UF/IFAS Fertilizer Rate and Nutrient Management Studies
Addressing SB 2500 (SA 1510A), FY 2023-24

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FDACS Contract #30171
Second Quarterly Report to FDACS-AES
Period covered: October 1 to December 31, 2023
Report date: January 30, 2024

Scope of work

To conduct a study designed to examine the appropriate rate for applying fertilizer on tomatoes, potatoes, citrus, corn, green beans, and any other crop identified by (UF/IFAS) as needing further research for normal and economical crop production. The study shall include recommendations on best management practices for supplying fertilizer to the crop to achieve maximum yield and quality goals of the grower while doing so in a manner that minimizes nutrient inefficiencies to the environment.

Second quarter state-level highlights

Activities and accomplishments

- Field research and maintenance continued with fall cropped tomato and bean plus perennial crops like sod, citrus, and peaches. Activities included site selection, field prep, planting, fertilizer applications, soil/plant/water sampling and analysis, plant growth measurements, remote sensing of plant health, soil moisture measurements, hydrologic data collection, harvesting, measuring yield and quality response to treatments.
- Huge volumes of data were analyzed: treatment effects on crop growth, yield, quality, and nutrient content, drone images, plant and soil sensor data, soil/plant/water test results, and model simulation improvements.
- Research and extension planning and prep for 2024 included IFAS team meetings with grower-cooperators, ordering supplies, preparing a site-specific survey, and hiring technical staff.
- Communications:
    - A communicator was hired to report on north Florida BMP work.
    - A watermelon success story was disseminated.
    - We started a new nutrient management blog (https://blogs.ifas.ufl.edu/nmp/)
    - Poster papers describing project research were prepared, scientific manuscripts were published in peer-reviewed publications, and research was presented at scientific conferences.

Significant findings and/or events occurring during the quarter

- Crop response to nutrient treatments:

    - Corn response to N sources was mixed.
    - Banding N fertilizer to corn improved efficiency.
    - Fertilizer rates correlated with plant nutrient content and fruit quality in peaches.
    - Tomato and bean yield increased with P rate in central and south Florida on soils that tested "high" in P according to the IFAS Mehlich 3 interpretation.
- Results of extractable soil P analysis differed depending on the type of instrument used to measure P in the lab (ICP vs UV). This finding suggests that evaluation of the M3-P soil test number should consider the lab instrument used.
- Soil N at various depths within and below the root zone were related to fertilizer rates.
- Carrot growers are considering adopting the new IFAS N management recommendation.
- Communication events:
    - Research updates presented at the Cold Hardy Citrus Field Day, SE Fruit & Vegetable Conference, and Watermelon Institute.
    - A vegetable research update was provided at an FFVA committee meeting.

Activities planned for the subsequent quarter

- Start or continue field research work (select/maintain sites, prepare plots, apply fertilizer, plant, install field sensors, collect soil/plant/water samples, drone missions, harvest, measure crop yield and quality responses to treatments, economic evaluation).
- Data analysis (soil/plant/water tests; crop yield and quality; crop modeling).
- Communication events:
    - Stakeholder education at NFREC Citrus Health Forum.
    - Discuss research results with Suwannee Basin corn growers committee.
    - Tomato, potato, bean, and corn discussion with Plant Nutrient Oversight Committee.
    - In-service training for extension faculty.
    - Prepare blogs.
    - Present research results at professional meetings, e.g., Southeastern Fruit & Vegetable Conference.
    - Prepare peer-reviewed research and extension publications.
    - Send site-specific survey questions to stakeholders.

Progress made towards overall project objectives

- High volume of soil and fertilizer response data accumulated will help improve soil test calibration and define site-specific nutrient management BMPs.
- Carrot recommendation (including use of controlled-release fertilizer) appears to be accepted by producers.
- Investigators published new extension documents on nutrient management.
- Excellent progress towards updating corn, tomato, potato, and bean recommendations.
- We are on the road to clear, holistic, and adaptable IFAS recommendations that will include:
    1. Soil test interpretation for the crop.

