Phosphorus Management Can Reduce the Effects of Soil Salinity

By Paul E. Fixen

Soil salinity is a limiting factor for crop production for many growers in semiarid regions. Both old and new research highlight the importance of phosphorus (P) management on these salt-affected soils.

SOIL SALINITY reduces the yield potential of vast acreages in western North America. The USDA Salinity Laboratory has estimated that nearly 8 million acres are classified as salt affected in the 17 western states of the U.S., including Hawaii. In many cases, water is not available to leach the salts below the root zone and growers must modify crop selection and management to minimize the negative effects on yields and profitability.

Early Research

Phosphorus can play a critical role in the successful management of these soils. As early as 1950, researchers observed that cereal crops growing in moderately saline soils in the glaciated eastern Dakotas often exhibited P deficiency symptoms. These observations caused them to conduct greenhouse and field experiments that generated similar and striking results. The field trial was conducted on a silt loam soil.

Dramatic oat and barley responses to P resulted, especially when banded with the seed (**Figure 1**). Researchers Fine and Carson wrote, "The symptoms usually noted and tentatively regarded as typical salt injury were completely alleviated in all plots receiving P in amounts over 40 lb P_2O_5/A broadcast, or 20 lb P_2O_5/A applied with the seed. The crop appearance was entirely normal in the case of both oats and barley in the phosphated plots, but the others and the oats in the field surrounding the experiment again showed the typical necrotic leaf tip in the seedling stage and later, copper-colored lower leaves and stunted growth, with a dark bluish-green color appearing in the upper leaves as the season progressed."

Later Research

Since this early study, several other researchers have demonstrated that P and salts interact. Nebraska researchers found that increasing salinity decreased both P uptake and P concentration in barley and corn plants. Increasing salinity in a California study reduced P concentration slightly in rye, a very salt-tolerant crop.

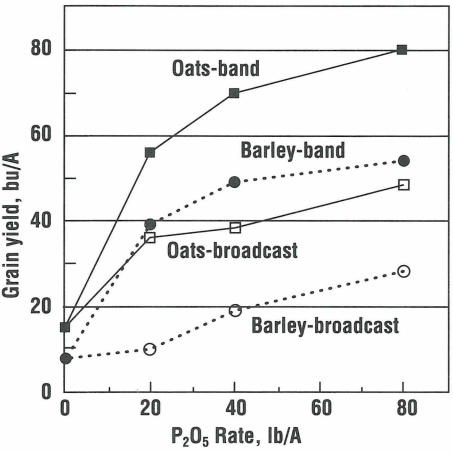
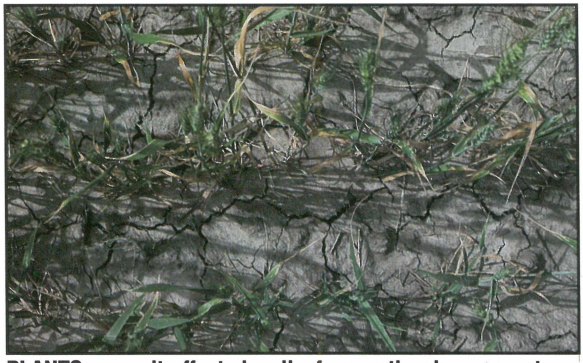


Figure 1. Phosphorus application to a saline soil affects small grain yield. (South Dakota)

Dr. Fixen is Northcentral Director, Potash & Phosphate Institute, P.O. Box 682, 305 5th Street, Brookings, SD 57006, phone: 405-692-6280.

Phosphorus-enhanced salt tolerance in tomato has been demonstrated in Australia with higher than normal P levels required when tomatoes are grown in saline environments. Similar results have been reported for the salt sensitive crops, millet and clover.



PLANTS on salt-affected soils frequently show symptoms similar to those of P deficiency.

Progress has been made in our understanding of how P increases salt tolerance of crops. The observation that plant P uptake and concentrations are often reduced as salinity increases suggests that higher soil or fertilizer P levels may be needed to compensate. Plants with adequate P appear to have an enhanced ability to regulate ionic distribution among leaves of different age, causing reduced levels of sodium (Na) and chloride (Cl) in sensitive young tissues.

Summary

Growers with salt-affected soils should be aware of the importance of providing adequate P to their crops. Banding has been the most effective method of application. The potential exists for a need to adjust soil test P interpretation for saline soils. However, the magnitude of the adjustment, if any, has not been defined. Monitoring the P status of crops using plant analysis may help determine if current practices are sufficient. ■

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collected during the 1st and 3rd cutting of the second year. Phosphorus tissue concentrations ranged from 0.14 to 0.24 percent and related nicely to treatment effects. Phosphorus levels decreased with initial K application when plant P requirements were not being satisfied. When adequate levels of P and K were present in the soil system, P tissue level was 0.18 to 0.20 percent for the first cutting and 0.22 to 0.24 percent for the third cutting. These concentrations reflect critical P levels for whole plants and for the alfalfa varieties evaluated.

Tissue K levels ranged from 1.12 to 1.57 percent when only P or K was provided. When both P and K were at adequate levels, tissue concentrations for the first cutting ranged between 1.25 and 1.42 percent. Third cutting of alfalfa contained higher overall concentrations of both P and K.

Sodium uptake is noteworthy as it relates to K. There is a direct competition within the plant between K and Na. When soil K is high, Na in the tissue is low. The opposite occurs when soil K levels are deficient or low. An increase in tissue Na results in the marginal necrosis seen on some cultivars. This necrosis should be identified as a K deficiency symptom, although it is not always recognized as such.

Summary

In the final analysis, adequate supplies of P and K must be made available to all alfalfa varieties for top yields and top profits. Adequate plant nutrition is essential for efficient production, high water use efficiency, and production of a high quality crop. Although alfalfa varieties do differ in their abilities to cope with low P and K availability, adequate P and K fertilization is essential for all varieties in a profitable production operation. ■