Progyp™ "A Soil and Plant Fertility Product"

Reducing Soil Acidity Caused by Nitrogen Fertilizers

Introduction:

Soil acidity is among the most important environmental factors which can influence soil properties and productivity, nutrient uptake and efficiency and crop production.

Causes of Soil Acidity:

Research shows that hydrogen (H^+) and aluminum (Al^{3+}) ions are the predominant forms of acidity in soils; the higher the H^+ and Al^{3+} concentration the lower the pH, increasing soil acidity. Each type of soil has a certain level of acidity depending upon its composition, agricultural practices and rainfall amounts, however, various factors over time cause changes in soil pH and acidity; fertilizer practices, leaching, erosion, crop uptake of basic cations (calcium, Ca^{2+}; magnesium, Mg^{2+}; potassium, K^+), decay of plant residues, microbial activity and plant root exudates are all means by which the soil acidity is increased.

Nitrogen Fertilizer Use:

One of the primary reasons for our soils becoming more acidic (lower pH values) over time is through the use of nitrogen (N) fertilizers containing ammonium-N. As the ammonium-N in fertilizers undergoes nitrification (conversion of ammonium to nitrate in soils by bacteria), H^+ is released, which can increase acidity. As the percentage of ammonium increases in a given fertilizer the acidifying potential will also be increased, thus reducing pH and increasing acidity in soils.

$$NH_4^+ + 2O_2 = NO_3^- + 2H^+ + H_2O$$

(Nitrification - 2 H^+ ions are produced for every ammonium ion converted to nitrate)

Ammonium-N can also increase acidity through plant uptake and soil solution charge balance. For example, as plant roots absorb ammonium-N (a positive charge) they secrete H^+ (another positive charge) to maintain charge balance across the membranes of the plant cell walls. One common way to express the relative acidifying effects of N fertilizers is through pounds of effective calcium carbonate (ECC) that is required to neutralize the acidity from 1 pound of actual N.

Amount of ECC required to neutralize the acidity created by different N fertilizers

N Fertilizers (Commonly Used)	Analysis N P K	Effect on Soil pH	Lbs. of ECC Needed to Neutralize 1 lb. of Actual N
Ammonium Sulfate	21-0-0	Very Acid	7
Sulfur-Coated Urea	35-0-0	Very Acid	7
Monoammonium Phosphate(MAP)	11-48-0	Acid	7
Ammonium Polyphosphate Solution	10-34-0	Acid	7
Diammonium Phosphate (DAP)	18-46-0	Acid	5
Ammonium Nitrate	34-0-0	Acid	3
Urea	46-0-0	Sl. Acid	3
UAN Solutions	32-0-0	Sl. Acid	3
Anhydrous Ammonia	82-0-0	Sl. Acid	3
Calcium Ammonium Nitrate	25-0-0	Sl. Acid	3
Calcium Nitrate	15-0-0	Basic	0
Potassium Nitrate	13-0-0	Neutral	0

This may raise some questions:

1. ***Why is anhydrous ammonia only slightly acidifying?***
   When ammonia is added to the soil it reacts with water to form ammonium-N, which is an alkaline reaction that initially raises the pH of the soil. However, as ammonium-N undergoes nitrification acidity is produced. These two reactions (the alkaline reaction of ammonia and the acid reaction of ammonium-N) do not quite balance out, but come close. The end result is a slight acidifying effect.

2. ***Why is urea only slightly acidifying?***
   When urea is added to the soil it undergoes a reaction to form bicarbonate and ammonium-N. The bicarbonate then reacts with H^+ ions in the soil solution, which temporarily reduces acidity, but acidity is again produced when ammonium-N undergoes nitrification. However, the overall net effect is similar to anhydrous ammonia in that it is only slightly acidifying.

3. ***Why do calcium nitrate and potassium nitrate not acidify soil?***
   Both calcium and potassium nitrate do not contain ammonium-N. As a result, they do not acidify the soil.

4. ***Why is ammonium sulfate more acidifying than other N fertilizers?***
   When added to soil ammonium sulfate does not use up any H^+ ions in the soil solution, therefore, the full acidifying effect of the nitrification process impacts soil pH.

Recommendations to Reduce Soil Acidity:

- Testing soil pH is an excellent indicator of soil acidity. To adjust soil pH to a desired level for a particular crop depends on the initial soil pH, soil clay content and soil buffer capacity (resistance to pH change).
- To reduce H^+ levels in the soil and soil acidity avoid or reduce the use of ammonium-N fertilizers:
  - A fertilizer strategy to limit soil acidity can reduce the rate of liming and decrease related liming expenses.
  - For example, use Progyp, which contributes no H^+ (acidity) to soils, in combination with low acidifying N fertilizers to displace ammonium sulfate or sulfur-coated urea. The Progyp will contribute soluble calcium and sulfur replacing contributions from limestone and sulfur containing N fertilizers.
  - By limited H^+ additions to soils, it may improve soil properties, pH stability, fertilizer efficiency and crop production.
- Combine limestone and Progyp applications – soluble calcium from Progyp can complement the neutralizing capacity of limestone to reduce soil acidity from H^+:
  - Limestone in soil has limited mobility; it reacts and moves very slowly into the soil to neutralize acidity (H^+). The carbonate in limestone acts directly on H^+ to convert it into non-acidic forms of H^+. Progyp, on the other hand, is very mobile and can move into the subsoil much more rapidly than limestone providing soluble calcium and sulfur into the lower levels of the soil. The soluble calcium from Progyp will displace H^+ in the subsoil; improving cation exchange capacity, base saturation and other soil properties, H^+ will then be leached from the subsoil providing a reduction in soil acidity.
- Low levels of soil acidity (H^+), if limited change in soil acidity is needed consider using Progyp, the soluble calcium from Progyp will displace H^+ in the subsoil; improving cation exchange capacity, base saturation and other soil properties, H^+ will then be leached from the subsoil providing a reduction in soil acidity.
- Make sure soils need liming - high pH can reduce nutrient availability and plant growth.

23011 Airpark Drive, Petersburg, VA 23803
Toll Free (800-798-5605)
Local (804-732-6551)
Fax (804-733-1368)

Granco Minerals