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Monitoring citrus nutrition in the Rio Grande Valley for fertilizer recommendations

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MONITORING CITRUS NUTRITION IN THE RIO GRANDE VALLEY FOR FERTILIZER RECOMMENDATIONS

A Thesis

by

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ABSTRACT

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Soil fertility and plant nutrition is crucial for a better yield and consistent harvest in the Rio Grande Valley for local farmers growing citrus trees. A field of oranges and a field of grapefruits were monitored and nutrition deficiencies were noticed that played an important role during fruit set. Soil samples that were taken throughout the year were analyzed via a carbon dioxide extraction method that mimics the way plants naturally take up nutrients or extract nutrients from every soil type. Macronutrients such as the N, P, K, Na, Ca, Mg and some of the micronutrients (Zn, Fe, Mn, and Cu) key role to determine the nutrient status of an orchard and gave us a great indication on deciding what fertilizers are going to be taken into consideration for pre and post-harvest for the following year.

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CHAPTER I

INTRODUCTION AND BACKGROUND

Introduction

Different plant types remove nutrients at different rates throughout the growing season, which affects both plant growth and crop yield. Soil type plays a large role in the availability and unavailability of nutrients to plants. Some soils readily leach out nutrients which become available to the plants growing, while other soils rapidly sequester nutrients into compounds that are not available to the plant. In many soils at the end of growth season, there may be little nutrients left in a soil available for plant uptake. In addition, to nutrients affecting plant growth, soil nutritional balance has extensive effects on water useage.Proper nutritional balance in soils can reduce water usage by 40 to 60 percent which in turns can dramatically reduce fertilizer requirements. Research on plant soil interactions are currently being performed at Texas A&M Citrus Center in Weslaco. The Texas A&M Citrus Center main campus is located on the east side of the City of Weslaco on the northeast corner of Expressway 83 and International Blvd (FM 1015).The research area is 2 miles south of the main campus which is known as the South Farm and consists of 250 acres. Of those 250 acres in the South Farm, only two blocks are being monitored which is approximately 20 acres. In the monitored two blocks, one block consists of grapefruit trees and the second block consists of orange trees. Soil samples were taken at two intervals once before fruit harvest and after fruit harvest. The foliage of the plants was analyzed monthly to observe changes in the nutrients and change in the nutrient requirements of the plant that were occurring with growth. The main objective of this project was to monitor the nutrition of citrus trees throughout the valley. The secondary objective of the study was to generate a reference dataset on how the minerals change throughout a growth season so fertilizer recommendations could potentially be made.

Citrus Industry in the Rio Grande Valley

Citrus is native to the Orient, having been known in China more than 4,000 years ago. Early explorers carried citrus to the Mediterranean area of Europe. From there it was carried to the West Indies by early settlers. Citrus subsequently spread across the Americas with early explorers, missionaries and settlers.

Orchards were established along the Texas Gulf Coast in the 1880′s. The earliest record of citrus in the Lower Rio Grande Valley was seedling orange trees planted by Don Macedonio Vela at the Laguna Seca Ranch in 1882. Orchards planted on trifoliate orange rootstock over the next quarter century failed because the rootstock does not tolerate alkaline soils or saline conditions of soil and water. Charles Volz successfully established an orange orchard on sour orange rootstock in 1908.

The Texas citrus industry is almost totally located in the Lower Rio Grande Valley, with about 85 percent of the acreage in Hidalgo County, 14 percent in Cameron County and only about 1 percent in Willacy County. Although hurricanes can cause considerable tree and crop damage, the major limiting factor in Texas citrus production is the risk of severe freeze damage. The economic costs of rehabilitating and/or replanting citrus orchards following a freeze are accentuated by the costs of recapturing markets lost to competing areas during freeze recovery.

Grapefruit (67%) and oranges (32%) dominate the Texas citrus industry, as less than 100 acres of other citrus are reported. There may be good potential for small acreages of so-called specialty citrus, particularly some of the tangerines, tangelos, lemons, limes, pomelos, and others. Such specialty citrus fruits should generate high returns in both gift fruit sales and at local roadside markets, even though production and marketing risks may be somewhat higher than for traditional grapefruit and orange orchards.

The total value of the citrus industry to the Texas economy normally is more than $200 million. The total crop value to the grower usually tops $50 million annually.

The present outlook for the Texas citrus industry is fairly stable. Although the overall size of the industry has decreased to about 40 percent of that existing in 1980, the demand for premium quality Texas Rio Red grapefruit and Texas sweet oranges continues to weather the vagaries of the market.

