UNIVERSITY OF FLORIDA
EXTENSION
Institute of Food and Agricultural Sciences

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Flatwoods Citrus

Vol. 7, No. 7 **July 2004**

Dr. Mongi Zekri
Multi-County Citrus Agent, SW Florida

UPCOMING EVENTS

SW Florida Citrus BMPs Meetings

Gulf Citrus Growers Association Office, LaBelle
◄ **July 20, 2004, 9:00 AM - 3:00 PM**

Hendry County Extension Office, LaBelle
◄ **August 11, 2004, 10:30 AM**

Annual Meeting and Professional Improvement Conference of the National Association of County Agricultural Agents
Date: July 11-15, 2004
Location: Wyndham Palace Resort and Spa in the WALT DISNEY WORLD Resort, 1900 Buena Vista Drive, Lake Buena Vista, FL

If you want to print a color copy of the Flatwoods Citrus **Newsletter, get to the Florida Citrus Resources Site at http://flcitrus.ifas.ufl.edu/**
You can also find all you need and all links to the University of Florida Citrus Extension and the Florida Citrus Industry

CITRUS EXPO

IN FORT MYERS

Wednesday, August 25 &
Thursday, August 26, 2004

Annual Conference of Extension Professionals (FAEP)

Date: September 19-23
Location: Cocoa Beach, Florida
http://extadmin.ifas.ufl.edu/

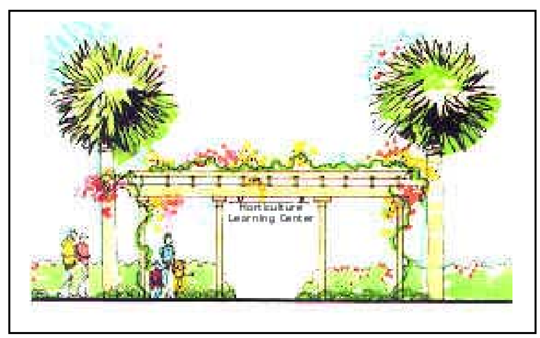
50th Annual Meeting of the InterAmerican Society for Tropical Horticulture (ISTH)

Date: October 24-29, 2004
Location: Universidad EARTH, San Jose, Costa Rica, http://www.earth.ac.cr
For more information, contact Dr. Richard Campbell at
rcampbell@fairchildgarden.org

SW Florida Yard & Garden Show

November 13 & 14, 2004

Saturday - 9:00 AM to 4:00 PM
Sunday - 10 AM to 4:00 PM



Where: SW Florida Horticulture Learning Center
Collier County University Extension Education & Training Center
14700 Immokalee Road, Naples, FL
For information, call (239) 353-4244

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CITRUS NUTRITION IN RELATION TO SOIL ACIDITY AND CALCAREOUS SOILS

I. SOIL ACIDITY AND LIMING

The optimum soil pH range for citrus trees is 6.0 to 7.0. Trifoliate hybrid rootstocks such as citrumelos and citranges do better at the low end of this pH range. For sandy soils, one ton of liming material such as dolomite will raise the soil pH by about one unit. Liming acidic soils is economically sound and essential for profitable crop production. Soil pH must be monitored every year through soil testing because development of soil acidity is a continuous process that requires repeated applications of liming materials. Always test your soil before liming. Do not assume that lime is needed. Certain soils may already contain excess lime. Such soils will typically have a pH between 7 and 8. When soil pH is high because of naturally occurring lime such as limestone, marl, or seashells, there is no practical, economical way of lowering the soil pH. Under these conditions, tolerant rootstocks to high pH soils should be selected to reduce nutritional disorders and deficiency problems. Sulfur added to soil can reduce the soil pH through bacterial action that transforms elemental sulfur to sulfuric acid. (Only the elemental form of sulfur is acidifying, not sulfate (SO_4^{2-}). However, the soil pH can return to its original value as soon as sulfuric acid is used up.

Problems in very acid soils

*Aluminum (Al) toxicity to plant roots
*Copper toxicity in soils that have received repeated Cu fungicide applications
*Manganese toxicity to plants in continuously wet soils
*Calcium & magnesium deficiencies
*Molybdenum deficiency
*Phosphorus tied up by iron (Fe) & Al
*Poor bacterial growth
*Reduced conversion of ammonium to nitrate

Problems in alkaline (high pH) soils

*Iron deficiency
*Manganese deficiency
*Zinc deficiency
*Excess salts (in some soils)
*Phosphorus tied up by calcium and magnesium
*Bacterial diseases and disorders

Factors affecting soil pH

Soils are not homogenous and the pH can vary considerably from one location in the field to another. It also varies with depth. Soils in different geographic regions may have different pHs because of several factors including the parent material and the climate.

Rainfall/leaching. Rainfall affects soil pH. Water passing through the soil leaches basic cations such as calcium (Ca^{2+}), magnesium (Mg^{2+}), and potassium (K^{+}) into drainage water. These basic cations are replaced by acidic cations such as aluminum (Al^{3+}) and hydrogen (H^{+}). For this reason, soils formed under high rainfall conditions are more acid than those formed under arid conditions.

