FLORIDA CITRUS PRODUCTION RESEARCH ADVISORY COUNCIL
Administered by the Florida Department of
Agriculture and Consumer Services
Charles H. Bronson, Commissioner

ELEVENTH ANNUAL REPORT
July 2002 - June 2003

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INTRODUCTION

Presented in this Eleventh Annual Report is information about research conducted during Fiscal Year 2002-2003 supported by the Florida Citrus Production Research Advisory Council operating under the Florida Citrus Production Research Funding Order. This research support program was established under the Florida Marketing Act which enables Florida citrus growers to tax themselves for the purpose of providing funding to support needed research. Growers approved this marketing order by referendum in 1991 and the Council began its work in 1992.

Financial Summary for Fiscal Year 2002-2003

Balance Forward 7-1-2002	$1,866,867
Collections 7-1-2002 thru 6-30-2003	1,856,822
Refunds	2,020
Total Cash	**$3,725,709**

Disbursements

Research Projects	$2,208,296
Administrative Cost	38,587
Total Disbursements	**$2,246,883**
Available for 2003-2004	$1,478,826

Message from the Scientific Coordinator

For the past 10 years, I have had the pleasure of serving the Florida Citrus Production Research Advisory Council (FCPRAC) as Scientific Coordinator and sole paid employee. After retiring from UF-IFAS in 1994, I saw an opportunity to continue working with Florida citrus growers when FCPRAC advertised the position. I applied, they hired me, and now nearly 10 years have passed.

To be honest, I had some trepidation about working for 14 bosses (the members of the Council) from different areas of the state. However, any fears I had about such an arrangement were quickly dispelled as I settled into the job. I am still in awe of the wonderful working relationships among the Council members and the complete absence of provincialism in the conduct of Council business. The Florida citrus grower has nothing to worry about with this group–they are focused and dedicated to the process of providing grower research box tax funds to the most deserving researchers.

The Council members work very hard; first, reviewing preproposals, then reviewing full proposals, and, later, meeting with researchers to find out first-hand what exactly they plan to do should they receive funding. In exchange for all this hard work, Council members receive no remuneration, only the satisfaction of a job well done. When I took the Scientific Coordinator position, I had no idea that these folks would work so hard, cooperate with each other so well, and make such well-informed decisions about the research they were funding with your money.

Leaving the service of FCPRAC will be difficult for me for this has truly been a wonderful relationship and a wonderful part-time job for me to undertake. However, I am not getting any younger, and it is time to let someone else share this opportunity by turning over the reins to a new Scientific Coordinator who will be hired to come on board July 1, 2004. The past 10 years have been some of the best of my life, and I am grateful to the Council and the growers they represent for the opportunity of serving you.

With my very best wishes for continuing success,

Larry K. Jackson
Scientific Coordinator
1994-2004

CHAIRMAN'S MESSAGE
December 31, 2003

Dear Florida Citrus Grower:

This is the annual report of the Florida Citrus Production Research and Advisory Council (FCPRAC). Here we tell how we have spent the money collected from the Florida Citrus Growers via this marketing order. The researchers we have funded describe their projects along with their results to date.

In January 2004, this program will be voted on again. The Florida Department of Agriculture and Consumer Services (FDACS) will mail out referendum ballots to approximately 8,500 citrus growers on or about January 1st. Ballots must be filled out and returned by January 31st. In order for this marketing order to continue taxing up to a one cent per box maximum, more than 50% of the growers must vote YES, and they must represent more than 50% of all commercial citrus acreage in the state. The tax currently is ¾ of a cent per box. This money is collected for citrus production research. Staff and overhead consume approximately 2% of funds, resulting in 98% of the funds collected being spent on research projects.

The Council presents this report as our testament to the value of this program to the Florida Citrus Industry. We encourage all growers to read this report and vote accordingly.

This report shows which problems the FCPRAC thought were of the highest research priorities to fund with existing monies over the last year. As you can see, we cover a broad range of research areas and have both long-term and short-term projects in the mix. The Council spends a lot of time reading, questioning, and prioritizing many research projects before deciding which ones to fund. The Research Community has done a good job at providing more proposals than we can possibly fund, which allows us the luxury of being very selective. Some good research and some very good researchers don't get funded. That is unfortunate, but it does force a ruthless efficiency. By partnering thus with the Research Community, the Industry has benefitted by being able to set priorities, influence research design, and the leveraging of public funds to our use. The Research Community has gained sorely needed funds as well as practical direction. We have made valuable progress over the years, and there is a reasonable expectation of much success in the future.

Dr. Larry Jackson, our Scientific Coordinator, rides off into the sunset next summer. Larry has been the brains of the FCPRAC for ten years, and an astonishingly accomplished individual for many decades. Larry has had a profound influence on our industry, serving skillfully in many different capacities. There is not enough space here, nor am I sufficiently eloquent, to enumerate the accolades he so richly deserves. I can attest that for one so highly educated, Larry has uncommonly good sense! As FCPRAC Scientific Coordinator, we are deeply indebted to Larry for his unwavering pursuit of good research and his insistence upon thrift, efficiency, and results. Larry, on behalf of the Council, please accept our best wishes to you and yours as you fade away into the Golden Years. As the FCPRAC Scientific Coordinator, you have been our much needed 'Velvet Hammer'! It has been a pleasure. **Thank you, Larry, for a job more than well done!**

Sincerely,

Peter McClure

FCPRAC Funding by Years for Each Category[z]

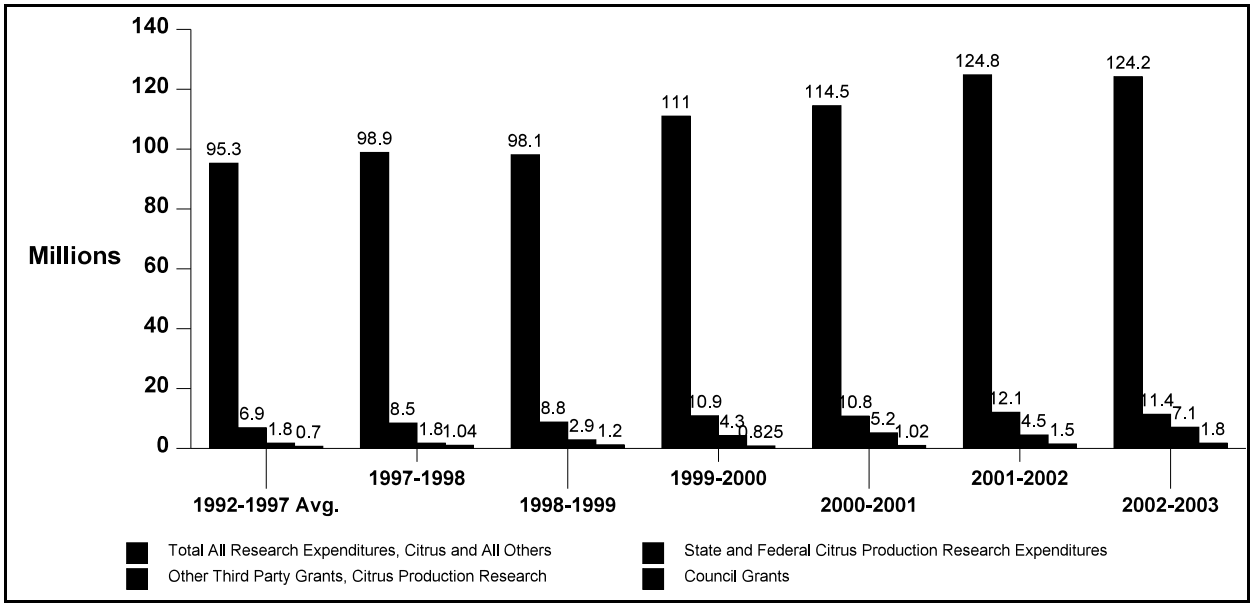
Grant Category	Avg for FY 93-97		FY 97-98		FY 98-99		FY 99-00		FY 00-01		FY 01-02		FY 02-03		FY 03-04	
Management/ Physiology	(10)	314,792	(14)	372,064	(17)	462,291	(7)	163,965	(10)	221,810	(13)	333,500	(11)	372,500	(12)	459,700
Plant Pathology	(12)	304,818	(10)	363,354	(14)	453,379	(9)	300,513	(10)	351,057	(12)	516,251	(10)	640,579	(8)	552,292
Entomology	(10)	306,762	(13)	258,814	(16)	340,208	(13)	250,035	(10)	239,070	(13)	326,154	(10)	523,870	(7)	493,304
Plant Improvement/ Other	(3)	127,398	(3)	135,000	(4)	177,000	(9)	338,722	(8)	360,500	(3)	578,000	(4)	687,965	(3)	703,000
Totals	(35)	1,053,770	(40)	1,129,232	(51)	1,432,878	(38)	1,053,235	(38)	1,172,437	(41)	1,753,905	(35)	2,224,914	(30)	2,208,296

[z]Smaller numbers in parentheses are numbers of projects (new and continued), larger numbers are funding in dollars.

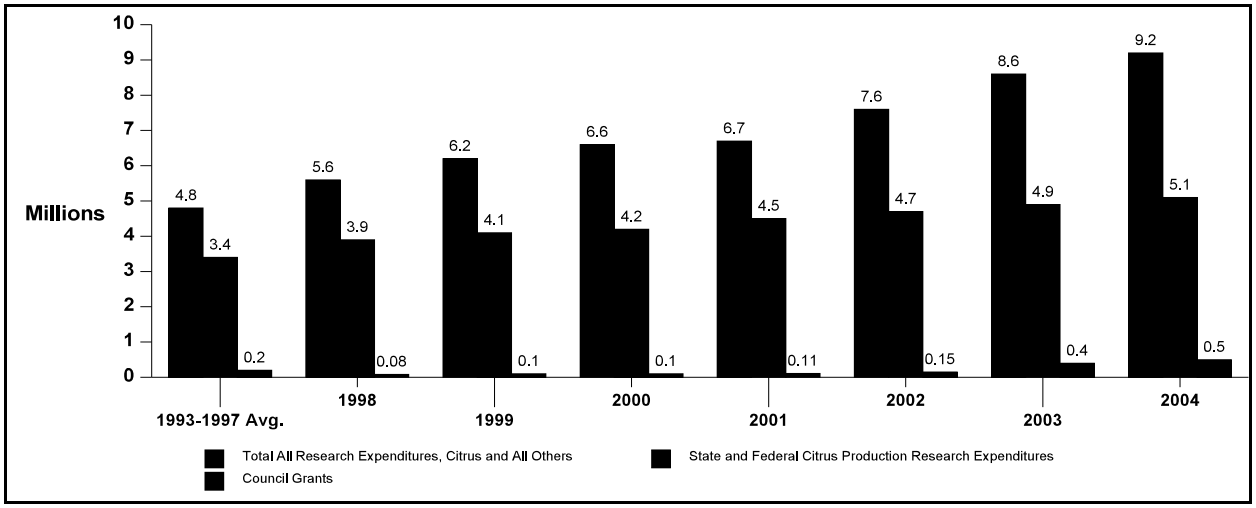
FLORIDA CITRUS PRODUCTION OVERVIEW

The Council views the monies invested through this program to be contributed by growers to enhance the existing research effort. In order to assure growers that their tax monies are in fact enhancing programs, the Council monitors overall citrus production research expenditures in relation to our funding. This section provides a summary of information received from IFAS and USDA-ARS regarding their research expenditures. The Council has not verified this information, and because we have not established firm definitions of each aspect of the research, we may see some adjustments in the future. Most of this information has not been presented in this form before. The Council can only provide this information because of the candid disclosures of the research institutions. We appreciate their openness and cooperation.

UF/IFAS AGRICULTURAL EXPERIMENT STATION



USDA - ARS



1. Council monies shown reflect actual expenditures by the institutions and do not reflect balance of grants held in reserve.

RESEARCH REPORTS

MANAGEMENT/PHYSIOLOGY
Continuing Projects

Rootstock Interactions with Disturbed Soil Profiles in Flatwoods Citrus
Project No. 002-01M

Investigators: Bill Castle
UF - IFAS - CREC

Brian Boman
UF - IFAS - IRREC

Tom Obreza
UF- IFAS - SWFREC

Progress Report for FY 02-03, Year 3 of 4.

Abstract

Rootstock selection in flatwoods Florida citrus groves is compromised to some extent by natural variations within the landscape and among soil series. These variations are generally retained, if not magnified, during the bedding process required in these regions. Further, site variability is a key factor limiting the use of Florida's major rootstock, Swingle citrumelo, and emphasizes the potential for the best rootstock choices to have important economic consequences. A means to conduct site assessments and match the outcomes with rootstock choices should be beneficial. Therefore, we propose to identify the features of several representative soils planted with citrus and their associated landscape positions that explain tree performance, particularly for trees on Swingle citrumelo rootstock. The goal of this work is to provide a soil- and site-related means to select rootstocks.

Objectives

1. Characterize grove sites and soil horizons by manual sampling;
2. Survey citrus groves to locate and compare areas of poor and good tree performance that can be related to soil conditions and rootstock;
3. Characterize soils at sites that are apparently unsuitable for certain rootstocks;
4. Determine which soil and site properties are most responsible for poor rootstock performance; and,
5. Observe root systems and measure root distributions.

Summary of Accomplishments

The canopy and trunk growth of Valencia trees on seven rootstocks planted in five soil types were measured for the fourth year, and yield was measured for the first time. All sites were also assayed for Phytophthora and only low levels were detected. Attempts to reproduce Swingle decline by repeated flooding have not been successful so far, but will be continued; also, declining trees were transplanted by tree spade from "poor" to "good" spots to determine if they can recover. One trial has succeeded so far in that the trees appear to be recovering. Water table fluctuation data were collected from several groves originally used to formulate hypotheses relating depth to clay, water table fluctuations, and soil organic matter content. Root system observations from trenching in the Gulf Region confirmed the importance of drainage and organic matter in soil profiles. The root observations led to the establishment of a large-pot trial consisting of grapefruit trees on Swingle planted in reconstituted Riviera soil or only in the soil of one horizon. Locating Indian River grove sites of poor- and well-performing citrus trees on Swingle citrumelo, Carrizo citrange, Cleopatra mandarin, and Smooth Flat Seville rootstocks has continued and been expanded to other regions of the State. A series of standardized data collected at these sites are assembled into a program that is essentially a reference library. Growers can then access the "library," find "cases" that match their own situations, and use the information as a guide to selecting rootstocks.

Funding:

FCPRAC Grants	$ 29,000
Agency Contribution	$ 65,000
Other Grants	$ 6,000
In-Kind Contributions	$ 8,000
Total	$108,000

Tree Thinning Studies to Improve the Production and Harvesting of Florida Oranges
Project No. 005-04M

Investigators: Jodie D. Whitney
Stephen H. Futch
IFAS - UF - CREC

Progress Report for FY 02-03, Year 4 of 5.

Abstract

Controlling tree size and maintaining good fruit production have been a problem in some orange plantings, particularly in cases where vigorous scion/rootstock combinations have been planted at close tree spacings. Fruit production is usually high early in the life of these plantings and then becomes marginal after the trees have reached containment size. Low or reduced fruit production reduces gross returns but further reduces net returns because the per box

harvesting costs can be higher. Tree thinning treatments have been under investigation to maintain or improve production and improve manual harvesting rates. The effects of many of these treatments on fruit yields and quality in Florida are not known. Two experiments were established to determine the affect of tree thinning on fruit yield, fruit quality, tree growth, and profitability. The two separate blocks consist of trees originally planted in 1990 at a tree spacing of 8' x 24' (227 trees per acre) on two-row beds. The blocks consist of Hamlin on Carrizo with tree thinning initiated in December 1998 and Valencia on Swingle citrumelo initiated in May of 2000. Current tree densities consists of 227, 151, and 113 trees per acre.

Objectives

1. Determine the effects of tree thinning on subsequent fruit yields and fruit quality.

2. Determine the effects of tree thinning on tree growth.

Summary of Accomplishments

The Hamlin/Carrizo and Valencia/Swingle tree thinning experiment is in its 13th year of growth, the fourth crop for Hamlins, and third crop for Valencias after thinning. The average 2002-03 yields (boxes per acre) for Hamlins was 722, 697, and 651 where the trees were unthinned, every second tree removed, and every third tree removed. However, the cumulative yield for the four seasons since thinning, tree removal rate has significantly suppressed the yield of Hamlins by 25.7% and 17.5%, respectively, where every second or third tree was removed as compared to the unthinned hedgerow. Corresponding pound solids per acre followed similar trends. The average 2002-03 yields (boxes per acre) for Valencia was 362, 234, and 294 where the trees were unthinned, every second tree removed, and every third tree removed. This block has a history of alternate bearing and was a low yielding block in 2000-01 and 2002-03 crop year. Cumulative Valencia yields for the three seasons after harvesting have also been significantly reduced where trees were thinned with a reduction of 37% and 25%, respectively, where every second or third tree was removed as compared to the unthinned hedgerow. Corresponding pound solids per acre followed similar trends. The differences in yields between treatments for both Hamlins and Valencias is decreasing as the trees fill in the allotted space where trees were removed. Change in tree growth over time, as determined by trunk diameter, was greatest where every other tree was removed and the least for the unthinned hedgerow.