Limited acreages of Foster (seedy, red) and Thompson (seedless, pink) grapefruit were established in the Valley in the late 1920s and into the 1930s. Ruby Red grapefruit was patented in 1934 as a bud sport discovered in 1929 on a Thompson tree imported from Florida in 1926. Red blush originated as a rebudded sour orange sprout, with the bud taken from a Thompson tree from the same lot of trees which gave rise to the Ruby Red.

Thus, the Texas citrus industry began, leading to a peak of more than 100,000 acres in the 1940s. Moreover, Texas’ reputation for quality red grapefruit production was established by the varieties that originated within the Rio Grande Valley. Changes and improvements in the Texas citrus industry have occurred primarily in response to natural disasters, particularly the freezes of the late 1940s, 1951, 1962, 1983, and 1989. From the earliest plantings of seedy oranges and white, seedy grapefruit, today’s orchards are primarily seedless oranges and super-red seedless grapefruit. Other improvements over time include closer tree spacings, laser land leveling, low-volume irrigation systems including micro sprayers and drip tubing, mechanical grove care equipment, more extensive use of herbicides for orchard floor management, and a juice processing facility for packinghouse eliminations.

A severe freeze over Christmas of 1983 destroyed 70 percent of that season's crop and reduced acreage from 69,200 acres to about 22,000 acres. No citrus fruit was produced during the 1984-85 seasons and only a modest amount in the 1985-86 seasons. Replanting was well underway, with approximately 36,000 acres in production, when another major freeze over Christmas of 1989 reduced the acreage to around 12,000. Obviously, production was curtailed at that point, and did not resume until the 1991-92 season. Although acreage increased to about 35,000 during the 1990's, urbanization, other land use, overall citrus economics, and other factors combined to lower citrus acreage to an estimated 27,000 acres in 2005.

The probability of a freeze in Texas is about the same as in Florida, but freezes usually are more damaging to the Texas citrus industry because of its concentration in a relatively small geographic area. Thus, a severe freeze in the Valley affects all orchards. By contrast, Florida and California acreage is dispersed over such a large geographic area that freezes rarely affect more than a portion of total acreage.

Although land prices in the Valley generally are lower than in competing citrus areas, Texas citrus production costs tend to be slightly higher than those for fresh fruit production in Florida. A major difference in costs can be attributed to irrigation, i.e., Texas citrus irrigation is essential and labor intensive. Florida citrus areas normally receive more than twice as much rainfall as the Valley, thereby reducing irrigation needs. Also, irrigation systems in Florida require comparatively less labor. Lower average orchard sizes in Texas preclude some economies afforded by larger operations.

Average Texas citrus production is somewhat lower than in Florida, even for the same rootstock-scion combinations, although Valley soils are considerably more fertile. Lower Texas production may result from a combination of soil and water salinity; the effects of generally hot, dry winds during flowering on initial fruit set; and smaller overall tree sizes because of higher tree densities and periodic freeze damage. Total production fluctuates from year to year, primarily in response to the prior season's production and to climatic variations from year to year. However, orchard management expertise is a critical factor in production, as better growers in Texas, typically out produce the average-in the good years as well as those not so good.

The Texas citrus industry has a solid infrastructure that has survived the economic hardships created by the freezes of the 1980's. Consolidations and mergers of packinghouses, grove care companies, supply and/or chemical companies have been the norm during the last 15 or so years. Today, there are three major packinghouses, plus several smaller ones, and one major processor, although some processing is carried out by existing packinghouses. The citrus industry is served by the Texas Valley Citrus Committee, Texas Sweet Citrus Advertising, Texas Citrus and Vegetable Growers and Shippers Association, Texas Citrus Mutual, Texas Produce Association, Texas Department of Agriculture, U.S. Department of Agriculture, Texas Agricultural Statistics Service, the Rio Grande Valley Grove Managers Association, and Texas Citrus Growers League. Moreover, citrus research and Extension programs are conducted by the U.S. Department of Agriculture, the Texas A&M University-Kingsville Citrus Center, the Texas

Agricultural Experiment Station and the Texas Agricultural Extension Service-all of which have personnel and facilities in the Lower Rio Grande Valley.

Current Citrus Research in the Rio Grande Valley

Huanglongbing (HLB), also known as citrus greening disease, is a bacterial plant disease that while not harmful to humans or animals, is fatal for citrus trees. The disease destroys the production, appearance and economic value of citrus trees. Diseased trees produce bitter, hard, misshapen fruit and die within a few years of being infected. HLB is considered to be one of the most serious plant diseases in the world and currently there is no cure.

HLB is spread by the Asian citrus psyllid, a tiny insect that feeds on the leaves and stems of citrus trees. When an Asian citrus psyllid feeds on an HLB-infected tree, it can pick up the bacteria that cause the disease. Once infected, a psyllid carries the disease-causing bacteria for life and can transfer the disease when feeding on other citrus trees. An important way to control the spread of HLB is to stop the Asian citrus psyllid [3]. The disease can also be spread by grafting infected plant tissue onto another plant.

