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PROEFSTATION VOOR TUINBOUW ONDER GLAS

Verslag bezoek aan "International Symposium on Soil Testing and Plant Analysis" in Californië

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Introductie

Van 13-19 augustus 1989 werd in Fresno, Californië, USA, het "International Symposium on Soil Testing and Plant Analysis" gehouden, het eerste dat specifiek rond deze onderwerpen werd georganiseerd.
Dit congres werd georganiseerd door de "Council on Soil Testing and Plant Analysis", een instantie die zich beijvert voor een goede ontwikkeling en een gunstige presentatie van grond- en gewasonderzoek, o.a. (via het CAST, het Centre for Agricultural Science and Technology) bij het U.S. Congress (bijlage 1). De Council telt thans 276 leden, waarvan 58 buiten de Verenigde Staten; haar jaarvergadering werd tijdens het symposium gehouden.
Het symposium telde ca. 180 deelnemers, voor het merendeel uit de Verenigde Staten. Opvallend was de geringe deelname van Europese landen: uit Nederland, België, Zweden, Zwitserland, Spanje en Italië waren enkele mensen aanwezig, terwijl b.v. Engeland, Duitsland, Frankrijk en Rusland in het geheel niet vertegenwoordigd waren.
Het programma was erg "los" gehouden: slechts 1 à 2 sprekers per dag, en verder uitsluitend posters. Hierdoor, en door de ruime pauzes, de gezamenlijke maaltijden en diverse excursies, was het volop mogelijk informeel van gedachten te wisselen, waarvan dan ook dankbaar gebruik is gemaakt.
Er waren ca. 150 posters aangemeld, waarvan er helaas slechts ca. 90 daadwerkelijk zijn gepresenteerd. Qua grondonderzoek kwam hieruit naar voren dat er veel verschillende extractiemethoden worden toegepast, alle met hun eigen claims over de goede correlatie met de gronden van het eigen landbouwgebied. Opvallend was de totale afwezigheid van onderzoek op het gebied van de bodemhygiëne.
Overigens blijkt het begrip "soil testing" breder te zijn dan "soil analysis": het eerste omvat zowel de analyse als de correlatie met de gewasopbrengst en zelfs het bemestingsadvies.
Bij het gewasonderzoek blijkt "tissue testing" een hulpmiddel te zijn bij de bemestingsadvisering. Ook hier werd vooral aandacht geschonken aan interpretatie van analyseresultaten, en weinig of geen aandacht aan de bepaling als zodanig (instrumentatie, storingen, enz.).
Zowel bij grond- als bij gewasanalyse waren maar weing posters gewijd aan verbetering of toepassing van analysemethoden. Wel was er grote interesse voor alles wat met "Quality Assurance" (kwaliteitsborging) te maken heeft, mede omdat vele laboratoria in de V.S. op commerciële leest zijn geschoeid. Enkele posters over dat onderwerp, met name van Nederlandse zijde, trokken dan ook flinke belangstelling.
Een bijeenkomst van de "Analyses Group North West", vergelijkbaar met de contactgroep Analytici, werd bijgewoond. Uit de daar gevoerde discussie aan de hand van een ringonderzoek bleek dat de problemen met betrekking tot de haalbaarheid van sommige elementen dezelfde zijn als in Nederland.
Standaardisatie van methoden is een onderwerp waar de Council zich meer op wil richten, in samenwerking met de ASTM (American Society for Testing and Materials) en de AOAC (Association of Official Analytical Chemist). Van onze kant is naar voren gebracht dat er binnen de ISO een commissie (TC 190) "Soil Quality" actief is, en dat het aanbeveling verdient om ook hiermee contact op te nemen.
De excursies naar het landbouwgebied rondom Fresno gaven een goede indruk van de Amerikaanse manier van werken. Men behaalt uitstekende oogsten, zowel kwantitatief als kwalitatief, dankzij het goede klimaat en de aangelegde bevloeiing, maar ook door uitbundige toepassing van bestrijdingsmiddelen. Bij deze excursies zijn helaas geen laboratoria op het vakgebied bezocht: het enige dat gepland was bleek wegens vakantie gesloten te zijn.

Hoewel de organisatie van het symposium niet geheel perfect was, is de eindindruk dat het een waardevolle uitwisseling van informatie is geweest. Het algemene gevoelen bij de deelnemers is, dat een dergelijke symposium elke drie à vier jaar zou moeten worden gehouden.

Grondonderzoek

Grondonderzoek in de USA is voornamelijk gericht op teelten in de open grond. Teelten onder glas of plastic zijn dermate zeldzaam, dat daarvoor geen speciale grondonderzoekmethoden zijn ontwikkeld. Voor wat betreft grondonderzoekmethoden is er dus voor de glastuinbouw niet veel te leren. Op het gebied van de organisatie van het grondonderzoek wordt duidelijk anders te werk gegaan dan hier. Door de laboratoria van de universiteiten of andere onderzoekinstellingen worden duidelijke voorschriften voor de methode van extractie en de analytische bepalingen gegeven. Aan de hand daarvan kunnen allerlei laboratoria grondonderzoek uitvoeren. Dit gebeurt dan door de universiteits laboratoria, maar ook door allerlei andere privaat laboratoria. Zo zijn er alleen in Californië al 80 privé laboratoria voor grondonderzoek. Het naast elkaar bestaan van overheids- en particuliere laboratoria wordt niet als een concurrentie ervaren.
De methoden die gevolgd worden zijn veelal welbekend en omvatten vooral de extracties volgens Mehlich, Olsen en Bray, die in gebruik zijn voor fosfaat en eventueel de kalibepaling. Voor kali wordt ook wel gewerkt met ammoniumacetaat oplossing. Een meer universeel extractiemiddel is de Morgans oplossing. Deze methode wordt echter maar sporadisch meer gebruikt. Bekend zijn de DTPA-extracties voor spoorelementen. Echt succesvol wordt hiermee echter nog niet geopereerd.
Voor zoutonderzoek wordt veel gebruik gemaakt van het verzadigingsextract. De bewerkelijke breiding hiervan vormt wel een rem op de toepassing.
Door de Council on Soil Testing and Plant Analysis wordt een brochure verzorgd waarin de methoden worden beschreven. De huidige uitgave was aan een revisie toe. Deze zal waarschijnlijk begin volgend jaar verschijnen. Het doel van deze uitgave is niet te komen tot bindende voorschriften voor grond- extractiemethoden, maar meer om te komen tot een samenvatting van alle toe te passen methoden.
Meer over genoemde methoden is te vinden bij Benten Jones, J.B., 1985 (Hort. Rev., 7, 1-68).
Een voorschrift voor bemonstering van de grond is opgenomen in bijlage 2. Het is samengesteld door A en L Agricultural Laboratories. Een instelling met 7 laboratoria, verspreid over de gehele USA.

Gewasonderzoek

Het gewasonderzoek wordt op ruimere schaal toegepast dan gebruikelijk is in Europa. De reden dat men er meer mee kan doen moet vooral gezocht worden in het feit dat er duidelijker voorschriften bestaan over bemonstering en interpretatie. Een voorbeeld van een bemonsteringsvoorschrift is opgenomen in bijlage 2. Deze voorschriften voor bemonstering zijn van groot belang, omdat de uitkomsten van de analyse sterk worden bepaald door de wijze van bemonsteren.
Gewasonderzoek wordt meestal uitgevoerd bij incidenten in de groei. Bij inzending van het gewasmonster moet dan ook een vrij uitgebreide vragenlijst worden ingevuld en meegezonden. Een voorbeeld zoals deze werd gebruikt bij de universiteit van Georgia in Athens is opgenomen in bijlage 4. In bijlage 4A is het bijbehorende analyserapport opgenomen.