Funding:

FCPRAC Grants	$10,000
Agency Contribution	$ 8,000
Other Grants	$ 0
Total	$18,000

Nutrient Management for Optimum Production Efficiency
Project No. 013-02M

Investigators: Joseph P. Albano
Kim Bowman
Michael Bausher
USDA - ARS - USHRL

Jeff Kuehny
LSU

Thomas Obreza
IFAS - UF - SWFREC

William Henriques
CDC - ATSDR

Progress Report for FY 02-03, Year 2 of 3.

Abstract

Citrus trees express episodic growth patterns of alternating shoot and root growth. In episodic plants, nitrogen uptake by roots is greatest during an episode of root growth, decreasing as an episode of shoot growth begins. There is little information documenting uptake and partitioning patterns for other essential nutrients during episodes of root and shoot growth, and the effects of foliar applied nutrients on the rhythm of root and shoot growth (flush) in citrus is unknown. Studies will be conducted under controlled conditions (laboratory) and in the field. 'Ruby Red' grapefruit and/or Valencia orange grafted on Swingle, Cleopatra, and Volkamer (less than 3 years old) will be used in laboratory studies, and mature (greater than 3 years old), established 'Ruby Red' grapefruit and/or Valencia orange on Swingle and Volkamer will be used in field studies. These studies will provide information to develop nutrient management plans for grapefruit and to support or revise Best Management Practices.

Objectives

1. Determine the nutrient uptake patterns during episodes of root and shoot growth.

2. Determine the effects of foliar applied nitrogen on the rhythm of root and shoot growth and nutrient uptake.

Summary of Accomplishments

Significant progress on characterizing nutrient uptake patterns in relation to root and shoot growth for Volkamer, Cleopatra, and Swingle rootstocks has been made this fiscal year. Results to date indicate that Volkamer and Swingle shoot and root growth are similar and both significantly greater than Cleopatra. As an average of all rootstock cultivars, 7 to 14 days prior to the initiation of shoot growth, calcium and potassium uptake, as determined by ion depletion from the bulk hydroponic solution, increased. As the rate of shoot growth slowed, uptake of calcium and potassium decreased. Uptake patterns for magnesium and phosphorous were similar to that observed for calcium

and potassium, but to a lesser degree of uptake (depletion). Depletion of calcium and potassium, and magnesium and phosphorous were similar, respectively. The uptake patterns for the metal micronutrients iron, manganese, copper, and zinc were similar for what was observed for the macronutrients previously discussed. Manganese and zinc had uptake patterns that were similar to calcium and potassium, and iron and copper had uptake patterns that were similar to magnesium and phosphorous, though for iron and copper, more erratic over the shoot growth period. To understand the effects of foliar nitrogen (urea) on shoot flush, research was conducted during the reporting period with 'Ruby Red' grapefruit grafted on Volkamer or Swingle rootstocks. Data from the study is currently being evaluated.

Funding:

FCPRAC Grants	$ 36,000
Agency Contribution	$ 89,200
Other Grants	$ 0
Total	$125,200

Foliar Application of NPK: Comparison of Urea Source, Value of P in the Foliar Application and Time and Rate of Application on Fruit Set and Yield of Florida Citrus
Project No. 013-03M

Investigator: L. Gene Albrigo
IFAS - UF - CREC

Progress Report for FY 02-03, Year 2 of 3.

Abstract

Previous work has shown that winter urea sprays can enhance flowering, and bloom and post-bloom application of NPK can increase set and yield. This study will provide comparative data on using various combinations of the three seasonal timings at 2 rates, and whether P sources provide any benefit since the amount of P in the fruit is small compared to N and K. In other studies in Valencias, biuret toxicity and possible yield reduction from 2 NPK sprays containing 0.8% biuret (w/w) urea are being compared to using < 0.5% biuret urea. The proposed work would look at these issues and provide more information for grower decisions on use of foliar NPK nutrition. This information would become part of a comprehensive nutrient management plan.

Objectives

1. Determine effect of various winter timings of flower enhancing urea sprays.

2. Determine flowering, fruit set, and yield response of a 3 spray (winter urea (1), bloom (2), and post-bloom (3)) vs. no foliar NPK, or use of 1, 2, or 3 only or 2 and 3 combined.

3. Determine effect of 2 rates of application of NPK in the bloom or post-bloom treatment.

4. Determine if a P source in the foliar sprays is beneficial in increasing fruit set and yield.

5. Evaluate 2 sources of P in the bloom and post-bloom spray program to determine if P uptake is different. Compare the NPK results to a spray containing only N and K.

6. Evaluate if < 0.8% (w/w) biuret in the urea in a 3-spray program results in more toxicity and a significant yield reduction compared to a < 0.5% biuret urea source.

7. Evaluate if PO_3 sprays of different concentrations up to 2 times the recommended rate result in any leaf burn or leaf drop.

Summary of Accomplishments

Foliar NPK sprays (14-7-7 at bloom and post-bloom) using either 0.4 or 0.8% biuret urea continue to show no difference in toxicity symptoms. It appears that 0.8% biuret urea could be used up to twice each year in a foliar spray program. First year yields from plots in good ridge and bedded groves were collected from the following: Valencia (2), Hamlin (2), Flame grapefruit, and navel orange blocks treated with 2 rates of NPK. These rates were applied at both bloom or post-bloom or just at one or the other timing with or without a winter urea spray. Other Valencia and Hamlin blocks were treated with NK sprays at bloom or postbloom with or without PO_4 or with PO_3 and with or without urea or PO_3 in the winter. Some treatments had yield increases that were more than a box per tree. There did not appear to be a consistent trend in which treatments gave the higher yields. Flower and fruitlet counts for the second year were made in all plots on spring and summer flush. These counts were significantly higher than for the previous year. Unlike the previous year, bloom sprays of PO_3 did not increase older leaf drop or twig die-back in any Valencia blocks even when applied at 2 times the recommended rate with KNO_3. There were no industry reports of PO_3 spray burn either.

Funding:

FCPRAC Grants	$30,000
Agency Contributions	$65,000
Grower Contributions-Time	$ 2,000
Other Grants	$ 0
Total	$97,000

Thirty percent of 1 faculty was applied to this project. Other infrastructure support was supplied at two locations of the University of Florida.

Biology and Control of Vines and Other Difficult-to-Control Weeds in Florida Citrus
Project No. 013-12M

Investigator: Dr. Megh Singh
UF- IFAS - CREC

Project Report for FY 02-03, Year 2 of 3.

Abstract

Cost of weed control is the largest single component of the production cost in Florida citrus. Chemical weed control is the most common and economic method used in citrus; however, certain weeds are either partially controlled or not controlled with the existing herbicides. Common examples are milkweed vine, balsam apple vine, Brazil pusley, dayflower, goatweed, doveweed, ragweed, Spanish needle, prickly sida, and teaweed. Higher rates of herbicides or their repeated use is commonly used to control these weeds. Higher rates not only increase the cost, but they are environmentally unsustainable. Often, even higher rates fail to control the tolerant weeds. Consequently, these weeds grow more luxuriantly since the competition from other weeds has been eliminated by chemical weed control, thereby potentially increasing losses to citrus in yield and also in quality while increasing production costs. Regeneration in many weed species is a warning signal for the future. Therefore, there is an immediate need to look into this aspect of the project where herbicide rotations or their tank mix with glyphosate could provide effective control of these hardy weed species. Specific objectives are outlined below:

Objectives

1. Study the bio-ecology of major weeds of citrus.

2. Evaluate new herbicides for the difficult-to-control weeds.

3. Integrate bio-ecological factors with herbicides for sustainable weed management.

Summary of Accomplishments

Excellent progress was made during the fiscal year. Several experiments were concluded and the salient findings are: Experiments were conducted on the effect of temperature, water stress, light, and pH on germination; seeding depth and flooding duration on emergence; evaluation of new herbicide trifloxysulfuron with and without surfactant compared to glyphosate, and effect of growth stage on herbicide efficacy for weed species of annual morningglory, beggarweed, Brazil pusley, johnsongrass, ivyleaf morningglory, milkweed vine, pigweed, ragweed, sicklepod, Spanish needles, teaweed, and yellow nutsedge. Glasshouse studies were conducted on efficacy of glyphosate formulations (Roundup UltraMax and Touchdown IQ) against barnyard grass, Spanish needles, milkweed vine, Guinea grass, ragweed, and bahiagrass and was compared to field effects on several weeds when applied at different times. Studies were also conducted on the potency of herbicide mixtures under field conditions for improved weed control with increased spectrum of weed kill and effect of some adjuvants on the efficacy of glyphosate against some broadleaf and grass weeds. Significant variations were observed on the germination/emergence of weed species due to variations in temperature, seeding depth, flooding, water stress, and interaction of temperature and water stress which can be exploited under field conditions for effective weed management. Trifloxysulfuron with surfactant had edge over glyphosate on certain weeds, but delay in application caused reduction in efficacy. No difference was recorded for different formulations of glyphosate; variations in efficacy, however, was observed for growth stages and application rates. Adjuvants significantly increased glyphosate efficacy; activity varied on grass and broadleaf weeds with selected adjuvants. Time of application of glyphosate under field conditions had significant effect on weed mortality.

Funding:

FCPRAC Grants	$40,000
Agency Contribution	$ 0
Other Grants	$ 0
Total	$40,000

Young Tree Replant Failure
Project No. 013-99M (Block Grant)

Investigators: Jim Graham
Tom Obreza
Steve Futch
Chris Wilson
Larry Duncan
IFAS - UF - CREC

Kim Bowman
Joseph Albano
Dan Chellemi
Steve Lapointe
USDA - ARS

Progress Report for FY 02-03, Year 2 of 5.

Abstract

Citrus reset/replant problems described by production managers as “failure to thrive” are becoming increasingly widespread in Florida citrus, and associated economic losses are considered highly significant. A survey based on mailings to the Florida Citrus Production Managers and an insert in Citrus Industry Magazine has been completed that identifies and characterizes the possible sources of reset/replant problems. Survey results provide key information for in-depth field studies under development to characterize problems and to find possible solutions. Multi-disciplinary teams have been assembled to address the remaining research objectives. Collaborative field experiments will be conducted in selected production systems in representative regions of the citrus industry. The goal is to develop recommendations that increase young tree performance, while reducing management costs, to sustain earlier tree profitability.

Objectives

1. Conduct survey of production managers to evaluate the extent and severity of problems with young tree performance.

2. Conduct site surveys for detailed evaluation of abiotic, biotic, and management problems.

3. Evaluate treatments that may improve young tree growth.

4. Conduct research on specific sources of young tree problems.

Summary of Accomplishments

Research studies have been initiated in 2002 that focus on specific problems associated with young tree performance. Sites were established in major citrus production areas (ridge, flatwoods southwest, and east coast) to compare the difference in pest, pathogen, and tree responses to varying soil types and environmental conditions, and to clipping vs. pushing of trees before replanting. In a ridge and flatwoods location, higher populations of Phytophthora occurred in sites where trees were clipped rather than in the push sites. In Labelle, 2-year-old Valencia trees on Swingle supported damaging Phytophthora in wet, fine-textured soil, whereas trees in an excessively drained sand supported intermediate populations. In an area of intermediate soil texture, little Phytophthora was detected. Tree performance was related to differences in soil texture and pathogen activity. In Ft. Pierce, the interaction of rootstock and soil type in expression of Phytophthora damage was evaluated for Valencia trees on 6 rootstocks planted 4 years ago on several soil types. Phytophthora appeared to be the cause of early mortality of trees on Sun Chu Sha and Cleopatra rootstocks. After 4 years, soil populations on all rootstocks were below the damaging level and no interaction with soil type was detected. In this same grove area, Hamlin trees on Cleopatra, Smooth Flat Seville, and Swingle rootstocks were planted in July 2002 to compare young tree performance on marginal versus good sites. A greenhouse and field experiment was initiated to study the responses of trees to continuous and intermittent flooding and high water table.

Funding:

FCPRAC Grants	$ 88,000
Agency Contribution	$ 24,000
Other Grants	$ 0
Total	$112,000

Grower Testing of Florida's DISC (Decision Information System for Citrus): Version 1.0
Project No. 022-01M

Investigators: L. Gene Albrigo
William S. Castle
Ronald P. Muraro
L. W. Timmer
T. Adair Wheaton
IFAS - UF - CREC

Howard W. Beck
James J. Ferguson
J. David Martsolf
Fedro S. Zazueta
UF - Gainesville

Progress Report for FY 02-03, Year 1 of 2.

Abstract

Making decisions about the best production practices, their timing, and options has become very complex. Expert systems based on timing production practices to vegetative and fruit development (phenology) stages can help to clarify timing and options to increase efficiency, provide record keeping, and free up time for other management decisions. Several integrated support systems for citrus decision making have been developed to the stage of functioning prototypes, Copper Spray Schedule System, Production Practices Module, and Flowering Expert System. The first phase of the phenology program, a flowering intensity and bloom date expert system, was first tested during the 2001-2002 winter-spring period. A complete management system based on stage of vegetative or reproductive development is envisioned.

Objectives

1. Continue to test and refine the Citrus Management System (CMS), which is linked to a flower intensity and bloom date expert system (done) that drives growth events for the fruit and vegetative cycles by citrus type. Production practices should be timed to growth events and linked to a weather data service.

2. Develop and integrate major management tools into the CMS (nutrient management, irrigation, IPM, etc.). Incorporate processing and fresh fruit control procedures.

3. Modify Pre-plant Decision System to incorporate soil specific relationships to rootstocks.

Summary of Accomplishments

The Flowering Expert System was tested with an expanded group of growers for a second year. The program was successful and predicted heavy flowering (occurred) and a bloom date that deviated from the actual bloom date by less than 7 days. More operational problems were identified and corrected. The FAWN weather network interface needs to be more reliable. Another year's data was collected to add additional cultivar growth curves. A fruit growth model can now be added to the flowering model to give a complete reproductive growth program for timing production practices. The Production Practices Scheduling System was improved and further developed through interaction with 3 grove production operations. Irrigation, fertilization, and some fruit development management programs were worked on and should be incorporated this coming year. Grower requirements for record keeping are good enough to complement some accounting systems, and a workable system was used by one cooperator. Data and preliminary rules for a freeze management program were put together. More growers are being recruited to

cooperate in the integration of production practices, development of appropriate record keeping and improvement of the user interface for accounting purposes.

Funding:

FCPRAC Grants	$ 40,000
Agency Contributions	$ 44,500
Grower Contributions-Time	$ 20,000
Other Grants	$ 0
Total	$104,500

Ten percent of 2 faculty, plus 5 percent of 3 growers' and 10 percent of 1 grower's time were used. Other infrastructure support was supplied at two locations of the University of Florida.

Refining Management Practices to Enhance Citrus Cropping and Improve Fruit Size
Project No. 022-08M

Investigators: Ed Stover
IFAS - UF - IRREC

Progress Report for FY 02-03, Year 1 of 2.

Abstract

Larger grapefruit receive a premium price early in the season. Large tangerines also receive a substantial premium, and alternate bearing can damage trees and compromise subsequent crops. Techniques for enhancing fruit size and cropping are being explored to provide good recommendations. In 3 previous trials, GA applied late in flower induction has greatly enhanced fruit size. Although hedging and topping around physiological drop did not enhance fruit size in earlier experiments, growers suggest that skirting and topping prior to bloom will be effective. Use of foliar K to enhance fruit size is common, and we don't know whether the effect is additive with other methods. Chemical thinning with NAA has been advantageous in many trials with alternate bearing varieties, but further work is needed to determine how best to use NAA thinning.

Objectives

1. Compare effects of NAA, skirting/topping, and winter GA treatments on fruit size, fruit numbers, and yield.
2. Determine potential additive effects between K treatments and other fruit size enhancement methods.
3. Determine cumulative effects of NAA thinning strategies.
4. Conduct commercial scale trials of NAA thinning.
5. Develop strong recommendations to help enhance profitability of Florida citrus production.

Summary of Accomplishments

Experiments comparing winter GA, topping, and other proposed fruit size enhancement techniques were initiated December 2002. Interesting observations include: topped trees flushed and completed flowering earlier than controls; a high proportion of flowers were in tree tops so that percentage flower removal exceeded percentage canopy removal; greater flower reduction from winter GA than in previous years, apparently related to cooler winter; and elimination of flowering in grapefruit treated with winter GA. Data analysis was completed in a 2-year study of commercial-scale NAA thinning of Murcott in the Ridge. Five blocks of varying age were thinned and in year of thinning averaged: 30% crop load reduction; 3-fold increase in 100+ size fruit; 90% reduction in small fruit; statistically insignificant 10% reduction in yield; and 10% increase in fruit value. Thinned trees averaged 3x increase in crop value in year following thinning, and in year 3 controls overcropped but thinned trees have good but not excessive crop. Data were analyzed for 3 years of data on Indian River Murcott, Sunburst, and Flame subjected to different thinning strategies; while fruit size increase occurred in some years, overall there was no significant effect of thinning. In these blocks, controls did not really overcrop in any year, perhaps due to dry springs even though they had a history of excessive cropping. Commercial scale thinning trials were initiated in 3 Murcott sites (Ridge and River) comparing effects of temperature and water stress. Multiple levels and times of topping are also being tested in another Murcott trial.

Funding:

FCPRAC Grants	$36,000
Agency Contributions	$45,000
Grower Contributions-In-kind	$ 5,000
Other Grants	$ 2,000
Total	$98,000

Thirty percent of 1 faculty and 25 percent of 1 faculty were applied to this project. Other infrastructure support was supplied by the Indian River Research and Education Center of the University of Florida.

