

Nutrient management of citrus trees on alkaline soils

By Mongi Zekri, Tom Obreza and Kelly Morgan

Calcareous soils are alkaline (pH > 7) due to the presence of excess calcium carbonate (CaCO₃). These soils can contain from 1 percent to more than 25 percent CaCO₃ by weight, with pH in the range of 7.6 to 8.4. In Florida, soil pH is usually not higher than 8.4 regardless of CaCO₃ concentration.

Many Florida flatwoods soils contain one or more horizons (layers) that are calcareous. A typical characteristic is an alkaline, loamy horizon less than 40 inches deep that can be brought to the surface during land preparation for citrus planting. Increased nutritional management intensity is required to successfully grow citrus on calcareous soils. Some grove soils (e.g. ditch banks) contain considerable amounts of lime rock or shell. It may not be economically justifiable to plant these sites with certain rootstocks considering the management problems and costs involved.

Citrus fertilizer management on calcareous soils differs from that on non-calcareous soils because the presence of CaCO₃ directly or indirectly affects plant availability of N, P, K, Calcium (Ca), Mg, Mn, Zn, Fe and Cu.

MACRONUTRIENTS

Nitrogen (N)

Soil pH affects biological and chemical reactions that influence plant N use-efficiency. Nitrification (the conversion of ammonium to nitrate by soil bacteria) is more rapid in soils with pH between 7 and 8. Volatilization of ammoniacal-N fertilizer can be significant if the pH of the soil surface is greater than 7 where fertilizer is applied. This condition occurs in calcareous soils or where the breakdown of the N fertilizer material produces an alkaline condition (e.g. urea decomposition).

Nitrogen fertilizer should be managed to minimize ammonia volatilization. If rainfall is not imminent following application of ammoniacal-N to the surface of a calcareous soil, the fertilizer should be immediately moved into the soil with irrigation water. Urea applied to the surface of any soil should also be irrigated in as soon as possible. Fertigation using either of these sources is a suitable application method because the N immediately enters the soil.

Phosphorus (P)

Availability of P 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. This 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, 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 P availability is controlled by the application rate of soluble P and the disso-



Calcareous soil in Southwest Florida

lution 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. To maintain P availability to citrus on calcareous soils, water-soluble P fertilizer should be applied on a regular, but not necessarily frequent, basis. Since P accumulates in the soil, it is at least partially available as it converts to less soluble compounds with time.

Potassium (K)

Low leaf potassium (K) concentration is common in groves planted on calcareous soils. If low yield, small fruit, fruit splitting, and/or creasing are observed, application of additional K fertilizer is justified. One approach is to increase the N:K₂O fertilizer rate ratio from 1:1 to 1:1.25 (i.e., apply 25 percent more K₂O than normal). This approach may not work in all situations. Therefore, if trees do not respond to soil applications, foliarly-apply potassium nitrate (KNO₃) or monopotassium phosphate (KH₂PO₄) may be applied two or three times during the spring and early summer. Take precautions to avoid foliar burn from high-spray concentrations, e.g., avoid concentrations greater than 20 lbs. KNO₃ per 100 gallons of water.

Magnesium (Mg)

If soil test Mg is medium or low (30 ppm or less) or if leaf Mg is below optimum (< 0.30 percent), apply Mg fertilizer at a rate equal to one-fifth of the N rate. Low leaf Mg concentration in groves on calcareous soils can also be addressed by applying foliar sprays of magnesium nitrate [Mg(NO₃)₂].

MICRONUTRIENTS

The quantities of micronutrients in 100 boxes of fruit (9,000 lbs.) are extremely small (0.11 lb.). Removal of micronutrients by the harvested fruit from even a high-producing grove is negligible compared with the amount present in the soil. In high pH (>7) soils, micronutrient availability (except Mo) decreases considerably. Micronutrients should be applied as needed based on visual foliar deficiency symptoms or low leaf analysis values. Factors influencing the effectiveness of foliar sprays include the formulation used, metallic rate per acre, and timing of the spray with respect to leaf age. Commercially-available micronutrient formulations applied at their recommended label rates will maintain

sufficient leaf concentrations, but one application usually will not correct moderate to severe deficiencies. Water-soluble micronutrient fertilizers may be included with post-bloom and/or summer sprays, preferably timed when leaves of new growth flushes are two-thirds to fully expanded.