Interpretatie vindt plaats aan de hand van normen en een daarbij behorende range, die voor verschillende gewassen zijn opgesteld en gepubliceerd in handboeken. Voor alle grote gewassen zijn vereiste gehalten bekend. Toch bestaan van tijd tot tijd wel twijfels over interpretatie, omdat deze afhankelijk kan zijn van de teeltomstandigheden. Daarom wordt ook wel gewerkt met verhoudingen tussen alle elementen berekend. Het element dat dan afwijkend is zal bij elke verhouding waarin het voorkomt een afwijking vertonen. Op deze wijze wordt dan niet gesteund op de enkele waarneming van het betreffende element, maar worden min of meer alle analyse uitkomsten in de beoordeling betrokken.
De gedachte achter een dergelijke beoordeling is dat een plant bij een tekort aan één bepaald element in het gewas voor de andere elementen min of meer optimale gehalten zal realiseren. Hiervan kan redelijkergewijs worden uitgegaan, als geen interacties optreden, omdat dan ook de verhoudingen met het element waarmee interactie optreedt gaan afwijken. Sluitend is deze wijze van interpreteren dus niet. In twijfelgevallen worden vaak beide methoden van interpretatie vergeleken.
In bijlage 5 en 5A zijn voor maïs en voor sojaboon gewenste verhoudingsgetallen ingevuld. Men dient hierbij te bedenken dat de macro-elementen in procenten en de micro-elementen in mg per kg zijn gegeven.
Bij één van de trainingssessions werd ons een handboek ter beschikking gesteld (Plant Analysis Handbook for Georgia) waarin voor diverse gewassen interpretaties van en adviezen voor analyseresultaten bijeengebracht waren. Het was samengesteld door de Coöperative Extension Service en de University of Athens. In bijlage 6 is een voorbeeld opgenomen van de gegevens voor tomaat.
Samenvattend kan worden gesteld dat in de USA meer gericht met gewasonderzoek in de praktijk wordt gewerkt dan in Europa wordt gedaan. Voorschriften over bemonstering en interpretaties van de gegevens worden beter samengevat en benut dan wij doen. Samenwerking op dit gebied lijkt zeker zinvol.

Verzouting

Fresno, de stad waar het symposium werd gehouden ligt midden in de San Joaquin Valley. In deze vallei vindt op zeer grote schaal landbouw plaats. Dit is alleen mogelijk door het intensieve bevloeiingssysteem dat is aangelegd.
Tijdens het symposium waren enkele excursies georganiseerd, waarbij kennis genomen kon worden van de teelten. Tijdens één van deze excursies kwam ook het probleem van het drainwater naar voren. Het lijkt niet aanvaardbaar dit te lozen in de oceaan. Eén van de meest nijpende problemen hierbij schijnt het seleniumgehalte te zijn. In bepaalde gebieden lost namelijk teveel selenium op vanuit de grond. Dit zou dan via het drainwater in de oceaan terecht komen. Het komt daarna weer in de vis en via de vis in het menselijk lichaam. Selenium zou accumuleren in de menselijke organen (nieren, lever) en is als zodanig toxisch als de accumulatie te groot is.
Oplossingen voor het drainwater worden in verschillende richtingen gezocht. In de eerste plaats wordt bekeken of het drainwater in de diepe ondergrond in zout water formaties kan worden gepompt. Hiertoe wordt geboord naar lagen op een diepte van ongeveer 2500 m. Ook wordt getracht het water biologisch te zuiveren van selenium. De resultaten waren goed; het gehalte daalde van 350 ppb naar 10 ppb. Voorlopig is dit project echter uitgesteld in verband met de hoge kosten. Een ander methode die wordt beproefd is een verdampingssysteem, waarbij dan weer gedestilleerd water en een zoutenmengsel ontstaan. Het zoutenmengsel zou dan weer gebruikt kunnen worden in de industrie. Een andere oplossing wordt gezocht via opname van planten. Sommige planten absorberen veel selenium.

Globaal worden ze als volgt ingedeeld:
1. Sterke accumulators (1.000-10.000 ppm).
2. Matige accumulators (enkele honderden ppm).
3. Niet accumalators (niet meer dan 50 ppm).

Voor gewassen die tot genoemde groepen behoren wordt verwezen naar California Agriculture, May-June, 1989, 19-20.

Door het telen van sterke accumulators wordt getracht de grond of het drainwater te ontdoen van selenium. De planten die seleen sterk absorberen worden er niet door vergiftigd ondanks de hoge concentraties.

Het probleem met het drainwater is hier wat expliciet toegelicht, omdat de glastuinbouw in Nederland ook problemen kent met de lozing van afvalwater. Het lijkt gewenst op de hoogte te blijven van de ontwikkelingen in Californië.

Who is CAST

The Council for Agricultural Science and Technology (CAST) is a consortium of 28 *scientific societies* associated with food and agriculture. Representatives of these societies serve on CAST's Board of Directors, the organization's chief governing body. In addition to supplying CAST with financial resources and leadership, the societies nominate independent scientists to write CAST publications. Thirteen smaller associate societies also belong to CAST.

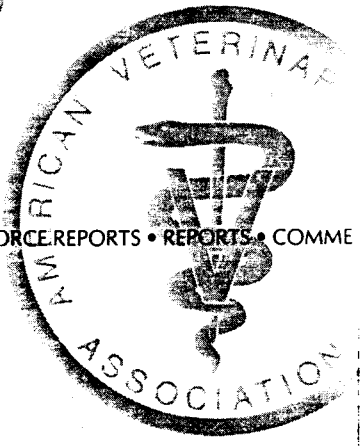
Numerous *nonprofit associations* and *state commodity groups* are part of CAST. *Agricultural and food companies* provide considerable financial support for CAST activities, but assume no responsibility for directing CAST actions.

Nearly 5,000 *individuals* are members of CAST and elect three representatives to the Board of Directors. They offer their time, money, and professional expertise to serve CAST.

What is CAST

CAST is a nonprofit educational organization founded in 1972 to represent the interests of food and agricultural science. CAST provides information, but does not take advocacy stances on issues.

CAST aims to compile and disseminate facts on the scientific aspects of broad public issues in agriculture and food processing to the government, the news media, and the public. CAST carries out this challenge by producing publications on many diverse topics and conducting liaison activities with policymakers, and the public. CAST attempts to shed scientific light on complex issues, but it is not a lobbying organization.



What does CAST do

CAST publishes several various types of scientific documents. They are classified by content and authorship. Since its founding, CAST has issued more than 200 publications.

Best known are the *task force reports,* CAST's primary output. The actual writing is done by volunteers, multidisciplinary groups of 15 to 25 scientists who need not be members of CAST or its member societies. The resulting reports are original documents bringing together the relevant scientific facts on an issue. Intended to be sound, objective pieces, the reports may state policy options but do not make recommendations. Report topic ideas are often received from legislators or federal regulatory agencies. The suggestions are reviewed by CAST's National Concerns Committee before being approved by the Board of Directors.