Detection of HLB can be difficult, as symptoms may not show up for more than a year after the tree has become infected. The first symptoms are yellowed leaves. However, citrus trees often have yellow leaves because of nutritional deficiencies. HLB leaf symptoms are somewhat unique in that the yellow mottling caused by HLB is not the same on both sides of the leaf. Later symptoms of HLB-infected trees include lopsided, small fruit, and premature and excessive fruit drop. Additionally, the disease can cause entire shoots or branches of the tree to become yellow [3].

HLB and the Asian citrus psyllid threaten not only local farms and farmers we count on for fresh, healthy, locally produced citrus, but also resident’s ability to grow citrus fruits in their backyards. If HLB is not stopped, all citrus in California is at risk of disappearing.

Once a tree is infected with HLB, it will die and must be removed to protect other nearby citrus trees. Diseased trees can become a reservoir and breeding ground for Asian citrus psyllids carrying HLB, allowing the insects to spread the disease. Infected trees must be removed to protect other citrus trees, the community’s citrus and the quality of life for future generations [5].

Up to today most of the research in the Rio Grande Valley is being focused in combating citrus greening disease. As we know that citrus greening disease is very fatal for citrus trees, it is not the only way we can protect the citrus industry [5]. Mineral nutrition is also an important sub science of plant physiology. When it comes to apply fertilizers to the citrus trees in the Rio Grande Valley, the majority of the people are just basing themselves on guidelines from Florida. There are many differences that Florida and the Rio Grande Valley have. For example, the soil texture, the amount of rainfall that we get and the climate.

There are many questions that have to be taken into consideration before planting citrus trees. For example, what elements must a plant absorb in order to live and grow? Can a plant grow when provided only with elements in inorganic form? If only minerals are required, then which ones, in what forms, and in what amounts? How can we know when a plant is lacking some essential element? How can we best provide the limiting element to overcome its deficiency? What do essential elements do to make them essential? Because we must properly feed the plants before we feed ourselves, these are important questions. Answers to the questions of mineral nutrition also add to our basic understanding of plants, for plant growth requires the incorporation of elements into the materials of which plants are made, and 15 to 20 percent of nonwoody plants are made from such elements; the rest is water [8].

A *pre-plant* **soil test** tells what fertilizers are needed to apply to get plants growing to a good start by providing them with proper soil fertility at planting. A *post-harvest* **soil test** tells what nutrients the crop removed so you can start preparing your soil for the next crop [9].

Different plants remove different nutrients at different rates throughout the growing season. Worse yet, some soils readily leach out nutrients while other soils rapidly tie up nutrients into compounds that are not readily available to the plant. By the end of the season, there can be little available nutrients left [8].

Proper soil nutritional balance can reduce water usage by 40 to 60 percent and dramatically reduce fertilizer requirements by applying only what the crop needs. You can’t guess about fertilizer application and expect to attain the best economic yields and plant quality [9].

As we enter the 21st century, we encounter difficulty in obtaining adequate irrigation water supply. Many water sources have an increasing salt content. Effluent water containing salts must be used. In other areas, the water levels of the underground aquifers are rapidly decreasing and governments are severely restricting the amount of water which may be withdrawn for irrigation. In still other areas, the quality of the underground aquifers is very poor resulting in the application of large amounts of salts. Use of less than ideal water quality requires a carefully designed fertility and water management program to optimize the use of water and minimize damage to soil and plants from excess salts in the water [9].

Most quality standards were developed many years ago when there was less knowledge and products available to help minimize the harmful effects of salts. Today with proper testing to identify the salt cations and anions, better water management is possible. Identifying the cations and anions is needed to properly manage water along with a soil analysis that identifies the 4 major salt cations. Couple water knowledge with proper testing of soils for soluble and extractable calcium along with the humus content, treatments can be made to minimize salt stress and optimize salt leaching. In the short run we can get more benefit from even good quality water with proper soil, plant and water test information. Balanced plant nutrition improves water use efficiency. Benefits from an inch of water can be tripled with the proper balance of plant food [2].

Water delivery systems such as Drip, micro-jet, LEPA, center pivot, etc., have all made big improvements in recent years. In most fields water can be the biggest limiting yield factor. However, just applying water does not necessarily recoup the investment in irrigation equipment; balanced plant nutrients and all BMP are needed.

Getting the most benefit from water depends mainly upon adequate and balanced plant nutrition. Even without irrigation the most profitable yields depend upon adequate nutrition so each inch of water makes the optimum yield [1].