Fertilizers. Both organic and non-organic fertilizers may eventually make the soil more acid. For example, transformations of ammonium- (NH_4^{+}) and urea-based fertilizers into nitrate (NO_3^{-}) release H^{+} that increases soil acidity. Therefore, fertilization with materials containing ammonium or even adding large quantities of organic matter to a soil will ultimately increase the soil acidity and lower the pH.

Common Fertilizers and their Equivalent Acidity or Basicity

Material	**% Nutrient in Material**	**Amount to supply one unit (20 lbs) of nutrient**	**$CaCO_3$ equivalent per unit (20 lbs) of nutrient***
Nitrogen fertilizers			
Ammonium nitrate	34	60	-36
Ammonium sulfate	21	98	-107
Anhydrous ammonia	82	24	-36
Diammonium phosphate	18	111	-71
Monoammonium phosphate	11	182	-107
Nitrogen solutions	28-32	71-63	-36
Calcium nitrate	15.5	129	+26
Potassium nitrate	14	143	+36
Sodium nitrate	16	125	+36
Urea	45	44	-36
Phosphorus fertilizers			
Diammonium phosphate	46	43	-21
Monoammonium phosphate	55	36	-28
Ordinary superphosphate	20	100	Neutral
Triple superphosphate	46	43	Neutral
Potassium fertilizers			
Potassium chloride	60-62	33-32	Neutral
Potassium nitrate	44	45	+11
Potassium magnesium sulfate	22	91	Neutral
Potassium sulfate	48-52	42-38	Neutral

***A minus sign indicates the number of pounds of pure $CaCO_3$ needed to neutralize the acidity created by 20 lbs of N, P_2O_5, or K_2O. A plus sign indicates that the material is basic and is equivalent to the number of pounds of pure $CaCO_3$ indicated.**

Plant uptake. When plants take up basic cations, they release H^+ to the soil solution so that electrical neutrality is maintained. The soil pH is reduced as a result.

Raising soil pH (liming acid soils)

Soils are limed to reduce the harmful effects of low pH and to add calcium and magnesium to the soil. The amount of lime needed to achieve a certain pH depends on the current pH of the soil and its buffering capacity. The buffering capacity is related to the cation exchange capacity (CEC). The higher the CEC, the more exchangeable acidity (hydrogen and aluminum) is held by the soil colloids. As with CEC, buffering capacity increases with the amounts of clay and organic matter in the soil. Soils with a high buffering capacity require larger amounts of lime to increase the pH than soils with a lower buffering capacity.

Most soil testing laboratories use a special buffered solution to measure the exchangeable acidity, which is the form of soil acidity that must be neutralized for a change in soil pH to take place. By calibrating pH changes in the buffered solution with known amounts of acid, the amount of lime required to bring the soil to a particular pH can be determined.

Lime reduces soil acidity (increases pH) by reducing the H^+ concentration through neutralization with carbonate (CO_3^{2-}) or hydroxide (OH^-). A Ca^{++} ion from the lime replaces two H^+ ions on the cation exchange complex. The hydrogen ions (H^+) are then reduced and changed into water (H_2O). An acid soil can become more acid as basic cations such as Ca^{2+}, Mg^{2+}, and K^+ are removed, usually by crop uptake or leaching, and replaced by H^+.

Benefits of liming to correct soil acidity

*Increased nutrient availability
*Improved fertilizer use efficiency
*Increased soil microbial activity
*Higher nitrogen fixation by legumes
*Reduced toxicity of copper
*Provision of additional amounts of Ca & Mg
*Improved soil physical conditions
*Increased cation exchange capacity
*Improved herbicide activity
*Increased growth and crop yield

Liming materials

The most common liming materials are calcitic or dolomitic agricultural limestone. These are natural products made by finely grinding natural limestone. Since natural limestone is relatively insoluble in water, agricultural limestone must be very finely ground so it can be thoroughly mixed with the soil and allowed to react with the soil acidity. Calcitic limestone is mostly calcium carbonate ($CaCO_3$). Dolomitic limestone is made from rocks containing a mixture of calcium and magnesium carbonates. Either will neutralize soil acidity. Dolomitic limestone also provides magnesium. Not all materials containing calcium and magnesium are capable of reducing soil acidity. Gypsum ($CaSO_4$) does not reduce soil acidity.

Application and placement of lime

Time of year. Lime may be applied at any time during the year to Florida citrus groves.

Lime placement. Since ground limestone is relatively insoluble in water, maximum contact with the soil is necessary to neutralize the soil acidity. Lime will not quickly move into the soil like water-soluble fertilizers. Even though it is usually recommended to thoroughly mix lime with the topsoil, it is not practical to incorporate it in a citrus grove. Therefore, it will take lime longer to raise soil pH in a grove compared with a field where it is incorporated. As soon as moisture is present, the lime will begin to react. Coarse lime particles react more slowly than very fine particles. Therefore, using very finely ground limestone is necessary to achieve the desired soil pH change within 4 to 6 months after application.