Recently published reports illustrate the diversity of subjects CAST chooses to tackle: "The Long-Term Viability of U.S. Agriculture", "Effective Use of Water in Irrigated Agriculture", "Ecological Impacts of Federal Conservation and Cropland Reduction Programs", "Ionizing Energy in Food Processing and Pest Control".

Another significant publication series is *Comments from CAST.* These documents may be written by one person or a small group of individuals. Although narrower in scope than the task force reports, *Comments from CAST* are also important responses to key national issues.

Member outreach is conducted via *NewsCAST,* a quarterly newsletter which reports on CAST board and headquarters activities and offers information on CAST publications.

Science of Food and Agriculture represents CAST's commitment to the future of agriculture. CAST provides the newsletter free of charge to high school science departments all over the country. Published two times during the school year, the newsletter contains features on food and agricultural science and careers, as well as learning activities.

Copies of all CAST publications are distributed to member organizations. Individual members receive *NewsCAST.* They may request a single free copy of each new document within one year of publication. Free copies of CAST publications are routinely sent to appropriate target groups, Congress, government agencies, and the news media. To encourage wider distribution, CAST publications are not copyrighted and may be reproduced without permission.

Despite its Midwestern location and ambiance, CAST maintains active liaison with the federal government and its agencies to determine what items should be high priority for CAST attention. CAST also responds to media reports and inquiries from public and private officials on matters of scientific interest.

Why join CAST

There are some excellent answers to that question. Institutional members join CAST because they share CAST's deep commitment to effective public education about food and agriculture. They know that they can rely on CAST to provide them (and important government decision makers) with the relevant scientific facts on key issues. A task force report from CAST carries weight in the circles where institutional members want to be heard and exert influence.

In a recent survey, CAST's individual members offered some of their reasons for supporting CAST. Sixty-three percent said they joined because they wanted information from CAST. But the greatest number (84%) said they are with CAST because they support the CAST mission.

That mission (and the reason why so many have chosen to become involved with CAST) is to (1) serve as a resource for those seeking information, (2) identify developing issues of broad concern, (3) organize task forces from relevant disciplines to assemble and interpret information, and (4) disseminate the information in an understandable fashion to the government, news media, and the public. CAST boasts nearly two decades of experience in promoting scientific understanding of the food and agriculture industries by preparing and distributing top-quality publications.

How to become a member of CAST

CAST is a private, nonprofit corporation. Memberships and donations are tax-deductible. Membership fees provide unrestricted resources for the CAST general operating fund.

Various CAST membership categories are defined as follows:

Individual: $20 regular, $100 Century Club, $1000 Cornerstone Club

Society: Up to $6600, based on number of members

Associate Society: $100 state, $150 regional, $200 national

Company/Coop: $150 to $6600 or more based on sales of agricultural/food products, or goods and services to agriculture

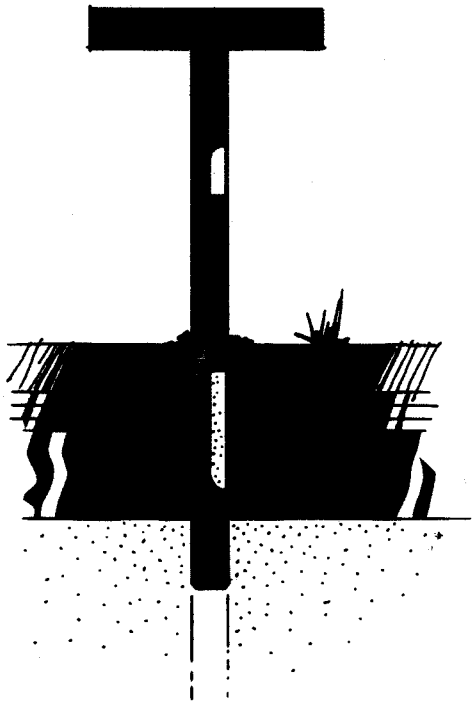
Nonprofit Association or Commodity Group: $100 state, $150 regional, $200 national

Subscribers who do not wish to be members of CAST may receive all CAST publications for $35 yearly (U.S.) or $50 yearly (outside the U.S.).

Cast member societies

American Academy of Veterinary and Comparative Toxicology
American Association of Cereal Chemists
American Dairy Science Association
American Forage and Grassland Council
American Meat Science Association
American Meteorological Society
American Peanut Research and Education Society
American Phytopathological Society
American Society for Horticultural Science
American Society of Agricultural Engineers
American Society of Agronomy
American Society of Animal Science
American Veterinary Medical Association
Aquatic Plant Management Society
Association of Official Seed Analysts
Council on Soil Testing and Plant Analysis
Crop Science Society of America
Institute of Food Technologists
North Central Weed Control Conference
Northeastern Weed Science Society
Plant Growth Regulator Society
Poultry Science Association
Rural Sociological Society
Society of Nematologists
Soil Science Society of America
Southern Weed Science Society
Weed Science Society of America
Western Society of Weed Science

REFERENCE GUIDE



SOIL SAMPLING

A&L AGRICULTURAL LABORATORIES

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Soil Sampling Procedures

The intention of the following information is to aid you in properly taking soil samples under various conditions and for specific purposes. As it has been said many times, "A soil test is only as accurate as the sample taken."

Sampling Tools

Tools that may be used to take a soil sample include a spade or shovel, soil sampling tube, or soil auger. Sample tubes or augers should either be of stainless steel or chrome plated.

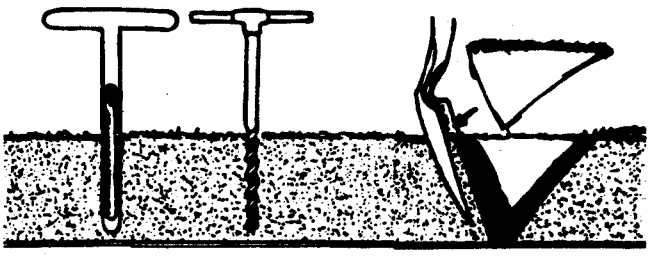
When sampling various soils at different times of the season it is important to use the proper equipment. A soil probe, either a hand tube or hydraulic probe, can be used under most conditions. A small wooden rod may be helpful in removing the soil core from the tube. The soil auger is especially useful when sampling frozen ground or heavily compacted soil that a soil tube can't penetrate. If a spade is used for sampling, dig a V-shaped hole to sample depth; then cut a thin slice of soil from one side of the hole.

If using a pail to collect the soil, it should be plastic to avoid any contamination from trace metals. For instance, soil will pick up zinc from a galvanized pail.

When sampling wet soils, vegetable oil or mineral oil may be used to lubricate the probe to minimize soil pushing ahead of the probe.

Sample Preparation

Mix cores or slices together in a clean plastic container and take enough subsample to fill the special soil sample bag provided by the laboratory. There is no need to process the sample further before shipment. At A & L Laboratories, the entire sample received is dried, ground, and sieved by experienced technicians.



Sample Size

A well-mixed composite from 10 to 20 random locations should be subsampled to give 1 to 1½ cups of soil to be sent to the laboratory for analysis. Greater amounts may be needed when physical properties of the soil (such as textural classification or available moisture) are to be measured.