Copper (Cu)

Some Central Ridge and east coast grove soils in Florida contain 300 to 400 lbs. Cu/acre in the top 6 inches of soil. A moderate, routine disease control spray program contributes an additional 3 to 4 lbs. Cu/acre/year, so no soil application of Cu fertilizer is needed in this case. Soil pH below 5.5 can solubilize soil Cu that is toxic to plants. Maintain soil pH close to neutral to reduce the potential for Cu toxicity. Some rootstocks (e.g. Swingle citrumelo) that perform poorly in high pH soils are also sensitive to high soil Cu. When replanting on old grove sites with low soil pH, the potential for toxicity is high. While the emphasis with old grove soils is on managing high soil Cu, most previously non-cultivated Florida sandy soils are deficient in Cu. If a grove is developed on a virgin sandy soil, Cu fertilizer should be included in the fertilizer blend.

Iron (Fe)

Soil applications of non-chelated, inorganic Fe fertilizers cannot correct visible Fe deficiency symptoms. Because these Fe fertilizers readily precipitate, they rapidly become unavailable to the tree. In neutral to slightly acidic soils, Fe deficiency can also be a problem if Cu is present at high concentration. Calcareous soils may contain high total Fe, but it is extremely insoluble. Visible Fe deficiency is common on these soils.

Citrus rootstocks vary widely in their ability to overcome low Fe stress. The easiest way to avoid alkaline-induced Fe chlorosis in citrus trees that are planted on calcareous soils is to use tolerant rootstocks such as Cleopatra mandarin and Volkamer lemon.

Iron chlorosis should be corrected by soil application of chelated Fe fertilizer. Chelates are superior Fe sources because sufficient Fe can be supplied at lower rates compared with inorganic Fe sources. The effectiveness of an Fe chelate depends greatly on soil pH. Fe-EDTA and Fe-HEDTA, which are relatively inexpensive, will correct Fe deficiency if soil pH is less than 6.5.

Agriculture-SFWMD Working to Settle Freeze Protection Issues



By Michael W. Sparks

Since the extended January freeze, the Southwest Florida Water Management District (SFWMD) has worked with stakeholders to develop a plan to meet agriculture's cold protection needs, while addressing the unintended consequences of both domestic and farm pumping.

The primary area of concern is the Dover / Plant City area where combined domestic and agriculture pumping in January caused the aquifer to drop 60 feet and created more than 750 temporary dry wells.

Florida Citrus Mutual, through board member and citrus grower Larry Black, along with other commodity groups, provided technical input as new rules for aquifer recovery strategy emerged. It was important for stakeholders to understand just how unprecedented 11 straight days of freezing temperatures are in Florida and that any new regulations shouldn't be reactionary.

The most significant change includes the requirement that new and repaired household wells must be cased to 105'. For agriculture, SFWMD is requiring aggregate cold protection quantities in the Dover / Plant City area to be reduced by 10 percent over five years and 20 percent over 10 years.

The reduction will be accomplished through the increased use of tailwater recovery ponds to supplement ground water for cold protection. The SFWMD has committed that the reductions are goals, and cold protection use will not be eliminated based on these new thresholds. SFWMD will allocate more funds to the FARMS program to assist growers with both the construction of tailwater recovery ponds and alternative cold protection programs.

The creation of this plan going forward showed that agriculture, homeowners and regulators can work together to find innovative solutions to collective problems. The working group met four times during the spring and summer and held two public meetings. I salute Larry Black and other members of the group for their commitment to this most important issue.

For more information on this project, see <http://www.swfwmd.state.fl.us/agriculture/freeze-management>.

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Do not apply these chelates to alkaline soil because they will readily break down, resulting in loss of available Fe by precipitation.