Petiole (Stem) or Leaf Testing is the only way to determine if the plant has adequate nutrition at any and all stages of growth. It is then very profitable to inject into the water system the right plant food and other aids in the right amount at the right time to get the highest return on the investment in water and plant food. Many new products are now on the market that can make farming more profitable when used properly [9].

Monitoring the mineral nutrition throughout the year for the citrus trees by using a carbon dioxide extraction which mimics the way plants naturally take in the nutrients, would be beneficial in order to adjust the fertilization to the citrus nutritional requirements throughout the growing season resulting in higher crop yields, reduced water use, eliminating fertilizer waste and ensuring a healthy, safe product [9].

CHAPTER II

MATERIALS AND METHODS

Soil and Plant Tissue Sampling

Soil samples were collected with a soil sampler from the north, south and the middle of the field being observed. The samples were taken from the 1st, 2nd, 3rd and 4th feet depth to have a better representation of the large root zone of the citrus trees. Soil samples were taken monthly to see the changes in the soil nutrition before and after harvest. Important step to distinguish the nutrition within the soil layers, one important thing is to prevent contamination. On the other hand, tissue samples were taken of an approximate 20 to 30 mature leaves in the north, south and center of the citrus field for analysis monthly.

Drying and Grinding of Soil and Tissue Samples

After soil samples arrive to the laboratory they were left drying for 24hrs so that the samples are accessible to work with and make the grinding easier for the following analysis. Once the soil samples were completely dried they were ground into small particulates and stored in labeled paper bags. As soon as the leaf samples arrived from the field they were removed from the bag and leaves that were not uniform with the bulk of the sample were discarded. Leaf samples were first washed with tap water once and then with deionized water and the stem of the leaf was removed (samples should be processed as soon as possible after arrival from the field).Leaf samples were placed into a drying oven at 70◦C and were allowed to dry overnight.

Extraction of Tissue Samples

Once samples were ready to analyze, a 0.5mg sample was transferred into100mL volumetric flasks which were labeled with a sample ID. Once the sample was in the flasks, 20mL of Pic-Nic (Perchloric ($HClO_4$), Nitric Acid HNO_3) at a ratio of 1:3 respectively. The samples were put into the hot plate in the fume hood and were extracted until the solution turned clear and were set off to cool. Samples were put back into the hot plate and added water up to the belly of the flask and continued the extraction for 2 minutes to ensure that the entire sample was extracted. Samples were brought up to volume with deionized water. The samples were capped and inverted 3 times to mix the solution. Samples were transferred from the volumetric flasks to the test tubes and were saved to read in the atomic absorption and on the inductively coupled plasma. The %N in the tissue samples were determined using the Kjeldahl extraction method. A 0.2gram sample of the ground tissue sample was transferred into large wide tall test tubes and 3mL of Rankers solution (salicylic acid and concentrated sulfuric acid). After the Rankers solution has been added, 3mL of sodium thiosulfate and 5mL of selenium of oxychloride was and was placed in the hot plate and extracted for about 30 minutes. Perchloric acid was added drop wise until the solution turned clear. Once the solution was clear it was left to cool and in a 100ml flask the solution was transferred from the test tube into the flask and was picked up to volume with deionized water.

%N, %P, Minerals and Micronutrient Analysis in Tissue Samples

From the ranker extraction, 1mL from the 100mL volumetric flasks was placed into 50mL volumetric flasks. Water was added to the volumetric flasks one fourth of the way and the solution were swirled to mix the solution. Once the solution was mixed, 2mL of sodium hydroxide was added and deionized water was added once again three fourths of the way in the flask. Finally, 1mL of nessler’s reagent was added and then brought up to volume with deionized water. The UV-Vis spectrophotometer was warmed for 20 minutes and the sample was read at 420 nm. For the %P and the micro-nutrients analysis, a direct analysis from the tissue extraction was analyzed in the inductively coupled plasma.

Carbon Dioxide and Water Extraction of Soils

For the carbon dioxide extraction 50grams of the soil sample was placed in a glass jars and 250mL of deionized water was added. Once the solution was in suspension it was capped with a probe that allowed carbon dioxide to go into the solution for 5 minutes and it was done three times. After the three 5 minute trials, the solution was filtered and the filtrate was transferred to the test tubes and 1ml of Lanthanum Oxide was added which ensured that any residual that would stay in solution with no interference. For the water extraction, a 20g sample of soil was placed in hard plastic jars and 100mL of deionized water was added and were put into a mechanical shaker for 20 minutes. After the solution settled, the solution was filtered and the filtrate was placed into the test tubes for the analysis of the macronutrient analysis.