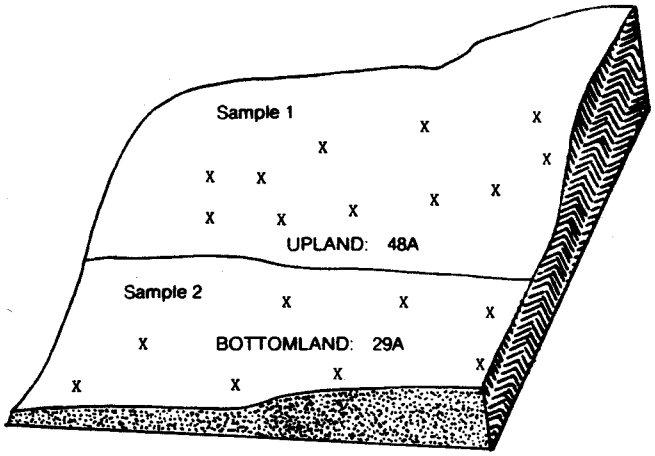
Sample Area

Area to be included in a sample generally should be no more than forty acres. Smaller acreages may be sampled when soil is not uniform throughout a field. A soil map or crop response map can be of help in distinguishing areas.

Areas that differ in soil type, appearance, crop growth or significantly in past treatment should be sampled separately, provided this area can be treated separately.

Avoid small areas that are different such as dead furrows, corners of fields, end rows, and poorly drained areas. Stay at least fifty feet from barns, roads, lanes, or fence rows.

The sample should be obtained from 10 to 20 locations within the area as diagramed below. Data has shown that this is a sufficient number of locations to "average out" the variations in most 40 acre areas.



When sampling problem areas, collect separate samples from both the poor area and the good area to use as a comparison. It would be advisable to run a complete test on a surface sample and a sample from a lower depth may provide additional information. Include a description of the problem when samples are submitted so that A & L agronomists may assist you in finding a solution.

If sampling an area with extreme variations, such as where land leveling has occurred or erosion and deposition are severe, the field should be sampled on a grid or incremental unit basis.

Sampling Depth

When sampling, scrape away plant residue and sample to 6 inches; or if primary tillage is deeper, sample to tillage depth. This is the depth which can be altered with fertilizers or soil amendments. Eighty to ninety percent of the nutrients taken up from the plant come from this tillage depth. It is recognized that plants also obtain nutrients from a lower depth. Subsoils can provide significant information regarding nitrate-nitrogen and sulfur.

When sampling for nitrate-nitrogen, the most appropriate time for sampling is in the spring or during the growing season. Since nitrate-nitrogen will move with the water front, it can be leached deeper with winter and spring precipitation, especially in sandy soils. Generally, when sampling for nitrate-nitrogen, A & L recommends a 0-6 inch sample and 6-24 inch sample. A 24-36 inch sample could also be taken to determine the nitrate-nitrogen level in this deeper portion of the profile. It is suggested that the depths are kept separate so that a more accurate assessment can be made regarding soil fertility and soil physical conditions.

Time to Sample?

Soil samples may be taken at any time through the year. However, it is generally recommended to stay consistent from year to year. If a particular field is sampled in the spring, it should be sampled in the spring in following years. If this cannot be done, some seasonal variations should be expected and taken into account.

In addition, pH can vary through the growing season due to presence of soluble salts, CO_2, organic matter decomposition, nutrient uptake and exchange and fertilizer applications.

Nitrate-nitrogen and sulfate-sulfur are leachable. Therefore seasonal variation may occur in levels of these nutrients, depending on soil types, weather patterns and moisture levels.

Consistency in the time of year samples are taken can eliminate much of the question of whether or not variation does occur in a particular soil. A field history should be established to help distinguish seasonal and sampling variation from real fertility changes.

The best time to take soil samples is probably whenever it best fits into your time schedule. However, there are several considerations:

1. Allow for ample time to receive results from the laboratory.
2. Sample when you will not be hurried - allow time for taking a representative sample.
3. Sampling should be done in accordance with the grower's field observation.
4. Taking both a soil sample and a plant sample during the growing season may help distinguish nutrient uptake patterns from chemical, physical, or disease factors.

It is recommended that you sample fields every other year or every third year. In the case of intensive cropping, manure or sludge applications, or sandy soils, annual sampling is recommended to monitor the available nutrients or potentially damaging salt accumulations.

Specialized Sampling

Sampling Reduced Tillage and No-Till

No-till and reduced tillage have different meanings to various people. When referred to here, we mean any tillage that doesn't incorporate soil much more than 3 inches. Ridge-till may or may not be considered reduced tillage under this definition. Remember, most disks and chisel plows, if run 6 inches deep, are only incorporating to one-half that depth.

To get a representative soil sample under these conditions, it is best that soil samples be taken from two depths. Take one from the surface 2 inches, and one from the 0-6 inch depth. Both samples are important. The 0-6 inch depth should be used for general fertilizer recommendations. The 0-2 inch sample should be used to adjust the fertilizer program for placement and to provide for accurate herbicide programs. Generally at the surface you will find higher fertility, higher organic matter content, and lower pH, all of which affect the fertility and herbicide programs.

Generally a basic test is adequate for the 0-2 inch depth. However, a more complete test should be run in some situations. Zinc deficiencies have been seen under reduced tillage, even though the 0-6 inch sample showed adequate levels. Shallow sampling revealed most zinc concentrated at the surface, positionally unavailable to plant roots under dry conditions. Soluble salts could also accumulate at the soil surface at higher concentrations than indicated by a 0-6 inch sample, causing stress to plants, particularly at early stages of growth.

Sampling Ridge-Till

When using ridge-till or ridging-up for flood irrigation, it is recommended that you sample half-way down the ridge at a 45° angle to the ridge as shown at right.

Sampling Center-Pivot Ground

Many who sample center-pivot ground include too large an area in their sample, creating an excessive variation in results from year to year. Here are several suggestions for best results:

1. Split the circle into thirds. This would limit the sample to about 45 acres. Take about 15-20 cores from each of these thirds.
2. If time or expense is a limitation, take one sample from the hillsides and another sample from the valleys.
3. If the circle is on flat land, sample two areas containing no more than 40 acres. These two areas could be extreme variations in the field. (For instance, sandy versus clay loams or one area that you know hasn't yielded as well as another area). Then either average the lab results from the two areas or else treat these areas of the field separately.

Whichever of these methods you use, keep the sample areas the same each year. With these methods, inconsistencies in results from year to year will be minimized and you will have a better field history file.

Sampling Fields with Varying Terrain

If bottomland and hills both represent significant amounts of a field, take a sample from each type of terrain. If either bottomland or hills represent just a small area of the field, do not include these areas in your sample.

Positive Placement of Fertilizer

Starters: When row-placed bands are used, sample between the rows. An exception may be where the total fertilizer program is in a row-placed band. Here you should probe about one-sixth of your total number of probes in or near the row.

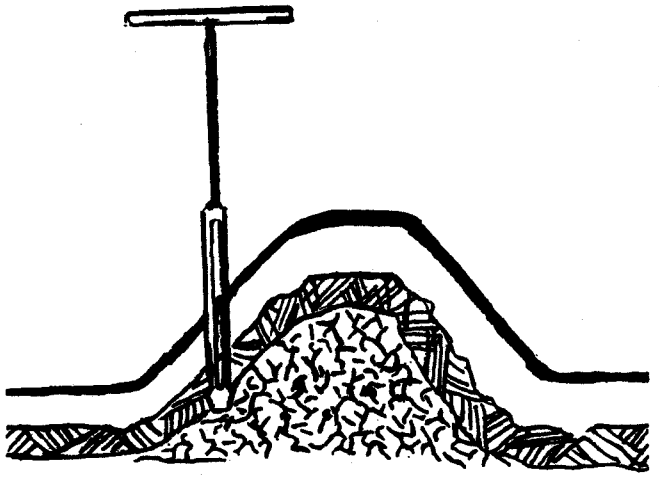
Strip/Deep Placement: Increase the number of cores per sample. Take two cores near each other at a distance equal to one-half the band widths. Sample in this manner at 12-15 locations to accumulate soil for a sample.

