



Effect of fertilizer salts on soil pH

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Fertilizer salts are often referred to as soluble salts since they dissolve readily in water and leach with rainfall. Salt levels are typically highest soon after the crop is fertilized and lowest in fall and winter months due to crop uptake/removal and movement with rainfall (leaching).

Soil water pH and buffer pH are standard electrode measurements made in soil testing labs. Soil water pH, often referred to as pH, is a measurement of acidity (hydrogen- H^+) in the soil solution; buffer pH is a measurement of exchangeable acidity (H^+ & Al^{+3}) associated with soil particles. Both of these pH measurements are needed to accurately estimate lime requirements. Soil water pH is usually measured in a distilled water solution after the sample has equilibrated for about one hour. After soil water pH is measured, a buffer solution is added to the sample and a reading taken at least 30 minutes later.

Soil pH may be affected if significant fertilizer salts are present; salts have no effect on buffer pH since the buffer solution contains salt. The presence of salt will lower soil pH reading compared to the absence of salts; the lower pH is often referred to as salt depression of pH. Salts may depress pH slightly (0.1 pH units) or by as much as 1.0 pH units.

The Agronomic Division lab estimates an average pH depression of about 0.6 pH units. For example, a soil pH of 6.0 without salts would read 5.4 if salts were present. Given the known effects of salts on pH measurement, some labs read pH in a weak salt solution to normalize pH from fertilizer salt effects.

In much of North Carolina, the summer of 2007 was exceptionally dry resulting in low crop yield, although fertilization was normal. Consequently, this fall and winter, soluble salt levels in the topsoil are more elevated than usual due to the presence of residual fertilizer. Therefore, soil test pH readings may be lower than expected due to salt depression of pH, consequently resulting in higher-than-normal lime recommendations. Another contributing factor is the drought, which has largely prevented the reactivity of any lime applied before last season's crop, especially lime applied under no-till conditions.

Many growers and consultants are questioning lime requirements being higher than normal. As explained, the higher-than-normal requirements could be due to salt depression of pH and limited reaction of applied lime, both due to dry soil conditions. The ultimate question is what should growers do about lime this season? Some helpful guidelines follow.

Guidelines for lime application in 2008

1. Where there is a history of soil sampling, use prior years' reports and management experience to finalize recommendations.
2. Check to see whether a higher lime recommendation may be due to the higher target pH of the upcoming crop. For example, whereas most crops have a target pH of 6.0, 6.2 is optimal for cotton and 6.5 optimal for bermuda.
3. Pay attention to the exchangeable acidity measurement (Ac value on NCDA&CS soil reports) because is not affected by salt. Exchangeable acidity is reflected in base saturation (BS%) data. Sandy, coastal plain mineral soils with a BS% of 80 typically have a soil pH of 5.8 to 6.0. Higher BS% values are expected for higher target pHs. Piedmont soils are generally similar to coastal plain soils in these relationships. For organic soils, a target pH of 5.0 is generally achieved at a BS% or 50 to 60.
4. Take particular care when liming sandy soils with low organic matter. They have low resistance to change in pH as compared to clay and organic soils (low buffer capacity) and are, therefore, easiest to overlime.
5. Given the crop and fertilizer management, consider the potential impact of low or high pH and ease of corrective action in finalizing recommendations.
 - Corn and tobacco can generally tolerate more acid conditions than legumes (soybeans and peanuts) and cotton.
 - Higher than normal pH often results in manganese deficiency, especially on sandy coastal plain soils.
 - Soybeans and small grains are more sensitive to manganese deficiency caused by high pH than corn or cotton. Manganese deficiency is easily corrected by foliar application.
 - Nitrogen inputs from ammonium and urea will lower pH. About 540 lb of lime is needed to neutralize acidity from 100 lb of nitrogen coming from ammonium sulfate; 180 lb of lime is needed for 100 lb of nitrogen coming from other urea or ammonium sources.
 - There is no way to correct low pH after the crop is planted.