Extraction of Micronutrients in Soil Samples

Besides the carbon dioxide and the water extraction, the samples have to go through a DTPA (diethylenetriaminepentaacetic acid) extraction which is used to extract the micronutrients. A 20gram sample of the top soil was added into plastic jars and 40mL of a DTPA solution was added.plastic jars were capped and were placed in the mechanical shaker for 2 hours, but in between the 2 hours, every 15minutes the shaker was stopped and the plastic jars were swirled so that the soil could be kept in solution. While the solutions were mixed in the shaker, the filtration process was set up by placing plastic tubes with filter paper ready so as soon as the 2 hours were finished shaken, the samples were transferred and filtered. The filtrate was transferred to labeled test tubes and the samples were run in the inductively coupled plasma and the atomic absorption to compare the results.

Determination of pH in Soil Samples

A 20 gram sample of the soil samples were placed in hard plastic containers and 40mL of Reversed Osmosis water was added to the samples. The samples were swirled to mix until the soil went into suspension and were left overnight so that the soil could settle and the solution was analyzed the following day. The pH meter was turned on and the electrode was placed in deionized water. The meter was standardized using 4.1, 7.40 and 10.0 buffer standards. The electrodes were rinsed with deionized water and blot dry with Kimwipes between each buffer to avoid contamination. After the electrode was calibrated, the samples were mixed to ensure a uniform pH throughout the sample. This also prevents mud from accumulating on the end of the electrode. The electrode was checked with the 7.4 standard every 6-8samples to make sure that the electrode was still calibrated.

Determination of Organic Matter in Soil Sample

A 1gram sample of the top soil was added into glass jars and 10mL of potassium dichromate solution was added and samples were swirled to mix. Slowly after the solution was mixed, 13mL of concentrated sulfuric acid was added to each jar for the complete oxidation of the solution. The solution was allowed to sit for 15 minutes to cool and after that 100mL of deionized water was added to each jar, samples were filtered and analyzed in a UV-Vis spectrophotometer at 650 nanometers and was recorded as % transmittance.

Soil Texture Analysis

After the soils samples are placed in small heaps in correct order, the index finger had to be moistening, and shaking of the finger was done to remove excess water. The finger was pressed lightly into the center of the heap to feel the soil by moving and rolling against thumb. This was done for all of the samples to test whether the sample was sand, sandy loam, loam, clay loam, clay, or heavy clay.

CHAPTER III

RESULTS AND CONCLUSION

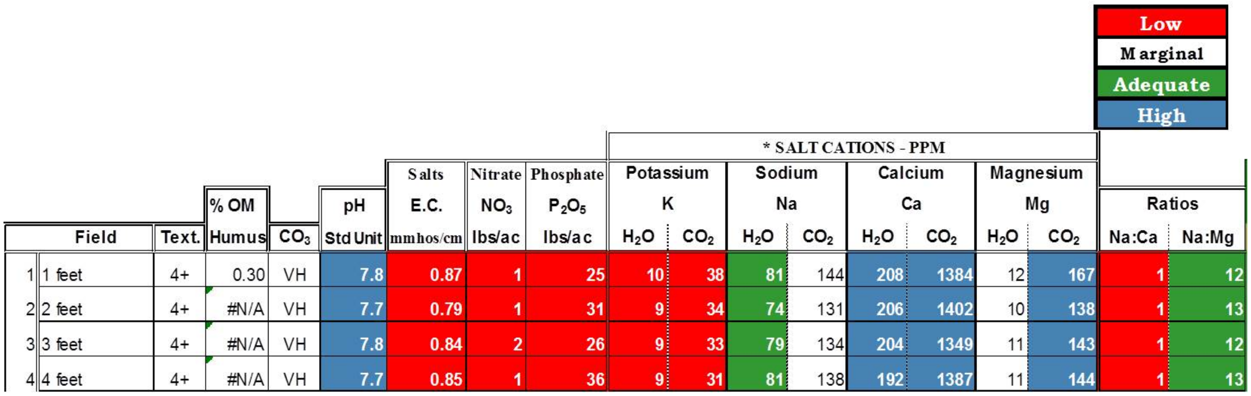
Results

SOIL ANALYSIS

NUTRIENTS AVAILABLE TO PLANTS

(Determined by Carbon Dioxide (CO_2) Natural Extraction Method)

