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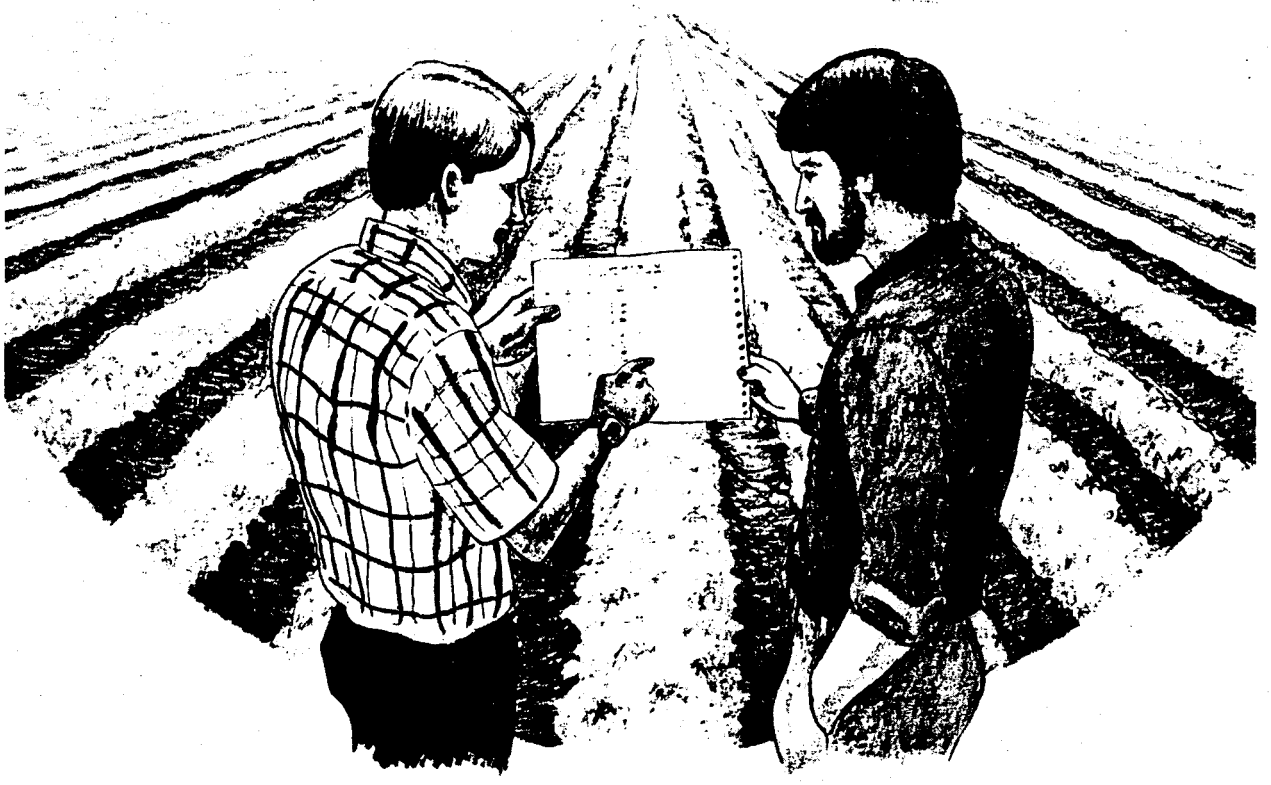
Soil, Container Media, and Water Testing

Interpretations and IFAS Standardized Fertilization Recommendations

E.A. Hanlon, G. Kidder, and B.L. McNeal*



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Soil, Container Media, and Water Testing

Interpretations and IFAS Standardized Fertilization Recommendations

E.A. Hanlon, G. Kidder, and B.L. McNeal*

The authors wish to express their thanks to Dr. R. D. Rhue for his efforts when he served as Director of the Extension Soil Testing Laboratory. His direction and leadership contributed greatly to the scientific foundation of this laboratory.

The updated interpretations and recommendations found in this publication represent the work of many extension specialists and are a result of an IFAS-wide effort to present the most current information to Florida's public. The authors wish to thank G. J. Hochmuth, T. H. Yeager, and C. L. Chambliss for the extra effort which they offered freely to improve the accuracy and timeliness of this publication.

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Table of Contents

Page

Preface vi

Section 1
The Extension Soil Testing Laboratory

Introduction 1
Operating Directive of the ESTL 1
Why Do We Fertilize? 1
Soil Sampling Variability 2
Nutrient Mobility 3
Types of Soil Sampling 3
  Predictive Soil Sampling 3
  Diagnostic Soil Sampling 3

Soil-Test Calibration 5
  The Calibration Process 5
  Interpretation of Soil-Test Values 7
  Recommendations based upon Soil Testing 8

Section 2
Description of Tests Offered

What Tests are Offered 9
  Commercial Production of Agronomic Crops, Forages, and Vegetables 9
  Landscape and Vegetable Garden Test 10
  Forest and Forest Nursery Soil Tests 10
  Container Media Test 10
  Water Test 11

How to Submit Your Samples to the ESTL 11
  Soil Samples 11
  Water Samples 11
  Methods of Sample Delivery to the ESTL 12

Section 3
Lime Requirement and Fertilizer Recommendations

-- Lime --

Lime Requirement 13

Table 1. Soil pH and liming footnotes 15

-- Fertilizer Tables --

IFAS Standardized Fertilizer Recommendations 16

Table 2. Current Mehlich-I soil-test interpretations used in the IFAS-wide Standardized Fertilizer Recommendation System 18

Table 3. IFAS standardized fertilizer recommendation for magnesium, all crops 18

Table 4. Target pH, and recommended N, P_2O_5, and K_2O fertilizer rates for agronomic crops 19

Table 5. Applicable footnote numbers and additional reading for agronomic crops 20

Table 6. Target pH, and recommended N, P_2O_5, and K_2O fertilizer rates for commercial vegetable production 21

Table 7. Applicable footnote numbers and additional reading for commercial vegetable production 22

Table 8. Target pH for citrus and blueberry production 23

Table 9. Applicable footnotes and additional reading for citrus and blueberry production 23

Table 10. Target pH, and recommended N, P_2O_5, and K_2O fertilizer rates for turfgrass production and lawns 24

Table 11. Applicable footnotes and additional reading for turfgrass production and lawns 25

Table 12. Target pH, and recommended N, P_2O_5, and K_2O fertilizer rates for ornamentals in commercial production and ornamentals in the landscape 26

Table 13. Applicable footnote numbers and additional reading for ornamentals in commercial production and ornamentals in the landscape 27

Table 14a. Footnotes used with agronomic crops 28

Table 14b. Footnotes used with vegetable crops 31

Table 14c. Footnotes used with citrus and blueberries 32

Table 14d. Footnotes used with turfgrasses 32

Table 14e. Footnotes used with ornamentals in commercial production and ornamentals in the landscape 33

Table 14f. Footnotes used with commercial forestry production 33

Table 14g. Footnotes used with landscapes, lawns, and vegetable gardens 34

Section 4
Electrical Conductivity Interpretations

Assumptions and Mode of Calculation 35
Modification for Soils Containing Gypsum or Lime 36
Inter-conversion from Former Soluble Salt Values 36
Salt-Index Ranges for Selected Commodities 37

Table 15. Relative yields of selected field and forage crops at selected salt-index levels 38

Table 16. Relative yields of selected vegetable crops at selected salt-index values 40

Table 17. Relative yields of selected fruit crops at selected salt-index values 41

Table 18. Relative yields of selected ornamentals at selected salt-index values 42

Section 5
Interpretation of Water-Test Results

Household Uses 45

Table 19. Interpretation for the hardness scale for household water 45

Table 20. Classification of irrigation water in terms of electrical conductivity 46

Section 6
Interpretation of Container Media Test

Uses for the Container Media Test 47
Interpretation of Results 47

Table 21. Interpretation of container media test for woody ornamentals 48

Table 22. Interpretation of container media test for bedding and pot plants 48

Section 7

Literature Cited 49

--- Purpose of This Manual and Intended Audience ---

This manual has been compiled for the purpose of providing a single reference source for information regarding interpretations of test results and fertilizer recommendations issued by the University of Florida, Institute of Food and Agricultural Sciences, Extension Soil Testing Laboratory (ESTL). The manual contains two divisions: 1) concepts of soil testing for fertilizer recommendations, and 2) a description of fertilization recommendations by commodity and type of test.

The first division explains the role that soil-fertility testing should play with respect to fertilizer use. Each of the tests offered by the ESTL is described, as well as the proper method of sample collection and handling.

The second division contains the current interpretations and fertilizer recommendations which comprise the IFAS Standardized Fertilizer Recommendations. These recommendations are under constant review and updated as needed; however, this publication should serve as a bench mark to indicate our current understanding. This review process involves over 200 IFAS faculty state-wide, both from commodity departments as well as the Soil Science Department to insure that these recommendations are reliable and practical.

Soil testing should be used as a tool to assist in making fertilizer management decisions. Proper use of fertilizers based upon soil testing works best when all management decisions are made wisely and all other production limitations are considered.

The IFAS Standardized Fertilizer Recommendations include not only information regarding the amounts of fertilizer but information on how to manage the fertilizer to obtain optimum yields while minimizing both production costs and possible environmental impact.

--- SECTION 1 ---

Introduction

The Institute of Food and Agricultural Sciences Extension Soil Testing Laboratory (ESTL) was established to serve the people of Florida by using soil and water testing as a vehicle to distribute current information regarding appropriate use of fertilizers and fertilizer-management techniques in the state.

Operating Directive of the ESTL

As part of the Soil Science Department of the Institute of Food and Agricultural Sciences (IFAS), the ESTL serves two primary functions:

1) to serve citizens of Florida, including growers, homeowners, and other interested parties, by providing specific, agriculturally-related soil and water testing through the Cooperative Extension Service, and

2) to provide analytical services needed to support research and extension field demonstrations involving proper management techniques and improved soil-testing procedures for efficient fertilizer use.

The ESTL provides chemical analyses of mineral and organic soils, container media, certain plant-tissue analyses, and irrigation and household water samples for Florida residents. Requests for testing of such materials as sewage sludges, wastewater effluent, sludges from water-treatment facilities, fertilizers, soil amendments, or limestone are referred to other governmental or private laboratories. Soil testing procedures for calcareous Florida soils, such as the marl and rockland soils of southeast Florida, have not yet been calibrated to crop response according to existing research literature. Therefore, the ESTL offers no testing of such soils.

Why Do We Fertilize?

To use soil testing and the resulting recommendations effectively, one must understand that fertilizer should be used to supply only that portion of the so-called crop-nutrient requirement which cannot be supplied from the soil. Fertilizer is applied to the soil, not to increase soil-test levels, but to improve plant nutrition. Without a positive crop response to this added nutrition, there is little incentive to add fertilizer to the soil. A crop can only produce its maximum yield (for a given set of environmental conditions) when plant-available nutrition, from both soil and added fertilizers, satisfies the crop-nutrient requirement.

For instance, some homeowners desire a thick, green lawn. If the lawn becomes pale green and ceases to grow vigorously, and the need for nitrogen (N) is indicated, the homeowner should add N fertilizer to improve the vigor of his grass. In this case, the desired crop response is a green lawn. However, a commercial producer of corn, for example, should not add fertilizer that simply results in greener corn plants, if there is no resultant increase in marketable corn yields.

The soil may already contain enough of each of the essential plant nutrients (from previous cropping, from previous fertilizer and lime additions, or from minerals found naturally in the soil, etc.), to supply all needed nutrients for optimum crop growth. At

other times, however, the soil may be low in one or more essential nutrients (leached due to rainfall, used by previous crops, etc.), and fertilizers or lime will be needed to produce optimum plant response. The nutrient status of the soil can be estimated though soil testing techniques which have been demonstrated to relate fertilizer additions to positive crop response.

Here are several of the benefits achieved by using a proper soil testing and fertilization system:

1. The crop is exposed to adequate, but not excessive, fertility. This condition permits an excellent chance of achieving optimum growth without wasting fertilizer resources and dollars or polluting the environment.

2. Because both soil fertility and fertilizers are used to satisfy the crop-nutrient requirement, only that fertilizer which is actually needed to satisfy plant nutrition is ever added to the soil.

3. Since fertilizers are added to the soil in amounts appropriate to optimize growth response, no damaging fertilizer salts are present to slow plant development.

Soil Sampling Variability

The chemical and physical parameters of a soil vary from site to site. This inherent variability directly affects the resulting fertilizer recommendation. In fact, most of the variability in soil testing comes from the soil sampling process. Little error originates within a well-run soil testing facility, due to quality-control procedures. Therefore, sampling errors should be minimized to obtain a representative soil sample from the management unit in question.

For commercial producers, the best way to sample an area is to partition the acreage into management units, i.e., blocks of land which should be managed differently. This partitioning should take into account such parameters as slope, soil type, soil fertility, cropping patterns, and drainage. Some fields require high levels of management to be productive, while others require much less management input. Each management unit should be sampled separately.

From 15 to 20 soil cores should be taken from throughout the management unit. These cores should be taken at random and mixed in a clean plastic bucket. The actual sample sent to the ESTL should be taken from this mixed, composited soil.

Within any management unit, there may be small areas that represent problem sites. Such areas may have chronic production problems, require different tillage techniques, or be poorly drained. These problem sites should be sampled separately. Remember that the goal is to obtain a soil sample that accurately represents the management unit. Problem areas do not represent the entire management unit and should not be included in the composite sample.

Homeowners and gardeners should consider their lawn as a management unit, while their vegetable garden as another management unit. Plants growing in the landscape vary widely in their liming and nutrient requirements. Consult the Landscape and Vegetable

Garden Information Form which shows species of similar needs and contains detailed information on soil sampling procedures.

Nutrient Mobility

The mobility of a nutrient within the soil is critical to the value of soil testing. For example, consider a mobile nutrient, such as nitrate. If a soil test for nitrate were made, that test might measure reliably the quantity of nitrate in the soil at the time of sampling. This quantity can change rapidly with rainfall, when some nitrate might be leached from the soil profile. Such leaching would dramatically change the quantity of nitrate available for plant use. Thus, nitrate soil testing is somewhat like taking a snap-shot of traffic at a busy intersection. You can count the cars in the picture at any one instant in time, but the movement of cars changes with time. Therefore, soil testing for mobile nutrients as a basis for making fertilizer recommendations at the beginning of a growing season is of little value under Florida's conditions of high rainfall and sandy soils.