MANAGEMENT/PHYSIOLOGY
Completed Projects

Development of a Precision Agriculture System to Manage Florida Citrus
Project No. 981-02M

Investigators: J. D. Whitney
T. A. Wheaton
W. M. Miller
M. Salyani
A. W. Schumann
IFAS - UF - CREC

J. Schueller
W. Lee
IFAS - UF - Gainesville

Progress Report for FY 02-03, Year 4 of 4.

Abstract

Citrus growers currently manage their groves or blocks as uniform production units, but considerable variability in various grove characteristics may exist. We have identified some specific soil factors responsible such as shallow water tables, organic matter content, and iron deficiency by using precision agriculture techniques. Precision agriculture also provides the tools which allow grove owners to manage such site-specific or smaller areas within their groves on an as needed basis. We propose to conduct further research into causal soil factors in different representative areas of the citrus industry and also to develop and test suitable site-specific remedies, rates of amendments, and cultural practices for these weak soils.

Objectives

1. Develop accurate and reliable methods for mapping citrus yields.

2. Develop a system to measure and map tree location, canopy volume, height, and other characteristics in a citrus grove.

3. Improve profitability by i) varying inputs and management strategies to optimize returns from both highly productive and less productive areas of a grove, ii) develop custom remedies for under-performing soils to improve productivity, iii) remove the least profitable portions of groves out of production in order to curtail losses.

4. Evaluate costs and returns of precision agriculture with interested citrus growers.

Summary of Accomplishments

In many flatwoods groves, there appears to be good correlation between soil and water table characteristics, many of which can be estimated from electrical conductivity surveys and the yield and tree growth response. Much of the spatial variability in citrus nutrition on flatwoods soils seems to be driven by deficiencies of soil organic matter (SOM), iron, and manganese. We have developed a method of mapping shallow water tables non-intrusively through EM38 surveys, which can assist growers when developing drainage systems for citrus blocks. Field experiments implementing modified irrigation practices have been initiated at Cargill and Southern Farms to determine which treatments may improve profitability. Fertilizer/soil amendment treatments are being tested to improve weak soils, grove uniformity, and yield at Ranch One and Southern Farms. We have conducted calibration and performance tests with variable rate fertilizer spreader equipment to develop guidelines and recommendations for Florida citrus. We have continued to work with ultrasonic systems provided by manufacturers to measure and map tree characteristics such as canopy volume, height, and foliage density. A wireless datalogger and field network system was developed for real-time site-specific soil moisture, rainfall, water table, and irrigation monitoring and control at remote experiment sites.

Funding:

FCPRAC Grant	$ 45,000
IFAS Contribution	$ 65,000
FDACS Grant	$ 55,000
IFAFS Grant	$160,000
Cargill	
Ranch One SHARE	$ 21,700
Total	$346,700

Phosphorus/Potassium Soil Test Calibration and Effects on Fresh Citrus Fruit Quality
Project No. 981-10M

Investigators: Thomas Obreza
Robert Rouse
IFAS - UF - SWFREC

Progress Report for FY 02-03, Year 5 of 5.

Abstract

Phosphorus movement to surface water and nutritional effects on fruit quality emphasize judicious use of P fertilizer. Citrus response to P is rare because it usually accumulates in soil. A calibration experiment using modern soil extractants was started in 1998 in a newly-planted citrus grove that was very low in soil-test P and K. A range of P and K fertilizer rates were applied to generate a wide range of soil-test P and K. Tree growth, yield, and fruit quality were measured and related to soil tests and fertilizer rates. This research will enable the Florida citrus industry to more appropriately allocate P and K fertilizer costs, minimize impact on surface water quality, and produce higher quality fruit by understanding the main effects and interactions of P and K.

Objectives

1. Calibrate a P (and possibly K) soil test for Florida citrus production, considering both yield and fruit quality as response variables in the calibration process.

2. Determine the main effects and interactions of P and K fertilization on yield and fresh fruit quality of Flame grapefruit and Hamlin orange.

3. Develop fertilization recommendations that will produce qualities most desired by fresh fruit consumers.

Summary of Accomplishments

In a 5-year period, K fertilizer did not accumulate in the soil even when applied at 200 lb K_2O/acre or more per year. Therefore, calibrating a soil test for K was impossible. Soil testing could not be used to guide citrus K fertilization on Immokalee soil. The strong sensitivity of citrus trees to K fertilizer rates underscores the need to apply K fertilizer each year. As the rate of K_2O fertilizer increased from zero to the optimum rate of about 200 lb/acre, tree canopy volume, fruit yield, fruit size, fruit "roundness," brix, acid, and peel thickness all increased. Leaf tissue K concentration also varied positively with K rate, emphasizing that leaf K is a much better indicator of citrus K nutrition than soil testing. In contrast to K, P accumulated in the soil following fertilizer application as indicated by increasing soil test P. With time, soil test P decreased after P fertilization was discontinued. Citrus trees were not at all sensitive to applied P fertilizer or soil test P. Canopy volume, fruit yield, and external/internal fruit quality failed to respond to the amount of P in the soil, even though numerous plots had soil test P interpreted as very low for row crops. Therefore, calibrating a soil test for P was also not possible. The lack of tree response to P was surprising considering that control plots never received any P fertilizer. Leaf tissue P remained in the optimum range in these plots throughout the duration of the experiment.

Funding:

FCPRAC Grants	$ 6,000	
Agency Contribution	$10,000	(IFAS citrus grove and grove care, salaries)
Other Grants	$ 3,000	(Foundation for Agronomic Research)
Total	$19,000	

Improved Nitrogen Use Efficiency Through Optimal Timing for Measuring Citrus Leaf N in the Field Project No. 012-15M

Investigators: A. W. Schumann
J. P. Syvertsen
T. A. Wheaton
IFAS - UF - CREC

Progress Report for FY 02-03, Year 2 of 2.

Abstract

Citrus leaf analysis is an important diagnostic tool, but the poor reliability and high cost of tissue analysis limits its use in making fertilizer N recommendations. Furthermore, the recommended time for collecting samples of 4- to 5-mo-old leaves in July/August is too late for the current year's crop and too early for the subsequent crop. New rapid methods for determining the N status of trees will be evaluated including instruments for nondestructive measurement of leaf N in the field. An instrument using near infrared (NIR) determination of N will be compared to traditional methods of sampling, drying, grinding, digesting, and measuring N concentration. More frequent leaf sampling, which can be better distributed both temporally and spatially within groves, will improve the value leaf N diagnostics to increase overall fertilizer N-use efficiency, better yields, and reduce NO_3-N leaching losses to groundwater. Nondestructive measurements of leaf N in the field will support the use of precision application rates which will increase efficiency and profits while reducing environmental impact.

Objectives

1. Determine the time of year for leaf analysis that is most diagnostic for optimal N fertilizer recommendations for the next crop. This will require interpolation of seasonal leaf N thresholds and evaluation with crop yield.

2. Develop methods for rapid, cost-effective estimation of leaf N and its within-block variation by using NIR spectroscopy.

Summary of Accomplishments

Objective 1) Spring flush leaves were sampled every month beginning in May 2001 and ending in April 2002 from the three FDACS-BMP funded citrus experiments of mature Valencia, Grapefruit, and Sunburst. Yield responses to N fertilizer in these experiments were linear in alternate high-yielding years and quadratic (reached a maximum beyond which yield declined) in alternate low-yielding years. Surprisingly, alternating leaf N levels corresponded to alternate bearing in that season, and the magnitude of this leaf N shift was at least as large as that due to fertilization rates. Consequently, real yield-limiting N deficiencies were masked by temporarily elevated leaf N concentrations on alternate 'high'-yielding years. The value of conventional leaf N thresholds in strongly alternate-bearing crops may therefore be questionable. Objective 2) Initial instrument selection, setup, testing, and calibration work was done in the laboratory with a 900-1700 nm NIR spectrometer to determine its ability to measure leaf N in dry leaf powder and fresh leaf samples from citrus trees. A special sample changing turntable was built to analyze fresh leaf samples without excessive heating by the NIR lamp. Although very good prediction of leaf N in dry leaf samples was developed, the NIR spectrometer was not able to

reliably measure N concentration in fresh leaf. The probable reason is that water (fresh leaves are ~60% water) interferes with the protein-N measurement in fresh leaves. However, moisture content of leaves can be rapidly and reliably determined with the NIR method on either the upper or lower leaf surface, and N concentrations in dry samples can be conveniently determined in the laboratory.

Funding:

FCPRAC Grants	$12,500
IFAS Contribution	$40,000
FDACS-BMP Grant	$20,000
Total	$72,500

PLANT PATHOLOGY
Continuing Projects

Development of Detection Methods for Citrus Psorosis Virus and Use of the Virus as a Vector to Express Foreign Genes in Citrus
Project No. 971-43P

Investigators: Kenneth Derrick
Gary Barthe
IFAS - UF - CREC

Progress Report for FY 02-03, Year 2 of 3.

Abstract

There is a need for methods for rapid indexing of citrus budwood for psorosis. Indexing for psorosis is now done by graft inoculation of citrus seedlings and observing leaf symptoms, which can be transitory and very mild. Also, there are some isolates that apparently do not induce any leaf symptoms, and bioindexing for psorosis is time-consuming and subject to considerable error. Psorosis is one of the few remaining virus-like pathogens of citrus that cannot be indexed by non-biological methods. We characterized an unusual spiral shaped virus, referred to as a spirovirus, that is associated with psorosis. We have had numerous requests from regulatory agencies and diagnostic laboratories for non-biological methods for detecting this virus for use in citrus clean stock programs. This project is designed to meet that need. In addition, the virus associated with psorosis has some unusual properties that make it an ideal choice for use as a vector for expressing foreign genes in citrus. The most obvious advantage of using a virus vector for citrus is that foreign genes can be expressed in existing trees.

Objectives

1. To develop rapid detection methods for citrus psorosis virus (CPV).

2. To develop a virus vector for expressing foreign genes in citrus.

Summary of Accomplishments

Several strains of the psorosis virus and some additional unknown infectious agents have been isolated from grove trees. Efforts are being made to characterize these unknowns using procedures similar to those that were used to characterize citrus psorosis virus. The sequence of the viral genome segment that encodes for the coat protein has been determined for isolate CRSV-4 and is being used to make various RNA transcripts for potential use as a virus-based gene vector. We have developed an efficient *Agrobacterium*-mediated transformation system for citrus. Constructs of the coat protein gene of citrus psorosis virus have been made and been used to make transgenic plants. This should be a model system for testing coat protein mediated resistance in citrus. Reliable PCR based detection methods for several isolates of the virus that causes citrus psorosis were developed in this project. In response to call outs from growers to examine citrus trees showing bark scaling, we are now making assays using the PCR methods for citrus psorosis virus and by biological indexing.

Funding:

FCPRAC Grants	$20,000
Agency* Contribution	$ 0
Other Grants	$ 0
Total	$20,000

*IFAS provides salary for PI and one technician.

Studies to Determine the Cause and Develop Strategies to Control Citrus Blight
Project No. 003-04P

Investigator: Kenneth Derrick
IFAS - UF - CREC

Progress Report for FY 02-03, Year 2 of 3.

Abstract

The Florida citrus industry loses more than 600,000 bearing trees per year to citrus blight. There are no reliable methods for controlling blight and the cause of the disease is unknown. The symptoms associated with citrus blight can be reproduced by root graft inoculations, which indicates the disease is caused by a pathogen. A major effort to determine the cause of blight using subtraction hybridization techniques is ongoing. Blight associated protein p12 is always present in trees with blight and appears to be involved in cell growth. Research is in progress to determine if p12 produced by the tree in an effort to resist the

disease, and will transgenic expression of the p12 gene in scions and rootstocks provide resistance to blight. In addition, using cDNA subtraction methods, we have found several additional genes that are either up or down regulated in blight affected trees.

Objectives

1. To determine the cause of citrus blight.

2. To determine the function of the blight protein p12.

3. To develop strategies to control citrus blight.

Summary of Accomplishments

The gene for the citrus blight associated protein, p12, was used to produce transgenic rootstocks (rough lemon, Carrizo citrange) expressing both sense (p12 producing) and antisense (blocking p12 production) directions. Some of the transgenic plants have multiple copies as shown by Southern blots. Further evaluations of these plants are in progress. Selected plants will be increased to produce trees for field trails for resistance to blight. Research of host genes that are either up or down regulated in response to blight using cDNA subtraction methods continues. Numerous genes that are affected by trees with blight have been identified, some of which are expected for diseased plants and some of which are of unknown function. Three subtracted libraries of cDNA from dsRNA from blighted and healthy trees were made. Approximately 130 clones from these libraries have been sequenced. Clones from various strains of citrus tristeza virus, strains of two known viruses that are not reported to infect citrus, and numerous unknowns were identified. Work continues to determine if any of these clones are from a pathogen associated with citrus blight.

Funding:

FCPRAC Grants	$56,822
Agency Contribution	$ 0
Other Grants	$ 0
Total	$56,822

Control of Citrus Canker with Novel Chemical Compounds
Project No. 013-07P

Investigators: J. H. Graham
IFAS - UF - CREC

T. R. Gottwald
USDA - ARS - Ft. Pierce

Progress Report for FY 02-03, Year 2 of 3.

Abstract

Two existing major outbreaks of Asiatic citrus canker caused *Xanthomonas axonopodis* pv. *citri (Xac)*, one in Miami Metro and a second in Manatee Co., and several other minor outbreaks scattered throughout the southern portion of Florida raise serious concerns regarding the spread of the disease to commercial citrus in Florida. Control of canker on susceptible varieties is limited with copper bactericides. Although copper diminishes infection to an extent by acting on surfaces of tissues to reduce bacterial populations, the effectiveness is minimal once rains with wind introduce bacteria into tissues. Other contact bactericides tested, including antibiotics, are not as effective as copper and development of antibiotic resistance within bacterial populations is common. A novel class of compounds that act through induced systemic resistance (ISR) might increase resistance of susceptible citrus tissues to citrus and complement the activity of copper that controls leaf surface bacteria.

Objectives

1. Screen new compounds for citrus canker control in the greenhouse using the citrus bacterial spot disease surrogate, *Xanthomonas axonopodis* pv. *citrumelo*.

2. Evaluate promising compounds from greenhouse tests in field situations utilizing existing nursery infestations of CBS for evaluation.

3. Test promising compounds resulting from the first two steps on citrus canker-infested trees under containment in greenhouse and field quarantine facilities in Florida and in Brazil.

Summary of Accomplishments

Induced Systemic Resistance compounds (ISRs), Actigard (acibenzolar-s-methyl) and Messenger (harpin protein), were screened in the greenhouse against *Xanthomonas axonopodis* pv. *citrumelo*, the cause of citrus bacterial spot (CBS), and *X. axonopodis* pv. *citri,* the cause of Asiatic citrus canker. Actigard and Messenger applied as foliar sprays 2 to 7 days before inoculation reduced lesion number when either bacterium at 10^3 or 10^4 cfu/ml was injection-infiltrated into Swingle citrumelo leaves. Based on this activity, the ISRs were evaluated under disease endemic conditions in southern Brazil in spray programs with and without copper oxychloride (CuOCl) and copper hydroxide ($Cu(OH)_2$) in replicated field trials of sweet oranges with low to moderate canker disease pressure. Actigard and Messenger were applied full season or in the first 2 or 3 sprays of a 6-spray program in an attempt with ISR to reduce canker disease on the spring flush leaves and thereby reduce subsequent fruit infection and drop. Sprays every 30 to 45 days of CuOCl and CuOH were moderately to highly effective in reducing foliar disease, fruit infection, and premature fruit drop. Actigard or Messenger with and without Cu formulations did not further reduce citrus canker incidence on foliage, fruit, or reduce fruit drop compared to Cu alone. Applications at 3 week interval of two formulations of a contact material DBNPA (Dow) that showed promise for control of *Xanthomonas* diseases in other fruit crops failed to control canker due to high solubility and lack of residual activity. Two compounds, an antibiotic (Gentamycin, Gowan), and

Famoxate (Dupont) are under evaluation based on their efficacy against bacterial *Xanthomonas* spot of tomato.

Funding:

FCPRAC Grants	$ 58,895
Agency Contribution	$120,000
Other grants	$ 11,000
Total	$189,895

Biology and Control of Fungal Diseases of Fruit and Foliage
Project No. 013-16P

Investigators: L. W. Timmer
K.-R. Chung
IFAS - UF - CREC

T. L. Peever
Washington State Univ.
Pullman, WA

Progress Report for FY 02-03, Year 2 of 3.

Abstract

Fungal diseases cause significant losses in external quality of fresh fruit and yield of all citrus. New fungicides, such as Abound, Headline, and Enable, and products which induce systemic resistance (SIR) promise to improve disease control. We propose to determine the baseline sensitivities of citrus pathogens to better manage resistance and to assess SIR products to determine their efficacy in disease management. Means of using the epiphytic growth on leaves to better time fungicide applications for greasy spot control will be investigated. We will evaluate thresholds for use of the Alter-Rater for different varieties and situations to better utilize the model. We propose to determine the origin of the postbloom fruit drop and Alternaria brown spot problems by using molecular methods to study population dynamics of these pathogens.

Objectives

1. Disease control - determine the baseline sensitivities of foliar fungal pathogens to Abound, Headline, and Enable; assess activity of resistance-inducing compounds for control of foliar fungal diseases.