Table 1

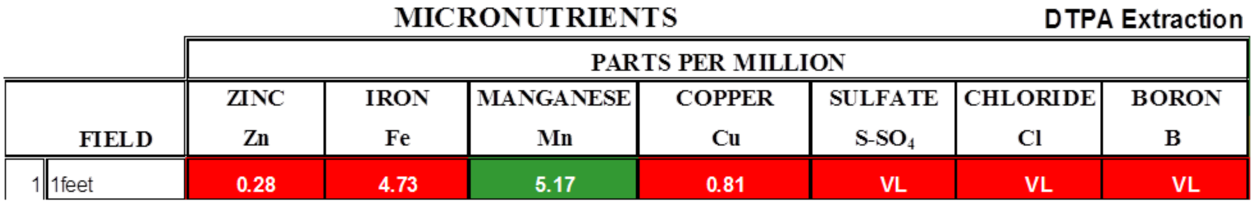


Low
Marginal
Adequate
High

									* SALT CATIONS - PPM									
						Salts	Nitrate	Phosphate	Potassium		Sodium		Calcium		Magnesium			
			% OM		pH	E.C.	NO_3	P_2O_5	K		Na		Ca		Mg		Ratios	
	Field	Text.	Humus	CO_3	Std Unit	mmhos/cm	lbs/ac	lbs/ac	H_2O	CO_2	H_2O	CO_2	H_2O	CO_2	H_2O	CO_2	Na:Ca	Na:Mg
1	1 feet	4+	0.30	VH	7.8	0.87	1	25	10	38	81	144	208	1384	12	167	1	12
2	2 feet	4+	#N/A	VH	7.7	0.79	1	31	9	34	74	131	206	1402	10	138	1	13
3	3 feet	4+	#N/A	VH	7.8	0.84	2	26	9	33	79	134	204	1349	11	143	1	12
4	4 feet	4+	#N/A	VH	7.7	0.85	1	36	9	31	81	138	192	1387	11	144	1	13

Table 1 shows an average analysis of the soil samples taken throughout the year for pre and post-harvest at the citrus field. As can be seen in the results of the different extractions presented , Salt cations: H_2O= represents the immediately available (Water soluble Extract) salts and ;and the CO_2 represents the available reserve (Carbonic acid extract).Because plant roots exude $CO_{2,}$ the data from this extraction gives data that better correlates to plant uptake from a soil. These values are the nutrients available to plants within the soil sample analyzed. Availability concentrations have been correlated through performing multiple plant analysis (crop logging) during a growing season. From Table 1the nitrate (NO_3^-) analysis and E.C. (electrical conductivity) were determined using the water extraction only and not the CO_2 extraction. As can be seen the available nitrate, in the soil was actually deficient to the recommended values of 35 to 90lbs/acre. The deficiency in nitrate in some parts of the citrus blocks presented symptoms of nitrate deficiency in the plants. The E.C. (electrical conductivity) is a measure of total water soluble salts, which affects the electrical conductivity of the water and is expressed as mmhos/cm.The phosphorus (P_2O_5) was extracted using the carbon dioxide extraction and the amount reported is in lbs/acre for the top foot of the soil.

