Abstract

Irrigation of agricultural crops with treated wastewater involves risks of yield reduction resulting from excessive salt and boron concentrations. Problematic salt and boron (B) content is particularly relevant in arid regions where potential transpiration is high. Increased salt concentration reduces soil water matric potential and subsequently causes decreased transpiration rates. Furthermore, specific-ion toxic effects and changes in soil hydraulic properties changes are likely to occur under saline conditions. While certain, low B concentration in soil solution is essential for plant growth and production; higher B concentrations become toxic for plants. Boron toxicity is crop specific, manifested by leaf burn, reduced transpiration, and decreased yield. The overall objective of this research was to investigate yield and transpiration rates of date palm seedlings (*Phoenix Dactylifera L.*, *cv. Medjool*) irrigated with water containing a range of salinity and B concentrations.

Twenty date palm seedlings were planted in one cubic meter lysimeters. Salinity and B treatments began 12 months after planting. Salinity and B levels were 0.5, 4, 8, and 12 dS/m and 0.2, 2, 5, 20, and 40 ppm, respectively. Monthly measurements of growth indices and of B and other major ion concentrations in leaves, soil and drainage water were taken. In addition, transpiration rates and electrical conductivity (EC) of drainage water were monitored on a daily basis. Fresh biomass was assessed ten months after treatments had begun. Relative transpiration was found to be linearly proportional to relative yield. Yield and transpiration decrease was associated with increased salinity levels. Linear decrease of yield and of transpiration was found in response to increased irrigation water salinity for low B concentrations (0.2, 2 and 5 ppm B). Yield and transpiration decreased with increased irrigation water B concentration. This decline was steep for treatments up to 20 ppm B. Additional increase of B concentration to 40 ppm did not produce differences in yield and transpiration. Boron therefore has critical influence on yield and transpiration in date palms but, at high levels plant response to B appears to become saturated.

Transpiration and yield decreased exponentially with increased B under several salinities levels, with dwindling of the decrease under high B concentrations. This restraint was possibly due to saturation of B adsorption on binding sites inside the date palm itself.

The character of yield (and of transpiration) response to combined stress of salt and excess B was consistent with Liebig's (1855) "law of the minimum". The law of the minimum dictates that, at low salinity levels there was a great risk for B toxicity, while at higher salinity levels the risk was poor. Salinity was the limiting factor affecting transpiration and yield at low B concentrations, whereas at high concentrations, B was the limiting factor. Date palm yields, calculated according to Mitscherlich's (1906) model, where plant yield was determined according to joint effects of B and salt, were incompatible with the experimental measurements of this project.

Boron concentration in the drainage water increased with increasing irrigation water B. Boron concentration in drainage developed starting at the onset of treatments, reached maximum levels after one month, and subsequently decreased in all of the B treatments with the exception of the control. Decreased transpiration, corresponding to increased salinity, was found to be responsible for reduced B concentrations in drainage water. Increase in irrigation water B concentration led to increased leaf B concentration; however, increased salinity caused reductions in leaf matter B. Boron concentration in the leaves started to increase approximately 45 days after beginning of the treatments. The delay was due to B adsorption in the soil. Decrease in yield and transpiration was the major cause of maintaining stable leaf B concentrations after maximal levels were reached.

Values of EC and B in soil solution were found to correlate with those in drainage water. Throughout the experiment, no significant differences between treatments were found for root or leaf sodium, calcium, or chloride content. No correlation was found between salinity levels and dry matter percentage of roots or leaves. Neither was correlation found for root or leaf sodium and potassium content.

Fraction of necrotic leaf area increased with increased irrigation water B concentration. Moreover, extent of necrosis decreased under high salinity

treatments. Necrotic leaf tissue fraction does not fully explain decreased transpiration.