Sampling for Herbicide Residue

Normal sampling procedure should be used with certain exceptions. The depth of the soil sample depends on the herbicide in question and the soil. Most herbicides do not move much in a fine textured (loam and clay) soil. Some exceptions are Amiben, Banvel, 2,4-D and Tordon. On coarse textured (sandy) soils, all herbicides have more movement. Manufacturers are able to supply this information for their own products.

Correct sampling depth is incorporation depth (i.e., 3") unless the herbicide is quite leachable due to its chemical nature or soil texture. If this is the case, a 6-7 inch depth is required. If moldboard plowing was performed prior to sampling for residue, sample to plowing depth and inform the laboratory of sample depth so that correct interpretation of residue effects may be made.

Each herbicide decomposes in the soil at its individual rate, but decomposition slows when the soil cools, and stops when soil temperature drops below 62° F. This should be considered when planning sampling for herbicide residues.



Sampling Various Cropping Practices

Pasture/Turfgrass

In sampling pastures, follow normal sampling procedures. However, sample depth should be 3-4 inches. Clean off the soil surface before probing and avoid sampling near manure piles. Also avoid areas where livestock congregate or heavily travel.

Alfalfa/Clover

Sample soil prior to planting so that both pH and fertility corrections may be made. A 0-8 inch sample is recommended unless problems exist. If alfalfa is no-till planted, a 0-3 inch sample and a 3-8 inch sample are recommended.

Orchard/Tree Farms

It is suggested that samples be taken from within the drip line of the tree at a 0-10 inch depth. Follow normal sampling procedures regarding number and handling of samples.

Soil and Plant Analysis for Problems

Soil and plant analysis during the growing season can be used to help diagnose growth problems. Many apparent nutrient deficiencies have causes that are more complex than simple mineral deficiencies in the soil. These causes can often be determined by an experienced agronomist using data from soil and plant analyses together.

When sampling problem areas, make as many observations as possible of conditions which might contribute to the problem - soil compaction, drainage, insects, disease, and other factors may contribute in varying degrees to problems observed.

Sampling for Nematodes

The best time to sample for most nematodes is while the crop is still growing so that spots stunted by nematodes can be easily identified. With most nematode species, populations are at their peak from July 15-August 15. In early, spring, significant populations have not yet developed. Therefore, pre-plant sampling for determining potential risk is of questionable value.

Ideally, one soil sample for nematodes should be taken for each five acres. If sampling a problem area, sample toward the outside edge of the area for greatest numbers. The largest populations of nematodes aren't likely to be found where the severest crop symptoms are seen because these plants are no longer able to support large nematode populations. It is advisable to take a comparison sample from an unaffected area.

Take the samples to a depth of 8 inches in the row from 20-25 locations using a soil probe or spade. Mix the samples in a bucket and immediately place one to two pints of soil in a bag. Be sure to mark the bag "For nematode analysis." Do not let the soil dry out or get hot. Keep samples in shade or in an insulated cooler until the samples can be sent.

The best method of collecting "root" samples is to spade up the plants and collect the tips of the roots and feeder roots. Nematodes feed most on the root tips so generally this is where greatest populations are found.

In most cases, during the growing season, root samples are more useful than soil samples. However, testing both soil and root samples will give you the most information.

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REFERENCE GUIDE

SAMPLING GUIDE FOR PLANT TISSUE ANALYSIS

A&L AGRICULTURAL LABORATORIES

MEMPHIS • OMAHA • FT. WAYNE • RICHMOND • LUBBOCK • MODESTO • FT. LAUDERDALE

Plant Tissue Analysis

The Increasing Need

Modern agriculture demands top yields...and quality yields. Additionally, you demand profitable yields. In satisfying these demands, plant tissue analysis has become a valuable crop production tool.

Top quality and profitable yields, unfortunately, don't just happen. Many factors need to be considered...like adequate moisture and fertility, proper plant population, adapted variety, disease and insect resistance and control...the list goes on.

One of the more important factors affecting crop yields is the ***nutrient status*** of the plant . . . or the flow of nutrients to plant tissues during the growing season. Nutrient status is an "unseen" factor in plant growth, except when deficiencies become so acute that visual deficiency symptoms appear on the plant.

Plant populations can be counted, and variety names or numbers can be read on the label. Rainfall can be measured with gauges. However, the determination of nutrient status of plants requires precision laboratory analysis of a plant tissue sample during the growing season.

How Can a Tissue Analysis Help?

A plant tissue analysis will show the nutrient status of the plants during the growing season and detect unseen hidden hunger. Plant tissue analysis can also supply information to confirm visual deficiency symptoms.

Though usually used as a diagnostic tool for future correction of nutrient problems, a plant tissue analysis from young plants will allow for a corrective fertilizer application that same season. Combined with data from a soil analysis, a tissue analysis is an important tool in determining proper fertilizer applications to balance the nutrient availability in the soil and the nutrient requirements of the crop.

A complete plant tissue analysis from A & L Agricultural Laboratories will identify the nutrient status of the following elements:

Nitrogen	Iron
Sulfur	Aluminum
Phosphorus	Manganese
Potassium	Boron
Magnesium	Copper
Calcium	Zinc
Sodium	

Collection and Preparation of the Sample

When gathering the tissue sample in the field, be sure to use a clean container. A plastic pail or a paper bag work best. Never use a metal container to gather the sample as the metal may contaminate the sample.

To insure proper sample amount on young plants, collect approximately one pint of lightly packed material.

If the plant samples have soil, fertilizer, dust or spray residues on them, they will need to be cleaned. A dry brush works well. For stubborn residues, wipe the samples with a damp cloth or wash the samples with distilled or deionized water. However, do not prolong the washing.

Air-dry the samples. Clean paper bags or envelopes work best to avoid contamination when mailing the samples to the laboratory. ***Never place fresh samples in a plastic bag!***

Do not include roots with samples submitted for nutrient analysis.

Disease analysis requires a separate sample. Please phone for instructions before submitting samples for disease diagnosis.

Tissue Sample Mailing Kits are Available

A & L Agricultural Laboratories will provide sample bags suitable for plant tissue samples and plant tissue information sheets. These sheets should be filled out accurately and completely. If complete information is submitted with the sample, the interpretation of the plant tissue analysis will be more meaningful.

Ship the sample directly to the A & L Agricultural Laboratory that serves your area.