Overliming

While a correct liming program is beneficial for plant growth, excessive liming can be detrimental because deficiencies and imbalances of certain plant nutrients may result. The practice of estimating lime requirement without a soil test is risky because it can lead to overliming.

Overliming causes the soil pH to increase beyond the range of optimum plant performance. Reduced plant growth is usually associated with deficiencies of micronutrients, which become less available as soil pH increases. Overliming is costly -- it costs to buy and apply the lime, and it costs in terms of reduced plant performance.

The principal factors contributing to overliming are: (1) application of lime to soil without testing if lime is needed, (2) liming to soil pH values much higher than those necessary to achieve the desired plant response, (3) liming to supply calcium (Ca) and/or magnesium (Mg) as nutrient elements without sufficient regard to the effect of lime on raising the soil pH.

If there is a need for Ca or Mg as nutrients and an increase in soil pH is not desired, another source of Ca or Mg should be used. Gypsum (calcium sulfate) and magnesium sulfate or oxide can supply Ca and Mg without affecting soil pH.

Calcium sources

Source	Chemical formula	Calcium carbonate equiv. (pure form)
Burned lime (Quicklime)	CaO	179
Hydrated lime (Builder’s lime)	$Ca(OH)_2$	135
Dolomitic lime	$CaCO_3 \bullet MgCO_3$	109
Calcitic lime	$CaCO_3$	100
Basic slag (by-product)	$CaSiO_3$	80
Marl (soft carbonates)	$CaCO_3$	70 to 90
Gypsum	$CaSO_4$	0
Calcium nitrate	$Ca(NO_3)_2$	20
Ordinary superphosphate	$Ca(H_2PO_4)_2 + CaSO_4$	0
Concentrated superphosphate	$Ca(H_2PO_4)_2$	0

II. CALCAREOUS SOILS

Calcareous soils are alkaline (have pH values greater than 7) because of the presence of free $CaCO_3$. Calcium carbonate ($CaCO_3$) can occur naturally in soils or can be added with alkaline irrigation water. Special nutritional management is required to grow citrus successfully on calcareous soils. However, planting citrus trees on these soils may not be economically feasible. The presence of $CaCO_3$ affects the availability of almost all nutrients.

Nitrogen (N)

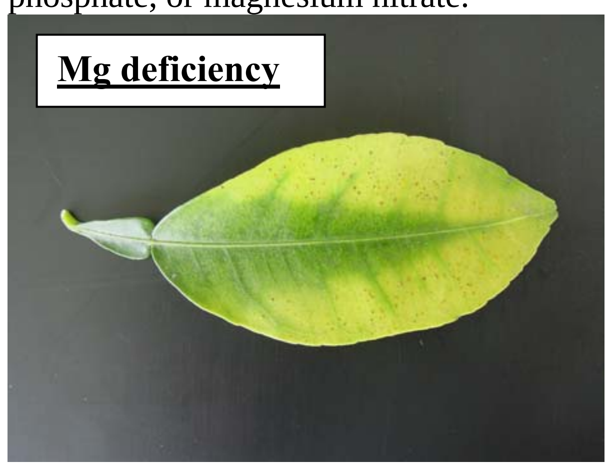
Nitrification, which is the conversion of ammonium (NH_4^+) to nitrate (NO_3^-) by soil bacteria, is most rapid in soils with pH values between 7 and 8. Ammonia volatilization is the loss of N to the atmosphere through conversion of the ammonium ion to ammonia gas (NH_3). Volatilization of ammoniacal-N fertilizer is significant when the soil surface pH is greater than 7. Nitrogen loss through ammonia volatilization on calcareous soils is a concern when ammoniacal N is applied on the soil surface and remains there without moving it into the soil. When applying dry fertilizer containing urea or ammoniacal N, the fertilizer should be moved into the root zone through irrigation or mechanical incorporation if rainfall or irrigation is not imminent. Applying a portion of the required N fertilizer foliarly (urea, potassium nitrate, calcium nitrate) will improve the N status. Applying N with irrigation water (fertigation) and scheduling irrigation to maintain the N in the root zone is a sound method to prevent large N leaching losses.

Phosphorus (P)

When P fertilizer is added to a calcareous soil, it undergoes a series of chemical reactions with Ca. These reactions decrease P solubility through a process called 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. Phosphorus fertilizer should be applied each year in newly planted groves on previously-non-fertilized soil until the groves begin to bear fruit. As the trees approach maturity, P applications can be limited to once every few years. Diagnostic information from leaf and soil testing can help determine whether P fertilization is necessary.

Potassium (K) & magnesium (Mg)

It is often difficult to increase K and Mg uptake with fertilizer applied to calcareous soils. High soil Ca suppresses K and Mg uptake by citrus trees through the competition of Ca, Mg, and K. In cases where soil-applied fertilizer is ineffective, the only means of increasing leaf K and Mg concentration is through foliar application of water-soluble fertilizers, such as potassium nitrate, monopotassium phosphate, or magnesium nitrate.