2. Improve timing of fungicide applications - develop means to measure epiphytic growth of *Mycosphaerella* and assess its use for timing of greasy spot sprays; determine appropriate thresholds for the Alter-Rater for brown spot control.

3. Investigate the origin of fungal pathogens - the relationship of *Colletotrichum acutatum* isolates from postbloom fruit drop and lime anthracnose and the origin of PFD; determine whether non-pathogenic strains of *Alternaria* or pathogens of rough lemon carry genes for the toxin for tangerines and have the potential to attack new varieties.

Summary of Accomplishments

About 60 isolates each of *Mycosphaerella, Colletotrichum, Alternaria, Diaporthe,* and *Elsinoe* were collected from different citrus species and locations around the state and assayed for sensitivity to Abound, Enable, and Headline at two fungicide concentrations to determine the range of baseline sensitivities to these fungicides. In field tests, phosphorous acid and salicyclic acid products showed some promise for replacing standard fungicides for early season control of scab and *Alternaria*. Ascospore release of *Mycosphaerella* is triggered by rainfall or irrigation, but not affected by daylight, darkness, or movement of leaves. Ascospores traveled at least 25 ft vertically and 300 ft horizontally. Application of urea, lime, or extra irrigations to leaf litter reduced pseudothecia and ascospore production by up to 90%. Sequencing of the ITS region and the glyceraldehyde phosphate dehydrogenase genes of Key lime anthracnose and postbloom fruit drop (PFD) isolates of *Colletotrichum acutatum* from 6 countries indicated that all PFD isolates are clonal and probably originated from a common source. *Alternaria* isolates causing brown spot of tangerines, leaf spot of rough lemon, black rot, as well as saprophytic isolates, have been collected and are being assayed for toxin production.

Funding:

FCPRAC Grants	$ 88,000
Agency Contribution	$ 75,000
Other Grants	$ 20,000
Total	$183,000

Management of Citrus Tristeza Diseases in Florida
Project No. 025-01P

Investigators: Bill Dawson
Steve Garnsey
Richard Lee
IFAS - UF - CREC

Tim Gottwald
Mark Hilf
Scott Adkins
USDA - ARS - Ft. Pierce

Peggy Sieburth
FDACS - DPI -Winter Haven

Progress Report for FY 02-03, Year 1 of 5.

Abstract

Citrus tristeza virus (CTV) is widespread throughout Florida. Nearly all orange trees and approximately 50% of the grapefruit are infected. Florida growers face several CTV-induced problems. First, the increasing distribution of decline isolates has removed sour orange as a rootstock choice. Growers are forced to use less well-adapted rootstocks and hence

suffer increased production losses from other problems. Secondly, the hazard of introduction and spread of new severe isolates, particularly those causing stem pitting, is increasing. The introduction of these severe stem pitting strains could seriously affect citrus production, perhaps tipping the balance such that Florida could not economically produce citrus. Increasing spread of the decline strain into budwood increase blocks has hampered nursery production because there is a lack of detection procedures to differentiate severe exotic strains from the decline strain that already is endemic in commercial citrus. We are making a unified, coordinated effort to manage the present situation and to be prepared to manage more severe CTV diseases should they become a problem in Florida.

Objectives

1. Categorize CTV isolates from other citrus growing areas and develop detection procedures to be able to prevent introduction and establishment of new isolates;

2. Adapt new CTV detection procedures for high output screening by DPI; and,

3. Develop cross-protecting isolates of CTV to protect against stem pitting and restore the use of sour orange rootstocks.

Summary of Accomplishments

Three different sensitive RNA-based diagnostic techniques are under evaluation for high-output screening by DPI of CTV isolates to identify isolates with a high probability of causing stem pitting. Unexpectedly, these procedures identified from field trees a series of closely related isolates identified to a CTV group (VT) that contains mostly stem-pitting isolates. Low levels of these VT-like isolates were found in several geographic areas. In three locations in Polk County, 50-88% of MCA-13-positive sweet orange trees contained the VT-like virus. To date, none has been detected in grapefruit trees. Stems from positive field trees were peeled, and mild to moderate stem pitting was seen in some of the sweet orange trees, but not the mandarins. These isolates have been inoculated into biological indicators to evaluate the degree of stem-pitting in sweet orange and grapefruit. We also are developing methods to protect trees from decline or stem pitting by mapping disease determinants in the virus for creation of protecting isolates and by examining existing protective systems in other countries for adaptation to Florida. We have mapped the seedling yellows component of the Florida decline isolate to the 3' terminus of the virus and are starting to evaluate the ability of this virus to protect against decline. We have ongoing experiments to reproduce and dissect a stem-pitting protection system from Peru in the quarantine greenhouse in Beltsville, MD. Preliminary evaluations made in early summer 2003 suggest that protection against stem-pitting symptoms and growth reduction was occurring, but not with all the isolates.

Funding:

FCPRAC Grants	$250,000
Agency Contribution	$ 40,000
Other Grants	$330,000
Total	$620,000

PLANT PATHOLOGY
Completed Projects

Development of Tolerance to the *Phytophthora palmivora*/*Diaprepes* Complex
Project No. 003-01P

Investigators: J. H. Graham
IFAS - UF - CREC
K. D. Bowman
USDA - ARS - Ft. Pierce

Progress Report for FY 02-03, Year 3 of 3.

Abstract

Interactions of several stress agents in Florida citrus groves exacerbate Phytophthora diseases, even on a normally resistant rootstock like Swingle citrumelo. A more aggressive species of *Phytophthora*, *P. palmivora,* attacks Swingle as well as Carrizo citrange and other rootstocks infested with *Diaprepes abbreviatus* on heavier, calcareous soils in other areas of the industry, even in absence of *Diaprepes*. Specific methods for identification and evaluation of *Phytophthora* resistance and tolerance to *Diaprepes* and marginal soils are proposed. The goal of this project is to continue research directed toward providing rootstock options for management of root weevils and other prevalent soil stress agents in Florida groves. This will be accomplished through greater resistance of rootstocks to *Phytophthora* spp. to increase tolerance of soil and pest interactions.

Objectives

1. To survey for *P. palmivora* in groves on Swingle with decline symptoms in comparison to other rootstocks.

2. To identify sexual and somatic hybrids with greater resistance than Swingle to *Phytophthora palmivora* and *P. nicotianae* using in vitro and greenhouse assays.

3. To screen hybrids with *Phytophthora* resistance in greenhouse and field assays to confirm that resistance is maintained when challenged with *Diaprepes* larval feeding.

Summary of Accomplishments

At the Kerr Center on the east coast, a *Diaprepes*-infested grove on poorly-drained soil types with damaging populations of *Phytophthora palmivora* and *P. nicotianae* was intensively sampled for *Diaprepes* and *Phytophthora*. Structural root damage was correlated with *P. palmivora* activity but not with *P. nicotianae*. Differential susceptibility of Cleopatra vs. Swingle rootstocks provided justification for seeking resistance to *P. palmivora* in citrus species such as mandarins and pummelos. Greenhouse screens in marginal soils infested with *Phytophthora* were developed to identify mandarins and pummelos and their sexual and somatic hybrids with trifoliate that possess greater resistance to *P. palmivora* than the standard rootstocks, Swingle and Carrizo. At the Kerr Center, canopies of Flame grapefruit trees on US 897 (Cleopatra mandarin x *P. trifoliata* 'Flying Dragon'), US 802 (Siamese Pummelo x *P. trifoliata* 'Gotha Road') and US-942 (*C. reticulata* 'Sunki' x *P. trifoliata*) were slightly larger than those on Cleopatra and more than twice the size of trees on Swingle and Carrizo, which were small and weak. After 24 months, there was a strong correlation between the level of Phytophthora on roots of 13 rootstocks and tree size. Improvement of rootstock adaptability to marginal soils and resistance to *P. palmivora* are demonstrated to substantially increase the tolerance to root attack by larvae of *Diaprepes*. Overall, greenhouse and laboratory testing aided in selection of the most promising rootstock candidates, but field testing under adverse conditions was most valuable for evaluation of rootstock tolerance to a wide range of pest, pathogen, environmental, and soil conditions.

Funding:

FCPRAC Grants	$ 53,990
Agency Contribution	$120,000
Other grants	$ 10,000
Total	$183,990

Investigations into an Unknown Flaky Bark Disease on Grapefruit
Project No. 003-02P

Investigators: P. D. Roberts
IFAS - UF - SWFREC

T. R. Gottwald
M. Hilf
USDA - ARS - Ft. Pierce

P. J. Sieburth
Bureau of Citrus Budwood Registration - DPI

S. M. Garnsey
IFAS - UF - CREC (USDA - ARS - retired)

Progress Report for FY 02-03, Year 3 of 3.

Abstract

A disease problem of unknown etiology that causes severe bark flaking in grapefruit was found in several commercial groves in SW and central Florida in 1998 and in additional groves in subsequent years. Trees exhibiting symptoms are typically 4-7 years. Affected grapefruit varieties are Marsh, Ruby, Rio Red, and Flame, and more than one type of rootstock. Decline and decreased yield are associated with the symptoms. Initial investigations into the cause of the flaky bark symptoms were negative for insect or pathogen, environmental stresses, nutritional or pH related damage. Observed trees showed a slow increase in disease incidence and severity from 1998-02 indicating persistence and spread of the disease. Identification of the cause of the flaky bark disease and its impact on tree health will lead to understanding and control of the problem.

Objectives

1. Identify the cause of the flaky bark disease.

2. Measure the increase and spread of flaky bark symptoms.

3. Determine the impact of flaky bark on tree health related to decline and yield.

4. Determine the extent of the problem on citrus in different production regions beyond Central and Southwest Florida.

5. Formulate control methods.

Summary of Accomplishments

1) Determination of the cause of flaky bark disease from transmission and indexing studies to date is inconclusive for either an abiotic or transmissible agent. Control and inoculated trees in transmission studies established in 1998 showed symptoms within 2 years, and, in 2003, 31% of all trees were symptomatic. Transmission studies to 8 varieties (Hamlin, Flame, Valencia, Minneola, Ray, March, Eureka Lemon, and Bearss) are pending. Neither the fungi and bacteria isolated from diseased samples nor the source of budwood appear to have a role in symptoms. 2) An increase of incidence (spread) and severity of flaky bark symptoms occurred in plots monitored 2000-2003. Temporal and spatial modeling programs analyzed plot data but results were inconclusive whether spread was consistent with movement typical of a pathogen or occurred randomly indicating non-pathogen. Additional plots will be established and data taken for a minimum of 5 years. Yield on symptomatic Rio Red trees was reduced 24% compared to asymptomatic trees. Yield on Flame was unaffected. Severity of symptoms expression was initially more severe on Rio Red than Flame in test plots but are now essentially the

same for both varieties. 3) Geographic distribution of symptomatic trees is limited to groves in Charlotte, Collier, DeSoto, Hendry, and Highland Counties. 4) Control measures cannot be formulated at this time. This problem may be of complex etiology such as Blight or Rio Grande Gummosis. Growers that are assessing the economic viability of affected groves, particularly Rio Red, might consider the potential yield reduction.

Funding:

FCPRAC Grant	$ 64,500
SWFREC, USDA, DPI	$ 49,103
Other Grants	$ 0
Total	$113,603

Evaluation of Exotic Pathogen Threats to Florida
Project No. 003-11P

Investigators: Harold W. Browning
Stephen N. Garnsey
IFAS - UF - CREC

Progress Report for FY 02-03, Year 3 of 3.

Abstract

The proposed research will generate a risk-based framework from which decisions can be made on relative importance of citrus diseases and what research needs to be done to address the most critical questions. This approach could be expanded to other research areas beyond the introduction of Exotic Diseases, making it a model for risk assessment and prioritization of research.

Objectives

1. Establish a basis for evaluating exotic pathogen threats that would include all major factors identified above;

2. Establish a list of exotic citrus pathogens that pose potential risks to Florida with a tentative ranking of relative significance. It is presumed that gaps in information will be recognized that may preclude accurate assessment in some situations;

3. Identify specific types of information needed to develop a more accurate assessment of exotic pathogens;

4. Identify needs for research that would improve options for either excluding or controlling specific pathogens; and

5. Generalize this risk assessment strategy so that it could be used more widely to address prioritization of risk of other citrus pests beyond diseases.

Summary of Accomplishments

The 17 exotic citrus diseases selected earlier as candidates for risk assessment of their potential to be introduced, become established, and ultimately affect the Florida citrus industry were subjected to in-depth review by a panel of experts during 2001-02. The evaluative instruments developed were applied to develop a summary of available information on each disease, collection of images of symptoms, and a series of quantitative evaluations. These scores were compared and discussed during panel meetings, leading to composite scores for each risk factor and for the major risk areas that comprise the evaluative tool. Research needs also were identified where lack of information made risk analysis difficult or vague. These results have been summarized and were compiled and shared widely with panel members and a group of third-party experts who have not been participating in the risk assessment. During 2002-03, verification of the evaluative tool and the resulting risk analysis of the 17 disease organisms was completed. Various levels of data, background information and images, and risk analysis have been prepared for posting on a web site for easy access and is now being updated. A workshop was held in June 2003 to discuss how this analysis can lead to recommendations for regulatory and other actions, as well as to finalize a set of research priorities for diseases that are viewed as high risk and for which data deficiencies have been identified. Data analysis and reporting are being completed, and a set of 86 prioritized research needs are compiled. Results of this work were presented at the National Meetings of the American Phytopathology Society in August 2003.

Funding:

FCPRAC Grants	$20,000
Agency Contribution	$15,000
Other Grants	$ 300
Total	$35,300

Evaluation of Hormone Inhibitors for Potential Disease Control of Postbloom Fruit Drop (PFD) and Infection Mechanisms of the Causal Fungus *Colletotrichum acutatum*
Project No. 012-04P

Investigators: Kuang-Ren Chung
Jacqueline K. Burns
L. W. Timmer
IFAS - UF - CREC

Progress Report for FY 02-03, Year 2 of 2.

Abstract

Postbloom fruit drop (PFD) disease of citrus caused by *Colletotrichum acutatum* and can result in disastrous yield losses without fungicide control. PFD causes fruit drop, production of persistent buttons, and leaf distortion, strongly indicating that hormones might be involved in symptom development. In this proposal, we investigated the types of hormones involved in the occurrence of PFD. We also evaluated the possibility of hormone inhibitors in preventing yield losses. We also investigate the mechanisms by which fungus attacks citrus. The proposal intends to provide valuable

information for future decision making on PFD management. Specific objectives are outlined below.

Objectives

1. To determine the roles of phytohormones, mainly ethylene, ABA, IAA or JA, in PFD development.

2. To evaluate the effectiveness of hormone inhibitors for preventing PFD and to provide better strategies for disease management.

3. To isolate fungal mutants defective in symptom development and/or pathogenicity.

4. To isolate the genes for pathogenicity that are responsible for fungal infection and/or symptom development.

Summary of Accomplishments

After *C. acutatum* infection, ethylene concentration in infected flower tissues increased by 3-fold as compared to water controls. IAA accumulation in infected petals was as much as 140 times that of the water control, whereas ABA showed no significant response. The contents of jasmonic acid (JA) and phytodienoic acid (a precursor for JA biosynthesis) also increased in flower petals after fungal infection. Molecular analyses using DNA markers also indicated that the genes encoding ethylene and jasmonic acid biosynthesis, and IAA regulation were highly expressed in infected flowers. Screenhouse trials revealed that hormone inhibitors such as clofibrate (anti-auxin), TIBA, HFCA, TCA, NPA (auxin transport inhibitor), 2,4-D, 2,3,5-TCPA, picloram, quercetin, salicyclic acid (SA) and acetyl-SA (JA inhibitor), and Rezist™ retain more fruit on grapefruit and sweet orange trees when applied 7-12 days after *C. acutatum* infection, providing a promising future for PFD management. The optimal rates and timing are being tested. We also have established a fungal transformation system for *C. acutatum* PFD and KLA fungal isolates using a plasmid DNA vector carrying a sulfonylurea resistance gene. The system intensively used for fungal mutagenesis has led us to the isolation of several fungal mutants that are defective in pathogenicity on either Key lime leaves or sweet orange flower petals. The flanking DNA fragments associated with the inserted plasmid were recovered from several mutants. Sequencing analysis led to identify the first gene, named *KLP1* (Key Lime Pathogenicity) gene from one of the tagged mutants. The *KLP1* gene encodes a fungal transcription activator and is involved in fungal pathogenesis. Gene replacement is being used to confirm its function. The funding from FCPRAC to this project has resulted in three publications.

Funding:

FCPRAC Grants	$ 49,372
IFAS	$ 65,000
Other Grants	$ 0
Total	$114,372

Identification of Fungicidal/Fungistatic Chemicals from Eggs of Citrus Nematodes
Project No. 021-10P

Investigators: Larry W. Duncan
Fahiem ElBorai
James H. Graham
IFAS - UF - CREC

James L. Nation
IFAS - UF - Gainesville

Progress Report for FY 02-03, Year 1 of 1.