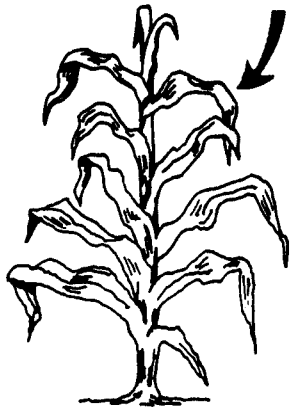
TISSUE SAMPLING TECHNIQUES FOR SPECIFIC PLANTS

CROP	WHEN TO SAMPLE	PART OF PLANT TO SAMPLE	NUMBER OF* PLANTS TO SAMPLE
FIELD CROPS			
Alfalfa	At 1/10 bloom stage or before	Mature leaf blades about 1/3 of the way down the plant	45-55
Canola	Prior to seed set	Fully developed leaves from top of plant	60-70
Cereal Grains (including rice)	Seedling stage	All the above ground portion	50-75
	or Prior to heading	Four uppermost blades from top of plant	30-40
Clover	Prior to bloom	Mature leaf blades about 1/3 of the way down the plant	50-60
Corn	Seedling stage	All the above ground portion	25-30
	or Prior to tasseling	The first fully developed leaves from the top	15-20
	or From tasseling to silking	The leaves below and opposite the ear	15-20
Cotton	Prior to or at first bloom or when first squares appear	The youngest fully mature leaves on the main stem	30-35
Flax	Seedling stage or prior to heading	Above ground portion or youngest mature leaves	50-60
Hay, Forage, or Pasture Grasses	Before seed head emergence or at the stage for best quality	The 4 upper most leaf blades	50-60
Milo-Sorghum	Before or at heading	Second leaf from top of plant	20-25
Peanuts	Before or at bloom stage	Fully developed leaves from the top of the plant	45-50
Soybeans	Seedling stage	All the above ground portion	20-30
	or Prior to or during initial flowering	The first fully developed leaves from the top	20-30
Sugar Beets	Mid-season	Fully mature leaves midway between the younger center leaves and the oldest leaf whorl on the outside	30-35
Sugar Cane	Up to 4 months old	Fourth fully developed leaf from the top	25-30
Sunflowers	Prior to flowering	Mature leaves from top of plant	25-30
Tobacco	Before flowering	Top fully developed leaf	8-12
ORNAMENTALS AND FLOWERS			
Carnations	Undisbudded plants	4th or 5th leaf pair from base of plant	20-30
	Disbudded plants	5th or 6th leaf pair from top of primary laterals	20-30
Chrysan-themums	Before or during flowering	Top leaves on flowering stem	20-30
Ornamental Trees and Shrubs	Current year's growth	Fully mature leaves	30-75
Poinsettias	Before or during early flowering	Most recently mature fully expanded leaf	15-20
Roses	During flowering	Upper leaves on the flowering stem	25-30
Turf	During growing season	Leaf blades; avoid soil contamination	2 cups of material

*Sample size should be equal to two cups of material.

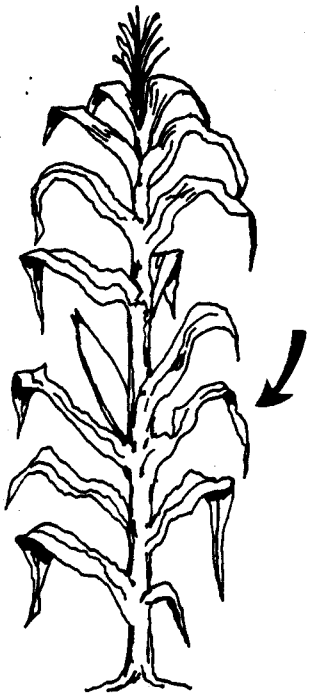
CROP	WHEN TO SAMPLE	PART OF PLANT TO SAMPLE	NUMBER OF PLANTS TO SAMPLE
VEGETABLE CROPS			
Beans	Seedling stage or Prior to or during initial flowering	Entire above ground portion Two or three mature leaves at the top of the plant	
Cabbage, etc. (Head Crops)	Before heading	First mature leaves from center of whorl	
Celery	Mid-growth cycle	Petiole of youngest mature leaf	
Cucumber	Before fruit set	Mature leaves near the base of the main stem	
Leaf Crops (Lettuce, Spinach, etc.)	Mid-growth	Youngest mature leaf	
Melons	Prior to fruit set	Mature leaves near base of main stem	
Peas	Before or during initial flowering	Leaves from the third node down from the top of the plant	
Potato	Before or during early bloom	Third to sixth leaf from growing tip	
Root Crops (Carrots, Beets, Onions, etc.)	Before root or bulb enlargement	Center mature leaves	
Sweet Corn	Before tasseling or At tasseling	The entire fully mature leaf below the whorl The entire leaf at the ear node	
Tomato (field)	Before or during early bloom stage	Third or fourth leaf from growing tip	
Tomato (greenhouse)	Before or during fruit set	Young plants: leaves from 2nd and 3rd clusters Older plants: leaves from 4th to 6th clusters	
FRUIT AND NUT CROPS			
Apple, Apricot Almond, Cherry, Peach, Pear, Plum	Mid-season	Leaves near base of current year's growth	
Blueberries		Youngest fully expanded mature leaves	
Grapes		Petioles from leaves adjacent to fruit clusters	
Lemon, Lime		Mature leaves from last flush of growth on non-fruiting terminals	
Orange	Mid-season	Spring cycle leaves, 4 to 7 months old from non-fruiting terminals	
Pecan	6-8 weeks after bloom	Leaves from terminal shoots, taking the pairs from the middle of the leaf	
Raspberry	Mid-season	Take youngest mature leaves on laterals of primo canes	
Strawberry	Mid-season	Youngest fully expanded mature leaves	
Walnut	6-8 weeks after bloom	Middle leaflet pairs from mature shoots	

Desired Sample Location From Common Crops



Corn...before tasseling

Collect the first fully developed leaves from the top of 15 to 20 plants. (If the plant is less than 12 inches tall, collect all of the above ground portion).

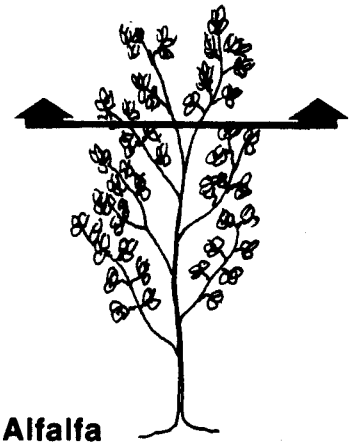


Corn...from tasseling to silking

Collect the leaves below and opposite from the ear of 15 to 20 plants.

Sorghum

Collect the second leaf from the top of 15 to 20 plants before or at heading.

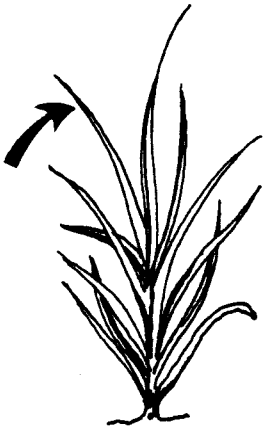


Alfalfa

Collect mature leaf blades and petioles about one-third of the way down the stem at one-tenth bloom stage or before.

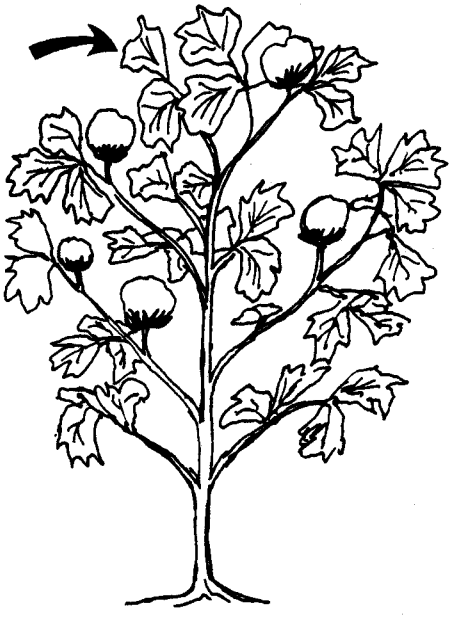
Soybeans

Collect the youngest mature trifoliate leaves from the top of 20 to 25 plants prior to or during flowering. (In the seedling stage, collect all of the above ground portion).