On the other hand, immobile nutrients tend to remain in the soil profile. Such nutrients, including phosphorus (P) and to a lesser extent potassium (K) (in sands), are retained by various physical and chemical means on surfaces within the soil, thereby resisting movement by leaching. Soil-test values obtained for immobile nutrients can be linked to crop response and, therefore, to a fertilizer recommendation.

Types of Soil Sampling

Soil sampling can be divided conveniently into two distinct types, predictive soil sampling and diagnostic soil sampling.

Predictive Soil Sampling

Those soil samples taken prior to planting a crop should be considered as *predictive* samples. Predictive soil sampling is the most common type of soil sampling. To represent best the fertility status of the soil in the management unit, the sample should be taken no more than 4 to 6 weeks prior to planting. With proper calibration of the soil test, the contribution to the crop-nutrient requirement from the soil for that particular immobile nutrient is estimated. It is from this soil sample that a prediction of crop-fertilization needs is made for the coming growing season.

Research has been reported throughout Florida to support predictive soil testing using many commodities and cropping systems. Such sampling and testing continues to be an excellent management tool.

Diagnostic Soil Sampling

Soil samples which are taken while the crop is actively growing should be considered as *diagnostic* soil samples. Such testing may be used to monitor soil-nutrient status to insure adequate nutrient supply to the plant. Monitoring can be of value for both immobile nutrients and mobile nutrients, since one wants to know the nutrient status at the time of sampling (i.e., a "snap shot") and is not interested in predicting the supply of soil-supplied nutrients for the entire growing season.

The reasons for poor plant growth can be myriad, but, for some reason, nutritional problems are often the first culprits considered. Data are sparse concerning the use of soil testing for diagnostic purposes. Only when diagnostic soil-test results are combined with other diagnostic clues can a proper interpretation be made by an experienced agronomist or horticulturist. Other needed parts of the diagnostic puzzle include:

- Stage of crop growth
- Soil-test results from an appropriate extraction solution
- Tissue samples from the proper plant part(s)
- Complete fertilizer, prior cropping, and pesticide records
- Weather records
- Pest scouting
- Experience.

Soil sampling by itself rarely provides enough information — additional diagnostic information is needed as well.

Soil-Test Calibration

The fundamental process which makes soil testing meaningful for fertilizer recommendations is calibration. A particular soil test is calibrated by relating preplant soil-test values to crop response to added fertilizer. For example, if a calibrated soil test indicates that the soil is low in a particular immobile nutrient, then there is a high probability that the crop will respond positively to the addition of that nutrient from fertilizer.

A soil-test method must be calibrated with crop response to function as a fertilizer management tool. However, information from a calibrated soil-test method should not be used to interpret a soil-test method that is not calibrated. Relating one soil-test method to another is termed **correlation**. Correlation of soil-test methods will not be discussed here, except to say that soil-test results which were obtained from two different extractants should not be compared directly.

The Calibration Process

Most land grant universities use the calibration process to validate use of a particular soil-test extractant. In the Southeast, calibration of the Mehlich-I procedure has been extensive and remains ongoing, especially in Georgia, Alabama, South Carolina, and Florida.

Figures 1 and 2 illustrate the relationship between soil testing and yield response to added fertilizer, the calibration process. These graphs were plotted using **generic data** to illustrate concepts and do not apply to any particular crop or soil-supplied nutrient. Figure 1 shows typical values for relative yield plotted against preplant soil-test results. Relative yield is useful in this case because of the way it is calculated:

$$\text{Relative Yield (\%)} = \frac{\text{Actual yield}}{\text{Highest actual yield for that year and that location}} \times 100$$

With this equation, relative yields from many locations and different years can be plotted on the same graph without worrying about the true magnitudes involved. An assumption that the range in actual yields is not extremely large must be true; otherwise, this type of graph will tend to distort the worth of yields at both high and low ends of the spectrum.

The data displayed in Fig. 1 are obtained by taking both preplant soil samples and yield measurements at harvest. Of course, such a graph would be composed of data from many locations, since such a range of soil-test values would not be found at any one location (research plots excepted). When the relative yield reaches about 97%, the corresponding soil-test value is usually considered to be the **critical value**. In this case, the critical soil-test value would be about 64 ppm.

If the soil-test value were lower than the so-called **critical value** then fertilizer would be recommended. More fertilizer is recommended when the soil-test value is considerably less than the critical value. Less fertilizer is recommended as the soil test approaches the critical value. Soils with test values *above* the critical value should be able to supply all of the particular nutrient in question for proper crop growth. Therefore, that nutrient would not be specified in the fertilizer recommendation.

In Fig. 2, the relationship between added fertilizer and relative yield is shown. One curve (open squares) represents what would happen to yield if fertilizer were added to soil that has a very low soil-test value, e.g., 4 or 8 ppm as shown in Fig. 1. The other curve (open triangles) illustrates the yield response to added nutrient if the soil-test value were closer to the critical value, e.g., about 40 ppm from Fig. 1.

Note that, at or above the critical value, only small yield increases can be expected from fertilizer additions (Fig. 1). Using a relative yield of 97% as the guide, you can see that adding more fertilizer than about 140 pounds per acre (lb/A) should do little to increase yield, even when the soil supplies very little of the nutrient (low soil-test curve, Fig 2.). For this generic situation, 140-lb/A would be the recommended fertilizer rate for this crop when the soil-test value is very low.

From Fig. 2, 97% relative yield is attained with the addition of about 60 lb/A when the soil test is in the medium range (open triangles). The soil test indicates that the soil will contribute some nutrition to the crop, so less fertilizer is needed to optimize yield.

These relationships among relative yield, soil-test value, and added fertilizer **do** exist and work **well** for immobile nutrients. Using these relationships will result in fertilizer use that is consistent with optimum yield production and yet is ecologically sound.

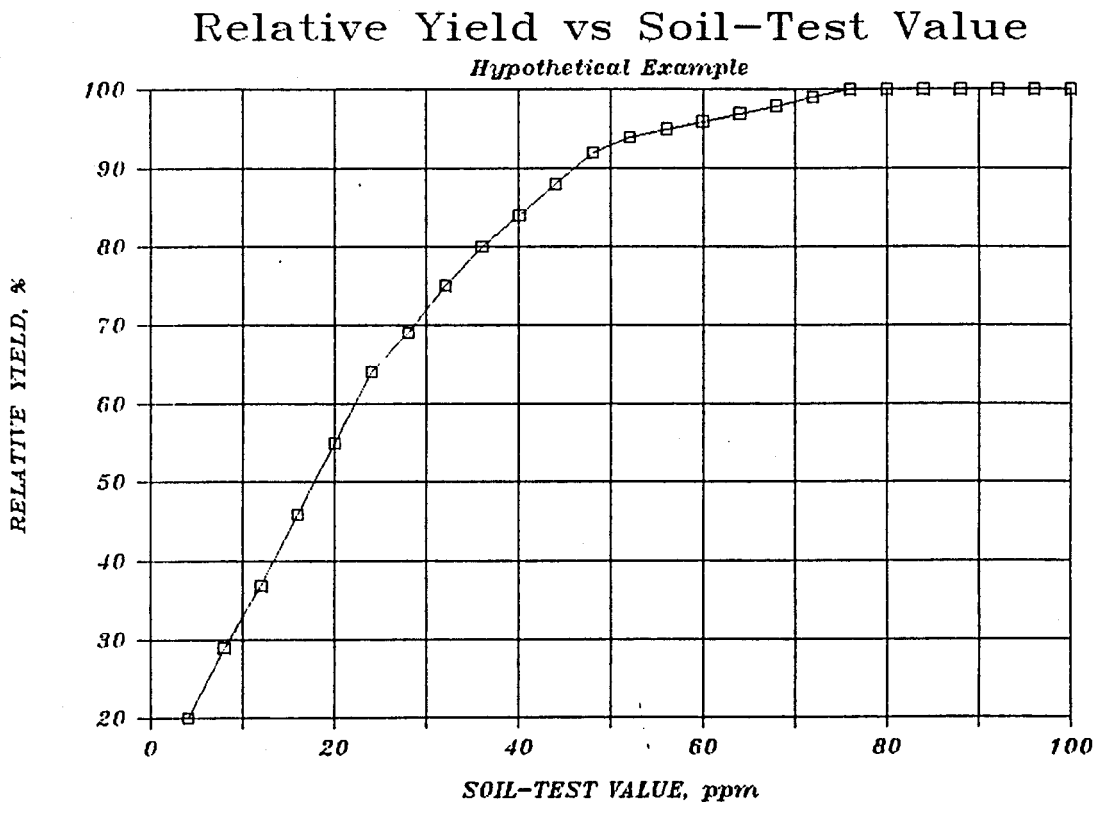

Figure 1. Hypothetical relationship between a calibrated soil test and relative yield.

Interpretations of Soil-Test Values

Interpretation is the process which verbally explains the relative meaning of a soil-test value. The interpretation scale used by the ESTL Laboratory consists of five levels ranging from **Very Low** to **Very High** (Table 2).

By definition, the division between **Medium** and **High** is termed the critical value. Above this point there is no expected crop response to added fertilizer.

Soil-test values lower than the critical value are interpreted as **Very Low, Low,** or **Medium,** indicating the extent to which the soil is deficient with respect to the measured nutrient. The probability of fertilizer-induced crop response decreases as the soil-test value approaches the critical value. Thus, less fertilizer is recommended.

When a soil tests **Very Low,** one can expect less than 50% of the crop-yield potential without addition of the deficient nutrient. If other nutrient levels and climatic conditions are suitable, then a positive crop response to added fertilizer is highly probable.

The expected crop yield is only 50 to 75% of the potential when the soil-test value is rated as **Low.** Within the **Low** rating, a positive crop response to added fertilizer is expected. When the soil test is in the **Medium** range, between 75 to 100% of the crop potential is expected and response to fertilizer is probable.

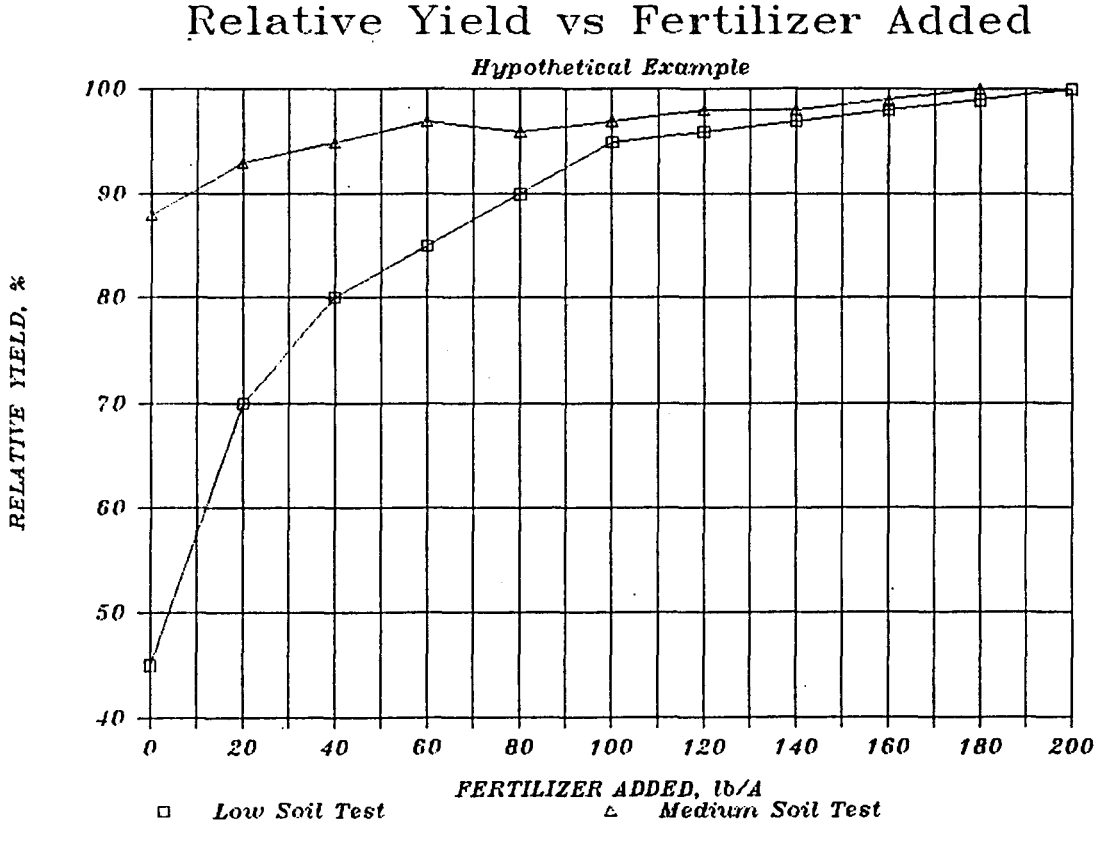

Figure 2. Hypothetical relationship between fertilizer additions and relative yield.

When the soil-test value is interpreted as **High** or **Very High**, it is unlikely that the crop will respond to added fertilizer. Adding fertilizer to soils testing **High** or **Very High** may provoke nutrient imbalances in the crop, contribute to excessive salt buildup within the soil profile, and contribute to environmental pollution through leaching of fertilizer from the soil profile. Adding fertilizer for "insurance" is not recommended since it is both costly and wasteful of a valuable resource.

Recommendations Based upon Soil Testing

There are two important aspects of effective fertilizer recommendations: fertilizer **amount** and relevant fertilizer **management practices**. Good recommendations cannot be based upon experience alone, since none of us can afford to experience many different fertilizer trials or management options. Results from replicated fertilizer trials and evaluations of management techniques are used by the ESTL to generate fertilizer recommendations and management-technique footnotes which are both timely and relevant. These IFAS-based recommendations provide a foundation for sound fertilizer practices that will ensure adequate fertility for optimum yield without the worry of crop damage or pollution from excessive fertilizer application.