A solution of 20 lbs KNO_3 per 100 gallons of water has been shown to raise leaf K, especially if applied two or three times during the year.

For citrus on noncalcareous soils, nitrogen and potassium fertilizer applications with a 1:1 ratio of N to K_2O are recommended. If leaf testing on calcareous soils reveals that high soil Ca may be limiting K uptake, the K_2O rate should be increased by about 25% to have a N:K_2O ratio of 1:1.25.

Zinc (Zn) & manganese (Mn)

At alkaline (high) pH values, Zn and Mn form solid compounds with low water solubility, decreasing significantly their availability to plants. On alkaline soils, soil applications of Zn and Mn fertilizers are ineffective. The least expensive way to correct effectively Zn and Mn deficiencies is through foliar sprays. Preliminary research data indicate little difference in magnitude of foliar uptake, regardless of the form of carrier or chelate applied.

Iron (Fe)

Iron is considerably less soluble than Zn or Mn in high pH soils. Thus, inorganic Fe contributes relatively little to the Fe nutrition of plants on calcareous soils. Citrus rootstocks vary widely in their ability to overcome Fe deficiency. The easiest way to avoid lime-induced Fe chlorosis in citrus trees to be planted on calcareous soils is to use tolerant rootstocks.

Existing Fe chlorosis can be corrected through soil application of Fe chelates.

Foliar application of iron compounds has not proven satisfactory on citrus trees because of poor translocation within the leaf. Furthermore, foliar sprays of Fe have the possibility to cause fruit and leaf burn.

Sulfur products used as soil amendments

Soil acidulents can improve nutrient availability in calcareous soils by decreasing the soil pH. Soils with visible lime rock or shell in the root zone would require repeated applications of a high rate of acidulent. Examples of S-containing acidulents include elemental sulfur (S) and sulfuric acid (H_2SO_4). These compounds act to neutralize $CaCO_3$ with acid. Ammonium sulfate [$(NH_4)_2SO_4$] acidifies the soil by converting NH_4^+ to NO_3^- during nitrification. The sulfate ion (SO_4^{2-}) alone possesses no acidifying power. Elemental S is the most effective soil acidulent. Although not an acidic material itself, finely ground elemental S is converted quickly to sulfuric acid in the soil through microbial action. Sulfuric acid reacts more quickly than any other material, but it is hazardous to work with and can damage plants if too much is applied at one time. Dilute concentrations of sulfuric acid can be applied safely with irrigation water and used to prevent Ca and Mg precipitates from forming in microirrigation lines. Repeated applications of sulfuric acid with irrigation water will tend to lower soil pH within the wetted pattern of the emitter.

The soil within the wetted pattern of a microirrigation emitter often becomes alkaline when the water contains bicarbonate, while the surrounding soil may be neutral or acidic. To lower the soil pH in this situation, acid or acidifying fertilizer must be applied to the wetted pattern only.

Summary of *citrus nutrition on calcareous soils*

1. Calcareous soils are alkaline because they contain free $CaCO_3$.

2. The availability of N, P, K, Mg, Mn, Zn, and Fe to fruit trees including citrus decreases when soil $CaCO_3$ concentration increases to more than 3% by weight. These soils generally have a pH value in the range of 7.6 to 8.3.

3. To avoid ammonia volatilization, fertilizers containing ammonium-N or urea should be moved into the root zone with rainfall or irrigation, or be incorporated into the soil.

4. Phosphorus fertilizer applied to calcareous soils becomes fixed over time. Plant P status can be evaluated using a leaf tissue test. If citrus leaf P is less than 0.12% indicating reduced soil P availability, then P fertilizer should be applied.

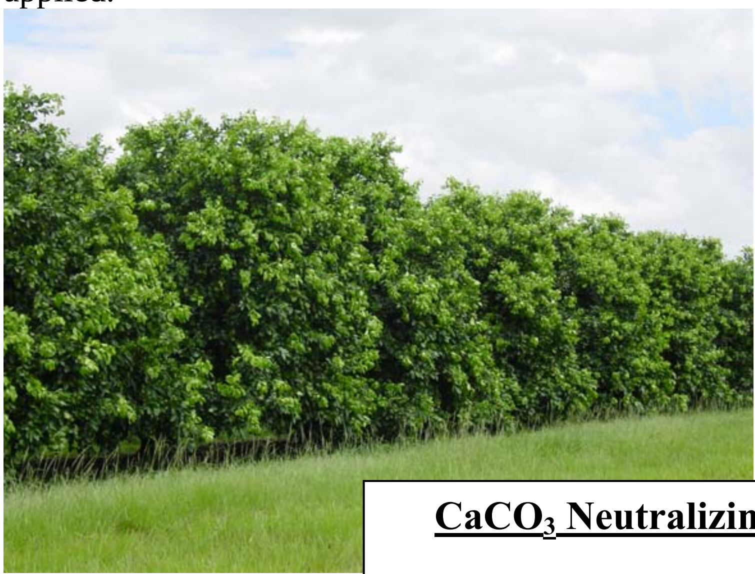
5. Trees planted on calcareous soils require above normal rates of K or Mg fertilizer for satisfactory nutrition. Foliar sprays of potassium and magnesium nitrates are effective where soil applications are not.

