Internal Bark Necrosis in Southeastern Arizona Apples

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Introduction

Internal bark necrosis (IBN) or apple measles is a physiological disorder which occurs on apple trees grown on non-calcareous, acidic soils. It is usually found on Red Delicious varieties which are less than 10 years old. Symptoms occur as a rough or pimply condition on the bark surface on 2-, 3-, and 4-year-old wood.

The condition was recently identified in several southeastern Arizona apple orchards. In some Arizona soils, acidification has occurred from long-term use of ammonia-based fertilizers. Fertilizers such as ammonium sulfate or anhydrous ammonia can also stimulate plant uptake of manganese from soil. The observed symptoms are the results of manganese (Mn) toxicity.

Materials and Methods

Trees in the experimental plot (Angel Valley Orchard, Bonita, Az) were chosen for the following symptoms of IBN: 2-year and older wood was blistered with necrotic centers in the cortex; in some trees, the outer layers of bark were scaly and peeling. Trees were planted in 1985 and were Starkspur Ultrared variety. The site had been previously farmed to cotton and corn. Furrow irrigation is used. The soil type mapped in the experimental area was a Tubac sandy loam.

Soil samples were initially taken in February 1989 and monthly throughout the growing season. Initial soil samples were taken to characterize the spatial variability of pH and DTPA extractable Mn in this orchard. The 0-6, 6-12, 12-24 and 24-36 inch layers of soil were sampled in three specific locations around two representative trees and composited; namely within the tree row at the drip line, at the drip line perpendicular to the tree row, and midway between the tree rows. Monthly soil samples were taken adjacent to the trees and at the drip line from the top nine inches of soil between February and October 1989. Trees also were observed monthly for IBN symptoms.

Lime (calcium hydroxide) applications were made on March 14, 1989. All experimental trees were pruned to remove the majority of affected wood prior to lime treatment; trunk and scaffold limbs were retained. Plots consisted of four trees in each of four replications. Treatments were control (no lime added), low application (0.5 ton lime per planted acre), and high application (1.0 ton lime per planted acre). These rates of lime are calculated on the basis of pure calcium carbonate ($CaCO_3$). The lime was placed in a rectangular area adjacent to the tree extending from the drip line to about halfway beyond the furrow towards the mid-row point. The material was lightly incorporated into the top several inches of soil by disking and irrigated normally following application.

The orchard was fertilized with 100 lbs. UN32 in April 1989.

Leaf tissue samples were obtained on July 14 according to standard procedures.

Results

Soil samples: The initial soil samples (prior to lime application) showed that the area of lowest pH and correspondingly highest Mn levels was confined to the surface 6 to 12 inches of soil, particularly in the area of the drip line of the trees (Figure 1). This also corresponds to the general location of the irrigation furrow and the point at which potentially acidifying nitrogen fertilizers are applied. The later monthly soil samples indicated that lime was effective in causing rapid and sustained elevation in the pH of the surface nine inches of treated soil (Figure 2).

Leaf samples: All leaf samples, regardless of treatment, had manganese concentration between 273 and 316 ppm. Toxicity is reported where the Mn content is greater than 200 ppm. Therefore, the lime treatments have not yet reduced Mn uptake by the trees.

Symptoms: No new bark symptoms are evident on treated or untreated trees following lime application. In those cases where scaly, affected bark was not pruned from the tree (i.e. on the trunk), this tissue has continued to peel and slough off.

Conclusions

Applications of calcium hydroxide were very effective at increasing the pH of the surface soil but had no effect on reducing levels of Mn in leaf tissue below the toxic range (200-300 + ppm Mn). One explanation of this is that deeper placement of lime, perhaps to 12-18 inches, may be required. It can also be concluded that surface applications of lime to existing orchards exhibiting IBN symptoms are not effective at reducing Mn availability after one growing season and perhaps longer. The most effective way to alleviate Mn toxicity in susceptible apple varieties grown on acidic soils is to apply lime prior to planting followed by incorporation to a depth of 12 inches or more if feasible.