--- SECTION 2 ---

Description of Tests Offered

The following discussion is intended to assist readers with questions regarding the ESTL services offered to clients. Only tests which have been shown through research/experience to assist in crop-management decisions are offered by the ESTL to Florida residents. It is the intention of the Extension Service to offer only analytical procedures whose results can be interpreted and, thus, render assistance with management decisions involving plants, soils, and fertilizers.

Certain samples will be analyzed by the ESTL free of charge. Diagnostic samples submitted by county Extension agents or state-wide Extension faculty of IFAS are among this group. Also, research samples from IFAS faculty who wish to obtain a standard fertilizer recommendation will be analyzed at no charge. Contact the ESTL for assistance with these types of samples.

Commercial Production of Agronomic Crops, Forages, and Vegetables

The extraction solution involving soil-fertility measurements used by the ESTL is the Mehlich-I extracting solution (0.05 M HCl + 0.0125 M H_2SO_4). This extracting solution has been called the **double-acid** extractant. However, the preferred **Mehlich-I** terminology will be used in this publication. This extractant is intended for sandy soils which have exchange capacities of less than 10 me/100 g and whose soil pH is less than 6.5. The method is not suited for alkaline soils (SRIEG 18, 1983).

The Standard Soil Fertility Test for noncalcareous mineral soils and organic soils, the so-called **routine test**, provides information concerning soil pH, lime requirement, P, K, calcium (Ca), and magnesium (Mg). The report specifies the amounts of lime needed, if any, to adjust the soil pH to a target soil pH range for a specified crop. Needed quantities, if any, of P_2O_5, K_2O, and Mg to increase the soil's supply of these nutrients for optimum crop production are specified in pounds per acre. Both P and K recommendations are expressed as pounds of the oxide per acre (i.e., lb P_2O_5/ac or lb K_2O/ac), the same system which is used in expressing the P and K concentration of fertilizers. To comply with current fertilizer-tag requirements, other recommended nutrients, such as Mg, are reported as pounds of the element per acre.

An integral part of the recommendations is a section of footnotes which elaborates on many aspects of fertilization for user-specified crops. Producers should use the information contained in these footnotes as management guidelines for efficient fertilizer use.

The ESTL also offers a micronutrient test for zinc (Zn), manganese (Mn), and copper (Cu). Growers should use micronutrient fertilizers with discretion, since it is often possible to create toxic levels of micronutrients in a soil. Frequently, producers will be adding one or more of these nutrients with their pesticides, thus, eliminating the need for addition from fertilizer sources. The primary value of the micronutrient soil test is to show that adequate levels of these nutrients already exist and, thus, to combat an insurance approach (commonly called the "shotgun" approach) to fertilization with micronutrients.

The micronutrient soil-test report lists the quantities of Mehlich-I extractable Zn, Mn, and Cu. A factsheet discussing the interpretation of these results, and proper micronutrient fertilization, is included with the report.

Landscape and Vegetable Garden Test

Homeowners and gardeners who do not care to use single-nutrient fertilizers are advised to choose OPTION 1 of the Landscape and Vegetable Garden Test. OPTION 1 includes soil pH determination and, if the soil is sufficiently acidic, a measure of the lime requirement (Adams-Evans Buffer Index). The report includes a recommendation for lime based upon results of the lime requirement and the crops specified by the client. Fertilizer recommendations accompanying OPTION-1 results are general recommendations and do not account for nutrients supplied to the plant from sources within the soil. Instead, all nutrition is assumed to come from fertilizer alone.

OPTION 2 includes information on the major soil-supplied nutrients in addition to soil pH and lime requirement. Homeowners can modify their fertilization program according to specific fertilizer recommendations based upon this soil test. Soil pH, Adams-Evans Buffer Index, P, K, Ca, and Mg are determined. All recommendations are reported as pounds of nutrient per 1000 square feet, instead of pounds per acre which is used for commercial crop production.

Forest and Forest Nursery Soil Tests

Recent revisions concerning forest-fertilization programs have changed the role of soil testing as a fertilizer-management tool. These revisions are the result of research conducted through the Cooperative Research in Forest Fertilization (CRIFF) program, a regional project involving both the forest industry and the University of Florida.

The new recommendation system primarily relates to pine plantations (Kidder et al., 1987) and is based upon the classification of soils into specific soil groups, known as the CRIFF soil groups (Hanlon and Munson, 1988). Soil testing of pine plantations is recommended only for CRIFF soil groups A, B, and C, depending upon the age of the stand. Information on the Pine Plantation and Pine Nursery Soil-Test Information Sheet describes proper soil-sampling techniques as well as recommendations for other CRIFF soil groups. This form is available from the nearest county Extension office.

Soil samples for pine plantations will be analyzed for soil pH and Mehlich-I extractable P. Each soil sample should consist of three separate samples representing the 0- to 8-inch, the 8- to 16-inch, and the 16- to 24-inch soil depths of the same site.

Pine nursery soil samples should be taken from the 0- to 6-inch soil depth only, and will be analyzed for soil pH, organic matter, and Mehlich-I extractable P, K, Ca, and Mg.

Container Media Test

This test measures the levels of water-soluble nutrients in soilless media (e.g., mixtures of materials such as perlite, Styrofoam, peat, pine bark, wood shavings, and sand). The Container Media Test is recommended as a diagnostic tool for fertilizer management in commercial container-plant production as a means of monitoring nutrients in the media throughout the growing season (Ingram and Henley, 1983). Test interpretations are meaningful only in commercial nursery situations. Unlike other soil tests offered by the ESTL, container-media samples should NOT be air-dried. Drying the media can affect adversely the results of the test by changing the amounts of nutrients extracted from the media.

Included in the Container Media Test are analyses for pH, electrical conductivity, nitrate-N, P, K, Ca, and Mg, all of which are measured in an extract from a water-saturated paste of the soilless media (Ingram and Henley, 1983). This report provides updated tables assisting with interpretation of results of the Container Media Test, as well as general fertilization guidelines. By using the Container Media Test regularly throughout the growing season, commercial producers can tailor interpretations and fertilizer recommendations to their individual management situations.

Water Test

The water test conducted by the ESTL is applicable for both home and irrigation waters. The ESTL provides a home-water testing service for mineral determinations only; all health-related inquiries should be directed to the nearest county health department. Municipal water sources are monitored for public safety by the Department of Health and Rehabilitative Services. Questions concerning municipal water quality should be referred to that agency.

Values reported in the water test include pH, sodium (Na), Ca, Mg, iron (Fe), chloride (Cl), total carbonates and bicarbonates, and electrical conductivity. Interpretations for home-water quality and irrigation-water quality are included with the report.

In Florida, many irrigation-water sources originate from limestone aquifers, resulting in high-pH waters. pH-sensitive crops, such as blueberries or pine seedlings, may benefit considerably by pretreating such water with acid to destroy carbonates and concurrently lower the water pH. Results from the total carbonates and bicarbonates test can be used to determine the amount of acid required to reduce this high-pH condition. Treatment of water with acid for agricultural purposes is discussed by Kidder and Hanlon (1985). A testing kit is available to Extension faculty for field testing of carbonates (Hanlon and DeVore, 1986).

How to Submit Samples to the ESTL

Soil Samples

Soil sampling literature, including request forms for all of the tests discussed above, sample bags, and mailing boxes are available from the nearest county Extension Office. *Notes in Soil Science No. 2D* briefly describes the ESTL testing services and indicates under which conditions each test may be applicable.

Water Samples

The container in which a water sample is sent to the ESTL can influence results greatly. The container should be either made of plastic or glass and clean to avoid contamination of the sample. Thoroughly flush the container several times with the flowing water. The sample should be taken several minutes after the water source has been flowing from the spigot or irrigation pump. The container should be filled completely with no airspace at the container top.

Methods of Sample Delivery to the ESTL

Samples may be mailed or shipped to the ESTL or delivered directly to the ESTL to save mailing delays. After testing is completed (normally three working days after sample receipt at the ESTL), results are mailed directly to the return address entered by the client on the request sheet. A copy of these results is sent to the county Extension office.

Occasionally, return mail may be too slow to permit timely management decisions. Most county Extension offices have the capacity to receive testing results via electronic mail. Currently, there is no extra charge for this service. County agents may contact the ESTL by telephone in extreme cases.

--- SECTION 3 ---

Lime Requirement and Fertilizer Recommendations

Lime Requirement

The Adams-Evans Buffer test (Adams and Evans, 1962) is used to determine the lime requirement, if any, for soil samples which have a soil pH below 6.0. This buffer system is more accurate when prescribing appropriate liming rates than when making a liming recommendation based on soil pH alone. Soil pH does not predict the buffering capacity of the soil, often called the **reserve acidity**. Many complex chemical factors contribute to reserve acidity and some form of buffering system is required to measure accurately this form of acidity. While other techniques may be used, most of the alternate methods are not suited for rapid laboratory analysis.

The original Adams and Evans procedure to calculate lime requirement has been replaced by a more accurate procedure calibrated with soils from Florida. This new approach uses the soil pH (2:1 V:V), a target soil pH, and the resultant pH of the soil mixed with the Adams-Evans Buffer, the so-called Buffer Index pH (Dierolf and Kidder, 1986).

In this context, soil pH should be adjusted to the target soil pH. A target pH based upon crop performance, nutrient availability, and experience, is specified for various crops in Tables 4, 6, 8, and 10. The following equation is used to determine lime requirement:

Lime Requirement =

26.1 - 3.40 x (Buffer Index pH) + 1.02 x (target soil pH - soil pH)

where:

Buffer Index pH is obtained by reacting the Adams-Evans buffer with a soil sample and then measuring the resultant pH;

Target soil pH is the pH to which the soil should be adjusted;

Soil pH is the pH of a 2:1 soil:water suspension.

This equation is used in the ESTL recommendation computer program, when needed. The lime requirement is rounded to the nearest 0.5 ton of lime for all Extension soil samples. Two examples are given to make the use of the equation clear.

Example 1. Assume that the crop is mulched tomatoes and therefore that the target soil pH is 6.5 (Table 6). The soil pH was measured as 5.5 with a Buffer Index pH of 7.45. Substituting these values into the above equation yields:

26.1 - 3.40 x (7.45) + 1.02 x (6.5 - 5.5) = 1.8 tons of ag lime per acre (T/A).

Rounding to the nearest 0.5 T/A, the recommendation would be for 2.0 T lime/A. If 2.0 T/A of ag lime (either dolomite or calcitic lime) were added to this soil, then the soil pH should approach 6.5 as the lime reacts with the soil's reserve acidity. The speed of this

reaction is dependent upon the fineness of the lime particles, soil moisture, temperature, and depth and method of lime incorporation into the soil. A rule of thumb often quoted is that this reaction will be complete about 6 months after application. However, under good conditions, much of the pH change will have taken place in the first few weeks after lime application.

Example 2. Assume that the crop is wheat for grain with a target pH of 6.0 (Table 4). The soil pH is 5.8 and the Buffer Index pH was measured at 7.55. Substituting into the preceding equation:

$$26.1 - 3.40 \times (7.55) + 1.02 \times (6.0 - 5.8) = 0.6 \text{ tons of aglime per acre (T/A).}$$

After rounding, the recommendation would be for 0.5 T lime/A. In this case, the grower may wish to wait another season and retest the soil's lime requirement. Since the soil's pH is so close to the target pH in this case, it is unlikely that wheat yield would benefit from the addition of lime.

The primary reasons why lime is added to soil are to reduce any toxic effects of soil aluminum and to improve nutrient availability for plants. Like fertilizers, lime should be added when it will cause a positive crop response. Florida's sandy soils contain low amounts of plant-available aluminum and have relatively low amounts of reserve acidity. Both conditions result in the fact that small amounts of lime are needed. In fact, overliming is now a common problem in Florida.

Irrigation waters from many of Florida's aquifers contain enough dissolved lime to add more than 0.5 T/A per growing season. This source of lime should be considered for irrigated crops to avoid the nutrient-availability problems that can result when soil pH is too high for proper crop growth. Besides quantifying the amount of lime that may be needed to modify soil pH, the ESTL furnishes additional information through a series of footnotes. Those footnotes which address questions related to soil pH and liming are found in Table 1. These footnotes are chosen programmatically for each sample based upon the sample's crop code, soil pH, Buffer Index pH, Target Soil pH, and Mehlich-I extractable Ca and Mg levels.

Table 1. Text of all soil pH and liming footnotes. Only relevant footnotes are used for each soil sample. Appropriate footnotes are cited as dictated by each sample's particular soil-test results and selected crop.

No.	*Footnote*
801	Either calcitic or dolomitic limestone may be used.
802	Recommendations are based on the Adams-Evans lime requirement test which is run on all mineral soils having a pH below 6.0. When the recommended amount of lime is incorporated in the surface 6 inches of soil, soil pH should adjust to a level above which additional liming benefit is not expected. Excessive applications of lime can result in nutritional disorders.
803	Lime soil with either dolomite or dolomitic limestone.
804	Magnesium (Mg) fertilizer is recommended. Dolomite is an economical, long-lasting source of Mg. Since this soil has a pH below 6.4, up to 1/2 ton dolomite/A may be used to supply Mg with little danger of over-liming. Alternatively, use 35 lb Mg/A of a more-soluble Mg source, such as magnesium sulfate or potassium magnesium sulfate, blended with other fertilizers.
805	Apply 500 lb gypsum/A as a calcium fertilizer source.
806	Apply the equivalent of 35 lb Mg/A in a soluble form, such as magnesium sulfate or potassium magnesium sulfate.
807	Lime requirement is not currently determined on soils containing more than about 15% organic matter.
808	It is generally impractical to apply less than one ton of agricultural lime per acre. Since the lime need is small, you may elect to either apply no lime or to apply 1 ton lime/A this year. A soil test taken in alternate years will help monitor soil pH and insure proper lime management.
810	The Adams-Evans lime requirement test is not valid and thus not run on soils that exhibit a pH greater than 6.0.
814	Magnesium (Mg) fertilizer is recommended. Dolomite is an economical, long-lasting source of Mg. Since this soil has a pH below 6.4, up to 20 lb dolomite per 1000 sq. ft. may be used to supply Mg with little danger of over-liming. Alternatively, use 0.2 lb Mg per 1000 sq. ft. of a more-soluble Mg source, such as magnesium sulfate or potassium magnesium sulfate, blended with other fertilizers.
815	Apply 10 lb gypsum per 1000 sq. ft as a calcium fertilizer source.
818	Since the lime need is small, you may elect to either apply no lime or to apply 45 lb lime per 1000 sq. ft. this year. A soil test taken in alternate years will help monitor soil pH and ensure proper lime management.
819	The pH of this soil is quite high. If this is a natural condition (i.e., if it is not from the over-application of lime), it is generally impractical to lower the soil pH with soil amendments. Use plant species that are tolerant of high soil pH.