Wheat, Oats & Grass

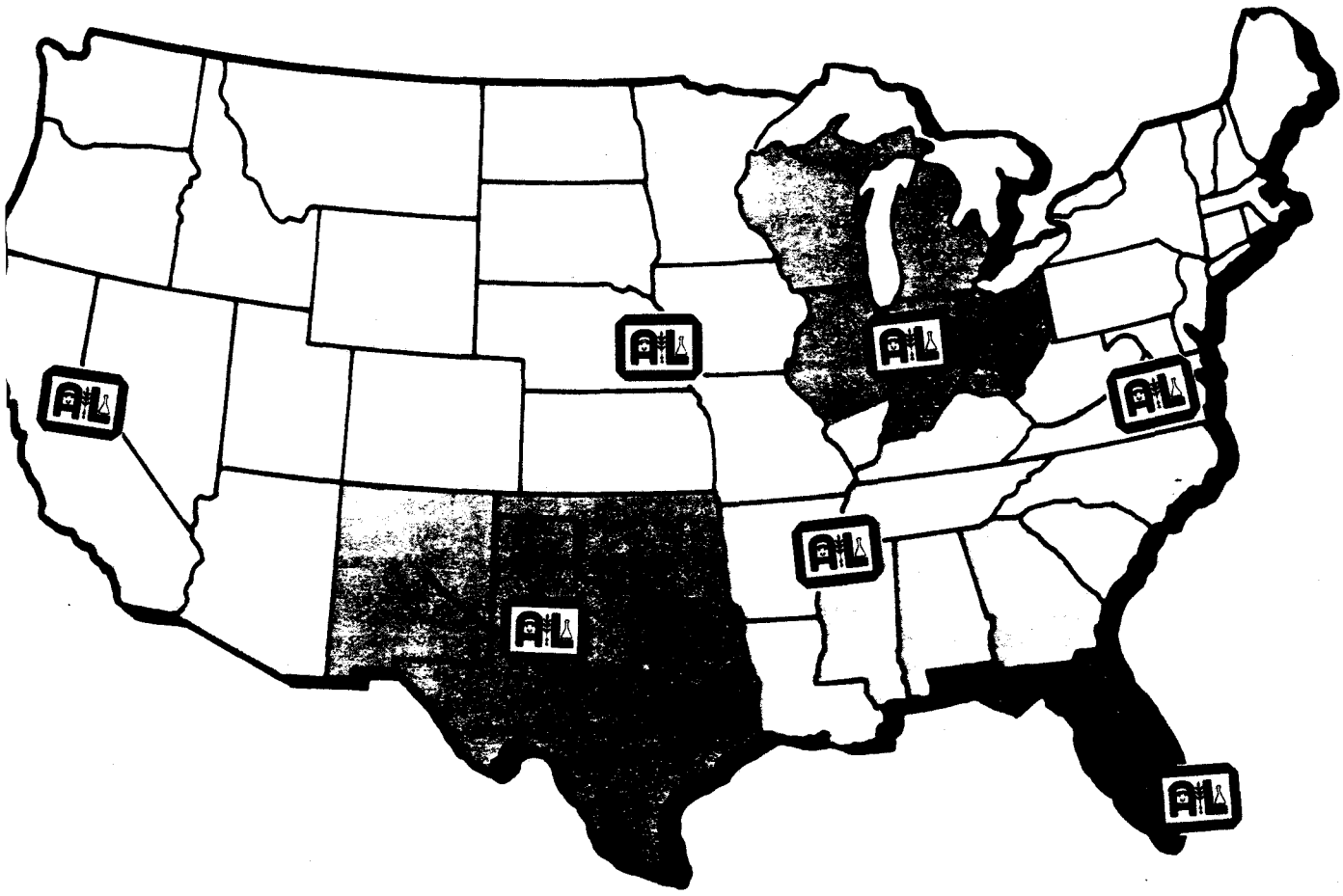
Collect the four uppermost leaf blades from the top of 30 to 35 plants. (In the seedling stage, collect all of the above ground portion). Sample should equal two cups.



Cotton

Collect the youngest fully mature leaves on the main stem from 30 to 35 plants selected at random prior to or at first bloom.

Complete Analytical Services



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PLANT ANALYSIS HISTORY FORM

The University of Georgia
Cooperative Extension Service
Soil Testing and Plant Analysis Laboratory
Athens, Georgia

GROWER

NAME (PRINT) Bill Jones
ADDRESS Rt. 4
CITY, STATE, ZIP CODE Pelham, GA
COUNTY AGENT
COUNTY Mitchell

SULFUR TEST: (EXTRA FEE) ☑ YES ☐ NO

FOR LAB USE ONLY

Lab No. _____
Date Received _____
Date Returned _____
Invoice No. _____
or
Fee Received _____

CROP: Corn
VARIETY OR HYBRID: DeKalb
THIS IS SAMPLE NUMBER 1 OF 20 SAMPLES
DATE PLANTED: 3/15
DATE SAMPLED: 4/22
STAGE OF GROWTH: (CHECK ONE) SEEDLING ☐ EARLY GROWTH ☑ BLOOM ☐ FRUITING ☐ MATURE ☐
WHEAT (ENTER GROWTH STAGE NUMBER) _____
PLANT HEIGHT 12 INCHES

PLANT PART SAMPLED: (CHECK ONE)

☑ WHOLE PLANT ☐ STEMS ☐ PETIOLES
☐ LEAVES ☐ TOP 6" OTHER _____

POSITION ON PLANT: (CHECK ONE)

CORN ☐ EAR LEAF ☐ LEAF BELOW WHORL
OTHER CROPS ☐ UPPER ☐ MIDDLE ☐ LOWER

APPEARANCE OF PLANT:

☐ NORMAL ☑ ABNORMAL Interveinal chlorosis
DESCRIBE

PLANT POPULATION: 31,000

PLANT DISEASES? ☑ NO ☐ YES
PEST PROBLEM? ☐ NO ☐ YES ?

IRRIGATION: _____ INCHES APPLIED
☐ NONE ☐ CABLE TOW ☑ CENTER PIVOT

INJECTION SYSTEM: ☑ YES ☐ NO

RAINFALL: (LAST 3 WEEKS)
☐ BELOW NORMAL ☐ NORMAL ☑ ABOVE NORMAL

AIR TEMPERATURE: (LAST 3 WEEKS)
☑ BELOW NORMAL ☐ NORMAL ☐ ABOVE NORMAL

FERTILIZER APPLIED TO SAMPLED CROP:

METHOD		N lb/A	P_2O_5 lb/A	K_2O lb/A	Date Applied
Broadcast ☐ or Knifed In ☐	Before Planting	40	40	100	3/12
	After Planting				
Row	Side Dress				
	Beside Seed				
Foliar					
Other					

micronutrients, insecticides, pesticides

Kind	Rate	Method	Date Applied
Zinc	5	Bdcst	3/12
Sulfur	20	Bdcst	3/12

SOIL TEST DATA: DATE OF PREVIOUS TEST _____ 19____
WAS SOIL TEST BY GEORGIA LAB ☑ OR OTHER LAB ☐
pH 6.6 P lbs/A 50 K lbs/A 140
Ca lbs/A 480 Mg lbs/A 65 L.R. _____

SOIL EROSION: ☐ NONE ☐ MODERATE ☐ SLIGHT ☐ SEVERE

SOIL TEXTURE: scl
(CLAY, SILT, LOAM, SAND)

DRAINAGE: ☐ POOR ☑ FAIR ☑ GOOD ☐ EXCESSIVE

WAS A SOIL SAMPLE ALSO TAKEN FROM THIS SAME AREA FOR:
1. SOIL TEST ☐ YES ☐ NO
2. NEMATODE ASSAY ☑ YES ☐ NO

IMPORTANT: Put original, second and third copy in small envelope. Place plant sample in large envelope and mail to the laboratory. Keep last copy for your records.