2. Target soil pH and lime recommendation if needed.
3. Fertilizer:
    - Rates (N, P_2O_5, K_2O, Mg, other nutrients).
    - Timing.
    - Placement (broadcast, sidedress, banding).
    - Sources (chemical form, water-soluble, CRF, EEF).
4. Water management.
5. Site-specific aspects.

Identified obstacles or challenges

- Bad weather: December 2022 freeze decreased 2023 north Florida citrus yield; heavy rain in the fall flooded some south Florida vegetable fields; drought in northwest Florida affected non-irrigated corn production.
- Delays (lab analysis, field sampling, finding and hiring qualified personnel).
- Potato seed availability.
- Difficult to find suitable experimental sites on commercial farms.
- Year-to-year funding complicates long-range planning.

Individual investigator quarterly reports (from north to south)

1. **Optimizing Nitrogen Management by Improved Fertilizer Placement and Utilizing Enhanced Efficiency Fertilizers** – Hardeep Singh – WFREC, Jay

Activities and accomplishments

- Harvested cotton trials at WFREC.
- Graduate student completed the analysis for samples from acid traps for ammonia volatilization.
- Ginned cotton samples and received lint quality analysis from Fiber and Biopolymer Research Institute at Texas Tech University.
- Presented results from the 1st-year corn and cotton trials at 2023 ASA-CSSA-SSSA meeting in St Louis.
- Graduate student Kulpreet Singh is writing a review article focused on use of enhanced efficiency fertilizers in row crop production systems.
- Investigator and graduate student met biweekly to discuss progress on data analysis and considerations for 2024 field trials.

Significant findings and/or events occurring during the quarter

- For the “right source” experiment in industrial hemp, urea + urease inhibitors resulted in the tallest plants (105 cm) and above-ground biomass (9,755 kg/ha), while UMAXX resulted in highest stalk biomass (3653 kg/ha) and seed weight (3,553 kg/ha).
- For the “right place” trial in cotton, there was no significant difference among placement treatments for seed cotton yield, but banded urea at the rate of 67.5 kg N/ha produced the highest numerical yield.

- There was no significant effect of nitrogen fertilizer sources on cotton yield and lint quality.
- This year, our cotton yields were significantly lower compared with previous years due to the long drought period experienced in August and September that is not common in normal years.

Activities planned for the subsequent quarter

- Preliminary results will be discussed with producers during extension meetings across panhandle Florida counties.
- The results from the 1st-year industrial hemp trial will be presented at the 2024 Southern Branch ASA meeting in Atlanta.
- Site will be selected for 2024 trials at West Florida Research and Education Center, Jay.

Progress made towards overall project objectives

- We successfully completed first year trials for evaluation of N fertilizer management for agronomic row crops in north Florida that will lead to improved BMPs for row crop fertilization.
- Field trials for corn, industrial hemp, and cotton have all been harvested.
- Excellent progress was made on sourcing and purchasing equipment and hiring the required personnel for the project.
- We are on target to achieve the project objectives.
- The FY 2023-24 plan of work is **40% complete**.

Identified obstacles or challenges

- None.

2. Developing Site-Specific Recommendations on Nitrogen Application Rates and Timing for Cold Hardy Citrus Production in North Florida – Muhammad Shahid – NFREC, Quincy

Activities and accomplishments

- Satsuma mandarin fruit were harvested for yield and quality analysis in October and November.
- SPAD and physiological attribute data were collected.
- Research results were presented at the Soil Science Society of America annual meeting, Oct 29-Nov 1.

Significant findings and/or events occurring during the quarter

- The investigator organized and presented at the Cold Hardy Citrus Field Day at NFREC in October, where more than 100 attendees including Florida and Georgia growers were updated with project findings.
- Project results were shared regionally with southern fruit workers at their conference at NFREC in November.

Activities planned for the subsequent quarter

- An investigator-organized educational Citrus Field Day is scheduled for February 22.
- First fertilizer treatment applications of 2024 will occur.
- First soil and tissue sampling of 2024 will occur.
- Trees in the young planting orchard that died due to the Christmas 2022 freeze will be replaced.
- Data from soil and sap-based sensors will be collected.