IFAS Standardized Fertilizer Recommendations

After a soil sample has been extracted with the Mehlich-I extractant and the extract analyzed, a computer program using the information presented in Tables 2 and 3 assigns an interpretation value of **Very Low** (VL), **Low** (LO), **Medium** (MED), **High** (HI), or **Very High** (VH) to the P, K, and Mg soil-test values. The computer program uses these interpretations to determine the IFAS Standardized Fertilizer Recommendation for each of these nutrients. The specific fertilizer levels of P_2O_5 and K_2O, given in lb/A, are listed by crop and soil-test interpretation in Tables 4, 6, 8, 10, and 12. These tables also contain the target soil pH and the recommended N fertilizer level for each crop.

Tables 5, 7, 9, 11, and 13 contain the important second half of any good recommendation — footnotes detailing management practices for optimum fertilizer-use efficiency. In addition to footnotes listed by crop, added information may be obtained by consulting the publications listed as references, which also serve as the source documents for the IFAS Standardized Fertilizer Recommendations. A complete listing of each footnote is given in Tables 14a through 14g.

Examples of the manual use of these tables may be of benefit to those who wish to use the soil-test results for additional crops not originally specified when the soil sample was sent to the ESTL. Do not use these tables for soil-test results which were obtained by other extractants. Such use will lead to incorrect interpretations and fertilizer recommendations.

Example 1. Soil-test results for a soybean field show the following values:

Soil pH	Adams-Evans Buffer Index pH	Mehlich I extractable P	K	Mg	Ca
		---------- ppm ----------			
6.5	---	12	120	45	>2000

Using Table 2, the soil-test values are interpreted as follows:

Soil pH	Adams-Evans Buffer Index pH	Mehlich I extractable P	K	Mg	Ca
		---------- ppm ----------			
---	---	LO	HI	HI	---

Notice that no interpretation of Ca is given. Mehlich-I extractable Ca is used only for the determination of the type of limestone to be recommended, where liming is needed. For most soils and most crops, liming to insure an adequate soil pH for proper crop growth will insure a more-than-adequate concentration of Ca for proper crop growth. Research results (Adams and Hartzog, 1980) have shown no crop response to added Ca, from either liming materials or gypsum, when the Mehlich-I extractable Ca level is above 250 ppm. The production of peanuts for seed is an exception to this statement and is addressed by an appropriate footnote.

Consulting Table 4 of this section for soybeans (crop code 11), the target pH (6.5) and the soil-test pH (6.5) are the same — hence no lime is required at this time. Zero lb N/A are needed, since soybeans are nitrogen-fixing legumes. Looking under the P_2O_5 "LO"

column, the IFAS Standardized Fertilizer Recommendation would be for 40 lb P_2O_5/A. Moving under the K_2O section to the column labeled "HI", the IFAS Standardized Fertilizer Recommendation would be for zero lb K_2O/A. Referring to Table 3, zero lb Mg/A would be recommended. A summary of these recommendations is listed below:

Lime Requirement Tons Lime/A	P_2O_5	K_2O	Mg
	-------- lb/A --------		
0	40	0	0

From Table 5 of this section for soybeans, footnotes 108, 124, and 128 would be printed to clarify and to amplify the correct cultural practices to be followed concerning this recommendation. The text of these footnotes can be found in Table 14a.

Example 2. Soil-test results for muskmelons growing under full-bed plastic mulch indicate the following values:

Soil pH	Adams-Evans Buffer Index pH	Mehlich I extractable P	K	Mg	Ca
		---------- ppm ----------			
5.9	7.55	9	40	48	>2000

Using Table 2, the soil-test values in this case for vegetable crops are interpreted as follows:

Soil pH	Adams-Evans Buffer Index pH	Mehlich I extractable P	K	Mg	Ca
		---------- ppm ----------			
---	---	VL	MED	HI	---

Consulting Table 6 for mulched muskmelon (crop code 206), the target pH (6.5) is greater than the soil-test pH (5.9). Using the equation given in section A above, the calculated lime requirement is only 0.38 ton lime/A. Rounding to the nearest 0.5 ton lime/A, the lime recommendation would be for 0.5 ton lime/A. In addition, 120 lb N/A are needed. Looking under the column labeled "VL" in the P_2O_5 section of Table 6, the IFAS Standardized Fertilizer Recommendation would be for 160 lb P_2O_5/A. Moving under the K_2O section to the column labeled "MED", the IFAS Standardized Fertilizer Recommendation would be for 100 lb K_2O/A. Referring to Table 3, zero lb Mg/A would be recommended. A summary of these recommendations is listed below:

Lime Requirement Tons Lime/A	N	P_2O_5	K_2O	Mg
	---------- LB/A ----------			
0.5	120	160	100	0

From Table 7 for mulched muskmelons, footnotes 250, 350, 351, 352, and 354 would be printed to clarify the cultural practices to be followed in association with this recommendation. The text of these footnotes can be found in Table 14b.

Table 2. Current Mehlich-I, soil-test interpretations used in the IFAS-wide Standardized Fertilizer Recommendation System.

Mineral, organic, and organic-mineral intergrade soils

Element	Crop	Rating				
		Very Low (VL)	Low (LO)	Medium (MED)	High (HI)	Very High (VHI)
		parts per million (ppm)				
P	All	<10	10-15	16-30	31-60	>60
K	All	<20	20-35	36-60	61-125	>125
Mg	All		<15	15-30	>30	

Table 3. IFAS standardized fertilizer recommendations for magnesium, all crops.

Element	Rating		
	Low LO	Medium MED	High HI
	lb Mg/A		
Mg	35	20	0

* If lime is needed (based upon the crop, soil pH, and Buffer Index pH) and the Mg soil test result is interpreted as LO, or MED, the ESTL computer program will recommend application of dolomitic limestone. Otherwise, the program will generally recommend Mg from other fertilizer sources.

Table 4. Target pH, and recommended N, P_2O_5, and K_2O fertilizer rates for agronomic crops. Phosphorus and K rates are based on interpretation of a Mehlich-I soil test.

CROP CODE	CROP DESCRIPTION	TARGET pH	N lb/A	P_2O_5 VL	P_2O_5 LO	P_2O_5 MED	P_2O_5 HI	P_2O_5 VH	K_2O VL	K_2O LO	K_2O MED	K_2O HI	K_2O VH
			lb/A	VL	LO	MED	HI	VH	VL	LO	MED	HI	VH
1	NON-IRRIG CORN, 10M/A*	6.5	120	100	80	40	0	0	100	80	40	0	0
2	NON-IRRIG CORN, 12.5M/A	6.5	150	125	100	50	0	0	120	100	60	0	0
3	NON-IRRIG CORN 15M/A	6.5	180	150	120	60	0	0	150	120	60	0	0
4	IRRIGCORN, 20M/A	6.5	180	150	120	60	0	0	150	120	60	0	0
5	IRRIGCORN, 25M/A	6.5	210	175	140	70	0	0	175	140	70	0	0
6	IRRIGCORN, 30M/A	6.5	240	200	160	80	0	0	200	160	80	0	0
7	GRAIN SORGHUM OR FORAGE SORGHUM FOR SILAGE	6.5	150	125	100	50	0	0	125	100	50	0	0
8	TRITICALE, OATS, OR RYE FOR GRAIN	6.0	70	100	80	40	0	0	100	80	40	0	0
9	COTTON	6.5	60	120	90	60	0	0	125	100	70	0	0
10	PEANUTS	6.5	0	100	80	40	0	0	100	80	40	0	0
11	SOYBEANS	6.5	0	60	40	20	0	0	60	40	20	0	0
12	FLUE-CURED TOBACCO	6.0	80	100	80	60	0	0	200	160	120	0	0
13	SUGAR CANE FOR SYRUP	6.0	90	100	80	40	0	0	100	80	40	0	0
14	SUMMER ANNUAL GRASSES	6.0	**	80	80	40	0	0	80	80	40	0	0
21	WARM SEASON LEGUMES	6.0	0	30	30	30	0	0	60	60	30	0	0
22	COOL SEASON LEGUMES OR LEGUME-GRASS MIXTURES	6.5	0	125	100	60	0	0	200	160	120	0	0
23	ALFALFA	7.0	0	150	125	80	0	0	200	160	120	0	0
24	BAHIAGRASS PASTURE												
	High-N Option	5.5	160	40	40	0	0	0	80	80	40	0	0
	Medium-N Option	5.5	100	25	25	0	0	0	50	80	0	0	0
	Low-N Option	5.5	50	0	0	0	0	0	0	0	0	0	0
25	IMPROVED PERENNIAL GRASSES (EXCLUDING BAHIA)	5.5	160	40	40	0	0	0	80	40	0	0	0
26	COOL SEASON ANNUAL GRASSES	6.0	80	100	80	40	0	0	100	80	40	0	0
27	WHEAT FOR GRAIN	6.0	80	100	80	40	0	0	100	80	40	0	0
28	WARM SEASON LEGUME-GRASS MIXTURES	6.0	0	80	80	40	0	0	80	80	40	0	0

* 10M/A refers to 10,000 plants per acre.
** Nitrogen recommendation is contained in footnotes 111 and 112.

Table 5. Applicable footnote numbers and additional reading for agronomic crops.

CROP CODE	CROP DESCRIPTION	FOOTNOTES	REFERENCES
1	NON-IRRIG CORN, 10M/A	101 120 124	Agronomy Facts 70
2	NON-IRRIG CORN, 12.5 M/A	102 120 124	Agronomy Facts 70
3	NON-IRRIG CORN, 15 M/A	103 120 124	Agronomy Facts 70
4	IRRIG CORN, 20 M/A	103 120 124	Agronomy Facts 70
5	IRRIG CORN, 25 M/A	104 120 124	Agronomy Facts 70
6	IRRIG CORN, 30 M/A	105 120 124	Agronomy Facts 70
7	GRAIN SORGHUM OR FORAGE SORGHUM FOR SILAGE	106 124	Agronomy Facts 70
8	TRITICALE, OATS, OR RYE FOR GRAIN	106 124	Agronomy Facts 133 and 147
9	COTTON	107 124	Agronomy Facts 111
10	PEANUTS	108 109 118 124	Agronomy Facts 70
11	SOYBEANS	108 124 128	Notes in Soil Science 23
12	FLUE-CURED TOBACCO	110 124	Agronomy Facts 70
13	SUGARCANE FOR SYRUP	106 124	Agronomy Facts 70
14	SUMMER ANNUAL GRASSES	111 124	Agronomy Facts 147
21	WARM SEASON LEGUMES	121 124	Agronomy Facts 147
22	COOL SEASON LEGUMES OR LEGUME-GRASS MIXTURES	115 122 124 129	Agronomy Facts 147
23	ALFALFA	116 120 123 124	Agronomy Facts 147
24	BAHIAGRASS PASTURE	124 131	Agronomy Facts 70 and 147
25	IMPROVED PERENNIAL GRASSES(EXCLUDING BAHIA)	124 125 126	Agronomy Facts 70 and 147
26	COOL SEASON ANNUAL GRASSES	112 124	Agronomy Facts 70 and 147
27	WHEAT FOR GRAIN	124 127	Agronomy Facts 133 and 147
28	WARM SEASON LEGUME-GRASS MIXTURES	121 124	Agronomy Facts 147

Table 6. Target pH, and recommended N, P_2O_5, and K_2O fertilizer rates for commercial vegetable production. Phosphorus and K rates are based on interpretation of a Mehlich-I soil test (IFAS Circular 806).

Crop Code	Crop Description	Target pH	lb/A/year										
			N	P_2O_5				K_2O					
			lb/A	VL	LO	MED	HI	VH	VL	LO	MED	HI	VH
200	Tomato or pepper	6.5	160	160	130	100	0	0	160	130	100	0	0
201	Mulched tomato	6.5	160	160	130	100	0		130	100	50	0	
202	Mulched pepper	6.5	160	160	130	100	0	0	160	130	100	0	0
203	Eggplant	6.5	120	160	130	100	0	0	160	130	100	0	0
204	Mulched eggplant	6.5	120	160	130	100	0	0	160	130	100	0	0
205	Muskmelon	6.5	120	160	130	100	0	0	160	130	100	0	0
206	Mulched muskmelon	6.5	120	160	130	100	0	0	160	130	100	0	0
207	Head cabbage	6.5	120	160	130	100	0	0	160	130	100	0	0
208	Mulched head cabbage	6.5	120	160	130	100	0	0	160	130	100	0	0
209	Lettuce and endive	6.5	110	150	120	90	0	0	150	120	90	0	0
210	Cucumber, squashes, or spinach	6.5	90	120	100	80	0	0	120	100	80	0	0
211	Mulched cucumber or squash	6.5	90	120	100	80	0	0	120	100	80	0	0
212	Broccoli or cauliflower	6.5	110	150	130	100	0	0	150	130	100	0	0
213	Mulched broccoli or cauliflower	6.5	110	150	130	100	0	0	150	130	100	0	0
214	Celery	6.5	200	300	200	100	0	0	300	200	100		0
215	Irish potato	6.0	150	120	120	60	0	0	140	140	70	0	0
216	Bushbeans, southern or English peas	6.5	60	80	80	60	0	0	80	80	60	0	0
217	Lima or pole beans	6.5	90	120	120	80	0	0	120	120	80	0	0
218	Sweet potato	6.5	60	120	120	80	0	0	120	120	80	0	0
219	Radish	6.5	90	120	120	80	0	0	120	120	80	0	0
220	Sweet corn	6.0	120	120	120	80	0	0	120	120	80	0	0
221	Watermelon	6.0	120	160	160	100	0	0	120	100	80	0	0
222	Mulched watermelon	6.0	120	160	160	100	0	0	120	100	80	0	0
223	Onion	6.5	120	120	100	80	0	0	120	100	80	0	0
224	Mulched strawberry	6.5	120	160	160	100	0	0	160	160	100	0	0
225	Mustard or turnip	6.5	110	150	130	100	0	0	150	130	100	0	0
226	Chinese cabbage or carrots	6.5	110	150	130	100	0	0	150	130	100	0	0
227	Okra or collard	6.5	110	150	130	100	0	0	150	130	100	0	0
228	Beets	6.5	90	120	120	80	0	0	120	120	80	0	0
90	Vegetable garden	6.5	100	140	140	70	0	0	140	140	70	0	0

Table 7. Applicable footnotes and additional reading for commercial vegetable production.