6. The least expensive and most effective way to correct Zn and Mn deficiencies of fruit trees is through foliar application of inorganic or organic chelated forms.

7. The easiest way to avoid lime-induced Fe chlorosis is to plant trees budded on tolerant rootstocks.

8. The most effective remedy for lime-induced Fe chlorosis on nontolerant rootstocks involves the use of chelated Fe.

9. Sulfur products that act as soil acidulents can potentially improve nutrient availability in calcareous soils.



$CaCO_3$ Neutralizing Power of Several S Sources

Sulfur Source	**Amount Needed to Neutralize 1,000 lbs $CaCO_3$**
Elemental Sulfur	320 lbs
Concentrated sulfuric acid (66° Baume)	68 gallons
Ammonium sulfate 21-0-0-24S	900 lbs

IMPORTANCE OF TISSUE AND SOIL SAMPLING AND ANALYSES IN ADJUSTING FERTILIZER PROGRAMS

Optimum growth and yield of high quality fruit cannot be obtained without adequate nutrition. The most successful fertilizer program should be based on tissue analysis, knowledge of soil nutrient status through soil analysis combined with university recommendations about optimum crop and fertilizer management practices. The deficiency or excess of an element will cause disturbance in plant metabolism and lead to poor performance. Appropriate steps have to be taken to diagnose nutritional problems and find solutions. Field trials, soil analysis and plant analysis have to be integrated together so that much of the guesswork is eliminated, fertilizer requirements are well assessed and fertilizer programs are adequately adjusted. Fertilizer recommendations should be based on the nutrient requirement of the crop to be grown and on the results of the tissue and soil test analyses.

Plant analysis

Nutrient concentrations in plant tissues are the most accurate indicator of the nutritional health of fruit crops. Plant analysis was demonstrated and proven to be an extremely useful tool for detecting nutritional problems and adjusting fertilizer programs of fruit trees including citrus. The concentrations of mineral nutrients in plant tissues have a controlling influence on growth and fruit yield of crops. In the case of fruit trees, research has shown that leaves are the best tissue for sampling because nutrients are gathered and redistributed throughout the plant, and the deficiency or excess of an element present in the soil is more often reflected in the leaf. Furthermore, it is easier to collect leaf samples than any other plant parts.

Used in conjunction with other data and observations, tissue analysis aids in evaluating the nutrient elements of the soil-plant system. It provides a way to evaluate the effectiveness of fertilizer programs. Tissue analysis is not only useful for determining whether or not the soil is adequately supplying the required nutrients, but also can be helpful for comparing various fertilizer treatments.

Tissue analysis has proven useful in confirming nutritional deficiencies, toxicities or imbalances, identifying “hidden” toxicities and deficiencies where visible symptoms are not manifested, evaluating the effectiveness of fertilizer programs, determining the availability of elements not tested for by other methods, and studying interactions among nutrients. Tissue analysis can be used to monitor nutrient status so that problems are avoided. The greatest limitation of relying on visual symptomology to manage fruit nutrition is that such symptoms indicate a problem already exists and reductions in growth, yield, and fruit quality may have already occurred. The goal in tissue analysis is to adjust nutritional programs to prevent nutritional problems and their costly consequences.

Adding fertilizer to the soil is no guarantee that plants will benefit from it. The form of the fertilizer may not be available to plants, or it might react with the soil to form insoluble compounds. Tissue analysis can also be used to determine whether fertilizer programs are performing according to expectations.

Leaf analysis integrates all the factors that might influence nutrient availability and uptake. It shows the balance between nutrients. For example, potassium (K) deficiency may be the result of a lack of K in the soil or from excessive Ca, Mg, and/or Na levels.

Adding N, for example, when K is low may result in K deficiency because the increased growth requires more K too.

Tissue analysis is the quantitative determination of the elements in plant tissue. Tissue analysis usually refers to analysis of nitrogen (N), phosphorus (P), potassium (K), magnesium (Mg), calcium (Ca), manganese (Mn), zinc (Zn), copper (Cu), iron (Fe), and boron (B). Sulfur and chlorine are at sufficient levels under most field conditions. However, chlorine may become excessive in saline soils or irrigation water. Similarly, molybdenum deficiency or toxicity is rare. Therefore, sulfur, chlorine, and molybdenum are analyzed in special cases only.

Leaf Sampling

For reliable results and useful interpretation of lab analysis reports, citrus growers, production managers, and consultants must follow the proper procedures for leaf sampling and sample handling because improperly collected leaf samples will provide misleading information about the nutritional status of the trees and the fertilizer programs.