Abstract

In a previous project supported by FCPRAC, effective management of citrus nematode was related to an increased incidence of *Phytophthora nicotianae* in soil in citrus groves. Citrus seedlings infected with both citrus nematode and *P. nicotianae* contained less fungal protein in roots and grew larger than seedlings infected by only the fungus. An apparent mechanism for inhibition of the fungus by the nematode was revealed by the discovery that eggs of the nematode (deposited at the root surface in nature) inhibit growth of the fungus on agar. We seek support to isolate and identify the chemicals in citrus nematode eggs that inhibit *P. nicotianae.*

Objectives

Our objective is to identify chemical agent(s) in eggs of *Tylenchulus semipenetrans* that inhibit the growth of plant pathogenic fungi such as *Phytophthora nicotianae*. The aim of the research is to initiate development of new and better ways to manage these fungi in citrus and other crops.

Summary of Accomplishments

A simple, reproducible bioassay was developed to measure the effects of chemical agents on growth of *P. nicotianae*. When the internal content of the citrus nematode egg was separated from the eggshell, growth of the fungus was stimulated by the internal content, but growth was completely inhibited by contact with the eggshell. Gentle heating of the eggshell (60°C) did not affect its inhibitory property, but heating at 90°C completely suppressed inhibition, suggesting possible involvement of a protein(s). However, treatment of eggshell with urea (to denature proteins) did not suppress the inhibitory effect of eggshell; indeed, the urea solution sometimes extracted anti-fungal compounds from the eggshell. Eggshells also remained inhibitory to the fungus following extraction with hexane, methanol, and methylene chloride. The liquid fractions of the latter two solvents exhibited antifungal activity, suggesting involvement of fatty acids, lipids, or carbohydrates. However, inhibition of fungal growth by the extracted compounds was minor compared to that caused by eggshell. Additional tests of material extracted with individual solvents and combinations of solvents are ongoing. This research was not initiated

until March 2003 due to a 7-month delay by the State Department in renewing the visa of Dr. Elborai. A supplemental report of the results of ongoing experiments will be submitted later this year.

Funding:

FCPRAC Grant	$22,000	
Agency Contribution	$17,000	(10% PI time,
	$10,000	Center overhead)
Other grants	$ 0	
Total	$39,000	

ENTOMOLOGY
Continuing Projects

Classical Biological Control of Citrus Psylla and Pink Mealybug
Project No. 971-21E

Investigators: Marjorie A. Hoy
UF - Gainesville

Ru Nguyen
DPI - Gainesville

Progress Report for FY 02-03, Year 3 of 4+.

Abstract

The Asian citrus psylla was discovered in June 1998 in southeastern Florida. We imported two host-specific parasitoid species in November 1998. After evaluation in quarantine, permission was obtained to release them; the first releases of *Tamarixia radiata* took place in July 1999 and of *Diaphorencyrtus aligarhensis* in spring 2000. During 2001and 2002, many groves in 21 counties were surveyed, and results indicated *Tamarixia* is multiplying, persisting, and spreading. Releases and surveys for *D. aligarhensis* were conducted during 2002, and during 2003 we have been monitoring population dynamics of psyllids and *Tamarixia* every week. In spring of 2002, the pink mealybug was discovered in Florida; parasitoids are being released; results to date indicate parasitoids are establishing, and we will rear additional parasitoids if needed. Parasitoids already released appear to be suppressing the mealybug.

Objectives

1. Obtain permits to import parasitoids of the citrus psylla and pink hibiscus mealybug.
2. Develop rearing methods.
3. Obtain parasitoids and evaluate them in quarantine; write environmental assessments.
4. Obtain permits to release them in Florida.
5. Mass rear and release parasitoids.
6. Evaluate overwintering, dispersal, and impact of parasitoids on pests.

Summary of Accomplishments

When this project began in 1998, neither pest was present in Florida, but both were targets of classical biological control programs because effective natural enemies were known. We were able to respond rapidly to the invasion of the Asian citrus psylla. Host-specific parasitoids were imported and rearing methods developed. A molecular test (polymerase chain reaction) was developed to confirm the absence of greening disease in the imported parasitoids as a method for preventing the accidental release of greening bacteria in Florida. *Tamarixia* was first released in July 1999. In March 2000, we obtained permission to release *D. aligarhensis*. Field surveys indicate *T. radiata* is persisting at a high frequency in the release sites and has spread; during spring 2002 all groves sampled had *T. radiata* present. In some sites, *T. radiata* has survived and persisted over three winters. Surveys to evaluate *D. aligarhensis* are ongoing.

Funding:

FCPRAC Grants	$32,000
Agency Contributions	$45,000
Other Grants	$ 0
Total	$77,000

Classical Biological Control of the Brown Citrus Aphid
Project No. 981-50E

Investigators: Marjorie A. Hoy
UF - Gainesville

Ru Nguyen
DPI - Gainesville

Progress Report for FY 02-03, Year 3 of 4+.

Abstract

The brown citrus aphid is an efficient vector of virulent strains of citrus tristeza virus and also serves as a direct pest of young flush in citrus trees. Our goal was to identify host-specific parasitoids of the brown citrus aphid, import them into quarantine, evaluate them, and, after approval by state and federal regulatory agencies, release them into Florida's citrus groves for

permanent establishment. *Lipolexis scutellaris* (recently renamed *L. oregmae*) was imported into quarantine in August 1999. Rearing methods were developed and a risk analysis conducted; permission to release *Lipolexis* was granted in June 2000 and releases were made throughout the state during 2000-2003. During 2002-2003, we monitored the citrus areas for *Lipolexis* and found it present, although in low numbers. Studies were conducted to understand what might affect establishment and effectiveness, including predation by fire ants and competition with another parasitoid, *Lysiphlebus testaceipes*. Current data indicate that *Lipolexis* is established and widely distributed in Florida. *Lipolexis* is parasitizing brown citrus aphids, as well as other aphids. This ability to parasitize other aphids should increase the ability of *Lipolexis* to persist when brown citrus aphids are absent.

Objectives

1. Identify source of appropriate parasitoids.
2. Obtain permits for importation from Australia and Asia.
3. Collect parasitoids from Australia and Asia.
4. Import parasitoids into quarantine.
5. Develop rearing methods.
6. Write environmental assessment.
7. Apply for permission to release parasitoids.
8. Mass rear and release parasitoids throughout Florida.

Summary of Accomplishments

We identified a parasitoid, *Lipolexis scutellaris* (now renamed *L. oregmae*), of brown citrus aphid in Guam and obtained a colony in June 1999, which was evaluated in quarantine. Rearing methods were developed, risk assessments conducted, and an application was submitted to the Department of Agriculture and Consumer Services for permission to release *Lipolexis* in Florida, which was granted in June 2000 after reviews of potential risks were conducted by the University of Florida, IFAS and the Division of Plant Industry. We knew that *Lipolexis* would attack other pest aphid species on citrus, including melon, spirea, black citrus, and cowpea aphids. Releases were begun in June 2000 and the first recoveries of adults occurred in July 2000 from brown citrus aphids. Between 2000 and 2003, we released approximately 60,000 *Lipolexis* throughout citrus-growing areas of Florida. Surveys conducted in citrus groves during 2001, 2002, and 2003 indicate that *Lipolexis* is widely distributed in Florida's citrus groves, although it is not yet abundant. In addition, surveys indicated *Lipolexis* is attacking the other aphid species in citrus, vegetables, and weeds. The ability of *Lipolexis* to attack other pest aphids in citrus and in vegetables and weeds may be beneficial in that hosts will be available throughout the year when brown citrus aphid populations are low. The disadvantage is that populations of *Lipolexis* may yet be spread "too thin." It will take additional time to resolve whether *Lipolexis* can become more abundant on brown citrus aphids in Florida's citrus groves. Sufficient time subsequent to the releases has not yet elapsed that we can resolve the ultimate effectiveness (or lack thereof) of *Lipolexis* as a natural enemy of the brown citrus aphid.

Funding:

FCPRAC Grants	$ 20,000
Agency Contributions	$ 70,000
Other Grants	$ 35,000
Total	$125,000

Keeping Citrus Propagation Increase Blocks Free of Severe Citrus Tristeza Virus
Project No. 013-05E

Investigators: Susan Halbert
Timothy Schubert
FDACS - DPI - Gainesville

Timothy Gottwald
USDA - ARS - Ft. Pierce

Progress Report for FY 02-03, Year 2 of 3.

Abstract

The establishment of brown citrus aphid has caused a significant increase in both incidence and severity of citrus tristeza virus (CTV) infection in Florida. The best way to ensure that Florida continues to have quality healthy citrus groves is to keep planting stock clean. Current Division of Plant Industry regulations require that citrus scion source trees be tested for CTV each year. If scion source trees are found positive for severe CTV, they are no longer allowed to be used as sources for budwood. Growers may choose to propagate via increase blocks that can remain in use for 24 months after establishment before additional CTV tests are required. The 24-month time period was never documented by data, but was considered a “best guess” at the time the regulations were written. Now that brown citrus aphid is well established and CTV transmission is increasing, it is time to determine whether earlier testing of increase blocks may be necessary to prevent distribution of plants infected with severe CTV.

Objectives

1. Establish insecticide treated and untreated increase blocks under commercial management.
2. Test the increase blocks periodically for severe CTV.
3. Monitor presence of brown citrus aphids.

Summary of Accomplishments

In July 2001, we began sampling an increase block established near Immokalee in April 2000. We collected leaves from all the plants (about 15,400) and 17.7% of the samples (10 plants/sample) were positive for severe CTV. In the second and third sets of samples (December 2001 and April 2002), rows 6 and 12 were sampled. In row 6, 10.6 % of the plants tested positive for severe CTV in December. No severe CTV was ever found in row 12. The pattern of severe CTV in the field suggested a combination of contaminated budwood and aphid transmission. This happened in spite of the fact that the grower followed the DPI regulations, indicating that the 2-year time frame for increase blocks may be optimistic for outdoor nurseries, even with minimal aphid pressure. A second increase block in a modified greenhouse was established in Winter Haven in June 2002. Liners, budwood, and two sets of subsequent samples were taken (24 October 2002 and 24 April 2003). All samples were negative so far. Another sampling is planned for August 2003. Brown citrus aphids were collected in the trap outside, but not inside the enclosure. Most plants sampled in the neighboring grove had severe CTV. The protection afforded by the enclosure and the clean start may account for the major difference in severe CTV incidence.

Funding:

FCPRAC Grants	$15,480
Agency Contribution	$25,500
Other Grants	$ 0
Total	$40,980

Maximization of Bait/Pesticide Combinations for Caribbean Fruit Fly Control in Florida Citrus Project No. 013-11E

Investigators: Herbert N. Nigg
IFAS - UF - CREC

Sam E. Simpson
FDACS - DPI - Winter Haven

Ed Exteberria
IFAS - UF - CREC

Kevin Goodner
USDA - ARS - Winter Haven

Don Harris
Ed Burns
FDACS - DPI - Winter Haven

Progress Report for FY 02-03, Year 2 of 3.

Abstract

The attractiveness of NuLure®/malathion and other bait-pesticides to Caribbean fruit fly has never been assessed. Also, the quantity consumed of a bait/pesticide for Caribbean fruit fly has not been determined. Consumption is an important consideration because we, and the public, believe that the flies consume the bait/pesticide combination used to control these flies. This is an important point because, in a toxicological test, flies are simply counted–alive or dead. But why did those flies, which survived, survive? Were they physiologically resistant or did they consume less pesticide than the dead flies? How does pesticide concentration affect the consumption of a bait/pesticide combination? Can we reduce the pesticide concentration in a bait by increasing consumption of the bait and maintain effectiveness? The objective of this project is to produce a maximally consumed, effective bait-pesticide that contains a minimal, but effective pesticide concentration.

Objectives

1. Compare food consumption techniques with Caribbean fruit fly (completed).
2. Compare the consumption of commercial lures by Caribbean fruit fly (almost complete).
3. Compare the consumption components of commercial lures, where known by Caribbean fruit fly (in progress).
4. Compare the attraction of the Caribbean fruit fly to host volatiles and other volatiles (complete).
5. Compare the attraction of the Caribbean fruit fly to bait/pesticide with pesticide concentration (in progress).
6. Compare the consumption of the Caribbean fruit fly of bait/pesticide with pesticide concentration (in progress).
7. Test the best combination in the greenhouse (in progress).
8. Field test our final product (scheduled spring 2004).

Summary of Accomplishments

We have completed our comparison of three food consumption techniques. We have shown that previously used techniques were either useless or 100% inaccurate. We have determined the attraction of Caribbean fruit fly to commercial lure components and to some host volatiles. We have discovered unique compounds that are attractive to immature flies. These are objectives 1-4. We have determined that sucrose is the appropriate sugar for Caribbean fruit fly at 0.2 M concentration, approximately 7% sucrose. Most commercial baits contain no sugar or, in the case of Spinosad, 14% sugar. We have determined that there is no toxic interaction between malathion and fluorescein, allowing progress with the ingestion of bait pesticides. We have tested and developed a greenhouse procedure for comparison of baits and are proceeding with greenhouse development and testing. Field testing is scheduled for spring 2004 dependent on greenhouse results. We are on time and on target with this project.

Funding:

FCPRAC Grants	$ 40,940
Agency* Contribution	$ 95,000
Other Grants (FDOC)	$ 10,000
Total	$145,940

* University of Florida, IFAS
Florida Dept. Agric. Cons. Serv.

Improving Efficacy of Sterile Insect Technique for Mediterranean and Other Tephritid Fruit Flies with Hormone Supplement Therapy
Project No. 022-07E

Investigators: Peter E. A. Teal
USDA - ARS - Gainesville

Yeudiel Gomez-Simuta
Tapachula, Mexico

Timothy C. Holler
USDA - APHIS - PPQ, Gainesville

Progress Report for FY 02-03, Year 1 of 2.

Abstract

The Sterile Insect Technique (SIT) is a proven safe method to eradicate Mediterranean and Mexican fruit flies, serious invasive insect threats to citrus production in Florida. The goal of our research is to develop a facile method for incorporating Juvenile Hormone therapeutic techniques into mass rearing of sterile Tephritid fruit flies and demonstrate to SIT program managers that the technique results in production of sterile male flies that are far superior in their abilities to mate with wild females than sterile males currently in use. To accomplish our goal, we are conducting the following studies:

Objectives

1. Study the effects of juvenile hormone (JH) supplement therapy on reproductive development, sexual signaling, and mating in the irradiated flies.

2. Determine the optimal age and stage of development for application of hormone supplement therapy and most effective dose of hormone for maximum acceleration of reproductive development and sexual signaling.

3. Compare the mating competitiveness of hormone supplement therapy treated males to untreated males.

4. Develop a method for application of hormone supplement therapy in mass rearing systems.

5. Provide documentation of improved mating competence to and transfer the technology to managers of factories that produce sterile flies for use in SIT programs.

Summary of Accomplishments

During the first year of our program, we have accomplished the following: 1) Developed an optimized protein supplemented diet based on the agar/sugar diet used as food for sterile adult flies prior to release. The standard diet used to feed sterile flies prior to release is composed of 50% sucrose, 0.75% agar, 0.03% methyl paraben, and 49% water. We determined that addition of 10% yeast protein hydrolysate or a common food product (Vegamite®, Kraft Foods, England) significantly increased pheromone production and mating when added to the standard diet and results in prolonged life. 2) Developed a method for homogenous incorporation of hormone into the diet currently used to feed adult sterile flies. This was accomplished by using a commercial formulation of the juvenile hormone analog methoprene. The formulation, Nevweb IGR 200, contains methoprene in a water soluble formulation and is equally distributed in either agar gel or the sugar yeast hydrolysate solid diets. 3) Determined the most effective dose of hormone for maximum acceleration of reproductive development and sexual signaling for optimal results. The results showed that 0.05% IGR in the diet was as effective in accelerating reproductive development as was applying 5 µg of methoprene in acetone to newly enclosed flies. Increasing the amount to 0.1% did not improve efficacy but decreasing the amount to 0.025% caused a reduction in efficacy. 4) Determined that feeding sterile males diet containing 0.05% IGR diet accelerated reproductive development and made them more attractive at any age than non-irradiated males fed the optimal sugar-protein diet.

Funding:

FCPRAC Grants	$14,400	
Agency Contribution	$28,000	(USDA)
	$ 5,000	(In kind support DPI - insects)
Other Grants	$21,431	(Calif CRB)
Total	$68,831	

Integrated Control of the Diaprepes Root Weevil
Project No. 031-10E

Investigators: Clayton W. McCoy
IFAS - UF - CREC

Stephen L. Lapointe
USDA - ARS - Fort Pierce

Other
Investigators: George H. Schneider III, Suzanne Fraser, Reed E. Burns, Jr.
FDACS - DPI

James P. Syvertsen, Hong Li, Larry W. Duncan, Jim H. Graham, Robin J. Stuart, Jorge Peña, William S. Castle
IFAS - UF - CREC

Jane Brockmann, Laura K. Sirot
UF - CALS

Wayne Hunter, Cindy McKenzie,
Albert A. Weathersbee, III
USDA - ARS

Progress Report for FY 02-03, Year 2 of 3.

Abstract

This progress report for FY 02-03 relates to specific projects of research teams developing pest management (IPM) components for controlling Diaprepes root weevil (DRW). The goal of the Block Grant team composed of State and Federal scientists is to implement control strategies, based on sound pest biology, that will increase citrus productivity through reduced crop loss. The content of this progress report includes both new research and continuation of work began in 2001-2002. Contributions from scientists are summarized as research accomplishments in the following block grant thrust areas: 1) biology/ecology, 2) plant resistance, 3) biological control, 4) cultural control, and 5) chemical control. It should be noted that accomplishments for Federal researchers are limited this year because their funding for research was delayed for a significant period of time.