CROP CODE	CROP DESCRIPTION	FOOTNOTES	REFERENCES
200	TOMATO OR PEPPER	250 251 354	Circulars 98C & 225C
201	MULCHED TOMATO	250 350 351 352 353 354	Circulars 98 & 225C
202	MULCHED PEPPER	250 350 351 352 353 354	Circulars 102E, 109, and 225-C
203	EGGPLANT	250 251 354	Circulars 102E & 225C
204	MULCHED EGGPLANT	250 350 351 352 353 354	Circular 225C
205	MUSKMELON	250 251 354	Circulars 122C & 225C
206	MULCHED MUSKMELON	250 350 351 352 354	Circulars 122C & 225C
207	HEAD CABBAGE	250 251 354	Circulars 117E & 225C
208	MULCHED HEAD CABBAGE	250 350 351 352 354	Circulars 123 & 225C
209	LETTUCE AND ENDIVE	250 251 354	Circulars 123 & 225C
210	CUCUMBER, SQUASHES, OR SPINACH	250 251	Circulars 101D, 103D & 225C
211	MULCHED CUCUMBER OR SQUASH	250 350 351 352 354	Circulars 101D, 103D & 225C
212	BROCCOLI OR CAULIFLOWER	250 251 354	Circulars 555 and 225-C
213	MULCHED BROCCOLI OR CAULIFLOWER	250 350 351 352 354	Circulars 555 and 225-C
214	CELERY	250 251 354	Bulletin 757 & Circular 225C
215	IRISH POTATO	251 253	Circulars H8 & 225C, SSSAJ 47:266 -270, & SCSSFP 41:193 -195
216	BUSHBEANS, SOUTHERN OR ENGLISH PEAS	250 251	Circulars 100, 225-C, and 478
217	LIMA OR POLE BEANS	250 251	Circulars 100 and 225-C
218	SWEET POTATO	250 251	Circulars 440-II, 551 & 225C
219	RADISH	250 251 252	Circular 225-C
220	SWEET CORN	250 251	Circular 99D & 225C
221	WATERMELON	250 251 354	Circulars 96G, 122, and 225-C
222	MULCHED WATERMELON	250 350 351 352 354	Circulars 96G, 122, and 225-C
223	ONION	250 350 354	Circulars 176E, 225-C & Bulletin 238
224	MULCHED STRAWBERRY	250 350 352 353 354 355	DOVER ARC SV 1978-2 and Circulars 142 & 225C
	MUSTARD OR TURNIP	250 251	Circular 225-C
226	CHINESE CABBAGE OR CARROTS	250 251	Circular 225-C
227	OKRA OR COLLARD 250 251		Circular 225-C
228	BEETS	250 251	Circular 492
90	VEGETABLE GARDEN	901 through 909	Circular 104P and Veg Crops Factsheet 74-3

* SCSSFP refers to the Soil and Crop Science Society of Florida Proceedings, and SSSAJ refers to the Soil Science Society of America Journal.

Table 8. Target pH for citrus and blueberry production. Soil testing is not used in determining fertilizer rates for these commodities.

CROP CODE	CROP DESCRIPTION	TARGET pH
60	CITRUS (ESTABLISHMENT)	6.5
61	CITRUS (BEARING TREES) OR DOORYARD CITRUS	6.5
67	BLUEBERRY (BEARING)	4.0

Table 9. Applicable footnotes and additional reading for citrus and blueberry production.

CROP CODE	CROP DESCRIPTION	FOOTNOTES	REFERENCES
60	CITRUS (ESTABLISHMENT)	402 403 405	Bulletin 536D
61	CITRUS (BEARING TREES) OR DOORYARD CITRUS	402 404 405	Bulletin 536D
67	BLUEBERRY (BEARING)	401 408	Fruit Crops Factsheet 46 and Circular 397

Table 10. Target pH, and recommended N, P_2O_5, and K_2O fertilizer rates for turfgrass production and lawns. Phosphorus and K rates are based on interpretation of a Mehlich-I soil test.

CROP CODE*	CROP DESCRIPTION	TARGET pH	N	lb/1000 sq ft/year									
				P_2O_5					K_2O				
				VL	LO	MED	HI	VH	VL	LO	MED	HI	VH
71	ATHLETIC FIELD,GOLF GREEN,TEE, OR FAIRWAY	6.5											
72	BAHIAGRASS LAWN	5.5	2.0	1.0	1.0	0.5	0	0	2.0	2.0	1.0	0	0
73	BERMUDAGRASS LAWN, NORTH	6.5	4.0	1.0	1.0	0.5	0	0	2.0	2.0	1.0	0	0
73	BERMUDAGRASS LAWN, SOUTH	6.5	5.0	2.0	2.0	1.0	0	0	3.0	3.0	1.5	0	0
74	CARPETGRASS LAWN	5.5	2.0	1.0	1.0	0.5	0	0	1.0	1.0	0.5	0	0
75	CENTIPEDEGRASS LAWN, NORTH	5.5	2.0	1.0	1.0	0.5	0	0	2.0	2.0	1.0	0	0
75	CENTIPEDEGRASS LAWN, SOUTH	5.5	2.0	1.0	1.0	0.5	0	0	2.0	2.0	1.0	0	0
76	RYEGRASS LAWN	6.0	1.4	0.5	0.5	0.2	0	0	1.0	1.0	0.5	0	0
77	ST. AUGUSTINE LAWN, NORTH	6.5	2.0	1.0	1.0	0.5	0	0	2.0	2.0	1.0	0	0
77	ST. AUGUSTINE LAWN, SOUTH	6.5	3.0	1.0	1.0	0.5	0	0	3.0	3.0	1.5	0	0
78	ZOYSIAGRASS LAWN, NORTH	6.5	3.0	2.0	2.0	0.5	0	0	2.0	2.0	1.0	0	0
78	ZOYSIAGRASS LAWN, SOUTH	6.5	4.0	1.0	1.0	0.5	0	0	2.0	2.0	1.0	0	0

* Samples sent from counties north of Orlando, including the panhandle, are assigned recommendations for the northern section of the state. This North/South distinction is automatically made by the computer program based upon the specified county.

Table 11. Applicable footnotes and additional reading for turfgrass and lawns.

CROP CODE*	CROP DESCRIPTION	FOOTNOTES	REFERENCES
71	ATHLETIC FIELD, GOLF GREEN, TEE, OR FAIRWAY	504	Soil Science fact sheet SL-21
72	BAHIAGRASS LAWN	501	Soil Science fact sheet SL-21
73	BERMUDAGRASS LAWN, NORTH	501	Soil Science fact sheet SL-21
73	BERMUDAGRASS LAWN, SOUTH	501	Soil Science fact sheet SL-21
74	CARPETGRASS LAWN	501	Soil Science fact sheet SL-21
75	CENTIPEDEGRASS LAWN, NORTH	501	Soil Science fact sheet SL-21
75	CENTIPEDEGRASS LAWN, SOUTH	501	Soil Science fact sheet SL-21
76	RYEGRASS LAWN		
77	ST. AUGUSTINE LAWN, NORTH	501	Soil Science fact sheet SL-21
77	ST. AUGUSTINE LAWN, SOUTH	501	Soil Science fact sheet SL-21
78	ZOYSIAGRASS LAWN, NORTH	501	Soil Science fact sheet SL-21
78	ZOYSIAGRASS LAWN, SOUTH	501	Soil Science fact sheet SL-21

* Samples sent from counties north of Orlando, including the panhandle, are assigned recommendations for the northern section of the state. This North/South distinction is automatically made by the computer program based upon the specified county.

Table 12. Target pH, and recommended N, P_2O_5, and K_2O fertilizer rates for ornamentals in commercial production and ornamentals in the landscape. Phosphorus and K rates are based on interpretation of a Mehlich-I soil test.

CROP CODE	CROP DESCRIPTION	TARGET pH	N	lb/1000 sq ft/year									
				P_2O_5					K_2O				
				VL	LO	MED	HI	VH	VL	LO	MED	HI	VH
600	COMMERCIAL WOODY ORNAMENTAL NURSERY GROWING PLANTS IN THE GROUND	6.0	6.9	2.3	2.3	1.1	0	0	4.6	4.6	2.3	0	0
601	COMMERCIAL NURSERY AZALEAS, CAMELLIAS, GARDENIAS, HIBISCUS, OR IXORA IN THE GROUND	5.5	3.4	1.1	1.1	0.7	0	0	2.3	2.3	1.1	0	0
602	WOODY ORNAMENTALS OR TREES IN THE LANDSCAPE	6.0	2.3	0.7	0.7	0.4	0	0	1.4	1.4	0.7	0	0
603	AZALEAS, CAMELLIAS, GARDENIAS, HIBISCUS, OR IXORA IN THE LANDSCAPE	5.5	1.1	0.3	0.3	0.2	0	0	0.7	0.7	0.3	0	0

Table 13. Applicable footnote numbers and additional reading for ornamentals in commercial production and ornamentals in the landscape.

CROP CODE	CROP DESCRIPTION	FOOTNOTES	REFERENCES
600	COMMERCIAL WOODY ORNAMENTAL NURSERY GROWING PLANTS IN THE GROUND	650, 651, 652	Bulletin 793
601	COMMERCIAL NURSERY GROWING AZALEAS, CAMELLIAS, GARDENIAS, HIBISCUS, AND IXORA IN THE GROUND	650, 651, 652	Circulars 460 and 461
602	WOODY ORNAMENTALS AND TREES IN THE LANDSCAPE	650, 653, 654	Ornamental Horticulture fact sheets 37 and 44
603	AZALEAS, CAMELLIAS, GARDENIAS, HIBISCUS, AND IXORA IN THE LANDSCAPE	650, 653, 654	Ornamental Horticulture fact sheets 37 and 44

Table 14a. Footnotes used with agronomic crops.

101	Apply all of the P_2O_5, 30% of the K_2O, and 20 lb N/A in a preplant or at-planting application. Four weeks after planting, sidedress the remaining 70% of the K_2O. Apply the remaining 100 lb N/A in two or more sidedressings, one of which should be at 4 weeks.
102	Apply all of the P_2O_5, 30% of the K_2O, and 30 lb N/A in a preplant or at-planting application. Four weeks after planting sidedress the remaining 70% of the K_2O. Apply the remaining 120 lb N/A in two or more sidedressings, one of which should be at 4 weeks.
103	Apply all of the P_2O_5, 30% of the K_2O, and 30 lb N/A in a preplant or at-planting application. Four weeks after planting sidedress the remaining 70% of the K_2O. Apply the remaining 150 lb N/A in two or more sidedressings, one of which should be at 4 weeks.
104	Apply all of the P_2O_5, 30% of the K_2O, and 30 lb N/A in a preplant or at-planting application. Four weeks after planting sidedress the remaining 70% of the K_2O. Apply the remaining 180 lb N/A in three or more sidedressings, one of which should be at 4 weeks.
105	Apply all of the P_2O_5, 30% of the K_2O, and 30 lb N/A in a preplant or at-planting application. Four weeks after planting sidedress the remaining 70% of the K_2O. Apply the remaining 210 lb N/A in three or more sidedressings, one of which should be at 4 weeks.
106	Apply all of the P_2O_5 and 30% of the K_2O and N in a preplant or at-planting application. Topdress or sidedress the remaining 70% of the K_2O and N. For small grains grown for grain, topdress during late January or early February. For grain sorghum or forage sorghum, sidedress before plants are too tall to cultivate or approximately four weeks after planting.
107	Apply all of the P_2O_5 and 30% of the K_2O and N in a preplant or at-planting application. Apply the remaining 70% of the K_2O and N in one sidedressing.
108	Application of 20 to 30 lb N/A may give vegetative response but is unlikely to increase harvested yield.
109	If peanuts are grown for seed or if they are Virginia type, regardless of soil test, apply gypsum in a band over the potential pegging zone at early flower. Apply 400 lb gypsum/A for runner types and 800 lb gypsum/A for Virginia types. Double these rates if broadcasting granular or phosphogypsum (bulk wet). For peanuts not grown for seed, apply gypsum as recommended above only if the calcium soil-test level is below 250 ppm Ca.
110	Apply 50% of the fertilizer at or before transplanting and the other half within 3 weeks of transplanting.
111	Apply 30 lb N/A, 50% of the K_2O, and all of the P_2O_5 fertilizer in a preplant or at-planting application. Apply 50 lb N/A and the remaining K_2O after the first grazing period. Apply an additional 50 lb N/A after each subsequent grazing period.
112	When planting a prepared seed bed, apply 30 lb N/A, 50% of the K_2O, and all of the P_2O_5 fertilizer in a preplant or at-planting application. Apply 50 lb N/A and the remaining K_2O after the first grazing period. Apply an additional 50 lb N/A after each subsequent grazing period. For overseeding established perennial grasses with cool season annual grasses, apply 50 lb N/A plus all P_2O_5 and K_2O after emergence. Apply an additional 50 lb N/A after each subsequent grazing period.
115	Apply all of the P_2O_5 and 50% of the K_2O fertilizer in late fall. Apply the remaining K_2O in early spring. If legumes are planted in combination with oats, rye, wheat, and/or ryegrass, apply 30 lb N/A in a preplant or at-planting application plus one additional 50 lb N/A application after the grass is well established.
116	Apply all of the P_2O_5 and 50% of the K_2O fertilizer in late fall. Apply the remaining K_2O in early spring.

118 Apply 0.75 lb boron/A in the fertilizer or 0.5 lb boron/A as a foliar spray with the first fungicide application.

120 Fertilizer should contain 15 to 20 lb sulfur/A. Apply as a sulfate (eg. gypsum, ammonium sulfate, magnesium sulfate, potassium sulfate, potassium magnesium sulfate), since elemental sulfur will react too slowly to supply the sulfur needs of the current crop.

