Ask Ms. Ag Expert

How does soil pH affect crop production?

Ken, from Saskatoon

A simple soil test will provide the soil pH. Soil pH is a measurement of the acidity (alkalinity) in soil. The pH level is a logarithmic scale ranging from 0 to 14. With 7 being neutral, values less that 7 are acidic, values greater than 7 are alkaline. As the H^+ (hydrogen) ion concentration increases, the pH level decreases. Then as pH increases, OH^- (hydroxyl) ions increase above 7. The optimal pH range for most crop plants is 5.5 to 7.0 however; each crop species has its own specific critical range.
Soil pH can influence on plant nutrient availability. If the pH level is outside the critical range, certain nutrients including micro-nutrients may not be readily available to the plant even if present in the soil. Crops can only reach their full yield potential, when the soil pH is within the critical range.

Soil pH affects the solubility of non-essential elements such as aluminum (Al) and manganese (Mn) which can restrict other plant-available nutrients. Here is how it can work: In low pH (acidic) soils, essential key plant-available nutrients like phosphorous, calcium and molybdenum become less available to the crop plants, and can have their availability restricted to the plants. Even if there are sufficient levels of these nutrients in the acidic soil, they are merely tied up or blocked by soluble aluminum ions.

Certain Agronomic Factors Can Influence Soil pH Levels in Western Canada (Ranked highest to lowest)

1. Soil Composition – The parent material (or primarily material the soil originated) can influence the pH of the soil. Also, the organic matter content can influence the level of acidity, since high organic matter can buffer acidity to some degree.

2. Nitrogen Fertilizer (Urea, UAN, Anhydrous) application increases the acidity level of the soil simply by releasing H^+ ions . Different forms of fertilizers can vary their effects on soil pH. Ammonium sulphate (AMS), is a significant influencer in reducing soil pH and is a crucial source of sulphur to supply canola crops. Information in Table 1 (below) demonstrates that it takes seven pounds of Aglime (crushed limestone as a source for agricultural lime) to neutralize the effects of one pound of nitrogen in AMS. Other common nitrogen fertilizer sources take less agricultural lime (Aglime) to neutralize the effects of soil pH.

Nitrogen Source	Aglime (pounds) to neutralize 1 pound of N
Ammonium Sulphate	7
Ammonium Phosphate	7
Anhydrous Ammonia	4
Urea	4
28% Solution	4

Table 1: Demonstrates the quantity of Aglime (crushed limestone) to neutralize 1 pound of nitrogen from nitrogen fertilizer sources. Reference: Dr. J. E. Sawyer, Iowa State University

3. Basic nutrients can be removed through cropping – Continuous cropping practices and even a steady increase in crop yields means there is an increased removal of plant available nutrients from Western Canada's soils. Over time, hydrogen can replace these depleting basic nutrients like Ca, Zn, Mg, K, P in the soil, increasing soil acidity.

4. Basic Ions - Can be washed down or leached by water movement, removing the basic plant available nutrients from the root zones leaving H^{+}, Al^{++}, and Mn^{+} which increase soil acidity. This is a major factor in soil pH reduction globally, especially in areas of high annual rainfall.

Lowering soil pH (Alkaline soils)
With the exception of extremely high value crops or ismall areas, it is not economical to attempt to lower the soil pH. Elemental sulphur can be used as a soil amendment to reduce the pH; however; the required amounts can be in excess of a metric tonne / acre depending on soil texture and calcium carbonate content.

Raising Soil pH (Acidic soils)
Liming can improve soil productivity. This is not a common a practice in Western Canada but it is common in the US and globally. The calcium in applied lime neutralizes (counteract) the acidic effects of H^{+} ions bound to soil organic matter and clay. As soil pH is raised with the use of lime, we increase the availability in other plant accessible nutrients.

$$CaCO3 + 2H^{+} = Ca+2 + CO2 \uparrow + H2O$$

Not all limestone products are the same. The ability to influence pH depends on the type of lime used. **One must consider two key factors when choosing what products to use:**

→ Calcium content of the product - lime products have a specific amount of calcium available to counteract the low pH. This is measured by the content of the calcium (CCE). Products like Super Cal -High Calcium Limestone is 96% effective or while wood ash can range from 30 -70% effective depending on the calcium content.

→ Particle size - The second factor to consider for limestone quality is the particle size. The smaller the particle, the less time it takes to effectively neutralize soil pH. Particle size is a measurement of the sieve size used to screen the limestone.

Effective Calcium Carbonate Equivalent (ECCE) combines the calcium content and particle size to determine the limestone quality on a percent basis.

The amount of lime needed will depend soil texture and the amount of soil pH change you wish to change and the soil depth you wish to influence. It is not uncommon to consider limestone rates of 2 to 5 metric tonne per acre for a heavy clay soil. Due to these high rates required for pH adjustments, application alone can be a challenge. Limestone products can be difficult to apply and special equipment may be required for uniform application. Western Canada is somewhat new to liming so this equipment is not easily accessible.