Progress made towards overall project objectives

- We are making good progress documenting impacts of fertilization rates on tree growth and performance, nutrient loads to the environment, and leaf nutrient status in space and time.
- The FY 2023-24 plan of work is **60% complete**.

Identified obstacles or challenges

- Severe cold damage due to the Christmas 2022 freeze resulted in a fruit yield less than 10% of anticipated in the 2023 harvest.

3. **Precision Ag Research to Fill Knowledge Gaps and Increase Adoption in North Florida Nutrient Best Management Practices** – Robert Hochmuth – NFREC Suwannee Valley, Live Oak

Activities and accomplishments

- Ms. Sydney Williams was hired as a Research Coordinator II. Sydney and Bob Hochmuth developed a plan of action to implement during the next year. We communicated our plan to Extension Agents in the Suwannee Valley and described Sydney's role in implementing this plan.
- As a result of 6 years of N fertilizer management research on carrot at NFREC-SV that included work with controlled release fertilizer (CRF), UF/IFAS developed a successful program using CRF with a split application, one at planting and one at 45-50 days after planting. This project was conducted in collaboration with the main carrot growers in the region and allied industry representatives, with funding support from FDACS, Office of Ag Water Policy. The collaboration has resulted in the first on-farm adoption of this CRF program on a 20-acre field in the region.
- Following the Suwannee Valley Extension Team's completion of a watermelon CRF project on 7 farms in the summer of 2023, extension faculty met with each farmer to review the results on their farm. An interview with each farmer was conducted and the results were summarized. This effort was a huge on-farm project involving a few hundred acres of watermelons across 5 counties.
- CRF BMP Watermelon Success Story:

- After participating in this project, farmers agreed that the CRF can deliver comparable total yields when employed as a BMP compared with conventional fertilizer programs.
- Farmers agreed the additional cost of CRF must be somewhat offset by other benefits, but farmers differed in the types of offsets they were seeking. For example: less time and labor, potentially higher yield, less leaching losses (therefore reduced N use), lower fuel expense, increased likelihood of meeting the required N rate target, fewer decisions to make on fertigations, and less fertigation events needed.
- One of the most important gains in knowledge noted on 100% of the farms was the importance of managing the drip irrigation system regardless of the fertilization program used, e.g., conventional or CRF.
- Overall impact: In cases where the correct season-long polymer fertilizer coating (proper release time) was used and proper irrigation management was followed, we observed somewhat higher yields, less leaching of N and K (based on soil sensor data), and lower total N rates used.

Significant findings and/or events occurring during the quarter

- We developed two blogs: "UF/IFAS Researchers in North Florida Examining Watermelon Best Management Practices" and "On Farm Extension Demonstrations Evaluating the Use of Controlled Release Fertilizers in Comparison to Conventional Fertilizers in Watermelons."
- Two BMP-related posters were accepted by the Southeast Regional Fruit and Vegetable Conference to be held in Savannah, GA in February: "Soluble and Controlled Release Fertilizers in Watermelon for Yield and Leaf Tissue Nutrients," and "2023 Controlled Release Fertilizer Watermelon On-farm Demonstrations."
- BMP topics were presented by Research Coordinator S. Williams and extension faculty R. Hochmuth, T. Sanchez-Jones, M. Warren and T. Pittman at the 2023 Suwannee Valley Watermelon Institute held in Fanning Springs in November. BMP topics included alternative approaches to improve N use efficiency and reduce N leaching using CRF or an all-liquid weekly fertigation program. One important finding common to several of these projects is the importance of irrigation management as part of a comprehensive BMP program. The use of soil moisture sensors is critical to properly manage water.

