na^+ and/or Cl^- accumulation in salt-sensitive cultivars in the three crops, while it showed no effect on Na^+ and/or Cl^- accumulation in the salt-tolerant cultivars. These results indicate that Na^+ and/or Cl^- accumulation may not be absolutely affected by transpiration, but depends on Na^+ and/or Cl^- exclusion ability in roots. When the plant has high Na^+ and/or Cl^- exclusion ability in roots, Na^+ and/or Cl^- uptake will be restricted by the roots. As a result, Na^+ and/or Cl^- accumulation in the plant will not be affected by transpiration. On the contrary, due to the low ability of restricting Na^+ and/or Cl^- uptake in roots in the salt-sensitive cultivars, the accumulation of Na^+ and/or Cl^- in their tissues will be affected by transpiration. Previous reports showed that transpiration influenced ion accumulation to the shoot in some species, while in some other species it had no effect. Therefore, the effects of transpiration on salts uptake has been argued. The present study shows that the inconsistent effect of transpiration on ion accumulation can be attributed to the Na^+ and/or Cl^- exclusion ability in roots.

Based on dry matter accumulation, increasing air humidity increased growth of salt-sensitive cultivars of the three crops under salinity. However, it showed no effect on salt-tolerant cultivars of soybean and melon or a negative effect on the salt-tolerant cultivar of tomato. The increased growth in salt-sensitive cultivars with increasing air humidity might have resulted from the decreased Na^+ and/or Cl^- accumulation at high humidity. As for the salt-tolerant cultivars, due to the unchanged Na^+ and/or Cl^- accumulation in response to increasing RH, their growth did not show a positive response to increasing RH.

The present study demonstrates that the effect of increasing air humidity on the growth of the plants under saline conditions depends on the Na^+ and/or Cl^- exclusion ability under saline conditions. If Na^+ and/or Cl^- exclusion ability is low, increasing air humidity will increase growth of plants by decreasing ion accumulation through decrease in transpiration. Therefore, there is considerable scope for improving plant growth under saline conditions when plants are grown in humid environments.