Table 2



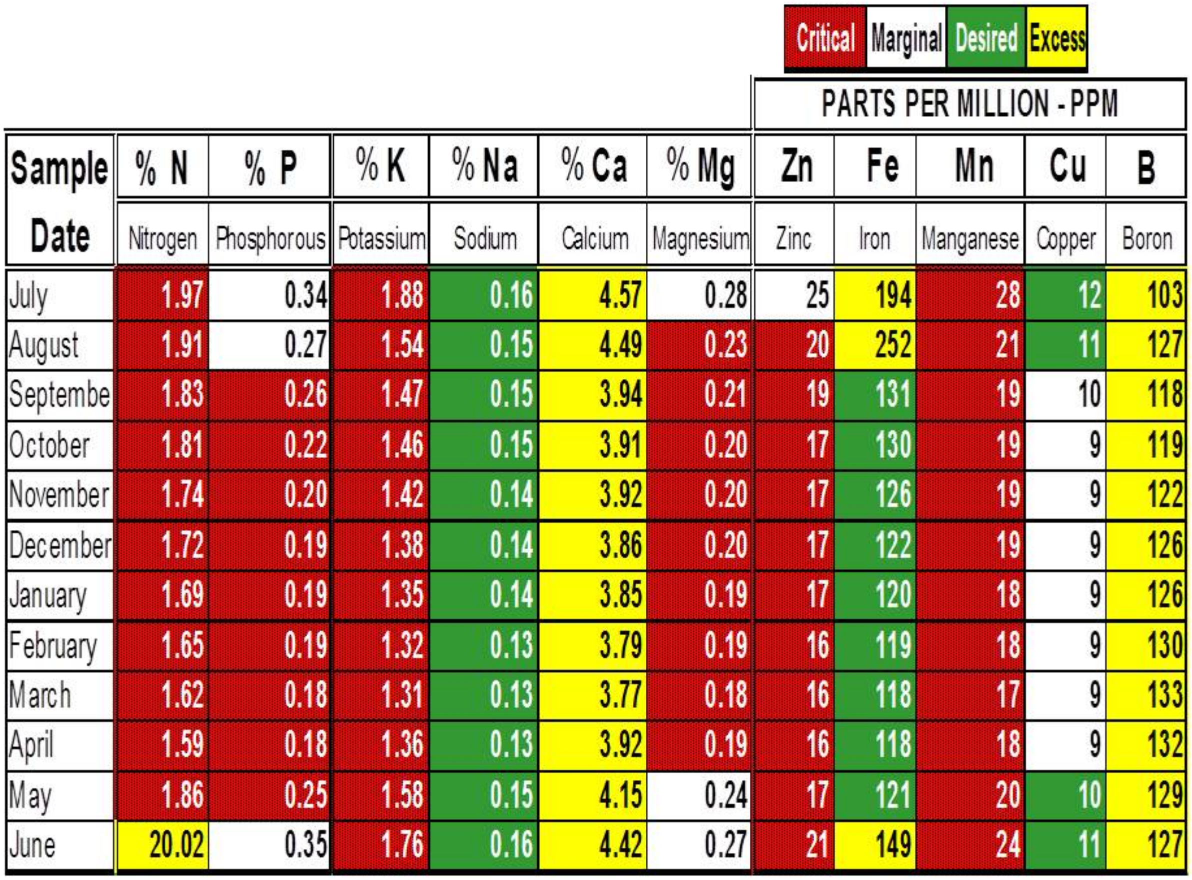
MICRONUTRIENTS — DTPA Extraction

		PARTS PER MILLION						
	FIELD	ZINC Zn	IRON Fe	MANGANESE Mn	COPPER Cu	SULFATE S-SO_4	CHLORIDE Cl	BORON B
1	1feet	0.28	4.73	5.17	0.81	VL	VL	VL

Table 2 represents the analysis of the micronutrients that were extracted with DTPA (Diethylenetriaminepentaacetic acid) from the top soil.

TISSUE ANALYSIS

Table 3



Critical Marginal Desired Excess

Sample Date	% N Nitrogen	% P Phosphorous	% K Potassium	% Na Sodium	% Ca Calcium	% Mg Magnesium	Zn Zinc	Fe Iron	Mn Manganese	Cu Copper	B Boron
							PARTS PER MILLION - PPM				
July	1.97	0.34	1.88	0.16	4.57	0.28	25	194	28	12	103
August	1.91	0.27	1.54	0.15	4.49	0.23	20	252	21	11	127
Septembe	1.83	0.26	1.47	0.15	3.94	0.21	19	131	19	10	118
October	1.81	0.22	1.46	0.15	3.91	0.20	17	130	19	9	119
November	1.74	0.20	1.42	0.14	3.92	0.20	17	126	19	9	122
December	1.72	0.19	1.38	0.14	3.86	0.20	17	122	19	9	126
January	1.69	0.19	1.35	0.14	3.85	0.19	17	120	18	9	126
February	1.65	0.19	1.32	0.13	3.79	0.19	16	119	18	9	130
March	1.62	0.18	1.31	0.13	3.77	0.18	16	118	17	9	133
April	1.59	0.18	1.36	0.13	3.92	0.19	16	118	18	9	132
May	1.86	0.25	1.58	0.15	4.15	0.24	17	121	20	10	129
June	20.02	0.35	1.76	0.16	4.42	0.27	21	149	24	11	127

Table 3 shows the tissue analysis of the orange leaves that was performed on the south farm field. The major difference from the orange and the grapefruits nutrient data was the difference in the percentage of N and percentage of P. The percentage of nitrogen in the grapefruit leaves was .1% to .2% less than that found in grapefruit.

Figure 1

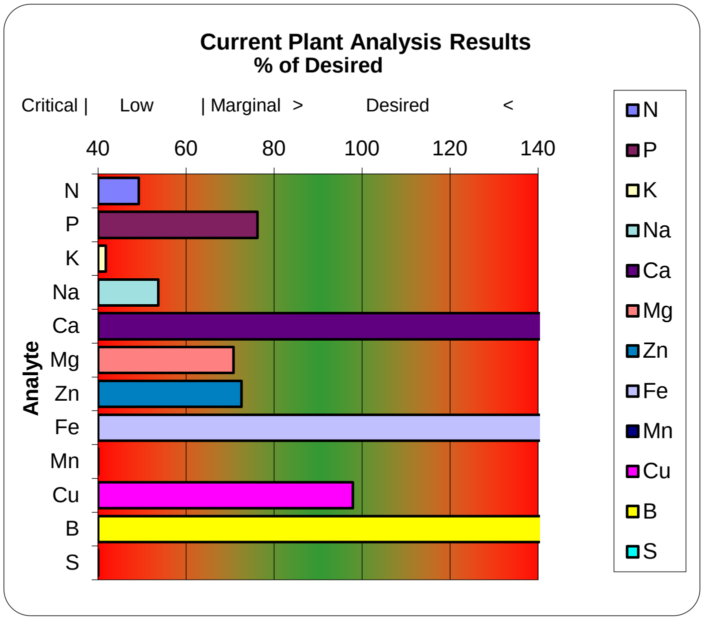


Figure 1 shows the average of the nutrients in the block that was observed.