The following research activities were conducted at the U.S. Horticultural Research Lab using funds provided by FCPRAC for the first Diaprepes Block Grant. Diverse approaches to control were explored including aspects of basic biology, plant resistance, viral pathogens, bacterial pathogens, cultural methods, and foliar sprays. Interactions between activities developed over the year. For example, a bioassay developed to study the effect of botanical compounds on neonate larvae is now being used to test newly acquired isolates of *B. thuringiensis*. Kaolin sprays are also being used for field evaluation of rootstocks (2a) to create a split-plot (infested vs. non-infested) design.

Objectives

1. Investigate both basic and field research on the biology, behavior, and ecology of all life stages of DRW in relationship to abiotic and biotic factors using sampling or forecasting methods.

2. Investigate root stock performance under different edaphic conditions in groves with and without *Phytophthora* spp. but under seasonal population pressure by DRW life stages.

3. Investigate the role of exotic and indigenous natural enemies of all DRW life stages as biological control agents.

4. Investigate the use of chemical and biological insecticides as foliar and soil treatments to control all DRW life stages with strong consideration to environmental effects.

5. Investigate other non-conventional cultural and mechanical methods for controlling all DRW life stages that are user-friendly.

Summary of Accomplishments

Biology/Ecology

Mass Production and Rearing Improvement of *Diaprepes abbreviatus* to Provide Essential Needs of Florida Researchers (Schneider, III, Fraser, and Burns, FDACS-DPI)

Shipment of various *Diaprepes* life stages were provided to eleven different researchers this past year. We provided over 600,000 eggs, 22,200 neonate larvae, 3,300 large grubs, 12 pupae, and 17,900 adult weevils. The demand for eggs was greatly increased and that for neonate larvae more than doubled this past year. Although larval development time remains long and variable, diet infestation rates were increased to hopefully provide more adult weevils in the coming year.

Irradiation of the larval diet with a 1.5 mrad dosage prior to infestation was adopted as a part of the mass rearing protocol after sufficient testing showed it had no gross negative effects, but greatly reduced the number of diet cups that needed to be discarded due to microbial contamination. An improved method for infesting neonate diet cups utilizing a Buchner funnel, vacuum pump, and shaker vial, instead of a small paint brush, was also tested and the practice adopted after it was shown to save both time and labor with no apparent negative effects on the neonate larvae. Also tested was the transfer of older instar larvae from diet to vermiculite media to try and shorten the larval development time interval which could significantly improve adult weevil production. The results thus far are inconclusive, and further testing is necessary to try and pinpoint an optimum age for transfer and to see if the additional labor of another step is worthwhile.

Reproductive Biology of the Diaprepes Root Weevil (Sirot, Brockmann, and Lapointe, UF-CALS, USDA, ARS)

We investigated seminal proteins in DRW that, together with sperm, comprise the ejaculate. In other insects, such proteins have profound effects on female reproductive behavior including delayed remating, increased egg-laying, and decreased longevity. Research into these proteins may lead to new methods for controlling reproduction. In DRW, significant levels of seminal proteins were transferred to females at the beginning of mating. Through radioisotope labeling, we demonstrated that male proteins are found throughout mated females, implying uptake by the hemolymph. They were found primarily in ovaries and eggs, suggesting a role in oviposition behavior and embryo nutrition.

Soil Characteristics and *Diaprepes* Management Zones at the Field Scale (Syvertsen and Li, IFAS-UF-CREC)

Citrus *Diaprepes* root weevil management requires an understanding of variations in soil properties in space and time. Starting in 2002, we conducted a study in a citrus grove of 'Hamlin' orange on Swingle citrumelo (*Citrus sinensis* L Osb. X *Poncirus trifoliate* L.) rootstock in a poorly drained Alfisols near Poinciana, Osceola County (Kelly Block; 28°22'N,

81˚58'W). The objectives were to assess the spatial variability of *Diaprepes* populations in relation to soil characteristics and to determine *Diaprepes* management zones related to spatial patterns of soil characteristics. Soil electrical conductivity (EC) was measured using EM38 throughout the grove. *Diaprepes* adult populations were monitored using Tedders traps placed in a 35 x 25 m grid across the grove, and soil organic matter, pH, P, K, Ca, Mg, and other properties were measured at each Tedders trap. A total of 1400 *Diaprepes* adults were captured in 2002. *Diaprepes* weevil distribution varied with space and time. Peaks of *Diaprepes* adults were measured in the non-flooded high elevation areas, and adults appeared in significantly ($P < 0.001$) higher numbers in June (450 weevils) than the other months (24-236 weevils). Three biological zones for *Diaprepes* populations were delineated based on the spatial patterns of soil EC. Regression correlations between EC and *Diaprepes* were significant within zones ($R^2 = 0.43$-0.55*). Over the entire field, *Diaprepes* frequency was significantly high in areas low in Mg and Ca ($r = -0.31$*). Semivariograms for *Diaprepes*, Mg, and Ca ranged within 100-175 m, which was matched with the *Diaprepes* biological zone limits. The match of the semivariogram ranges of soil variables with the *Diaprepes* biological zone limits, suggested the management zones for integrated *Diaprepes* weevil control. *Diaprepes* root weevil management could be related to site elevation, flooding, and soil liming practices. However, further study is necessary to test these hypotheses. More precise *Diaprepes* trap monitoring and soil sampling are also needed to capture more detailed soil variability in space and time. We plan to establish a monitoring network in different sites using transects with screen cage trap-soil neighboring sample points located about 10-15 m apart to better capture variability of soil, *Diaprepes* population, and landscape position for improved management of *Diaprepes* pests.

Citrus Rootstock Growth Subjected to Flooding and *Diaprepes* Feeding (Syvertsen and Li, IFAS-UF-CREC)

Flooding events and *Diaprepes* root feeding may have long-term negative impacts on citrus rootstock growth. We conducted a greenhouse study to determine the effects of different flooding durations on soil redox potential, citrus seedling growth, and plant water relations. We studied interactions between previous flooding and *Diaprepes* larval root weevil feeding on leaf stomatal conductance and root damage. The experimental design was completely randomized with two rootstocks (Swingle citrumelo (SWI) and Smooth Flat Seville (SFS)), four flooding durations (0, 10, 20, and 30 days), and larval feeding for 42 days. Plants were flooded, then drained for a week, and five neonate larvae per seedling were introduced onto the soils. Flooding significantly reduced redox potential. Flooding treatment, rootstock variety, and their interaction significantly affected leaf stomatal conductance ($P < 0.001$). Swingle appeared to be more tolerant of flooding stress than SFS. Survival of *Diaprepes* larvae was higher in flooded treatments than non-flooded treatments ($P < 0.05$). Flood damaged seedlings were more susceptible to root injury by larval feeding than non-flooded seedlings. Treatments flooded for 10 days had higher stomatal conductance and lower root injury from larval feeding than those flooded for 30 days. We conclude that a negative soil redox potential and a decrease of leaf stomatal conductance might be useful as early indicators of plant water stress from flooding and root damage from weevil larvae. The potential associations of flooding, root feeding by *Diaprepes* larvae, and infections by *Phytophthora* or other pathogens should also be studied.

Effect of Different Control Strategies for Citrus Root Weevils and Phytophthora on Weevil Abundance, Fibrous Root Density, and Yield (McCoy, Graham, Duncan, and Stuart, IFAS-UF-CREC)

The seasonal control of different life stages of *Diaprepes abbreviatus* and *Pachnaeus litus* using different foliar and soil treatments was compared to no control for 3 consecutive years in a commercial orange grove near Fort Pierce, FL. Seasonal control of *Phytophthora* spp. was also evaluated with and without fungicide in a strip plot design. Treatment effects were determined by measuring weevil abundance via Tedder traps, fibrous root density, and fruit yield.

Pachnaeus litus was more abundant in the grove than *D. abbreviatus* throughout the study. Seasonal abundance of adults was highest from March through June. Total adult weevils trapped seasonally varied within plots and between replicates, thereby masking treatment effects. Two foliar sprays applied during peak adult abundance had no significant effect on total adult weevils captured annually. One or two soil applications of a chemical or biological pesticide respectively had no significant effect on total *Diaprepes* trapped within a year, however, there was a tendency for lower numbers. This trend was also seen where multiple applications to foliage and soil were applied against *Diaprepes*. In the case of *P. litus*, no significant differences were found between treatments and control. Fibrous root density was significantly higher in all treatments receiving two applications of fungicide annually; however, no treatment effects were found for yield in years 1-3.

Plant Resistance

Field Comparison of New and Commercially Available Rootstocks for Resistance to DRW (Lapointe, USDA, ARS)

Three rootstock trials containing standard rootstocks and selected promising new hybrids were planted with cooperators in Diaprepes-infested sites in Indian River County in late 2002 and early 2003. Young tree performance on these sites is being monitored, and additional trials in other Diaprepes-infested areas are planned.

Assessing Rootstocks and Management Tactics on Suppression of Diaprepes (McCoy and Castle, IFAS-UF-CREC)

A long-term study is underway to determine the seasonal effect of high DRW populations on the growth and development of reset Hamlin orange budded on different non-resistant and *Phytophthora* resistant

rootstocks in clay loam soil with and without pest control. After 2 years of optimum care and regular pest control that included suppression of *Diaprepes* with foliar sprays on a monthly basis, trees have grown uniformly throughout the study site. According to soil sampling, *Phytophthora* spp. levels were too low for regular treatment. According to trunk growth measurements taken for all rootstocks after 2 years post-plant, tree growth was significantly greater for C-35 citrange. C-32 citrange, Swingle citrumelo, and Cleopatra mandarin, in that order, were similar in growth. C-22 citrange was the slowest growing rootstock. In 2003, DRW was allowed to infest the whole planting and season-long weevil control initiated in trees representing one-half the plot. Control decisions were based on visual and trap counting of adult and larval insects.

Biological Control

Ants, Pesticides, and Biological Control of *Diaprepes abbreviatus* (Stuart and McCoy, IFAS-UF-CREC)

Two manipulative field studies are currently under way to test how alterations in ant communities impact predation pressure on *Diaprepes.* In one study, granular ant baits are being applied at different rates to determine their impacts on ant communities and predation. Such applications tend to reduce the abundance of red imported fire ants (*Solenopsis invicta* Buren) but enhance the diversity of the ant community in general, and we want to determine whether this process will have a positive or negative impact on predation pressure on *Diaprepes*. We are also using a tree-banding technique to exclude ground-nesting ants from citrus canopies to test how the presence or absence of these ants influences predation pressure in the canopy, and the abundance and distribution of other pests such as aphids, scales, and psyllids. Ants tend to be extremely common on the ground and in the canopy of Florida citrus groves and undoubtedly have a major impact on various ecological interactions. However, they can have both positive and negative effects as they prey on certain insect pests (e.g., *Diaprepes*, leaf miners) but protect and potentially enhance others (e.g., aphids, scales, psyllids). These studies will help us unravel the positive and negative impacts of ants within groves and to determine to what extent ants should be conserved for their beneficial impacts. Our first year with the granular ant bait study indicates that reductions in fire ant populations by about 50% (measured using hamburger baits) results in a similar reduction in predation on *Diaprepes* neonates (measured using laboratory reared neonates placed in the field). Moreover, across treatments in which ant populations were reduced to varying degrees, the response of ants to the hamburger baits was highly correlated with predation pressure on *Diaprepes* neonates ($r = 0.623$, $df = 26$, $P = 0.0004$). The granular ant bait study is continuing, and additional data for other kinds of baited and passive traps have yet to be analyzed, but the results to date reinforce the view that ants are major predators on *Diaprepes* neonates on the soil surface, and that reduction in ant populations also reduces the effectiveness of ant predation on *Diaprepes* neonates. The tree-banding study was initiated this summer and no data are yet available.

A Lethal Male Strategy for Management of Diaprepes (Hunter and Lapointe, USDA, ARS)

Infection of Diaprepes by an insect virus (IIV6) was confirmed by scanning electron microscopy. Infection was covert and transovarial transmission was demonstrated. To facilitate identification of infected tissues, a complete histological description of the reproductive and alimentary systems was completed. This atlas of the internal morphology and histology of Diaprepes will be made available to other Diaprepes researchers.

Development of Bacterial Entomopathogens (Weathersbee, McKenzie, and Lapointe, USDA, ARS)

A technician was hired and identification of bacterial isolates collected from Diaprepes cadavers was initiated at USHRL. Twenty-five isolates of *Bacillus thuringiensis* were obtained from a USDA collection including several beetle-active isolates. These isolates are currently being characterized by bioassay against Diaprepes larvae, including neonates using the bioassay developed for screening of botanical compounds.

Foliar Sprays of Kaolin-Based Particle Films (Lapointe, USDA, ARS)

Field trials on the effect of Surround, a kaolin-based particle film, are now in their third and final year. Suppression of oviposition by DRW continues to be documented along with a highly significant effect on tree growth. A new trial was established to examine possible interactions between soil fertility and growth enhancement by Surround. One trial at an infested commercial grove was terminated due to sale of the property. A new trial was established in a commercial grove in central Florida. While data confirm the effect of deterrence by Surround to oviposition by Diaprepes, the effect is diluted by the growth enhancement we have observed on heavy soils in St. Lucie County. Surround-sprayed trees were more vigorous and produced flush at a greater rate resulting in greater adult feeding on unprotected foliage that emerged between spray dates. Frequent applications of Surround also appeared to induce outbreaks of scale insects.

Classical Biological Control of Diaprepes with Egg Parasites (Peña, IFAS-UF-TREC)

A total of 2,710,300 *Q. haitiensis* and 402,309 *A. vaquitarum* have been released in Florida until December 2002. A 14% recovery has been recorded on citrus groves in Indian River County for *Q. haitiensis* whereas 43%, 17%, and 14% recoveries of *A. vaquitarum* have been registered in citrus groves located in Miami-Dade, St. Lucie, and Polk counties, respectively. *Q. haitiensis* appears to be affected by temperatures lower than 59°F, perhaps reducing its effectiveness during winter months. Two exploratory trips were undertaken in May and June 2003 in the island of Dominica. Parasitism of Diaprepes eggs in this island fluctuated between 35 to 63%. These trips resulted in the introduction of two additional strains of *Q. haitiensis* and *A. vaquitarum* collected from higher altitudes than the previous strains and perhaps less susceptible to Florida winter temperatures. The exploratory trips resulted in the discovery and introduction of two additional egg parasitoids, i.e.,

Haeckeliana sp. (Hymenoptera: Trichogrammatidae) and a Platygasteridae. All specimens are being successfully reared at TREC under quarantine conditions. The parasitoids will be released after specificity tests are performed and permits obtained.

Cultural Control

A Survey of Potential Cover Crops for Toxicity to DRW Larvae (Lapointe, USDA, ARS)

Species of legumes with potential as cover or companion crops in citrus were examined for repellency and toxicity to Diaprepes adults and larvae. Species such as *Arachis pintoi* (perennial peanut), *Crotalaria pallida* (rattlebox), and *Cajanus cajan* (pigeon pea) were shown to be excellent hosts for larval development and therefore not appropriate for use with citrus (Lapointe 2003, Florida Entomologist 86:80-85). Toxicity to larvae and antifeedant activity towards adults were demonstrated for the legume *Tephrosia candida* (Lapointe et al., 2003, J. Economic Entomology 96:811-816). A new high-throughput bioassay involving use of neonate larvae was developed. Roots of *T. candida* were toxic to neonate and 3-week-old larvae. There was significant antifeedant activity towards neonates not previously observed for older larvae. Activity was isolated in biochemically separated fractions, and these are now being analyzed to identify active compounds.

Chemical Control

Effect of Thiamethoxam on Neonate *Diaprepes abbreviatus* in the Laboratory and Greenhouse (McCoy, IFAS-UF-CREC)

Thiamethoxam, a second-generation neonicotinoid insecticide, is toxic to a wide range of foliar and soil-inhabiting insects that include whiteflies, aphids, Colorado potato beetle, and wireworms. In soil column bioassays, thiamethoxam at two rates was highly effective as a contact insecticide against neonate *Diaprepes abbreviatus* after 144 hr exposure. In a greenhouse trial where four rates of thiamethoxam were tested as a soil drench for controlling neonate larvae in container-grown citrus, all rates gave virtually 100% control and total plant protection at 6 weeks post-treatment. In a similar residual trial, thiamethoxam gave excellent larval mortality and plant protection up to 80 days post-treatment. Efficacy at low rates and long residual favor field testing against citrus root weevils.

Funding:

FCPRAC Grants		
	IFAS	$ 176,000
	USDA	$ 145,000
Agency* Contribution:		
	IFAS	$ 245,000
	USDA	$ 390,000
Other Grants		$ 230,000
Total		$1,014,050

ENTOMOLOGY
Completed Projects

Assessment of Interactions Between Predators and Parasitoids of Brown Citrus Aphid (BCA): Synergism or Antagonism?
Project No. 012-10E

Investigators: H. W. Browning
J. P. Michaud
IFAS - UF - CREC

Progress Report for FY 02-03, Year 2 of 2.