Considerable care is needed in taking samples. Chemical analysis values can only be useful if the samples obtained are representative of the blocks they were taken from. The proper sampling, preparation and handling would affect the reliability of the chemical analysis, data interpretation, nutritional recommendations, and adjustment of fertilizer programs.

Procedures for proper sampling, preparation and analysis have become standardized for meaningful comparisons and interpretations. Leaf samples must also be taken at the proper time because nutrient levels within leaves are continually changing. Nitrogen (N), P and K levels normally decrease, while Ca and Mg increase as the leaf ages from the spring through the fall. However, leaf mineral concentrations of most nutrients are relatively stable within 4 to 6 months after emergence of the spring flush. Therefore, for mature tree blocks, the best time would be in July and August to collect four- to six-month-old spring flush leaves. If taken later in the season, the summer flush would probably be confused with the spring flush.

Each leaf sample should consist of about 100 leaves taken from non-fruiting twigs of 15- 20 uniform trees of the same variety and rootstock, and under the same fertilizer program. Clean brown paper bag should be used. Information sheets from the testing lab should be completed for each sample as this information helps when interpreting the results. The sample bag and the corresponding information sheet should each be carefully labeled with the same identity so that samples and sheets can be matched in the laboratory.

Sampling techniques for leaves

♦ Immature leaves should be avoided because of their rapidly changing composition.

♦ Abnormal-appearing trees, trees at the edge of the block and trees at the end of rows should not be sampled because they may be coated with soil particles and dust or have other problems.

♦ Do not include diseased, insect damaged, or dead leaves in a sample. Use good judgment.

♦ Select only one leaf from a shoot and remove it with its petiole (leaf stem).

Diagnosing growth disorders

♦ Collect samples from both affected trees as well as normal trees.

♦ Trees selected for sampling should be at similar stage of development and age.

♦ Whenever possible, confine the sampling area to trees in close proximity to each other.

Handling of leaf samples

♦ Samples should be collected in clean paper bags and clearly identified.

♦ They should be protected from heat and kept dry and cool (stored in portable ice chests), and placed in a refrigerator for overnight storage if they cannot be washed and oven dried the same day of collection.

♦ For macronutrient analysis, leaves usually do not need to be washed.

♦ Leaves should be dried in a ventilated oven at 60-70^{o}C.

Preparation for analysis

♦ Leaves that have been recently sprayed with micronutrients for fungicidal (Cu) or nutritional (Mn, Zn) purposes should not be analyzed for those micronutrients because it is unlikely to remove all surface contamination from sprayed leaves.

♦ For accurate Fe and B or other micronutrient determination, samples would require hand washing, which is best done when leaves are still in a fresh condition.

♦ For micronutrients determination, the leaves should be washed with a detergent and rinsed with tap water, then rinsed in diluted hydrochloric acid (5%) solution and finally rinsed 3 times with distilled water. It is difficult to remove all surface residue even with the acid rinse, but this procedure removes substantially most of it.

The laboratory will determine the levels of each nutrient in the plant sample, and will indicate if each nutrient level is excessive, high, adequate, low or deficient. Leaf analysis standards are shown in the Table below. The balance between nutrients should be carefully examined. For example, increasing K rate when Mg is low may cause Mg deficiency. An increase in N when K is low may result in K deficiency.

Soil analysis

Soil analysis is an important method for gaining basic information regarding the chemical status of the soil. It can also provide data on extractable and available nutrients, which are useful in formulating and improving a fertilizer program. Soil analysis is particularly useful when conducted over several years so that trends can be seen, solid information can be gathered, and proper adjustment of fertilizer programs can be achieved. However, it should be understood that soil analysis alone cannot be relied upon totally to formulate a fertilizer program or diagnose a nutritional problem in a grove.

Unlike leaf analysis, there are various methods and analytical procedures of soil analysis used by laboratories. Different procedures extract different amounts of nutrients from the soil. Therefore, to draw accurate conclusions from soil tests, consistency in adopting the same methodology and extracting solution is very important because an optimum value for a nutrient with a particular extractant may be a deficient value with another extractant.

The total quantity of a nutrient measured by soil analysis is very often not the exact measure of the quantity actually available to the trees. Even the so-called “available” portion of a nutrient determined by soil analysis is at best a tentative estimation because it is measured by empirical methods using particular solvents which cannot be taken to duplicate the action of the plant roots.

In Florida, soil tests for the relatively mobile and readily leached elements such as N and K are of no value. Soil tests are mainly important for pH, P, Mg, Ca, and Cu. For Florida sandy soils, using the Mehlich-1 or double acid (hydrochloric acid + sulfuric acid) extraction procedure adopted by the University of Florida analytical lab, 40-60 lbs/acre (20-30 ppm) of P, 70-120 lbs/acre (35-60 ppm) of Mg, 500-800 lbs/acre (250-400 ppm) of Ca, and 5-10 lbs/acre (2.5-5 ppm) of Cu are considered adequate for citrus. A Ca:Mg ratio of 7:1 seems desirable and ratios of higher than 10 may induce Mg deficiency problems. Copper levels higher than 50 lbs/acre may be toxic to citrus trees if the soil pH is below 6.