Iron chlorosis of citrus trees on susceptible rootstocks growing on calcareous soil is not easily corrected. Effective Fe chelates for these soils are available, but the treatments can be expensive and leaf color improvement is usually transient. Choose Fe-DTPA for mildly-alkaline soils (pH 7.5 or less), and choose Fe-EDDHA for highly-calcareous soils (pH greater than 7.5). Organically-complexed Fe exists in byproducts like wastewater residuals (biosolids) or certain drinking water treatment residuals (Fe-humates). Biosolids are potentially useful because they contain a high concentration of Fe in a complexed form that does not readily precipitate. Research with Fe-humate applied to citrus trees showed that moderate Fe deficiency could be corrected for a relatively low cost.

Zinc (Zn)

Soil pH is the most important factor regulating plant-available Zn. Zinc precipitates at alkaline pH, markedly decreasing availability, so a soil pH less than 7 is preferred. Although there

Table 1. Materials that can be used to lower soil pH, and their acidifying power relative to CaCO₃

Acidifier	Amount needed to neutralize 1,000 lbs. of pure CaCO ₃
Elemental sulfur	320 lbs.
Concentrated (98%) sulfuric acid	68 gal
Ammonium thiosulfate 12-0-0-26S	1,600 lbs.
Potassium thiosulfate 0-0-25-17S	3,800 lbs.
Ammonium sulfate 21-0-0	900 lbs.

are natural mechanisms that increase the availability of Zn in alkaline soils, Zn deficiencies are common. Special consideration should be given to groves that are visually monitored for citrus greening disease symptoms.

Application of foliar Zn fertilizer is usually combined with pesticide sprays scheduled in April or May at 3 to 5 lbs. of metallic Zn/acre using either ZnO or ZnSO₄. A number of other formulations are available for foliar application, including nitrates and organically-chelated forms using lignin sulfonate, glucoheptonate, or alpha-keto acids. Practically speaking, inorganic and organic Zn fertilizer sources are about equally effective with respect to foliar absorption. Application of Zn directly to acidic soils

is not economically practical due to the massive rates required to correct a deficiency. Zinc should not be soil-applied to groves on calcareous soils because the alkaline pH renders the Zn unavailable almost immediately.

Manganese (Mn)

The behavior of Mn in the soil is similar to that of Zn, especially with respect to relative availability in acidic and alkaline soils. Either sulfate, oxy-sulfate or some oxide forms of Mn can be used to correct Mn deficiency with the degree of effectiveness decreasing in that order.

Soil application of Mn is not recommended on calcareous soils where Mn deficiency is commonly encountered.

For groves on acidic soils that show persistent Mn deficiency symptoms on young foliage, apply 7 to 10 lbs. of Mn as MnSO₄ per acre to the soil. On calcareous or heavily limed acid soils, foliar-apply 3 to 5 lbs. of Mn per acre. A special effort to prevent Mn deficiency symptoms should be made in groves being visually monitored for citrus greening disease symptoms.

Boron (B)

While boron is required in miniscule amounts, there is only a small difference between deficiency and toxicity. Apply B annually as a foliar spray or in a dry fertilizer mixture at approximately 1/300 of the N fertilizer rate, but not both. If trees are irrigated with reclaimed water, B fertilization may not be necessary.

Molybdenum (Mo)

Molybdenum is also required in very small amounts. If Mo deficiency occurs, it usually means that the soil is highly acidic. The deficiency is corrected by a foliar spray that may last for several years.

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by decreasing soil pH. The rate of a soil acidifier required to cause a plant response depends on the amount of CaCO_3 in the soil. The chance of a positive plant response to broadcast applications of an acidifier is near zero if lime rock or shell is visible in the root zone. In contrast, it is feasible to acidify soils with lower CaCO_3 content (e.g., from over-liming) or those that have become alkaline from repeated application of high-bicarbonate irrigation water.

Soil acidifiers include elemental sulfur (S) and ammonium or potassium thiosulfate $[(\text{NH}_4)_2\text{S}_2\text{O}_3, \text{K}_2\text{S}_2\text{O}_3]$. The S in these compounds converts to sulfuric acid in the soil that neutralizes CaCO_3 and decreases soil pH. Ammonium sulfate $[(\text{NH}_4)_2\text{SO}_4]$ acidifies the soil through nitrification that releases H^+ as NH_4^+ converts to NO_3^- . Elemental S is the most effective soil acidifier. The powder form can be difficult to handle due to dustiness and fire hazard, and can cause severe root burn if not applied properly. To overcome these problems, some S products have been formulated into porous pellet-like particles that are much easier to handle and apply.

