Soil pH and Crop Response

CERTIFIED CROP ADVISER

By Greg Patterson, *CCA*

One of the most overlooked problem areas in crop production today is soil pH. Too often when we receive soil test results we ignore the pH or lime requirements because we don't count it as a direct nutrient input. The reason for this is because pH or buffering soils has not received the attention that it warrants since most agronomists assume that its importance is understood.

Have you ever noticed during one of your walking crop inspections, a field or even a spot in a field with barren cobs, stunted growth, yellowing, etc.?

If yes, have you taken the time to test these areas or even consult a soil test to determine the cause? Problem areas such as these are usually caused by soil pH being either too high or too low, and no amount of fertilizer application will correct this condition. Because of the direct effect on soil chemistry and soil plant interactions, pH range is the most important factor that should be taken into account when developing a cropping program.

The ideal pH level for most plant growth, and adequate nutrient release is in the range of 6.2 – 6.8. At this level nutrients are readily available and if adequately supplied plant growth is optimum. The benefit of this is better plant production and less chance for disease and poor quality.

Acid or low pH soils become toxic to plants due to the increased availability of certain nutrients, however this is not the only reason for poor plant growth in low pH soils. Soils are acid because the subsoil or parent materials are acid and low in calcium, magnesium, potassium, and sodium, or because these elements have been removed from the soil by harvesting crops. Calcium plays an important role in plant nutrition from protein synthesis by its enhancement of the uptake of nitrogen to a number of complex enzyme systems. Ekdahl (1957) et al, found that root growth was increased 40% when the pH of the soil was increased from 5.5 to 7.2. The reason for this is that calcium plays a major part in the development of young root hair tissue and cell elongation. Therefore, in soils deficient in available calcium, root development is greatly inhibited, reducing the plant's ability to take up nutrients and water.

In acid soils low in available calcium, other factors also influence the uptake of nutrients and the retention of nutrients by plant roots. Low pH soils contain high levels of hydrogen ions that are toxic to root development and have a detrimental effect on root permeability. Long exposure to low pH or excess hydrogen ions, cause root membranes to become leaky and they may lose nutrients (cations) that have previously been absorbed. The high concentration of hydrogen ions also competes with other nutrients for absorption sites both on the exchange complex and the root surface (Christiansen et al 1970).

Another major interaction that is not completely understood is the effect pH has on bacteria and other organisms in the soil that are beneficial to plant growth.

Rhyzobia bacteria, required by legumes to produce nitrogen, are affected by pH as listed in the table below. Although the tolerant ranges of rhyzobia to pH are wide the amount of nitrogen that is produced is greatly influenced by less than optimum pH.

Microbial activity in soils that are involved with the mineralization of organic matter and the release of nutrients are greatly influenced by pH. Nitrosomonas and nitrobacteria that are responsible for ammonification from decomposition of organic matter and the oxidation of ammonia to nitrite and nitrate are greatly influenced by pH. Nitrification being greatly reduced at pH values less than 6 or greater than 8. In general, the mineralization of all nutrients and the levels at which they become available for plant nutrition or become toxic is greatly influenced by soil pH.

Soil pH correction and calcium content of a particular soil type, however general it may seem, is also specific to certain crops. An ideal level for some crops may not be optimum for others that require high levels of calcium. When determining whether a field requires lime, we need to look at the balances of the cations and the crop to be grown in order to make this decision. Often times we make the decision not to spread lime on a particular field because the pH is above 6.0 and for most cases within the tolerant range. However, we should also look at the balance of the cations before we rule out the need for lime application.

In summary, with lower commodity prices, higher input costs and the need to reduce the per unit cost of production, it is essential that we produce higher yields of quality product. Therefore when designing a cropping system, details such as soil pH must be analyzed and more attention paid to the basics of plant nutrition.

TABLE 1

	Optimum pH	Rhyzobia pH Tolerant Range	Rhyzobia Killed at pH
Red Clover/Sweet Clover	6.5	4.5 – 8.0	4.7
Alfalfa	6.2	4.7 – 8.3	5.0
Soybeans/White Beans	6.0	4.8 – 8.3	4.0

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