Does Saline Drainage Water Affect Crop Tolerance to Boron?

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Executive Summary:
Reuse of saline drainage water is a management option on the west side of the San Joaquin Valley (SJV) that is necessary for reducing the volume of drainage water (San Joaquin Valley Drainage Implementation Program, 2000). A potential limitation in implementing a reuse system is determining the extent by which boron, a naturally occurring element in the drainage water, affects the selection, growth and yield of crops in the reuse system.

Previous reuse studies, some of which have been previously funded by the UC Salinity/Drainage Task Force, have shown that numerous species ranging from those classified as salt-tolerant (e.g. cotton, certain forages, etc.) to moderately salt sensitive (e.g. tomato and melon) can be grown successfully using saline drainage water (ECi of 7 and 8 mg/L B or higher) applied for the majority of the season (Technical Reuse Report, 1999). Despite their reported success, there remains a concern that previously salinized fields will be unsuitable to certain crop rotations, particularly those crops that are sensitive to boron.

Boron is a concern for several reasons. First, boron is an element that is essential for crops but has a small concentration window between that what is considered deficient and that which is potentially toxic. Moreover, because boron has a higher affinity to the soil than common salts, it takes much more water to reclaim soil B to pre-existing levels than it does to reduce the salinity to pre-salinization levels. Furthermore, the B concentration in San Joaquin Valley drainage water varies widely but in nearly al cases, it far exceeds kevels that would result in toxic conditions based on B-tolerance guidelines.

Unlike guidelines for salt tolerance, the guidelines for boron tolerance are limited. With the exception of a few sand tank studies that actually provide B coefficients (i.e. threshold and slope) for a few crops (see Maas and Grattan, 1999), most of the B classification has come from work conducted over a half century ago by Eaton et al. (1944). More importantly, these older studies defined the B-tolerance limit based on the development of incipient injury on the crop (i.e. foliar burn), not yield response under a range of B concentrations.

The question is often raised, are the effects of salinity and boron on crops additive, synergistic, or antagonistic? Despite the common occurrence of high boron and high salinity in many parts of the world, very little research has been done to study the interaction of the two. For those that have been done, contradictory results have been obtained. A combination of both field and controlled greenhouse studies are needed to evaluate B tolerance particularly in relation to salinity. Our goal is to answer this question. Should the answer be that the effects of the two are antagonistic, then B may not be a limiting a factor in the reuse systems than previously thought.

An interdisciplinary research project is proposed involving scientists from the University of California and USDA-ARS Salinity Laboratory in Riverside. The objective is to conduct several experiments in the greenhouse and the field to evaluate the interactions between B and saline drainage water and to determine how limiting B really is to plants grown in drainage reuse systems. Several crops will be tested and experiments will include variable salinity and boron treatments. Particular interest will be directed towards the composition of the salinizing solution to determine what role various salts have on the salinity-boron interaction. It is possible that SJV drainage water that contains a mixture of ions including substantial amounts of sulfate reduces B's toxic effect. Team members, with expertise in soils and irrigation management, plant physiology, salinity and plant nutrition, and soil chemistry will evaluate the interactions between salinity and boron on crops and to determine if, when, and why they occur. This interdisciplinary research will hopefully lay to rest the question of whether boron is a major limitation in drainage reuse systems.