Abstract

Ladybeetles are very important beneficial insects in Florida citrus, contributing to biological control of aphids, psyllids, mites, mealybugs, scales, and other important pests. We have assessed, to some degree, the potential of certain aphid parasitoids to negatively impact populations of two ladybeetle species important in biological control. Our results have raised other interesting questions, in particular, how these ladybeetles maintain such good biocontrol of BCA despite the fact they no longer have successful larval development on an exclusive diet of BCA. The proposed work should improve our understanding of the nutritional ecology of these important predators in the citrus ecosystem and may reveal new ways to maximize their efficacy and prevent the breakdown of biological control of foliage feeding pests.

Objectives

1. Evaluate the role of various potential dietary supplements (moth eggs, mites, pollen other insect prey) in enhancing the larval survival of *Harmonia axyridis* and *Cyconeda sanguinea* when they feed primarily on BCA;

2. Compare the suitability of BCA as prey for coccinellid larvae when reared on alternative host plants (cotton and jasmine orange) so as to determine whether the suitability of the prey is in any way a function of its host plant (citrus);

3. Further explore the nature of enhanced toxicity of BCA resulting from parasitism by *L. testaceipes* and whether or not this effect can be compensated for by addition of key supplements to the larval diet.

Summary of Accomplishments

This project made significant strides in the first year and early parts of the second year of the grant period. The primary investigator, Dr. Michaud, departed UF employment in late 2002, having made progress on most of the objectives outlined for the second year of this grant. Field assessment of the mortality factors affecting BCA were continued by Dr. Michaud, while laboratory competition studies were expanded to further evaluate the role of aphids parasitized by *L. testaceipes* in predator food selection by the coccinellid predators. Survival and development success of larval forms of the two primary aphid predators, *H. axyridis* and *C. sanguinea,* were evaluated fed on both parasitized and unparasitized aphids in these trials. Adult survival and reproductive fitness was also evaluated as a measure of the quality of BCA as a host for ladybeetle development with and without parasitoid competition. Due to departure of Dr. Chow in summer 2002 and Dr. Michaud in October 2002, the laboratory experiments completed to date were summarized and are being published by Dr. Michaud, and the residual funds as of November 1, 2002, are being returned to FCPRAC.

Funding:

FCPRAC Grants	$10,000	($5,164 being returned to FCPRAC)
Agency* Contribution	$ 1,600	
Other Grants	$ 0	
Total	$11,600	- $5,164 = $6,436

Monitoring and Insecticidal Control of Asian Citrus Psylla in Florida
Project No. 021-03E

Investigators: Carl C. Childers
Diann Achor
IFAS - UF - CREC

Progress Report for FY 02-03, Year 1 of 1.

Abstract

Asian citrus psylla, *Diaphorina citri* Kuwayama (Hemiptera: Psyllidae), caused significant reduction in young tree growth throughout Florida during 2001 and 2002. Proper timing and identification of effective insecticides and rates are needed to control citrus psylla on young citrus trees to assure optimal tree growth and development. Added urgency is needed for the citrus industry if the bacterial disease, citrus greening, becomes established on citrus in Florida. Development of color attractants for monitoring adult activity within different citrus blocks or smaller orchard locations would be useful in planning insecticidal spray application.

Objectives

1. Identification of the best color attractant for adult Asian citrus psylla.
2. Identification of effective insecticides and rates and their optimal timing.
3. Evaluation of the direct impact of adult Asian citrus psylla on developing young flush.

Summary of Accomplishments

Objective 1. Thirty-three hues of orange, green, yellow, red, and white were evaluated during 2002 for comparative adult attraction. None of these colors or hues has provided superior attraction when compared to two commercially available traps (e.g., Gempler's yellow (R16201) trap or the yellow-green Multigard trap with grids. Differences in adult psylla numbers on west facing traps were significantly lower than east facing traps in some tests. Trap catches were significantly greater at the ½ meter height when compared with 4 meters. During 2003, 5 field trials compared 10 different traps set at ½ meter. No differences in trap catches of an apparent low population of adults were obtained. Objective 2. Two field trials evaluated the efficacy of 9 insecticides for controlling psylla on young trees. Admire 2F at 0.25 oz form/tree, Temik 15G at 2 oz form/tree, and Actara 25WG at 4 oz form/acre provided effective control of citrus psylla. Danitol 2.4EC at 16 oz/acre, Lorsban 4EC at 5 pints/acre, and Provado 1.6F at 10 oz/form/acre applied as foliar sprays were effective for less than 10 days. Sol-Oil 97 (435 oil), Sol-Oil (455 oil), or Sunspray 11E at 5 gal/acre, Mite-E-Oil alone at 2 gal/acre or in combination with either Kinetic (5 oz/100 gal) or Citru-Film (0.5 gal/acre) were ineffective in suppressing adult psylla in two field trials. Sol-Oil (455), Sunspray 11E, Mite-E-Oil alone or with Citru-Film provided some suppression of psylla nymphs after 8 days post-treatment in one test. Only Mite-E-Oil in combination with either Kinetic or Citru-film provided slight short-term suppression of nymphs in the second field trial. Objective 3 is incomplete at this time.

Funding:

FCPRAC Grants	$20,000
IFAS Contribution	$40,000
Total	$60,000

Impact of 455 and 470 Petroleum Oils vs. 435 Oil on the Beneficial Mite Complex and Their Use in an IPDM Program for Florida Citrus Growers
Project No. 021-04E

Investigator: Carl C. Childers
IFAS - UF - CREC

Progress Report for FY 02-03, Year 1 of 1.

Abstract

Substantial progress has been made in identifying expanding uses and benefits of petroleum oil spray programs on Florida citrus. However, growers need to know the impact of using the heavier 455 and 470 petroleum oils in one or two spray applications

during the summer for greasy spot control and subsequent impact on both pest and beneficial mite populations over the season. These are essential points in completing the data packages for developing cost-effective Integrated Pest and Disease Management Programs (=IPM) for Florida citrus growers. Continued assessment of petroleum oil use patterns for the benefit of citrus growers is essential.

Objectives

1. Comparative greasy spot control.

2. Impact of petroleum oil treatment on citrus rust and spider mite populations.

3. Rind blemish comparisons of citrus rust mite on fruit.

4. Comparative treatment impacts on the beneficial mite populations. This complex includes both predacious and fungal feeding mite species.

Summary of Accomplishments

Two field experiments were established to compare single versus double applications of Sol-Oil 97 (435), Sol-Oil (455), and Sunspray llE (470) applied at 5 gpa during the summer and compared against Kocide applied twice at 4 lb metallic/acre and all compared against untreated check blocks. Each treatment was applied in 200 gpa and replicated 5 times in 20 or 25 tree plots. Objective 1. None of the treatments in either test had significant differences in the percentage of leaves that dropped from greasy spot infection. All treatments provided significantly lower percentages of greasy spot infected leaves that remained on the trees versus the untreated check in test 13. In test 14, two applications of 435 provided superior greasy spot control versus one 435 application while there were no differences between single or double applications of the two heavier oils. The two copper applications provided comparable control to any of the oil treatments, and all treatments had significantly less greasy spot infection compared to the check trees. Objective 2. The oil treatments in test 13 all provided similar suppression of citrus rust mites on fruit and leaves while the copper treatment had significantly larger rust mite numbers during July-August on both fruit and leaves. Slightly greater rust mite pressure was recorded in the single 435 and 455 applications. The copper treatment had larger rust mite densities during August-September on fruit and leaves. Objective 3. All foliar treatments had reduced rind blemish injury due to rust mite feeding. Rind blemish injury was significantly greater on the copper, untreated, and single 455 oil treatments. Objective 4. Beneficial mite samples were collected.

Funding:

FCPRAC Grant	$15,000
IFAS Contribution	$30,000
Total	$45,000

An Assessment of Biological Control of Asian Citrus Psyllid in Florida
Project No. 022-02E

Investigators: H. W. Browning
J. P. Michaud
IFAS - UF - CREC

Progress Report for FY 02-03, Year 2 of 2.

Abstract

The introduction of Asian Citrus Psyllid (ACP) into Florida in 1998 has raised concern over the presence of yet another citrus pest in Florida, and one who is reported to transmit citrus greening disease in other parts of the world. In the interest of developing an approach for management of increasing pysllid numbers in commercial citrus, experiments have been conducted to identify the major predators and other natural mortality factors affecting citrus psyllid. Similar comparative studies are being conducted in Puerto Rico under alternative funding. Indications that existing natural enemies might contribute to suppression of field populations of citrus psyllid in Florida are being followed up with field and laboratory studies.

Objectives

1. Reiterative, non-destructive sampling of ACP populations (cohort studies) will be conducted to objectively assess all biotic sources of mortality of juvenile stages of ACP in natural infestations in established citrus groves. This work will be complemented by independent field trials to assess the acceptability of ACP adults as prey for various spider species.

2. Laboratory feeding trials will be conducted to determine the suitability of ACP nymphs as food for larval development and adult reproduction of the primary predator species attacking it in the field.

Summary of Accomplishments

This project made significant strides in the first year and early parts of the second year of the grant period. The primary investigator, Dr. Michaud, departed UF employment in late 2002, having made progress on most of the objectives outlined for the second year of this grant. Field observations and cohort evaluation by Dr. Michaud provides information on the seasonality of both psyllid and natural enemy activity in various parts of the state. The major mortality factors are being identified, and the role that they play is being characterized. Some information on the establishment of the introduced parasitoid, Tamarixia radiata, also was obtained in the process. Results indicate that the presence of ACP has led to increased numbers of some predators that prefer psyllids to aphids, and laboratory trials have shed light on the relative abilities of these natural enemies to develop and survive on a diet of ACP. Due to departure of Dr. Michaud in October 2002, the field and laboratory

experiments completed to date were summarized and are being published by Dr. Michaud, and the residual funds as of November 1, 2002, are being returned to FCPRAC. A manuscript entitled "Natural Mortality of Asian Citrus Psyllid in Central Florida" has been prepared by Dr. Michaud.

Funding:

FCPRAC Grants	$15,000	($5,164 being returned to FCPRAC)
Agency Contribution	$ 1,600	
Other Grants	$ 0	
Total	$16,600	- $5,164 = $11,436

PLANT IMPROVEMENT/OTHER
Continuing Projects

A Comprehensive Program for the Genetic Improvement of Florida Citrus Scion and Rootstock Varieties
Project Number 0110-03I

Investigators: Fred G. Gmitter Jr.
Jude W. Grosser
William S. Castle
IFAS - UF - CREC

Gloria A. Moore
IFAS - UF - HOS

Progress Repot for FY 02-03, Year 3 of 10.

Abstract

Florida faces many challenges in the production and marketing of citrus products. To insure that the Florida citrus industry can have the most genetically advanced varieties to maintain a competitive advantage, an integrated and comprehensive program for the genetic improvement of scion and rootstock varieties has been established. The overall goal of this project is to develop, test, and release new rootstock and scion varieties for Florida growers through the application of appropriate genetic tools and strategies. Additionally, research focused on the development of basic information and improved tools for breeding and selection will be conducted. Particular objectives are given below.

Objectives

1. Resistance to devastating diseases and pests;
2. Adaptation to diverse soils, growing conditions, and environmental stresses;
3. Improved product marketability through enhanced fruit and juice quality and extension of the harvest season; and
4. Lower input costs, along with increased yields and profits.
5. High quality, seedless, easy-peeling mandarins.

Summary of Accomplishments

SECTION 1 – SCION IMPROVEMENT

Sexual Hybridization: More than 2000 embryos were rescued from interploid crosses made in spring 2002 and plants were regenerated through tissue culture and micrografting techniques. Technique improvements have resulted in nearly 100% success in this process. Pollen from several superior somatic hybrids including Rohde Red + Dancy, Succari + Murcott, and Valencia + Murcott were utilized in interploid hybridizations. Triploid families from 2001 and earlier have been planted in the field. Thirty-five new interploid crosses were made in spring 2003. Crosses designed to move canker resistance from kumquat into mandarin-hybrid scions and to begin studies on the genetic resistance to canker were initiated. An additional 1000 trees from irradiated budwood of LB8-9 were produced to select less seedy budlines.

Evaluation and Selection: Data from two Earlygold, Itaborai, etc. trials continued to be collected. A Vernia field trial was planted in the IR area. Testing of juice from promising sweet orange and grapefruit clones has been increased and accelerated; hundreds of clones were sampled from various plant families throughout the season and run through the CREC juice analysis facilities. Grapefruit clones from fruit chimeras and tissue culture were evaluated for fruit quality traits. At least 15 selections were made from mandarin families, following evaluation of ~2000 hybrids for fruit and tree characteristics. Sensory panel evaluations comparing early-maturing Valencia selections with Vernia, Midsweet, and standard Valencia; and a comparison of late-maturing Valencia clones continued with promising results. Plants of ~20 sweet orange selections introduced to evaluate for early-season juice color and yield were propagated and placed in two field sites.

Released Materials: Data are being collated and packaged for the release of LB8-9, a hybrid that produces fruit resembling Minneola, but with superior qualities. Approximately 20 acres of trees were topworked to produce sufficient fruit for market analysis and development, and an additional rootstock trial has been propagated to determine the selections' performance on various standard and new rootstocks under east coast conditions. Three cybrid lines of

LB8-9 were identified that have significantly lower seed counts.

Somaclonal Variation: Planted one trial, and at three other locations, large numbers of trees were topworked to advanced Valencia somaclone selections. Planted two small grapefruit somaclone populations (pink and red) at the CREC. Produced new somaclone populations of two early-maturing Valencia selections. Produced two new somaclone populations: **a**) a protoplast-derived population from the previously selected very-early maturing Valencia clone SF14W-62, and **b)** an organogenesis-derived population from a cybrid Rhode Red sectored chimera (C1-41). Identified a late-maturing seedless Valencia selection with good fruit size and fresh market potential. Initiated evaluation of fruit from second-generation trees of promising selections.

Somatic Hybridization: Produced a new tetraploid breeding parent of Murcott + LB8-8 and cybrid shoots of LB8-9 containing the mitochondrial genome of Satsuma (with a goal of seedlessness without otherwise changing cultivar integrity). Identified two additional nearly seedless somatic hybrid fruits with possible commercial potential: Valencia + (Robinson x Temple) and Succari + Murcott.

Miscellaneous: Budded a population of approximately 75 triploid grapefruit-like hybrids for field planting. Planted populations of irradiated "Snack" mandarin and two early-maturing Duncan grapefruit somaclones at CREC. Budded >100 triploid "acid fruit" hybrids from 2000 crosses and produced 380 new triploid hybrids from 2001 crosses. Assayed 12 triploid acid-fruit hybrids that have Lakeland Limequat as a parent for canker resistance – identified a few resistant hybrids. Budded 380 triploid "acid fruit" hybrids from 2001 crosses, including several hybrids with potential canker resistance from Lakeland Limequat for field evaluation (2004 planting).

SECTION 2 – ROOTSTOCK IMPROVEMENT

Somatic Hybridization: Emphasis continued on production of selected mandarin + pummelo combinations in efforts to develop a replacement for sour orange: eight new hybrids were produced including several with CTV-resistant Chandler pummelo or pre-selected Chandler seedlings, and several with pre-selected nematode-resistant pummelo seedlings. A vigorous somatic hybrid of Murcott + Rubideaux trifoliate orange was also produced. Hybrids produced during 2001/2002 were propagated by rooted cuttings for further evaluation. Several of the new mandarin + pummelo somatic hybrids produced during the past two years were entered into the CTV screening experiment being conducted in the new Core Screening Greenhouse.

Rootstock Breeding/Selection at the Tetraploid Level: More than 50 "tetrazyg" hybrids selected from 2001 crosses were infected with a quick-decline CTV isolate and planted in a challenging field site. These hybrids were also propagated by rooted cuttings and are being prepared for replicated Diaprepes, blight, and/or salinity screening. More than 100 new "tetrazyg" hybrids including some fathered by Cleo + Swingle or sour orange + Flying Dragon for the first time, were selected from 2002 crosses for wide adaptation and Phytophthora resistance. Seed trees of the "tetrazygs" from 2001 crosses were produced and will be planted at the CREC later this year. Seed trees of selected pummelo seedlings (mostly from CTV-resistant 'Chandler') were planted at the CREC and these same selections budded with quick-decline CTV were planted at the Fort Pierce REC. 2003 crosses included several new parental combinations. Identified several 'tetrazyg' rootstocks that were tolerant of the Phytophthora/Diaprepes complex under greenhouse conditions (in cooperation with Jim Graham and Clay McCoy).

Sexual Hybridization/Selection: Four crosses were made in spring 2003 for rootstock improvement, to combine genes for multiple disease resistance, soil adaptations, tree size control, and superior nursery and field performance characteristics. Seed from such crosses made in spring 2002 were collected and sown. Hybrid individuals were selected and grown off for field planting and primary evaluation and selection. Evaluations of previously produced hybrids for tree health and vigor, fruitfulness, seediness, and the degree of nucellar embryony were continued. From this, more than 35 selections meeting minimum criteria were made for advanced trials, and trees have been propagated and/or planted. Seedlings of several hybrids and parents for rootstock breeding were screened in replicated tests for tolerance of high pH heavy soil and for resistance against two species of Phytophthora. Numerous seedlings from crosses of Hirado Buntan pummelo with Amblycarpa and Shekwasha mandarins were selected directly in high pH, calcareous soil inoculated with *Phytophthora*, including ten that were also selected for salinity tolerance.