Ammonium thiosulfate and potassium thiosulfate are clear liquid fertilizers containing $\text{S}_2\text{O}_3^{2-}$. They can be blended with N, P and K solutions to form a wide variety of N-P-K-S formulations. Thiosulfates are non-corrosive and non-hazardous to handle, and are well-adapted to the methods used to apply fertilizer solutions. The soil within the wetted pattern of a micro-irrigation emitter often becomes alkaline when the water source contains bicarbonate while the surrounding soil may be neutral or acidic. Lowering the soil pH in this situation requires an application of acid or acidifying fertilizer to the wetted pattern only. Application of acid or thiosulfate fertilizer through the irrigation system can be effective in treating this problem.

This article is a communication of the UF-IFAS Extension/Research Team. For more information and program updates, please go to <http://solutionsforyourlife.ufl.edu/> or contact your county Extension agent.

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FDOC Focuses on Marketing to Serve Florida Citrus Growers; Four 10-hour Days Makes Sense

By Ken Keck



Our marketing staff was hard at work over the summer finalizing the FDOC 2010-2011 marketing plans that were unveiled at the Florida Citrus Commission meeting in September. Marketing programs are fully integrated across all points of communication and will deliver positive messages about Florida citrus through innovative channels with a strong emphasis on social media to reach our younger target consumer. You can see a description of the domestic and international marketing plans in their entirety at www.fdocgrower.com/marketing.php.

We are anxiously awaiting the release of the USDA crop estimate this month so we can finalize our operating budget at the Oct. 20 commission meeting.

FDOC will focus first and foremost on marketing Florida citrus, as recommended by the Long Range Planning Advisory Council. We have designed our programs with flexibility so that dollars can be reallocated to meet other industry needs as necessary, such as disease research or weather events.

On another note, after extensive consideration and study, we have revised FDOC business hours to four 10-hour days. The Bartow office is open Monday through Thursday, 7 a.m. to 5 p.m.

In making this change, a primary concern is that we maintain service to you, our customer, at the same level as in the past. The earlier start to the day is a rejection of “bankers’ hours” and we believe it fits more in line with the starting hours of growers. During non-business hours, FDOC provides access to reports, forms and other information via www.FDOCGrower.com. Designated managers remain on call through electronic mail and mobile phones for critical taxpayer and industry needs.

We began to explore workday flexibility prior to the move to Bartow which was mandated by the state legislature. In reviewing agencies within Florida and in other states, we found that organizations had been able to reduce utility costs and increase employee efficiency by implementing a four-day schedule. Some agencies also experienced a reduction in sick leave as employees were able to schedule medical and personal appointments on the weekday when the office was closed. See Florida TaxWatch analysis, page 28, at <http://www.floridatxwatch.org/resources/pdf/03042010FullReport.pdf>.

For FDOC, moving to Bartow increased the commute for 83 percent of our employees, including individuals who drive from the Tampa and Orlando metropolitan areas. The four-day work week results in less travel time and expense for employees while also providing a positive environmental benefit of reduced fuel emissions. In an era of state budget reductions, FDOC employees (as with all state employees) have not received any across-the-board, cost-of-living increases in four years. Back-of-envelope calculations found that commuting costs will be reduced by approximately \$50,000 per year.

Although the physical office is now closed on Fridays, marketing activities on behalf of growers continue. Our staff still participates in industry activities and meetings, conducts retail sales calls, attends trade shows and responds to media inquiries as business needs dictate.

FDOC strives to be flexible and forward thinking and to optimize resources. We remain firmly grounded in our mission to grow the market for you, the Florida citrus grower. I look forward to discussing the upcoming citrus season and our marketing plans with you.

The mission of the Florida Department of Citrus is to grow the market for the Florida citrus industry to enhance the economic well-being of the Florida citrus grower, citrus industry and the state of Florida.

Ken Keck, Executive Director, can be reached at 863-537-3999.

For more information, visit www.FDOCGrower.com



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