121 Apply all of the P_2O_5 and K_2O in spring or early summer when seedlings or regrowth are 3 to 4 inches tall. Species included are aeschynomene, alyce clover, desmodiums, hairy indigo, perennial peanut, and other tropical legumes.

122 Species included are all true clovers (white, red, arrowleaf, crimson, subterranean), vetches, lupines, and sweet clover.

123 Apply all of the P_2O_5 and 50% of the K_2O fertilizer in late fall. Apply the remaining K_2O in early spring. If the alfalfa is mechanically harvested rather than grazed, apply an additional 30 lb P_2O_5/A and 60 lb K_2O/A after each harvest. An additional application of 100 lb K_2O/A in June or July may increase summer survival of alfalfa. Apply 3 lb boron/A per year to alfalfa in three 1 lb/A applications. Copper and zinc fertilizer may be needed if soil pH is above 6.5.

The lime requirement shown above is adequate for established alfalfa. However, if the alfalfa has not yet been planted, apply and incorporate one ton of lime/A if the soil pH is below 6.6. Lime is especially important for establishment of alfalfa. It is not practical to incorporate lime once the alfalfa is planted.

124 IFAS recommendations emphasize efficient fertilizer use without losses of yield or of crop quality. Efficient fertilizer use results in high production with minimum impact to our environment. Since fertilizer use and management are only two aspects of crop production, growers are encouraged to consider IFAS recommendations in light of their entire management strategy, including financial considerations.

125 Grass species included are bermuda, star, limpo, and digit.

126 For new plantings, apply only 100 lb N/A and split as follows: apply 30 lb N/A, all of the P_2O_5, and 50% of the K_2O as soon as plants have emerged. Apply the remaining K_2O and 70 lb N/A 30 to 50 days later.

For grazed, established stands, apply 80 lb N/A, all of the P_2O_5, and 50% of the K_2O in early spring. Apply the remaining N and K_2O at mid-season. Under intensive management in central and south Florida, up to 200 lb N/A may be economically viable for stargrass and bermudagrass. In that situation, apply 80 lb N, all of the P_2O_5 and K_2O in early spring, follow with 50 lb N/A in mid-season, and 70 lb N/A and the other 50% K_2O in mid to late September.

If cutting for hay or silage, apply 80 lb N/A, all of the P_2O_5 and K_2O in early spring. Apply an additional 80 lb N/A and 40 lb K_2O/A after each cutting.

127 Apply all of the P_2O_5, 50% of the K_2O, and 40 lb N/A at planting. Topdress the remaining N and K_2O in late January. On land which lacks clayey soil within the top 6 to 8 inches of the surface, apply 5 to 10 lb sulfate-sulfur/A at planting and 10 lb sulfate-sulfur/A in the topdressing. Wettable or other elemental forms of sulfur will react too slowly to supply the sulfur needs of the current crop. On flatwoods soils with pH above 6.1, apply 10 lb manganese/A. On better-drained sands with pH above 6.5, apply 6 to 10 lb manganese/A.

128 The recommended rates of fertilizer are sufficient to produce soybean yields in the 60 bu/A range. If yields from this field have never exceeded 40 bu/A under current management, reduce P_2O_5 and K_2O recommendations by 20 lb/A. If yields from this field have never exceeded 25 bu/A, reduce P_2O_5 and K_2O recommendations by 40 lb/A. Often this adjustment will mean that you will achieve your yield potential without any P or K fertilizer additions.

129 These recommendations are made assuming adequate soil moisture will be available either from rainfall or irrigation. In south Florida, lack of adequate rainfall during the cool season frequently causes stand failure or limits growth. Under non-irrigated conditions in south Florida, the probability of inadequate moisture is high and the likelihood that the crop will benefit from applied fertilizer is low.

131 Fertilization Management Notes for Bahiagrass Pastures

For new plantings, apply only 100 lb N/A split as follows: apply 30 lb N/A, all of the P_2O_5, and 50% of the K_2O as soon as plants have emerged. Apply the remaining K_2O and 70 lb N/A 30 to 50 days later.

For established stands of bahiagrass, apply all of the fertilizer in the early spring to maximize much-needed spring forage. Bahiagrass is a very efficient forager and recovers nutrients from deeper in the soil profile that other popular forage grasses so danger of leaching losses is low. Three fertilization options are presented below. Choose the option which most closely fits your fertilizer budget, management objectives, and land capability.

High-Nitrogen Option Apply 160 lb N/A and the soil-test-based recommended rates of P_2O_5 and K_2O for each of your pastures. The fertilization rates suggested in this option are high enough to allow bahiagrass pasture to achieve well above average production. Management and environmental factors will determine how much of the potential production is achieved and how much of the forage is utilized.

Medium-Nitrogen Option Apply around 100 lb N/A this year. At that level of N fertilization, P and K may be limiting if your soil tested low in these nutrients. Apply 25 lb P_2O_5/A if your soil tested low in P and none if it tested medium. Apply 50 lb K_2O/A if your soil tested low in K and none if it tested medium. Re-test your soil every second or third year to verify P and K levels. If you plan to make a late-season cutting of hay, apply 80 lb N/A between August 1 and 15 (about 6 weeks before the growing season ends).

Low-Nitrogen Option (for Grazed Pastures only) Apply around 50 lb N/A this year, recognizing that N will be the limiting nutrient. Thus, do not apply P or K. If you follow this practice of applying only N to your pasture for more than one year, apply the P and K recommended by soil tests every third or fourth year to avoid excessive depletion of those nutrients. Do not use this option if you cut hay since nutrient removal by hay is much greater than by grazing animals.

Table 14b. Footnotes used with vegetable crops.

250	Indicated fertilizer amounts, and the nutrients already in the soil, will satisfy the crop nutrient requirement for this cropping season. Fertilizer and water management are linked. Maximum fertilizer efficiency is achieved only with close attention to water management. Supply only enough irrigation water to satisfy crop requirements. Excess irrigation may result in leaching of N and K, creating possible plant deficiencies. For subsurface irrigation, maintain a constant water table between 15 and 18 inches below the top of the bed. On soils that have not been in vegetable production within the past 20 years, or where micronutrients are known to be deficient, apply 5 lbs of Mn, 3 lb Zn, 4 lb Fe, 3 lb Cu, and 1.5 lb B/A. Use soil testing to monitor micronutrient status every 2 years. When deciding about micronutrient applications, consider micronutrients added to the crop via fungicides. Some micronutrients can build up in the soil -- avoid micronutrient toxicity.
251	Fertilizer should be applied in split applications to reduce leaching losses and lessen danger of fertilizer burn. Broadcast all P_2O_5 and micronutrients, if any, and 25 to 50% of the N and K_2O in the bed at planting. Apply remaining N and K_2O in sidedress bands during the early part of the growing season. In cold soil or after fumigation, apply 20 to 25% of the recommended N in the nitrate form. Additional, supplemental sidedress applications of 30 lb N/A and 20 lb K_2O/A should be applied only after rainfall/irrigation amounts exceed 3 inches within a 3-day period or exceeds 4 inches within a 7-day period. Avoid mechanical damage to plants when applying fertilizers.
252	The amounts suggested are generally sufficient for 2 or 3 crops in succession.
253	Where scab-resistant cultivars are grown, a pH between 6.0 and 6.5 is optimum. Where scab-susceptible cultivars are grown, the pH should be below 5.2 or above 7.2.
350	Supply 25 to 50% of the N in the nitrate form if soils were treated with multi-purpose fumigants.
351	For subsurface irrigation, incorporate 10 to 20% of the N and K_2O, plus all of the P_2O_5 and micronutrients, if any, into the bed. Apply the remainder of the N and K_2O one inch deep in one or more bands about 6 to 10 inches from the plants. For drip irrigation, incorporate 20 to 40% of the N and K_2O and all of the P_2O_5 and micronutrients, if any, into the bed. Apply the remainder of the N and K_2O periodically through drip tubes according to the rate of crop growth. For management systems where both seep and drip irrigation are being used, apply no more than 20% of the N and K_2O, plus all of the P_2O_5 and micronutrients, if any, into the bed. Apply the remainder of the N and K_2O periodically through drip tubes according to the rate of crop growth. For overhead irrigation, incorporate all of the N, K_2O, P_2O_5, and micronutrients, if any, into the bed prior to installation of the plastic mulch.
352	Amounts suggested are for the first crop. Squash and cucumber following other crops on the same mulch may not need additional fertilizer. If fertilizer is needed for the second crop, apply fertilizer using a liquid-injection wheel or via drip irrigation.

353	From 25 to 30% of the N may be supplied from slow-release N sources, such as sulfur-coated urea or isobutylidene-diurea (IBDU).
354	Transplants may benefit from application of a dilute, soluble starter fertilizer, especially at cool soil temperatures.
355	Broadcast all the P_2O_5 and micronutrients, if any, and 25% of the N and K_2O into the bed. Place the remaining N and K_2O in a band 2 to 3 inches deep in the center of the bed.

Table 14c. Footnotes used with citrus and blueberries.

401	Except for pH, lime requirement, and in some instances P, soil-test results are generally not used as a basis for fertilization of perennial fruit and nut crops in Florida. Program fertilization is practiced, and plant-tissue testing may be helpful for certain crops.
402	For specific citrus fertilization recommendations, refer to IFAS bulletin 536 D, "Recommended Fertilizers and Nutritional Sprays for Citrus." For assistance with interpretation, contact your county Extension office.
403	A general recommendation for citrus establishment follows: Use dolomitic limestone to raise soil pH above 6.0, if necessary. During the first year make four or five applications of 0.08 lb N, 0.02 lb P_2O_5, and 0.08 lb K_2O per tree. Double this rate in the second year. In the 3rd through the 6th years, make three fertilizer applications, each containing 0.08 lb N, 0.02 lb P_2O_5 and 0.08 lb K_2O per year of tree age. Example: 0.32 lb N per tree three times in the fourth year after planting. Magnesium, manganese, copper, and boron will also be needed on land not previously fertilized with these nutrients.
404	Generally oranges require 0.4 lb of N/year/box of fruit and grapefruit require 0.3 lb N/box of fruit up to a maximum of 250 lb N/A. The general K_2O requirement is the same as the N requirement. If the P soil-test level is high or very high, no P fertilizer is recommended; otherwise apply 0.2 lb P_2O_5/box of fruit every fourth year. Leaf tissue analysis is recommended for guiding fertilization, and is especially helpful in determining the need for micronutrient fertilization.
405	Long-term liming experiments have demonstrated consistent and significant citrus yield increases up to a soil pH of 7.0, even where Cu toxicity is not a problem. However, maintenance of soil pH levels in excess of 7.0 is not generally recommended.
408	Soil pH should be between 4.0 and 5.2 for Florida blueberries. Iron deficiency chlorosis, characterized by interveinal yellowing in young leaves, is often the result of soil pH above 5.2. To lower the soil pH, apply agricultural grade sulfur or aluminum sulfate to the soil. If soil pH is within the proper range and plants are chlorotic, apply soluble iron to the plants.

Table 14d. Footnotes used with turfgrasses.

501	For details on fertilization obtain Soil Science fact sheet SL-21, "General Recommendations for Fertilization of Turf-Grasses on Florida Soils," from your county Extension agent. These rates are for normal, healthy lawns. Double the rates for high maintenance turf. Divide annual rates into 2 to 8 applications depending on location and management levels. Apply no more than 1.0 lb N/1000 sq. ft. per application.
504	Standard fertilizer recommendations for growing high quality turf are not given here. Management level and local conditions greatly influence fertilizer input. Contact your county Extension agent if a recommendation is required.

Table 14e. Footnotes used with ornamentals in commercial production and ornamentals in the landscape.

650	Indicated fertilizer amounts, coupled with nutrients already in the soil, will satisfy the crop-nutrient requirement for this growing season. Fertilizer and water management are linked. Maximum fertilizer efficiency is achieved only with close attention to water management. Supply only enough irrigation water to satisfy plant requirements and minimize leaching conditions.
651	Broadcast P_2O_5 either in one application or at half the recommended amount in each of two applications during the growing season. To minimize leaching losses, broadcast N and K_2O in small increments throughout the growing season. Schedule one application every 4 to 6 weeks (six to eight times per growing season), adding 10 to 15% of the recommended amount of N and K_2O at each application. To insure equal coverage when fertilizer rates are small, blend all compatible fertilizers or add needed nutrients through the irrigation system.
652	Additional supplemental broadcast applications of 10% of the recommended amounts of N and K_2O should be applied only after rainfall amounts exceed 3 inches within a 3-day period or exceed 4 inches within a 7-day period. Avoid mechanical damage to plants when applying fertilizers.
653	Established trees (more than three to five years since transplanting) do not need routine fertilization. For recently-planted trees, broadcast fertilizer within a diameter of 1.5 times the dripline diameter.
654	Broadcast P_2O_5 either in one application or as half the recommended amount in each of two applications during the growing season. To minimize leaching losses, broadcast N and K_2O in small increments throughout the growing season. Schedule one application every 12 weeks (three times per growing season), adding 33% of the recommended amount of N and K_2O at each application. To insure equal coverage when fertilizer rates are small, blend all compatible fertilizers or add needed nutrients through the irrigation system.

Table 14f. Footnotes used with commercial forestry production.

701	Based upon subsoil pH, this pine plantation is likely to benefit from P fertilization. After 1 year of growth, N and P fertilizers in combination occasionally produce increased tree growth. If N fertilizer is added alone to young plantations, undesirable weed competition may result with little increased pine growth.
702	Fertilizer addition is not recommended. Increased pine growth is not expected from fertilizer addition because soil-test results predict that the trees will obtain adequate nutrition from the soil alone.
703	No fertilizer is recommended for pines growing on soils in CRIFF Soil Groups D, E, F, and G.
704	Fertilizer recommendations for pine plantations older than 8 years are not based upon soil testing.
705	For detailed recommendations, contact CRIFF coordinator in Gainesville (904-392-1850).

Table 14g. Footnotes used with landscapes, lawns, and vegetable gardens.