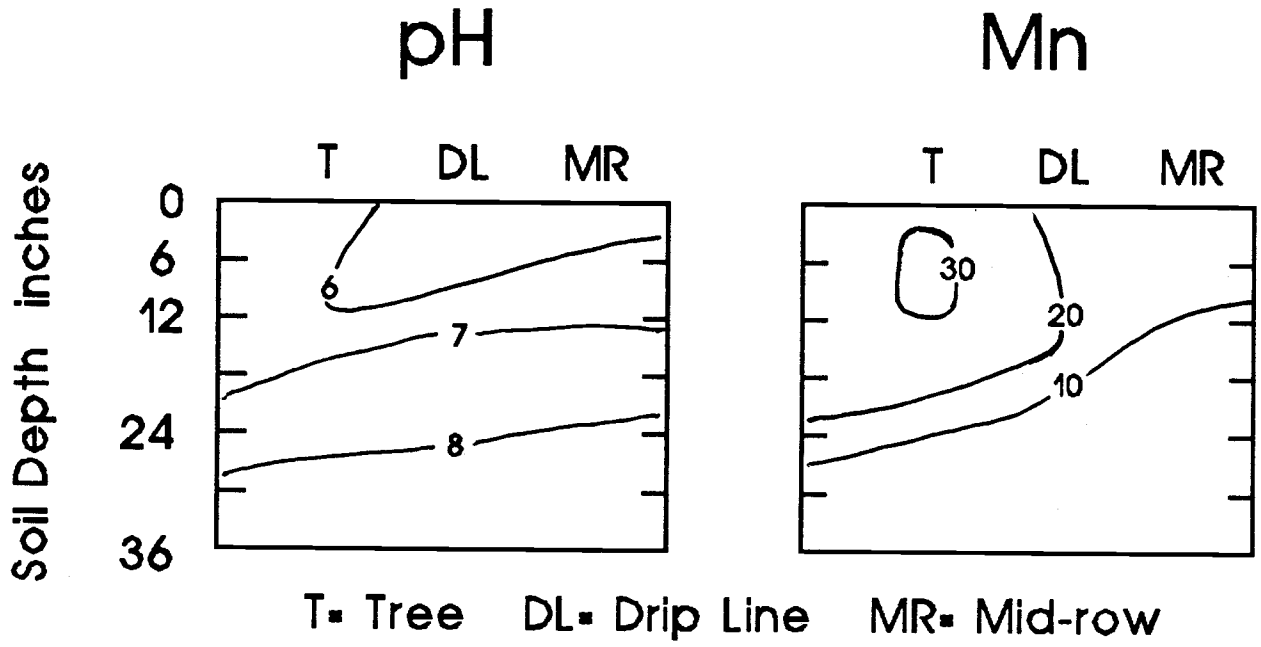

Figure 1. Soil pH and extractable manganese distribution in Spur Red orchard prior to lime applications.

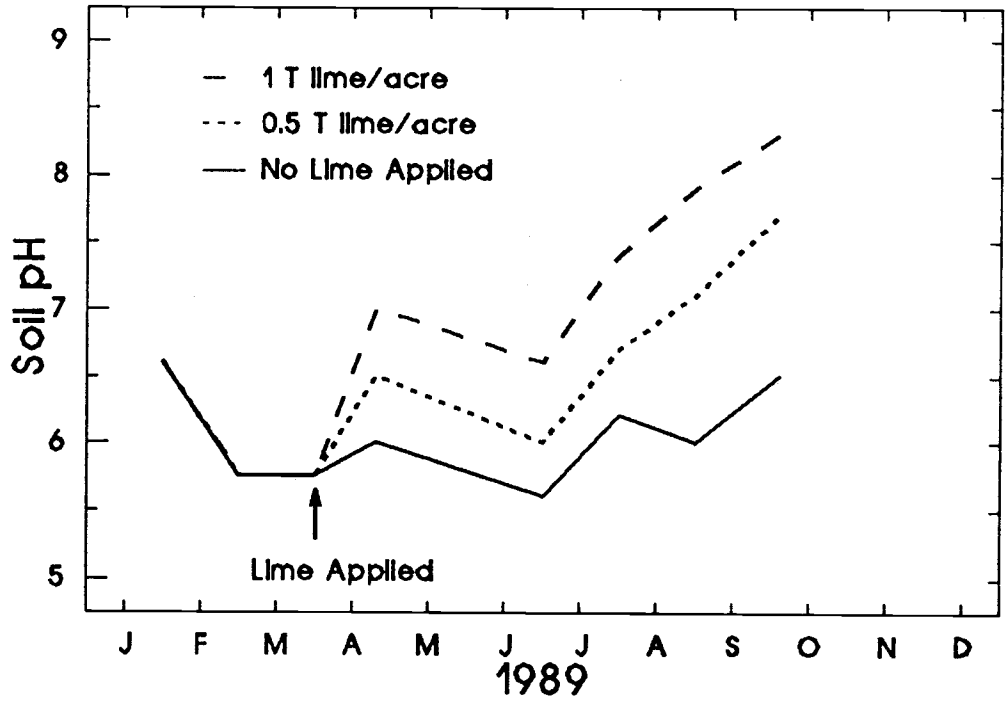

Figure 2. Seasonal changes in soil pH in a Tubac sandy loam receiving different rates of lime.