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Nitrification approaches zero below pH 5. Ammonium-N fertilizers applied to calcareous soils are converted within a few days to nitrate, which moves freely with soil water. The acidity produced during nitrification is quickly neutralized in highly calcareous soils but may lower the pH value in soils containing low levels of $CaCO_3$.

Ammonia volatilization is the loss of N to the atmosphere through conversion of the ammonium ion to ammonia gas (NH_3). Volatilization of ammoniacal-N fertilizer is significant only if the soil surface pH value is greater than 7 where the fertilizer is applied. This condition occurs in calcareous soils, or where the breakdown of the N fertilizer produces alkaline conditions (e.g., urea decomposition). Nitrogen loss through ammonia volatilization on calcareous soils is a concern when ammoniacal N is applied to the grove floor and remains there without moving into the soil. Following an application of dry fertilizer containing ammoniacal N, the fertilizer should be moved into the root zone through irrigation or mechanical incorporation if rainfall is not imminent. Urea breakdown creates alkaline conditions near the fertilizer particle; surface application of urea can cause N loss if the urea is not incorporated or irrigated into the soil, regardless of initial soil pH.

THE EFFECT OF $CaCO_3$ ON MAGNESIUM AND POTASSIUM

Although low concentrations of Mg and K in citrus leaves are not uncommon in groves planted on calcareous soils, there is not necessarily a concurrent reduction in fruit yield or quality. If a low concentration of leaf K or Mg is found in a grove that produces satisfactory yield and quality, attempts to increase leaf levels with fertilizer are not necessary. However, if a detrimental condition such as low yield, small fruit, or creasing is observed, an attempt to raise the leaf K or Mg concentration with fertilizer is justified.

It is often difficult to increase leaf Mg and K levels with fertilizer applied directly to calcareous soils, which contain tremendous quantities of both exchangeable and nonexchangeable Ca. Leaf Mg and K concentrations are strongly influenced by soil conditions that control leaf Ca concentration, including high soil Ca levels. High Ca levels suppress Mg and K uptake by citrus trees in part, presumably, through the competition of Ca^{2+}, Mg^{2+}, and K^{+}. Citrus growing on soils high in Ca often requires above normal levels of Mg and K fertilizer for satisfactory tree nutrition. In cases where soil-applied fertilizer is ineffective, the only means of increasing leaf Mg or K concentration may be through foliar application of water-soluble fertilizers, such as magnesium nitrate [$Mg(NO_3)_2$] or potassium nitrate (KNO_3).

THE EFFECT OF $CaCO_3$ ON PHOSPHORUS

Phosphorus availability in calcareous soils is almost always limited. The P concentration in the soil solution is the factor most closely related to P availability to plants. The sustainable concentration is related to the solid forms of P that dissolve to replenish soil solution P following its depletion by crop uptake. Many different solid forms of phosphorus exist in combination with Ca in calcareous soils. After P fertilizer is added to a calcareous soil, it undergoes a series of chemical reactions with Ca that decrease its solubility with time (a process referred to as **P fixation**). Consequently, the long-term availability of P to plants is controlled by the application rate of soluble P and the dissolution of fixed P. Applied P is available to replenish the soil solution for only a relatively short time before it converts to less soluble forms of P.

TESTING CALCAREOUS SOILS FOR P

Accumulation and loss of soil P can be evaluated through soil testing, but more information is required to make a fertilizer recommendation based on this method. The amount of extractable P must be related to crop yield or quality. An ideal P-extracting solution should remove from soils only those forms of P that are available to plants. This is difficult to achieve with the extracting solutions that are currently used.

The major extractants used by southeastern U. S. soil testing laboratories to measure soil P include Mehlich 1 (double acid), Bray P1 and P2, and sodium bicarbonate. Mehlich 1 is not appropriate for use on calcareous soils because its extracting ability is weakened by exposure to $CaCO_3$. While Bray and sodium bicarbonate have been consistently correlated to P uptake by plants growing on calcareous soils in other parts of the United States, these extractants have not been calibrated with citrus leaf P concentration or yield on Florida calcareous soils. Mehlich 3, a newer extractant with promising ability for Florida conditions, is not yet widely used and also will require calibration. Currently, no suitable extractant for soil P has an established, calibrated