Impact Of N-Fertilization And Irrigation On Active And Reserve Soil Acidity

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Soil acidity presents a complex production problem in the successful growth and yield of cotton (Gossypium hirsutum L.). Excessive soil acidity results in low soil pH which may liberate plant toxic levels of manganese and aluminum by soil minerals, and interfere with nitrogen and phosphorus availability. Soil acidity is composed of two components. Active soil acidity is measured as soil pH and reacts quickly in the soil-plant system. Potential or reserve acidity is inactive in the soil, and acts as a source of replenishment for active acidity. Sources of active acidity are exchangeable and dissolved hydrogen and aluminum ions. Sources of potential or reserve acidity include 1exchangeable aluminum displaced from clay minerals and aluminum polymers deposited in the soil and on the interiors of siliceous clay minerals. Potential acidity may release hydrogen ions that will enter the soil and replenish active acidity. Together, active acidity and potential acidity comprise the total acidity of a soil. When lime applications are necessary to reduce soil acidity, both the active soil acidity and the replenishing potential acidity must be neutralized to result in a soil pH that is acceptable for crop growth.

Acid soils typically have soil pH values less than optimum for plant growth. Generally, soil pH values below 5.5 tend to impede healthy, rapid plant growth. Sources of acidity vary widely among soils but may be classed as either geologic or agricultural. Geologic soil acidity results from the weathering of sulfide and aluminum bearing minerals. The weathering of these minerals results in hydrogen and aluminum ions which are released into the soil solution. Agriculturally produced soil acidity may be generated from the application of ammoniacal-nitrogen fertilizers, sulfur and sulfide fertilizers, and the removal of basic cations of the soil with crop harvest. Irrigation water with high salt content or high bicarbonate content is known to neutralize acidity and add basic cations to the soil, thereby reducing total soil acidity.

Studies to determine the effect of ammoniacal-nitrogen fertilizer treatments and irrigation methods on plant growth and development of cotton as well as changes in soil properties were conducted. These studies were carried out in side-by-side irrigation blocks at the Southeast Branch Experiment Station at Rohwer, Arkansas, on an Hebert silt loam (fine-silty, mixed, thermic Aeric Ochraqualfs) soil. This test, the McConnell - Mitchell Plots, is the oldest continuous agronomic test in Arkansas. The irrigation method reported is furrow flow and was compared to a dry land control. Nitrogen treatments reported within each block are 0-, 60-, and 120 lb N/acre. Nitrogen treatments were first applied in 1982 and continued through1999; discontinued from 2000 through 2003; then resumed in 2004. Soil samples were taken in the early spring of 2005 prior to N-fertilization from depths of 0 to 6 inches and 6 to 12 inches. The samples from three replicates of each N-treatment from both blocks were analyzed for active and potential acidity. Active soil acidity was determined by measuring the pH of a soil and water slurry. Potential acidity was determined by titrating soil-water slurries with calcium hydroxide solutions and evaluating changes in pH.

The calcium, sodium and bicarbonate contents of the irrigation water at the test site were driving forces to reduce both active and potential soil acidity. Fertilization with ammoniacal-nitrogen sources was the driving force in increasing active and potential soil acidity. Active soil acidity was monitored over the duration of the experiment.