Soil tests are most useful in monitoring soil pH in established citrus groves. Soil pH greatly influences nutrient availability, and many nutrient deficiency can be avoided by maintaining soil pH between 6 and 7. Nutrient deficiencies or excesses (toxicities) are more likely when the pH is outside of this range.

In some cases, soil tests are needed to determine the best method of correcting a deficiency identified through leaf analysis. For example, Mg deficiencies may result from low soil pH or excessively high soil Ca. Dolomitic lime applications are advised if the pH is too low, but magnesium sulfate is preferred if soil Ca levels are very high and the soil pH is adequate. If the soil Ca levels are excessive and the soil pH is relatively high, then foliar application of magnesium nitrate is recommended.

A poor relationship may exist between soil and plant nutrient levels in perennial crops including citrus. Often fruit trees contain sufficient levels of a nutrient even though soil test values are low. On the other hand, high soil nutrient levels do not assure an adequate supply to the trees. Adequate nutrient uptake by trees can be hindered by other problems such as drought stress, flooding stress, root damage, and cool weather. Tissue analysis along with soil tests can help pinpoint the problem.

Furthermore, several other factors such as plant species, cultivars, rootstocks, microbiological activity, climatic conditions, and plant needs at different growth stages have to be considered for more reliable interpretation and application of the soil analytical data and formulation of a fertilizer program.

Soil sampling

The accuracy of a fertilizer recommendation depends or how well the soil sample on which the recommendation was based represents the area of the grove. In Florida, if soil samples were to be collected once a year, the best time would be at the end of the summer rainy season and prior to fall fertilization, usually during September and October. However, soil sampling may be conducted at the same time as leaf sampling to save time and reduce cost.

Standard procedures for proper sampling, preparation and analysis have to be followed for meaningful interpretations of the test results and accurate recommendations. Each soil sample should consist of 15-20 soil cores taken at the dripline of 15-20 trees within the area wetted by the irrigation system to a depth of 6 inches. The area sampled should be uniform in terms of soil and tree characteristics and correspond to the area from which the leaf sample was taken. Individual cores should be mixed thoroughly in a plastic bucket to form a composite sample. Subsample of appropriate size should be taken from the composite mixture and put into labeled paper bags supplied by the lab. Soil samples should be air-dried but not oven-dried before shipping to the testing laboratory for analysis.

Traditional sampling vs. other sampling strategies

Tissue and soil sampling and testing to determine fertilizer recommendations for the whole grove followed by uniformly applying a fertilizer over the entire area is still the most practiced and accepted nutrient management strategy. However, there is a problem with this method because some trees may be over fertilized and others may be under fertilized. It is well known that variability exists within groves. Understanding this variability and taking it into consideration allows the grove to be efficiently managed.

The basic principle of the "traditional way" is continued sampling at the same location from year to year. This technique assumes that the selected area is less variable but representative of the entire grove or major portion of the block. Representative sites are selected based on several things including close observation of the trees, past grower experience, crop load, soil surveys, and remote sensed images. This technique has the advantage of minimizing sampling errors and the number of samples, and is less expensive and less time-consuming than the grid sampling method, but does not provide a full indication of field variability.

With the new advances in technology, "grid sampling" for precision agriculture has been gaining ground. The first step in grid sampling is to divide the field into small areas. The second step is to identify a representative location within the grid from which the sample will be collected. Grid sampling has the advantage in being integrated into commercial Global Positioning System (GPS) based soil sampling and nutrient-mapping Geographic Information System (GIS) to use Variable Rate Technology (VRT) management. However, dense grid sampling can be quite expensive and non-profitable for some growers.

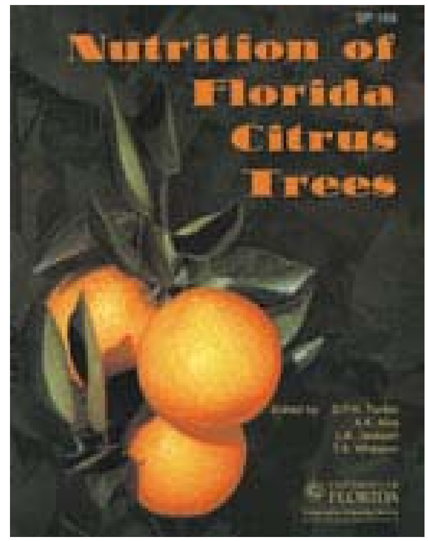
Between the traditional way of sampling and the grid sampling strategy there is interest in the "management zone" method. Prior knowledge by growers and production managers can help delineate management zones based on several characteristics such as soil type, high and low yielding areas, soil water and nutrient holding capacities, and depth to the water table. This method involves less sampling than the grid method but is based on more targeted sampling than the traditional way. With this technique, different fertilizer rates can be applied to a smaller number of zones even without the need of VRT equipment.