PLANT ANALYSIS REPORT

GROWER:

BILL JONES

PELHAM, GA 31779

DATE: 08/09/89

COUNTY: MITCHELL

KIT NUMBER: 502

LAB NUMBER: 4082

SAMPLE NUMBER: 1

CROP: CORN-WP

UNIVERSITY OF GEORGIA
COOPERATIVE EXTENSION SERVICE
ATHENS, GA. 30602

PERCENTAGE(%)						PARTS PER MILLION(PPM)					
N	P	K	CA	MG	S	MN	FE	AL	B	CU	ZN
3.60	.20	3.20	.42	.12	.27	60	40	91	6	8	10

RECOMMENDATIONS

MEAN RATIOS & RATIO RANGES - CORN LEAVES

Expression	Ratio Mean	Desired Ratio Range
N/P	9.93	7.65 - 12.21
N/K	1.6	1.00 - 2.10
N/Mg	15.0	9.00 - 21.00
N/Ca	6.4	4.00 - 8.80
N/S	14	10.00 - 18.00
N/Zn	0.12	0.07 - 0.17
N/B	0.49	0.28 - 0.70
P/K	0.16	0.10 - 0.22
P/Mg	1.46	0.84 - 2.08
P/S	1.56	0.94 - 2.16
P/Zn	0.012	0.006 - 0.018
K/Ca	4.48	2.22 - 6.74
K/Mg	10.47	5.01 - 15.93
K/S	9.88	6.23 - 13.53
K/Zn	0.085	0.043 - 0.127
Ca/Mg	2.40	1.62 - 3.18
Ca/S	2.43	1.43 - 3.43
Ca/B	0.08	0.04 - 0.12
Mg/S	1.15	0.47 - 1.83
Mn/Fe	0.54	0.19 - 0.89
Mn/Zn	2.38	0.81 - 3.59
Mn/Cu	8.05	1.36 - 14.74
Mn/B	10.7	0.2 - 21.2
Zn/Cu	3.85	1.15 - 6.55

*Yields > 160 Bu/A

MEAN RATIOS & RANGES* - SOYBEAN LEAVES

Expression	Mean	Ratio Range
N/P	14.92	12.39 - 17.45
N/K	2.56	2.06 - 3.06
N/Ca	4.72	3.14 - 6.30
N/Mg	16.37	11.64 - 21.10
N/S	18.45	16.29 - 20.61
N/Mn	0.08	0.05 - 0.11
N/Zn	.16	0.09 - 0.25
N/B	.20	0.07 - 0.33
P/K	.17	0.13 - 0.21
P/Ca	.32	0.20 - 0.44
P/Mg	1.10	.75 - 1.45
P/S	1.15	.85 - 1.45
K/Ca	1.97	1.16 - 2.78
K/Mg	6.56	4.43 - 8.69
K/Mn	0.03	0.02 - 0.04
K/Zn	0.06	0.04 - 0.08
Ca/Mg	3.59	2.53 - 4.65
Ca/S	3.78	2.64 - 4.92
Ca/Zn	0.03	0.01 - 0.05
Ca/B	0.04	0.01 - 0.07
Mg/S	1.43	1.11 - 1.76
Mn/Zn	2.22	0.55 - 3.89
Mn/B	2.50	0.61 - 4.39

*Yields = $\geq$ 40 Bu/A

Plant Part and Time:

- Young plants—Leaves adjacent to 2nd and 3rd clusters.
- Older plants—Leaves from 4th to 6th clusters prior to or during fruit set.

Element and Sufficiency Range	Interpretation and Recommendations
Nitrogen (N) Young plants: 4.00-5.00% Older plants: 3.50-4.00%	Deficiency is an uncommon problem in greenhouse tomatoes. Usually excesses occur which result in poor fruit set and increased susceptibility to disease and insect attack. Maintaining the nitrogen level at the lower end of the sufficiency scale is desirable. When N is high, no more N fertilizer should be applied and growth media should be leached to remove excess N if possible. For hydroponic solutions, reduce the N concentration in the nutrient solution.
Phosphorus (P) 0.50-1.00%	Deficiency not likely to occur. Normally with a good fertility program, adequate P is supplied.
Potassium (K) 3.50-5.00%	Deficiency is not likely to occur with a good fertility program. Frequently K levels may be too high for best cation balance with Ca and Mg. In such cases, no more K fertilizer should be applied and the soil media leached to remove excess K. For hydroponic solution, reduce the K concentration in the nutrient solution.
Calcium (Ca) 0.90-1.80%	Deficiency is a common problem in greenhouse tomatoes. When the growth media is soil, it should be well-limed. For artificial mixes, applications of calcium sulfate (gypsum) may be needed to provide the Ca essential to prevent the physiological disease known as blossom-end rot. The use of Ca $(NO_3)_2$ as a source of N is recommended. Foliar applications of $Ca(NO_3)_2$ or $CaCl_2$ (1.0 lb. in 100 gal. water) can provide some of the Ca needs when plants are deficient in Ca. For hydroponic solutions, special additions need to be made to insure an adequate Ca supply.
Magnesium (Mg) 0.50-1.00%	Deficiency is a common problem usually due to inadequate Mg in the growth media. When deficient, Mg may be soil applied at the rate of 5 lbs. magnesium sulfate or equivalent per 1000 sq. ft. or foliar applied by dissolving 10 lbs. magnesium sulfate in 100 gals of water. Foliar applications are only temporary treatments and soil additions of Mg are recommended to control the deficiency for the length of the growing period. For hydroponic solutions, special additions need to be made to insure an adequate Mg supply.
Manganese (Mn) 50-500 ppm	Deficiency is not likely to occur. Manganese may be high, particularly on soils which have been steam sterilized.
Iron (Fe) 50-300 ppm	Deficiency is not likely to occur. High Fe test results normally indicate soil or dust contamination. An accurate Fe determination can only be made with washed leaves.
Boron (B) 35-60 ppm	Tomato has a high B requirement. Boron additions may be required to maintain the plant B level within the sufficiency range. Apply 0.5 lb. borax per 1000 sq. ft. for soil and artificial mixes if B has not already been applied. Take care to insure that excessive B is not applied.

Element and Sufficiency Range	Interpretation and Recommendations
Copper (Cu) 8-20 ppm	Deficiency is not likely to occur.
Zinc (Zn) 20-100 ppm	Deficiency is not likely to occur.
Aluminum (Al) Less than 200 ppm	High Al levels are not likely to occur unless associated with soil or dust contamination (Fe will also be high).