Field Trials: Tree size data was collected from Valencia and Roble trees on 70 different rootstocks (mostly somatic hybrids and autotetraploids) from the Sandridge trial (McTeer property), and several rootstocks with potential to control tree size were identified; also on the Ridge, a fourth year of yield data were obtained from the Earlygold et al. rootstock trial. Routine data were collected from several trials in the Indian River region, and the initial measurements of tree growth and cropping from Valencia somaclone selections were planted on several rootstocks at two locations: near Bok Tower and Arcadia. A ten-acre trial was planted in Haines City to evaluate new Valencia somaclones and Vernia on several rootstocks (Jim Hughes property). A small trial of Earlygold on seedlings of five selected somatic hybrids was planted in the Haines City area (McTeer). A few hundred trees of Midsweet on seedlings of the sour orange + Carrizo somatic hybrid were planted in St. Cloud as resets (Orie Lee). Ten trees each of Valencia on five new somatic hybrid rootstocks were planted in the blight-screening reset program with Orie Lee in St. Cloud. A small Murcott reset rootstock trial was planted with Wheeler Bros. in Ortona to evaluate Heen and Amblycarpa mandarins, and two mandarin + pummelo somatic hybrids. Propagation of new material continued for

trials on Barron Collier (Silver Strand grove), Becker Citrus (Hobe Sound and B-4), Orie Lee, David Garrett, Lamar Evans, Scott citrus Mgt., Southern Gardens, and McTeer properties. Resets (new material) were planted in several other trials. Triploid mandarin hybrids were budded to two dwarfing somatic hybrid rootstocks and a control in efforts to reduce the field space and time associated with scion development. Propagation was initiated for trials on Barron Collier (Silver Strand grove), Orie Lee, Scott Citrus Mgt., and McTeer properties. Four years of data collection were completed for two cooperator field trials in the IR area.

SECTION 3 – PLANT MOLECULAR GENETICS AND TRANSFORMATION

Gene Cloning: Several candidate genes for citrus transformation have been cloned including: plant genes that influence disease resistance, some from other species; and the early genes in the carotenoid biosynthetic pathway that determine rind/juice color. Progress has also been made towards the cloning of genes involved in cold-hardiness and citrus blight. Several resistance genes at the CTV resistance gene locus have been cloned, and they are being used in experiments to confirm their function and to identify the resistance gene(s) most important for CTV resistance. A number of transgenic plants have been produced to test the activity of these genes; more transgenic plants are being produced. New and more specific molecular markers were developed and used for efficient screening of CTV and citrus nematode resistance. We have isolated several sequences from citrus that are highly similar to the rice *Xa21* gene that encodes resistance to a bacterial pathogen similar to the pathogen causing citrus canker. These sequences are being used to recover similar genes from canker resistant plants for testing against canker in the future.

Transformation: Populations of transgenic grapefruit plants (Ruby Red, Flame, White Marsh, and Duncan) and Carrizo plants containing a hairpin p23 CTV construct (for potential CTV resistance) were produced (using the Agro method), and the in-vitro assay to determine if they are resistant to CTV replication was initiated. Transgenic Hamlin sweet orange plants containing the wild type Xa21 *Xanthomonas* resistance gene from rice were produced using the protoplast transformation system. These plants are being propagated for a canker resistance assay to be conducted in the quarantine facility in Gainesville. The Xa21 c-DNA (intron free) with an added expression tag was cloned into transformation vectors, and transformation experiments were initiated (with a goal of improving canker resistance). The first transgenic Hamlin plants containing the 392-CTVsequence (for potential CTV resistance) were regenerated (via Agro-transformation).

Core Citrus Transformation Facility (CCTF): During this third funding year, the CCTF began to fulfill its function as a service lab for producing transgenic citrus plants by responding for requests to produce transgenic plants for CTV resistance, disease resistance, and orange juice quality. The CCTF is expected to include orders from additional CREC scientists (Diaprepes resistance) and possibly from non-citrus Gainesville scientists (stress tolerance) during the next year.

SECTION 4 – GENERAL

Chris Hook was hired as an assistant to the project manager. The Core Screening Facility was activated with a CTV screening run initiated. Plants to screen for additional traits were propagated. Appropriate colleagues, and a statistician, were consulted to devise screening procedures.

Funding:

FCPRAC Grants	$ 475,000
Agency Contributions	$ 600,000[a]
Other Grants	$ 467,000
In-Kind Contributions	$7,600,000[b]
Total	$9,142,000

[a]Includes PI and USPS salaries and fringe, and special support for the CCTF and greenhouse cost-sharing.
[b]Based on grower contributions through cooperative trials; average land values, grove care, and harvest costs.

Development of Promising New Rootstocks and Scions for Florida Citrus
Project No. 025-02I

Investigators: Kim D. Bowman
Jose Chaparro
Randall Niedz
USDA - ARS - USHRL

Progress Report for FY 02-03, Year 1 of 8.

Abstract

Growers do not make a good profit from trees that decline from disease, are slow to begin cropping, bear poor quality fruit, never produce good yields, or become too large for efficient management and harvest. These problems that reduce production efficiency and profitability can be eliminated by planting better scion cultivars on improved rootstocks. The proposed research will help develop new rootstocks and scions with superior field performance for use by the industry. Candidate rootstock and scion cultivars will be created by hybridization, mutation, and transformation. The most promising new cultivars will be identified through use of biological and molecular screens and entered into long-term field trials at multiple sites. Release of new rootstock and scion cultivars will be based on performance information from these trials over multiple years.

Objectives

1. Create new candidate rootstocks and scions using hybridization, transformation, and mutation.

2. Screen new candidate cultivars to select those with most needed rootstock or scion traits.

3. Establish field trials with the best new rootstock and scion cultivars at multiple locations.

4. Evaluate field performance of the best new rootstock and scion cultivars over multiple years.

5. Release new rootstock and scion cultivars when they appear promising for use in Florida.

Summary of Accomplishments

New crosses to create an improved sour orange hybrid rootstock and improved scions were completed and more than 3000 hybrid seed collected and planted. Budwood of high quality mandarin hybrids were irradiated to generate seedless selections and entered into field tests. New rootstocks and potential parents were tested for tolerance of *Phytophthora* and problematic flatwoods soil in greenhouse and field tests. Two plasmids containing a citrus anti-*Phytophthora* gene were constructed for protoplast and *Agrobacterium* transformation of citrus. Experiments have been initiated (using histochemical staining, western blotting, and real-time PCR) to verify plasmid functionality. Sour orange parental germplasm was evaluated to determine the best sources of CTV resistance. Testing for CTV resistance in new scions and rootstocks developed important new information on solutions to the sour orange CTV decline problem. Performance information on new rootstocks and scions was collected from bearing trials, and new trials were established in additional areas. Results from trials indicate that some new USDA rootstocks and scions under evaluation may be superior to existing cultivars for some common production situations. Hybrid rootstocks US-802, US-897, and US-942 appeared especially promising for test planting on ridge and flatwoods sites and were included in new rootstock trials planted this year. Detailed information on rootstock disease resistance and field performance was reported at 2003 FACTS and several other meetings attended by growers. Presentations on citrus rootstock response to specific disease and soil problems were given at the Florida State Horticulture Society Annual meetings in 2002 and 2003 and manuscripts submitted.

Funding:

FCPRAC Grants	$ 200,000
Agency Contribution	$1,800,000
Other Grants	$ 0
Total	$2,000,000

PLANT IMPROVEMENT/OTHER
Completed Projects

Provision of Office, Computer, and Clerical Support for Dr. Larry Jackson, Scientific Coordinator for FCPRAC
Project No. 0110-11O

Investigators: Harold W. Browning
IFAS - UF - CREC

Progress Report for FY 02-03, Year 1 of 1.

Abstract

The FCPRAC provides significant financial support and direction to citrus production research conducted by IFAS, the USDA, ARS, and other research organizations in Florida and beyond. The grower-driven process has brought greater interaction between the growers and production managers and the research agencies, leading to improved progress towards solving industry challenges related to production. A great deal of this improvement is due to enhanced communication and coordination of efforts, and every opportunity should be recognized to enhance this communication. The CREC, as a major recipient of FCPRAC funding, has the infrastructure in place to support the Research, Extension, and Teaching Programs of the Center and provides access to these facilities to Emeritus Faculty and Visiting Scientists as a matter of course. Thus, the offering of space and support to the FCPRAC Coordinator is in keeping with established policy, and the funding request is to provide for the expendable supplies and to aid in deferring the personnel costs associated with the work load.

Objectives

1. Provide office, computing, and clerical support to FCPRAC Scientific Coordinator at UF, IFAS, CREC.

Summary of Accomplishments

Provision of office, computing, and clerical support was provided at UF, IFAS, CREC during 2002-03 as planned. Office space in building 7110 was made available, and internet- and network-linked computing was available. Clerical support was available to assist with calls for pre-proposals, proposals, processing and managements of proposals, and preparation of the annual report. The UF, IFAS, CREC website remained the electronic home base for FCPRAC, and the calls for proposals, instructions for pre-proposers, and annual reports were updated for broad access. Timely management of the FCPRAC documentation and grant processing by Dr. Jackson was facilitated through the support provided by UF, IFAS, CREC.

Funding:

FCPRAC Grants	$5,000
Agency Contribution	$ 0
Other Grants	$ 0
Total	$5,000

Expanding Citrus Resources Available On-Line
Project No. 021-02O

Investigators: M. A. Ritenour
IFAS - UF - IRREC

James J. Ferguson
IFAS - UF - Gainesville

Progress Report for FY 02-03, Year 1 of 1.

Abstract

In the past decade, computer technology and on-line databases have become much more extensive, reducing the need to physically visit libraries to access critical information. The proceedings of the Florida State Horticultural Society house a wealth of information for the citrus industry. Digitizing citrus-related FSHS papers and organizing them at one web site would allow rapid, easy access. In addition, unlike journal articles and books, proceedings from numerous University of Florida citrus workshops are not widely available, even at libraries. We propose creating a searchable online database of FSHS citrus-related papers (1996-1999) and UF citrus workshop proceedings. The addition of both IFAS workshop proceedings and FSHS citrus-related papers will further enhance the availability of citrus resources available on the internet. These resources can be quickly accessed to solve problems when they occur, or to simply browse through when considering ways to improve one's operation.

Objectives

1. Collect and scan available University of Florida citrus workshop proceedings into the Citrus Resources Web Site and then organize them for easy access.

2. Collect and scan existing citrus papers published in the FSHS proceedings between 1996 and 1999 into the computer and organize and post the information on the Internet for easy access.

Summary of Accomplishments

The printer of the Florida State Horticultural Society (FSHS) Proceedings (E.O. Painter) was contacted, and they graciously provided electronic versions of the entire proceedings from 1994 to 2001. All Citrus Section papers were reformatted (due to changes between program versions), then saved in a common, downloadable format using Adobe Acrobat, and a web page interface created. All original electronic documents, converted documents, and web page interface were then sent to the FSHS web committee chair and FSHS webmaster (Jackie Burns) for posting. This past year, the FSHS BOD also approved posting the entire 2002 proceedings on the FSHS website. The following Proceedings of the Florida State Horticultural Society are now posted at: http://webluis.fcla.edu/cgi-bin/cgiwrap/fclwlv3/wlv3/DGref/DBWM/CM02/P1basic with a link from the Florida Citrus Resources website (http://flcitrus.ifas.ufl.edu/). The site currently includes: The entire 2002 proceedings (Vol. 115); Citrus section papers from the 1995 to 2001 (Vol. 108 to 114) proceedings; Still to come: citrus section papers from 1994 (Vol. 107). The following UF short course and workshop proceedings were collected, scanned into downloadable (pdf) format, organized, and posted on the Florida Citrus Resources Web Site (http://flcitrus.ifas.ufl.edu/): Diaprepes Short Course Proceedings; Citrus Flowering and Fruiting Short Course; Quality Control Assessment Methodology; Citrus Water Management; Factors Affecting Fruit Quality; Fresh Citrus Quality; Citrus Flowering, Fruit Set and Development; Proceedings of the Second International Citrus Short Course: Water Relations; Proceedings of the First International Citrus Short Course; Citrus Maturity and Packinghouse Procedures.

Funding:

FCPRAC Grants	$ 7,965
Agency Contribution	$ 7,000
Other Grants	$ 0
Total	$14,965

FCPRAC PROJECTS APPROVED FOR FY 2003-2004

FCPRAC #	Investigator	Proposal Title	Agency	$$$
002-01 M	Castle	Rootstock Interactions with Disturbed Soil Profiles in Flatwoods Citrus	IFAS - CREC	51,000
005-04 M	Futch	Tree Thinning Studies to Improve the Production and Harvesting of Florida Oranges	IFAS - CREC	10,000
013-02 M	Albano	Nutrient Management for Optimum Production Efficiency	USDA - FT. PIERCE	36,000
013-03 M	Albrigo	Foliar Application of NPK: Comparison of Urea Source, Value of P in the Foliar Application and Time and Rate of Application on Fruit Set and Yield of Florida Citrus	IFAS - CREC	30,000
013-12 M	Singh	Biology and Control of Vines and Other Difficult-to-Control Weeds in Florida Citrus	IFAS - CREC	40,000
013-99 M	Graham	**Block Grant:** Young Tree Replant Failure	IFAS - CREC	90,000
022-01 M	Albrigo	Grower Testing of Florida's DISC (Decision Information System for Citrus)	IFAS - CREC	40,000
022-08 M	Stover	Refining Management Practices to Enhance Citrus Cropping and Improve Fruit Size	IFAS - FT. PIERCE	36,000
032-02 M	Schumann	Implementation of Precision Agriculture Technology to Improve Profitability of Florida Citrus	IFAS - CREC	42,100
032-03 M	Lee	Citrus Yield Mapping System Using Machine Vision	IFAS - GNV	25,000
034-08 M	Parsons	Effects of Irrigation and Fertilizer Management on Sweet Orange	IFAS - CREC	27,500
034-10 M	Schumann	Soil Amendments to Improve Tree Performance on Florida Citrus Soils	IFAS - CREC	32,100
Table 1 - Approved FCPRAC Management Physiology Projects				459,700

FCPRAC #	Investigator	Proposal Title	Agency	$$$
003-04 P	Derrick	Studies to Determine the Cause and Develop Strategies to Control Citrus Blight	IFAS - CREC	56,822
013-05 P	Halbert	Keeping Citrus Propagation Increase Blocks Free of Severe Citrus Tristeza Virus	DPI - GNV	15,480
013-07 P	Graham	Control of Citrus Canker with Novel Chemical Compounds	IFAS - CREC	60,990
013-16 P	Timmer	Biology and Control of Fungal Diseases of Fruit and Foliage	IFAS - CREC	79,000
025-01 P	Dawson	**Block Grant:** Management of Citrus Tristeza Diseases in Florida	IFAS - CREC	250,000
033-02 P	Chung	Identification of Effective Compounds from Antagonisms for Controlling Foliar Fungal Pathogens of Citrus	IFAS - CREC	25,000
033-03 P	Chung	Field Trials of Hormone Inhibitors on Yield Production of Citrus Associated with Postbloom Fruit Drop (PFD) and Fungal Pathogenicity of *Colletotrichum acutatum*	IFAS - CREC	45,000
971-43 P	Derrick	Development of Detection Methods for Citrus Psorosis Virus and Use of the Virus as a Vector to Express Foreign Genes in Citrus	IFAS - CREC	20,000
Table 2 - Approved FCPRAC Plant Pathology Projects				552,292

FCPRAC #	Investigator	Proposal Title	Agency	$$$
013-11 E	Nigg	Maximization of Bait/Pesticide Combinations for Caribbean Fruit Fly Control in Florida Citrus	IFAS - CREC	40,940
013-14 E	Schneider	Mass Production and Rearing Improvement of Diaprepes abbreviatus to Provide Essential Needs of Florida Researchers	DPI - GNV	22,800
022-07 E	Teal	Improving Efficacy of Sterile Insect Technique for Mediterranean and Other Tephritid Fruit Flies with Hormone Supplement Therapy	USDA - GNV	16,064
031-10 E	McCoy	**Block Grant:** Integrated Control of the Diaprepes Root Weevil	IFAS - CREC	321,000
032-01 E	Childers	Assessment of Petroleum Oil Only in 4 Sweet Orange Blocks for Processed Fruit	IFAS - CREC	38,000
032-05 E	Stansly	Biological Control of Citrus Leafminer with the Parasitic Wasp *Citrostichus phyllocnistoides*	IFAS - IMMOKALEE	22,500
971-21 E	Hoy	Classical Biological Control of Citrus Psylla and Pink Mealybug	IFAS - GNV	32,000
Table 3 - Approved FCPRAC Entomology Projects				493,304
FCPRAC #	**Investigator**	**Proposal Title**	**Agency**	**$$$**
0110-31 I	Gmitter	**Block Grant:** A Comprehensive Program for the Genetic Improvement of Florida Citrus Scion and Rootstock Varieties	IFAS - CREC	475,000
025-02 I	Bowman	**Block Grant:** Development of Promising New Rootstocks and Scions for Florida Citrus	USDA - FT. PIERCE	223,000
001-01 O	Browning	Provision of Office, Computer, and Clerical Support for Dr. Larry Jackson, Scientific Coordinator for FCPRAC	IFAS - CREC	5,000
Table 4 - Approved FCPRAC Plant Improvement and Other Projects				703,000
Total for All Approved Projects for Fiscal Year 2003-04 =			**$2,208,296**	