Growers should stay flexible and prepared to adjust their sampling and management strategies because emerging technology will keep refining sampling systems and integrating useful information from database including yield maps, tree age, size, and performance, soil characteristics, satellite images, and aerial photographs.

Conclusion

Tissue and soil analyses are a powerful tool for confirming nutrient deficiencies, toxicities and imbalances, identifying "hidden hunger," evaluating fertilizer programs, studying nutrient interactions. However, if initial plant and soil sampling, handling, and analysis of the sample were faulty, the results would be misleading. Experience with interpreting the overall tissue analysis reports is essential because of the many interacting factors, which influence the concentrations of elements in plant tissue. Thus, tree size, cropping history, sampling techniques, soil test data, and knowledge of nutrient concentrations and leaf analysis standards all need to be considered in the final diagnosis. If properly done, tissue and soil analyses can point the way toward more economical and efficient use of fertilizer materials, avoiding excessive or inadequate application rates.

For more information check "Nutrition of Florida citrus trees", UF-IFAS publication SP 169.



Standard Table for Assessing Nutritional Status and Adjusting Fertilizer Programs for Citrus

Leaf analysis standard for assessing current nutrient status of citrus trees based on concentration of mineral elements in 4- to 6-month-old-spring-cycle leaves from non-fruiting terminals.

Element	Deficient less than	Low	Satisfactory	High	Excess more than
Nitrogen (N) (%)	2.2	2.2-2.4	2.5-2.8	2.9-3.2	3.3
Phosphorus (P) (%)	0.09	0.09-0.11	0.12-0.17	0.18-0.29	0.30
Potassium (K) (%)	0.7	0.7-1.1	1.2-1.7	1.8-2.3	2.4
Calcium (Ca) (%)	1.5	1.5-2.9	3.0-5.0	5.1-6.9	7.0
Magnesium (Mg) (%)	0.20	0.20-0.29	0.30-0.50	0.51-0.70	0.80
Sulfur (S) (%)	0.14	0.14-0.19	0.20-0.40	0.41-0.60	0.60
Chlorine (Cl) (%)	------	------	less than 0.5	0.5-0.7	0.7
Sodium (Na) (%)	------	------	less than 0.2	0.2-0.5	0.5
Iron (Fe) (ppm)	35	35-59	60-120	121-200	250
Boron (B) (ppm)	20	20-35	36-100	101-200	250
Manganese (Mn) (ppm)	18	18-24	25-100	101-300	500
Zinc (Zn) (ppm)	18	18-24	25-100	101-300	300
Copper (Cu) (ppm)	4	4-5	6-16	17-20	20
Molybdenum (Mo) (ppm)	0.06	0.06-0.09	0.1-1.0	2-50	50

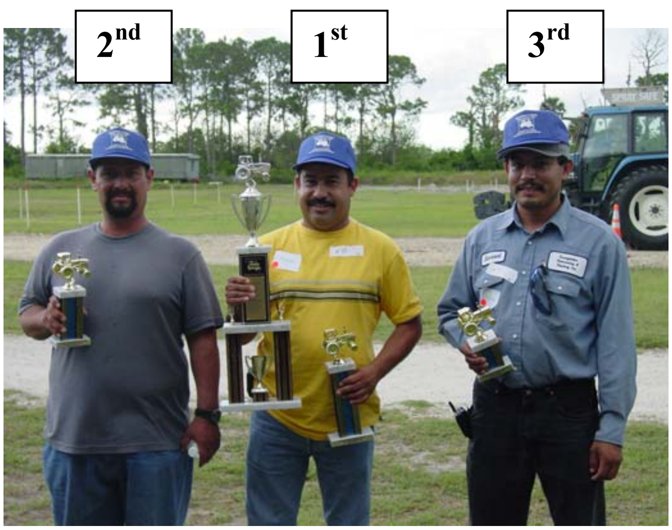
The Fourteenth Annual Farm Safety Day held on Saturday 5 June 2004 was a big success.

Over the past few years, The Farm Safety Day has been proven to be a very effective way in providing an educational opportunity for farm equipment operators and workers.

Certificates of appreciation were sent to the
2004 Farm Safety Day Committee Members, Helpers, Speakers & Sponsors

Gold Sponsors: $200	*Silver Sponsors: $100*
Donald Allen, ***Aglime Sales, Inc.***	Thad Boatwright, ***Monsanto***
Jeff Haines, ***Deseret Farms of Ruskin***	Jack Paul, ***Bob Paul, Inc.***
Sam Hipp, ***Production Soils LLC***	James Snively, ***Southern Gardens Citrus***
Rachel Walters, ***Bayer CropScience***	David Wheeler, ***Wheeler Brothers, Inc.***

Congratulations to the winners of the 2004 equipment operators contest and to their respective companies!



First: Miguel Rodriguez, Deseret Farms

Second: Jose Torres, Six L's Farm Op. 2

Third: Isrrael Rodriguez, Everglades Harvesting

Trophies were given to the winners.
Engraved plaques were given to their respective companies.
The big trophy will stay for one year at the company that has the 1st place winner.