Discussion

Growth responses can be expected below 40lbs/acre and high phosphate requiring crops may respond to additional phosphate up to 200lbs/acre test. The percentage Organic Matter (Humus) improves CEC (cation exchange capacity), soil physical condition, water and nutrient holding capacity. In general the higher the % Organic Matter the better crop growth and yield. The organic matter in the soils reported in the present study-was 3%, were ideal % humus is in the range of 2.8-4.8, in the Rio Grande Valley, the soils fall within the optimum range for growth . From the carbon dioxide extraction, the salt cations K, Na, Ca and Mg. Extractable potassium (CO_2 extraction) is the amount available to a crop in a growing season. 80ppm of K^+ is the minimum and for plants with high potash needs are up to 120ppm. From the results it can be seen that low K^+ results low for most plant requirements .The available calcium and magnesium fall within a good range for plant growth and crop production. The soils been tested are calcareous soils which are common to the Rio Grande Valley, due to the high concentration in limestone deposits in the soils. Sodium to calcium ratios (Na: Ca) and sodium to magnesium ratios (Na: Mg) were tested. These ratios help evaluate salt problems and are indicators of soils physical condition for water and root penetration. Na/Ca should be less than 6 and Na/Mg ratios should be below 20 for regular crops. However, the ratio of Na/Mg should be below 10 for sugar producing crops which includes citrus trees. As can be seen in the results, low Na/Ca ratio and high Na/Mg ratios are observed in the soils of the Rio Grande Valley, which should affect crop production. However, the data presented in table 2 uses the standard DTPA extraction, a standard chemical extraction as used by most laboratories. The DTPA method is not calibrated as the natural extraction methods used for major nutrients in the carbon dioxide extraction, but has been an excellent extract when it comes to relate the needs of the plant to what is actually available to the plant. Other sources may be more effective (Chelated forms). This analysis was only performed for the top soil where micronutrients are present in higher quantities. Only the concentrations of Zn, Fe, Mn and Cu, as micronutrients were determined . Most of the micronutrients were found to be deficient for citrus except for manganese (Mn) which this reflected many of the plants physiology. Although there was a drop in most of the nutrients during fruit set, it was not enough to prevent a good yield during harvest season. Nitrogen levels were found to range between 2.3- 2.8%, which are good levels for the tree. During the entire season, especially during fruit set the %N was below the range that was required. The %P in the range of 0.12-0.15% is a good percentage which in most of the season there was enough in the samples. Low phosphates are rarely found in the valley in older orchards. Various foliage symptoms were helpful in indicating specific deficiency or excess, such as salt excess, boron excess, iron deficiency, zinc deficiency. Most of the nutrients in the table were dropped as soon as the season of blooming and fruit set started which the nutrient symptoms were also distinguished from several leaf patterns.

Conclusion

Different plants remove nutrients from soil at different rates throughout the growing season. As can see from the results presented in the study, the highest nutrient requirement for citrus trees is during the blooming and fruit set. Having a great soil foundation would help us have less problems when application of foliar fertilizer comes into play and constantly monitoring of tissue analysis would prevent the drop of the nutrients, as well as it would make the trees stronger against disease. Here in the Rio Grande Valley, the soil conditions help tremendously when compared to regions like Florida or California were fertilizers are in constant application due to their sandy soils which are unable to hold and store the nutrients necessary for citrus growth. The constantly monitoring of citrus nutrition in the Rio Grande Valley will help any citrus growers with battling some of the plant diseases which are related to nutritional needs. In addition, gathering nutritional data will help growers enhance their crop production. Through the careful application of fertilizers, growth aids, and water usage.

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BIOGRAPHICAL SKETCH

My name is Iram Lopez, I was born in Pharr, Texas on June 29, 1988, and moved to Rio Bravo Tamaulipas. Rio Bravo Tamaulipas is where I attended school up to second grade. My family decided to move back to the United States and since then we have lived in South Texas. I attended Whitney Elementary from second grade all the way to fifth grade. I transferred to L.B.J Middle school, which is located in Pharr, TX. I attended and graduated from P.S.J.A. North High School, located in Pharr, TX. During my time in middle school and high school years, I was more interested in sports and never had an interest in the sciences. As soon as I started college at UTPA, I started liking chemistry due to a chemistry professor that really inspired me. I graduated with my bachelor's degree in chemistry in May 2011, and as of May 2014 I have earned my Master degree in chemistry. My email is ialopez3@broncs.utpa.edu.