901	Sidedress every 3 weeks or after heavy rains. On each 100 sq. ft. use 1/4 cup ammonium nitrate mixed with 1/4 cup muriate of potash, or use 2 cups of 6-8-8 fertilizer.
902	Apply 1 lb sulfur/100 sq. ft. to lower soil pH. Also, apply 1 oz/100 sq. ft. of a complete micronutrient mix, or use a complete fertilizer which contains micronutrients.
903	This report does not contain fertilization recommendations. Pamphlets on fertilization of lawns, vegetable gardens, dooryard fruits, and ornamentals are available from your county Extension service office.
908	Since no crop code was specified, fertilizer and lime recommendations have been omitted. Contact your Extension agent for specific recommendations.

--- SECTION 4 ---

Electrical Conductivity Interpretations

Assumptions and Mode of Calculation

Soluble-salt problems in Florida arise from two common sources: saltwater effects in coastal areas, including saltwater intrusion of wellfields (where the predominant ions are sodium and chloride), and salt effects due to over fertilization (where the predominant highly-soluble ions are potassium, chloride, ammonium, nitrate, and sulfate). Historically, the ESTL has reported soluble salt values for Florida soils in terms of ppm, using a dry-soil basis. Though this approach works poorly at best in much of the world, it has served Florida agriculture well, because of the uniformly sandy nature of Florida's mineral surface soils. However, because of its infrequent use elsewhere, the ppm dry-soil convention isolates Florida's growers and ag-industry personnel from the large and steadily growing body of salinity literature world-wide. For this reason, the ESTL has recently converted its soluble salts index to a saturation-extract electrical conductivity (EC) basis.

Excessive soluble-salt effects on plant growth can be classified into osmotic (related to total salt levels) and specific-ion effects. The latter include the effects of ions which are particularly harmful to sensitive species, such as sodium, chloride, boron, and fluoride. This effect is generally less severe than the osmotic effect. Osmotic effects are commonly inferred from the EC of a soil extract, with the EC being proportional to the soluble-salt concentration and generally negatively correlated with plant-growth response.

The saturation extract has been adopted as the soil water-content standard for such soluble-salt measurements. In general, the water content of soil following drainage of free water from either over-irrigation or a heavy rain (the so-called **field capacity**) is about 1/2 that at saturation. Similarly, the water content at the crop's **permanent wilting point** (from which the crop will not recover even if the soil is rewetted) is 1/2 to 1/3 that at field capacity. Use of water contents higher than saturation introduces the risk of solubilizing slightly-soluble salts such as lime and gypsum, and of significantly changing the soluble-cation composition due to exchange of ions such as calcium and magnesium, for ions such as potassium, sodium, and ammonium, as the soil solution is diluted during extraction. For a reasonably rapid and reproducible estimation of soluble salts for extremely sandy soils such as are common to Florida, however, the analyst often has no choice but to use a higher water content for extraction of soluble salts.

The water content used at the ESTL for soluble-salts estimation has been 2:1 water:soil, or 200%. It has been determined (R. D. Rhue, unpublished data), for a group of 100 Florida mineral surface soils, that the average water content (air-dry basis) at saturation was 26% w/w. Hence, the conversion factor between EC as measured, and EC of a typical saturation extract, is approximately 8 (200% divided by 26% = 7.7). This value, the measured EC in dS/m x 8 or in mmho/cm x 8, is termed the **salt index** for the soil sample in question. The salt index will vary as rainfall or crop uptake removes soluble salts from the crop-root zone, or as fertilizer salts or salts from irrigation water are added to the soil. Salt index also normally varies both across the crop bed (depending upon fertilizer placement and upon former water-movement patterns) and with depth beneath the bed. Current wisdom holds that the crop responds to the weighted-average salinity (EC) within the root zone though this is likely inaccurate for banded fertilizer placement. If sufficient low-salinity water is maintained in the root zone for plant evapotranspiration needs, many plants (barring specific-ion effects) will grow quite well despite the presence of moderately- to highly-saline water within normal rooting depths.

Modification for Soils Containing Gypsum or Lime

Because of the high water content used for soluble-salts estimation at the ESTL, the client must be aware of possible misinformation if the soil sample also contains gypsum or lime. Approximately 25% of the soil samples received by the ESTL in recent years have evidenced pH values high enough to suggest the presence of lime. Even for soils not recently limed, the continued use of irrigation water from limestone aquifers may have resulted in the accumulation of free carbonates in frequently-wetted portions of the profile. Lime is soluble to the extent of approximately 0.1 dS/m (mmho/cm) at pH 8, and progressively more soluble at lowered pH values. Because of lime dissolved at 200% water content (a 2:1 water:soil ratio) which would not be in solution at 26% water content (saturation), a correction factor of 1.0 should be subtracted from the salt index for soil samples known to contain free carbonates in addition to their soluble salts.

Gypsum is soluble to the extent of 2.0 dS/m (mmho/cm), with its solubility essentially independent of pH. The 2:1 water:soil ratio is totally inappropriate for soils containing gypsum. A large (e.g. 100-200g) sample of such soil should instead be extracted under pressure or vacuum at the saturation water content (25-30% for typical Florida sands), and 2.0 subtracted from the resultant EC value to obtain an estimate of the contribution of non-gypsum salts to the sample's salinity. This is not within the scope of services routinely provided by the ESTL.

Inter-Conversion from Former Soluble-Salts Values

Conversion from former ESTL soluble-salts values (expressed on the basis of ppm, air-dry-soil) to saturation-extract EC (salt index) values requires knowledge of the types of salts being dealt with. For coastal areas in which the salts are primarily of marine origin, an average equivalent weight for the salts present would be approximately 60 mg/meq. For primarily fertilizer-salt mixtures, however, as was apparently assumed by early formulators of the former ESTL approach, an equivalent-weight value of approximately 70 mg/meq is more appropriate instead. Scientists at the U.S. Salinity Laboratory (Richards, 1954) assumed an equivalent weight of 64 mg/meq for "typical" western-U.S. irrigation waters.

Inter-conversion of the two types of values can be calculated as follows:

Salt index (dS/m, or mmho/cm, saturation-extract basis) =

$$\frac{\text{Soluble Salts (ppm soil, or mg/kg, air-dry basis)}}{\text{Equivalent Weight of Salt (mg/meq)}} \times \frac{1\text{ kg}}{1\text{L}} \times \frac{100\%}{26\%} \times \frac{1\text{ dS/M}}{10\text{ meq/L}}$$

Simplifying the above expression, Salt index = Soluble salts x 0.0055

To convert from salt index values back to soluble salts,

Soluble Salts (ppm soil, air-dry basis) =

$$\text{Salt index (dS/m, or mmho/cm)} \times \frac{10\text{ meq/L}}{1\text{ dS/m}} \times \frac{26\%}{100\%} \times \frac{1\text{ L}}{1\text{ kg}} \times \frac{70\text{ mg/meq}}{1\text{ mg/kg per ppm}}$$

Simplifying this equation results in: Soluble salts = Salt index x 180

Though an equivalent weight of 70 mg/meq appears to have been used for earlier ESTL inter-conversions, the lowered equivalent weight for salts almost exclusively of marine origin should be kept in mind when working with former ESTL values in coastal areas. For some interpretations from the data, this is a significant (nearly 20% difference) distinction.

Salt-Index Ranges for Selected Commodities

In using the following tables, please note that crops are grouped from most-sensitive to least-sensitive within a given crop type. In addition to the direct relative-yield values for the crop (comprising all but the two right-hand columns in the table), there is also provided a) a salinity-threshold value below which no salinity effects are observed; and b) a percentage-yields decrease per unit salt-index increase for salt-index values above the salinity-threshold value. These are provided for more precise interpretation of the data, and also for ease of data entry into computer-based yield predictors if the client is using such.

Table 15. Relative yields of selected field and forage crops at selected salt-index levels (Carter, 1981).

Plant Name	Scientific Name	Relative yield (%) at salt-index values of: 1	2	3	4	6	8	10	12	16	20	24	Salinity-effect threshold (ds/m)	% Yield decrease per subsequent dS/m increase
Moderately Sensitive														
Alfalfa	Medicago sativa	100	100	93	85	71	56	42	27				2.0	7.3
Clover	Trifolium spp.	100	94	82	70	40	22	0					1.5	12.0
Corn, forage	Zea mays	100	99	91	84	69	54	39	24				1.8	7.4
Flax	Vinum usitatissimum	100	96	84	72	48	24	0					1.7	12.0
Lovegrass	Eragroslis spp.	100	100	92	83	66	49	32	15				2.0	8.5
Peanut	Arachis hypogaca	100	100	100	77	20	0						3.2	28.6
Rice, Paddy	Oryza sativa	100	100	100	88	63	39	15	0				3.0	12.2
Sesbania	Sesbania exaltata	100	100	95	88	74	60	47	33				2.3	7.0
Trefoil, big	Lotus uliginosus	100	100	87	68	30	0						2.3	18.9
Vetch, common	Vicia sativa	100	100	100	89	67	44	22	0				3.0	11.1
(Also in this group: bentgrass, canarygrass, millet, sweet clover, timothy)														
Moderately tolerant														
Barley, forage	Hordeum vulgare	100	100	100	100	100	86	72	58	30			6.0	7.0
Clover, berseem	Trifolium alexandrinium	100	97	91	86	74	63	51	40	17			1.5	5.8
Fescue	Festuca clatior	100	100	100	99	89	78	68	57	36			3.9	5.3
Hardinggrass	Phalaris tuberosa	100	100	100	100	89	74	59	44	14			4.6	7.6
Orchardgrass	Dactylis glomerata	100	97	91	84	72	60	47	35	10			1.5	6.2
Ryegrass, Perennial	Lolium perene	100	100	100	100	97	82	67	52	21			5.6	7.6
Safflower	Carthamus tinctorius	100	100	100	100	100	90	80	50				6.5	—
Sorghum	Sorghum bicolor	100	100	100	100	90	78	63	50	22			4.8	—
Soybean	Glycine max	100	100	100	100	80	40	0					5.0	20.0
Sudan grass	Sorghum sudanese	100	100	99	95	84	78	69	61	43			2.8	4.3
Sugarcane	Saccharum spp.	100	98	92	86	75	63	51	39				1.7	5.9
Trefoil, birdsfoot	Lotus corniculatus tenuifolium	100	100	100	100	90	70	50	30	0			5.0	10.0

Table 15. (continued)

Plant Name	Scientific Name	Relative yield (%) at salt-index values of: 1	2	3	4	6	8	10	12	16	20	24	Salinity-effect threshold (ds/m)	% Yield decrease per subsequent dS/m increase
Wheat	Triticum aestivum	100	100	100	100	100	86	71	57	29			6.0	7.1
Wildrye, beardless	Elymus triticoides	100	100	98	92	80	68	56	44	20			2.7	6.0

(Also in this group: bromegrass, dallisgrass, milkvetch, oats, rhodesgrass, rye [hay], wheatgrass [slender, western], wildrye [Canada].)

Tolerant

Barley, grain	Hordeum vulgare	100	100	100	90	80	60	40	20				8.0	5.0
Bermudagrass	Cyneden dactylon	100	100	93	80	67	42	16	0				6.9	6.4
Cotton	Gossypium spp.	100	100	98	88	78	57	36	16				7.7	5.2
Wheatgrass, crested	Agopyron desertorum	98	90	82	74	66	50	34	18				3.5	4.0
Wheatgrass, fairway	Agopyron cristatum	100	100	97	83	69	41	14	0				7.5	6.9
Wheatgrass, tall	Agropyron elongatum	100	100	98	89	81	64	47	31				7.5	4.2

(Also in this group: butall alkaligrass, rescuegrass, saltgrass, wildrye [altai, Russian].)

Table 16. Relative yields of selected vegetable crops at selected salt-index values (Carter, 1981).

Plant Name	Scientific Name	Relative yield (%) at salt-index values of: 1	2	3	4	6	8	10	12	16	20	24	Salinity-effect threshold (ds/m)	% Yield decrease per subsequent dS/m increase
Sensitive														
Bean	Phaseolus vulgaris	100	81	62	43	6							1.0	18.9
Carrot	Daucus carota	100	86	72	58	30	1						1.0	14.1
Celery	Apium graveoleus	100	90	75									—	—
Okra	Abelmoschus esculentus	100	90										—	—
Onion	Allium cepa	100	87	71	55	23	0						1.2	16.1
Strawberry	Fragaria spp.	100	67	33	0								1.0	33.3
Moderately Sensitive														
Broadbean	Vicia faba	100	96	87	77	58	38	19	0				1.6	9.6
Cauliflower	Brassica oleracea	100	100	93	85								2.5	—
Cabbage	Brassica oleracea var. Capitata	100	98	88	79	59	40	20	1				1.8	9.7
Corn, sweet	Zea mays	100	96	84	72	48	24	0					1.7	12.0
Cucumber	Cucumis sativus	100	100	94	81	55	29	3					2.5	13.0
Lettuce	Latuca sativa	100	91	78	65	39	13						1.3	13.0
Muskmelon	Cucumis melo	100	100	95	80								2.5	—
Pea	Pisum sativum L.	100	100	90									2.5	—
Pepper	Capsicum annum	100	93	79	65	37	8						1.5	14.1
Potato	Solanum tuberosum	100	96	84	72	48	24	0					1.7	12.0
Radish	Raphanus sativus	100	90	77	64	38	12						1.2	13.0
Spinach	Spinacia oleracea	100	100	92	85	70	55	39	24				2.0	7.6
Squash	Cucurbita maxima	100	100	90	74								2.5	—
Sweet potato	Ipomoea batatas	100	95	84	73	51	29	7					1.5	11.0
Tomato	Lycopersicon esculentum	100	100	95	85	65	46	26	6				2.5	9.9
Moderately tolerant														
Beet, garden	Beta vulgaris	100	100	100	100	82	64	46	29	0			4.0	9.0
Broccoli	Brassica oleracea var. capitata	100	100	98	89	71	52	34	16				2.8	9.1
Kale	Brassica campestris	100	100	100	100	100							6.5	—
Tolerant														
Sugarbeet	Beta vulgaris	100	100	100	100	100	94	82	71	47	24	0	7.0	5.9

Table 17. Relative yields of selected fruit crops at selected salt-index values (Carter, 1981).

