Agro Services International Inc.

Nutrient Management in high pH soils

Alkaline soils have pH values higher than 7.0 and are quite common. Many of these soils are naturally alkaline while others have been made alkaline by over-liming or using high pH irrigation water in arid areas. Whatever the cause, these soils possess unique properties that can severely limit plant growth and require special management.

The high pH itself does not have a large effect on most crops although there are exceptions. In most cases, plants growing on alkaline soils are affected by nutrient problems.

As the soil pH increases, the solubility of many nutrients is reduced. As a result, these nutrients are precipitated as solid materials that plants cannot use. For example, the solubility of iron at pH 4.0 is 100 ppm but if the pH is increased to 6.0, the solubility drops to 0.01 ppm. At pH values above 7.5, the amount of iron in solution is often too low to sustain healthy plant growth.

Iron is not the only nutrient that becomes unavailable to plants at high soil pH, the same problem also occurs with phosphorus, manganese, zinc, copper and boron. Many alkaline soils also contain low amounts of magnesium. The calcium levels of these soils are often very high and this can reduce the uptake of potassium and magnesium even when there is enough in the soil.

Plants differ in their ability to tolerate high pH soils. In moderately alkaline soils, some plant roots can secrete high amounts of acids into the soil. This lowers the pH immediately around around the roots and increases nutrient availability. In very alkaline soils (pH values above 7.8), even these plants experience nutrient deficiencies.

Iron deficiency in beans on a high pH soil.

Micronutrient deficiencies may sometimes be seen in crops grown on alkaline soils. In many cases there are no clear plant symptoms, but growth is poor because of the nutrient deficiencies.

The first step in managing these soils is to measure the pH to confirm that they are really alkaline. If the soil pH is greater than 8.3, the level of soluble salts and sodium should also be analyzed to determine if the soil is also saline and/or sodic. Saline soils require special management techniques which are not covered in this document.

In soils that do not contain free carbonates, it is possible to reduce the pH by applying elemental sulfur. The sulfur itself has no effect on pH, but it is converted into sulfuric acid by bacteria in the soil. Acidifying fertilizers such as ammonium sulfate will also gradually reduce the soil pH. It is very difficult to acidify soils that contain free carbonates.

It is usually easier to manage the nutrient deficiencies than to acidify alkaline soils. A soil test is therefore needed to determine which nutrients are in short supply. It is critical to have a complete analysis done, including the levels of micronutrients which are often deficient. You also need to be careful about how the analysis is done.

Several laboratories use acidic solutions to extract nutrients from the soil. These methods work well on acidic soils but give misleading results on alkaline soils as they dissolve nutrients that are not really available to plants. For example, the commonly used Double-Acid, Melich 3, Bray's or Troug's methods of determining available phosphorus all give incorrect results on high pH soils. The Olsen or Modified Olsen methods must be used in this case.

If phosphorus is needed, a soluble fertilizer must be used. TSP, DAP or MAP are suitable, rock phosphate is not as it does not release its nutrients under high pH conditions. Where possible, the phosphorus should be banded in the soil to reduce fixation.

Magnesium should also be applied as soluble materials. SULPOMAG, kieserite and epsom salts work well. Magnesium carbonate and oxide are not as effective as they do not dissolve in alkaline soils.

The micronutrients present special problems. The oxides and carbonates do not dissolve in alkaline soils, but even the soluble materials such as sulfates are rapidly precipitated, making them ineffective. Specially prepared chelates are necessary. EDTA chelates are often used but in the case of iron, the expensive DTPA and EDDHA chelates may be needed. For this reason, it is often more cost-effective to foliar-apply micronutrients to crops growing on alkaline soils.

All potassium fertilizers can be used on high pH soils. Ammonium based fertilizers and urea can be lost from high pH soils by ammonia volatilization and therefore nitrate-based materials may appear to be a better choice. However, the nitrates can be easily leached or denitrified under high rainfall conditions. The only practical way to manage nitrogen on these soils is to either apply small, regular doses or use slow-release materials.

There are cases of sandy soils with moderate to high pH levels that do not contain sufficient levels of calcium. In this instance, limestone should not be used to supply the calcium, gypsum or calcium nitrate can be used instead.

The nutrient deficiencies that occur on alkaline soils often cause crop failure, but if a balanced plant nutrition program is implemented, most crops can be successfully grown.

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