Plant Name	Scientific Name	Relative yield (%) at salt-index values of: 1	2	3	4	6	8	10	12	16	20	24	Salinity-effect threshold (ds/m)	% Yield decrease per subsequent dS/m increase
Sensitive														
Avocado	Persea americana	100	90	70									1.0	—
Blackberry	Rubus spp.	100	89	67	44	0							1.5	22.2
Grapefruit	Citrus paradisi	100	97	81	65	32	0						1.8	16.1
Lemon	Citrus limon	100	91	75									1.0	—
Orange	Citrus sinensis	100	95	79	63	32	0						1.7	15.9
Peach	Prunus persica	100	94	73	52	10	0						3.2	18.8
Pineapple guava	Feijoa sellowiana	100	71	34	0								1.2	—
Raspberry	Rubus idaeus	100	80	62									1.0	—
Moderately sensitive														
Grape	Vitis spp.	100	95	86	76	57	38	18	0				1.5	9.5
Moderately tolerant														
Fig	Ficus carica	100	100	100	100	85							4.2	—
Pomegranate	Punica granatum	100	100	100	100	85							4.0	—
(Also in this group: lime [rangpur], mandarin [Cleopatra]).														
Tolerant														
Date	Pheonis dactylifera				100	93	86	78	71	57	42	28	4.0	3.6
Natal Plum	Carissa grandiflora				100	100	82						6.0	—

Table 18. Relative yields of selected ornamentals at selected salt-index values (Carter, 1981).

Plant Name	Scientific Name	Relative yield (%) at salt-index values of: 1	2	3	4	6	8	10	12	16	20	24	Salinity-effect threshold (ds/m)	% Yield decrease per subsequent dS/m increase
Sensitive														
Algerian ivy	Hedera canariensis	100	81	62	35								1.0	—
Burford holly	Olex cornuta	100	82	59	36	0							1.0	—
Heavenly bamboo	Nandina domestica	100	88	75	61	34	7						1.0	—
Hibiscus	Hibiscus rosa-sinensis Brilliante	100	86	72	58	28	0						1.0	—
Pittosporum	Pittosporum tobira	100	89	79	69	50	30						1.0	—
Rose	Rose spp.	100	74	36	0								1.0	—
Star jasmine	Trachelospermum jasminoides	100	83	61	40	0							1.6	—
	(Also in this group: burnet)													
Moderately sensitive														
Arborvitae	Thuja orientalis	100	100	91	81	62	43	24					2.0	—
Bottlebrush	Callistemon viminalis	100	94	85	77	59	41						1.5	—
Boxwood	Buxux microphylla var. japonica	100	96	86	76	54	32	11					1.7	10.8
Dodonaea	Dodonaea viscosa var. Atropurpurea	100	94	86	77	59	42	25	9				1.0	7.8
Juniper	Juniperus chinensis	100	91	81	72	54	36	18	0				1.5	9.5
Lantana	Lantana camara	100	92	82	72	51	30	9					1.8	—
Oleander	Nerium oleander	100	100	93	86	72	58	44	30				2.0	—
Pyracantha	Pyracantha braperi	100	99	90	81	62	43	24	6				2.0	9.1
Silverberry	Elaeagnus pungens	100	95	87	78	59	41	23	16				1.6	—
Texas privet	Ligustrum lucidum	100	94	85	75	56	36	16	0				2.0	9.1
Viburnum	Viburnum spp.	100	90	73	58	32	10						1.4	13.2
Xylosma	Xylosma senticosa	100	94	81	67	40	14						1.5	13.3

Table 18. (continued)

Plant Name	Scientific Name	Relative yield (%) at salt-index values of: 1	2	3	4	6	8	10	12	16	20	24	Salinity-effect threshold (ds/m)	% Yield decrease per subsequent dS/m increase
Moderately tolerant														
Alkali sacaton	Sporobolus airoides	100	100							0				
Dracaena	Dracaena endivisa	100	100	100	94	76	58	40	22	0			4.0	9.1
Euonymus	Euonymus japonica					100	77	27	0				7.0	—
Tolerant														
Bougainvillea	Bougainvillea spectabilis				100	100	100						8.5	—
Rosemary	Rosmarinum lockwoodii				100	85		68					4.5	—

--- SECTION 5 ---

Interpretation of Water-Test Results

Household Uses

A detailed interpretation of analyses conducted on home water is printed directly on the water report form which can be found in appendix A of this publication. An extended discussion is included here to emphasize certain points.

1. Water Hardness

Originally, the hardness of a water was understood to be a measure of the capacity of that water for precipitating soap. Soap is precipitated chiefly by the Ca and Mg ions commonly present in water, but also may be precipitated by other polyvalent ions. Because only Ca and Mg are commonly present in significant concentrations in natural waters, hardness is defined as a characteristic of water which represents the total concentrations of Ca and Mg ions expressed as $CaCO_3$ (Rand, Greenberg, and Taras, 1976).

(ppm Ca X 2.5) + (ppm Mg X 4.1) = ppm hardness,

where the factors 2.5 and 4.1 are conversions for ppm Ca and Mg, respectively, to ppm of $CaCO_3$.

Table 19. Interpretation of the hardness scale for household water.

Rating	Hardness (ppm)
Soft	0 to 17
Relatively Soft	18 to 50
Moderately Soft	51 to 120
Hard	121 to 170
Very Hard	>170

2. Iron

High levels of Fe in home water can impart a metallic taste to water and can stain clothes and plumbing. Staining can be caused by as little as 0.3 ppm Fe.

3. pH

Acid water is corrosive and, therefore, water should be on the alkaline side of the pH range to prevent damage to metal parts of the water system.

4. Electrical Conductivity, Sodium, and Chlorides

Although all salts dissolved in water contribute to its electrical conductivity, high values of Na and Cl are usually associated with salt water intrusion, which is a problem for many wells in coastal areas. Water containing 0.4 to 0.6 dS/m tastes "salty" to most people. There is no economical means at present for removing salts from water supplies.

5. Total Carbonates

The total carbonates test is reported but not used for households.

Irrigation Water

1. Electrical Conductivity, Na, and Cl

Table 20. Classification of irrigation water in terms of electrical conductivity (Adapted from Richards, 1954).

Class of Irrigation Water	Electrical Conductivity (mmhos/cm)
Excellent	<0.25
Good	0.25 to 0.75
Permissible	0.75 to 2.00 *
Doubtful	2.00 to 3.00
Unsuitable	>3.00

* Container nurseries using water with an electrical conductivity greater than 1.0 mmhos/cm should monitor the electrical conductivity of the container media frequently to guard against salt build up.

2. pH

High pH irrigation water that contains carbonates and bicarbonates of Ca and Mg is a problem with some deep wells. Irrigation with alkaline water may cause a gradual increase in soil pH and lead to **over-liming** injury for soils already limed for optimum crop production. For high-cash-value crops, it may be economically desirable to treat alkaline water with an acid to reduce the harmful effects of excess carbonates. Notes in Soil Science No. 18, "Neutralizing Excess Bicarbonates from Irrigation Water" (Kidder and Hanlon, 1985) describes such water pretreatment, while Notes in Soil Science No. 25, "Quick-Test Method for pH and Bicarbonates in Water" (Hanlon and DeVore, 1986) describes the use of a portable field kit designed for use by county Extension faculty working with high pH water problems.

3. Iron

Iron can be a problem for irrigation water under some conditions. In drip irrigation systems as little as 0.3 ppm Fe may lead to clogging of the emitters. Some foliage plants can be damaged by Fe stains if water high in Fe is used for overhead irrigation. The quality of tobacco leaves has been damaged by deposits of Fe from irrigation water.

--- SECTION 6 ---

Interpretation of Container Media Test Results

Uses for the Container Media Test

The Container Media Test is designed for estimating the nutritional needs of plants grown under intensive management typical of container-plant production. Specialized interpretation of these results is necessary. Results are *not meaningful* for agronomic situations or for home vegetable or flower gardens.

Container media differ greatly from agricultural soils in both physical and chemical characteristics. The status of plant nutrients in soilless container media can be determined best through the results of the Container Media Test.

Results of the Standard Soil Fertility Test should not be compared to results of the Container-Media Test due to the different extraction procedures of each test. The fundamental purpose of the Standard Soil Fertility Test is to act as a predictive management tool for agricultural soils by estimating the portion of the Crop Nutrient Requirement that must be supplied through fertilizer for the growing season. The Container Media Test is designed as a diagnostic management tool for soilless media in which plants are already growing.

Interpretation of Results

General interpretations for the Container Media Test are given in Tables 21 and 22. However, it is advisable to observe plant growth and response to fertilizer management, as well as to monitor nutrient status, through a regular program of media testing (refer to IFAS Bulletin 231 and Circular 589 for more information). Such a program will help producers to develop specific interpretations based upon media-test results for their particular crops, media, and management situations.

When test results indicate that the container media is in the **Low** range, plants may respond to added nutrients. The **Acceptable** range should be viewed as adequate for good plant growth. Additions of nutrients to media testing Acceptable may or may not produce additional plant growth. In general, plants may be ready for market 1 to 2 weeks earlier if nutrients in the media are maintained in the **Optimum** range as compared to the Acceptable range. No benefits are expected to added fertilizer when media nutrients test in either the **High** or **Very High** ranges. In fact, excessive nutrient loss from the media during irrigation, as well as nutrient disorders are possible, when nutrients are maintained in either of these two ranges.

When making interpretations, one must consider that container-nutrient levels are influenced by many factors including environmental factors, fertilizer solubility or release characteristics, and water management. For example, a water-soluble nitrogen fertilizer applied just prior to sampling may produce High nitrate-nitrogen media-test results that may decrease or stabilize in subsequent samplings. Thus, repetitive, consistent sampling is important to establish and maintain optimal nutrient levels in the container medium. The Container Media test can be a valuable management tool to assist in fertilizer decisions, especially when results can be interpreted in light of cultural management techniques used by the producer.

Table 21. Interpretation of container media test for woody ornamentals (Adapted from Yeager and Ingram, 1985).*

Analysis	Rating Category				
	Low	Acceptable	Optimum	High	Very High
pH	<5.0	5.0-5.5	5.5-5.8	5.8-6.5	>6.5
Electrical conductivity, dS/m	<0.7	0.7-1.0	1.0-1.5	1.5-3.0	>3.0
Nitrate-N, mg/L	<40	40-80	80-100	100-200	>200
Phosphorus, mg/L	<3	3-8	8-12	12-18	>18
Potassium, mg/L	<10	10-20	20-40	40-80	>80
Calcium, mg/L	<10	10-20	20-40	40-100	>100
Magnesium, mg/L	<10	10-15	15-20	20-60	>60

*Plants of the Ericaceae family (eg. azaleas) and salt-sensitive plants require only one half the levels of nutrients shown in this table.

Table 22. Interpretation of container media test for bedding and pot plants (Warncke and Krawskoff, 1983).

Analysis	Rating Category				
	Low	Acceptable	Optimum	High	Very High
pH	<5.3	5.3-5.6	5.6-5.8	5.8-6.5	>6.5
Electrical conductivity, dS/m	<0.8	0.8-2.0	2.0-3.5	3.5-5.0	>5.0
Nitrate-N, mg/L	<40	40-100	100-200	200-300	>300
Phosphorus, mg/L	<3	3-5	6-10	11-18	>18
Potassium, mg/L	<60	60-150	150-250	250-350	>350
Calcium, mg/L	<80	80-200	200-400	>400	
Magnesium, mg/L	<30	30-70	70-140	>140	

--- SECTION 7 ---

Literature Cited

Adams, F., and C.E. Evans. 1962. A rapid method for measuring lime requirement of red-yellow podzolic soils. Soil Sci. Soc. Am. Proc. 26:355-357.

Adams, F., and D.L. Hartzog. 1980. The nature of yield responses of Florunner peanuts to lime. Peanut Sci. 7:120-123.

Carter, D.L. 1981. Salinity and plant productivity. In: Chemical Rubber Co., Handbook Series in Nutrition and Food. Chemical Rubber Co. Press, Boca Raton.

Dierolf, T.S., and G. Kidder. 1986. Laboratory evaluation of the Adams-Evans lime requirement method for Florida's sandy soils. Soil Crop Sci. Soc. Fla. Proc. 45:29-33.

Hanlon, E.A., and J.M. DeVore. 1986. Quick-test method for pH and bicarbonates in water. Notes in Soil Sci. No. 25. IFAS, Univ. of Fla, Gainesville.

Hanlon, E.A., and K.R. Munson. 1988. Forest soils of Florida: Useful groupings for forestry purposes. Soil Sci. Factsheet SL-57. IFAS, Univ. of Fla, Gainesville.

Ingram, D.L., and R. W. Henley. 1983. Nursery laboratory development and operation. Fla. Coop. Ext. Serv. Circ. No. 556. IFAS, Univ. of Fla., Gainesville.

Jarrell-Ash Division/Fisher Scientific Company. 1982. Jarrell-Ash ICAP-9000 Plasma Spectrometer, Operator's Manual. Waltham, MA.

Kidder, G. and E.A. Hanlon. 1985. Neutralizing excess bicarbonates from irrigation water. Notes in Soil Science No. 18. IFAS, Univ. of Fla, Gainesville.

Kidder, G., N.B. Comerford, and A.V. Mollitor. 1987. Fertilization of slash pine plantations. Circular No. 735. Fla. Coop. Extn. Ser., IFAS, Univ. of Fla., Gainesville.

Rand, M.C., A.E. Greenberg, and M.J. Taras (eds.). 1976. Standard methods for the examination of water and wastewater. American Public Health Assoc., Washington, D.C.

Richards, L.A. (ed.). 1954. Diagnosis and improvement of saline and alkali soils. Agricultural Handbook No. 60. U.S.D.A. Washington, D.C.

Southern Region Information and Exchange Group on Soil testing and Plant Analyses (SRIEG 18). 1983. Reference soil test methods for the Southern region of the United States. So. Coop. Ser. Bull. 289. Univ. of Georgia, Athens, GA.

Warncke, D.D., and D.M. Krawskoff. 1983. Greenhouse growth media: Testing and nutrition guidelines. Extn. Bull. E-1736. Mich. St. Univ., East Lansing, MI.

Yeager, T.H. 1986. Fertigation Management for the Wholesale Container Nursery. Fla. Coop. Ext. Serv. Bull. 231. IFAS, Univ. of Fla., Gainesville.

Yeager, T.H., and D.L. Ingram. 1985. Container production of holly in Florida. Fla. Coop. Ext. Serv. Circ. 589. IFAS, Univ. of Fla., Gainesville.