Activities planned for the subsequent quarter

- S. Williams will develop 1 to 2 blogs per month about BMP successes in the Suwannee Valley and develop a way to link BMP projects in the region to various web sites such as one at NFREC-SV. Sidney will develop an interactive map identifying BMP projects being conducted at NFREC-SV and on farms in the region, and will submit educational posters on BMP work at various professional and stakeholder meetings.
- We will present the posters at the SE Regional Fruit and Vegetable Conference in January in Savannah, GA. R. Hochmuth will speak at this same conference on watermelon water and nutrient management. Growers from Florida and surrounding states attend this conference. R. Hochmuth will also presenting this BMP work at the

Alabama Fruit and Vegetable Conference and at the Georgia Watermelon Association Annual Convention.

- Research activities at NFREC-SV will include several N rate and BMP projects on corn, snap beans, carrots, and watermelon. This work represents as many as 12 trials.
- The UF/FAS Extension Florida Stakeholder Engagement Program (STEP) will be implemented for the 3rd year, growing corn at NFREC-SV. The competition is devised to introduce BMPs and new technologies while generating data on what makes for a successful harvest.
- The Corn BMP Advisory Committee will meet to review research data and discuss future research needs.

Progress made towards overall project objectives

- Our carrot research led to an updated N management recommendation using CRF sources of N, following UF/IFAS research on conventional N fertilizer rates that supported a recently-adopted carrot N recommendation of 200 lbs/acre. A new EDIS document was published in 2023 on this topic: "Carrot (Daucus carota) Production in the Sandy Soils of North Florida: Nitrogen Fertilization Guidelines" by Morgan Morrow, Vivek Sharma, Robert C. Hochmuth, Charles Barrett, and Marina Burani-Arouca.
- Our on-farm watermelon research has helped develop acceptance among farmers of CRF N as a BMP and a possible solution to reduce N losses to leaching in the sandy soils of Florida. It is estimated there will be more than 2,000 acres of CRF used on Florida watermelons in 2024 due to the ongoing research and extension work during the past 6 years.
- Great effort is being expended by several UF/IFAS faculty and staff in research and extension activities targeted at field and silage corn growers in the Suwannee Valley. We are beginning to see adoption of techniques that improve N-use efficiency through side-dress applications compared with broadcast applications. Current research is evaluating N sources, rates, placement, and timing (4Rs) to continue to refine corn BMPs for N.
- The FY 2023-24 plan of work is **25% complete**.

Identified obstacles or challenges

- Having sufficient support staff at times is a challenge to keep up with so many activities.

4. **Quantifying Nitrogen and Phosphorus Losses Using Advanced Tools to Estimate Nitrogen and Phosphorus Requirements** – Lakesh Sharma – Soil, Water, and Ecosystem Sciences, GNV

Activities and accomplishments

- The cover crop trial is still in place on the same plots where the corn was planted to evaluate biomass production and N mineralization by the cover crop mix (arugula, mustard, sorghum sudangrass, and sunn hemp) resulting from different N rates applied to previous cash crop (corn).

- Cover crop trial biomass and soil sampling were conducted at 30-day intervals; the last sampling was completed mid-December.
- LI-COR 600PF handheld porometer equipment was ordered in early December.

Significant findings and/or events occurring during the quarter

- A manuscript entitled "Yield and plant height predictions of irrigated maize through remote sensing in north Florida" was submitted to *Computers & Electronics in Agriculture*. Authors: Diego Arruda Huggins de Sá Leitão, Ayush Sharma, Aditya Singh, and Lakesh Sharma. Manuscript was accepted and published in December 2023.

Activities planned for the subsequent quarter

- Finish N budget paper including data from both sites and both years.
- Write a review paper on N management for corn in Florida.
- Collect leachate samples monthly from the lysimeter plots.
- The corn committee will meet on January 19 to hear a full report on 2023 data collection and analysis.
- Corn N rate study will resume in March.

Progress made towards overall project objectives

- Fig. 1 shows the relationship between nitrogen (N) rates and corn yield for Site 1 and Site 2 in 2023. Analysis of variance results showed that the interaction between location (Site 1 and Site 2) and N rates (0, 70, 140, 210, 280, and 350 lbs/acre) was significant. Tukey's test was performed to compare yield means across rates x sites. The highest average yield was observed at Site 2 with 280 lbs/acre, while the lowest average yields were observed at 0 lbs/acre, regardless of location.

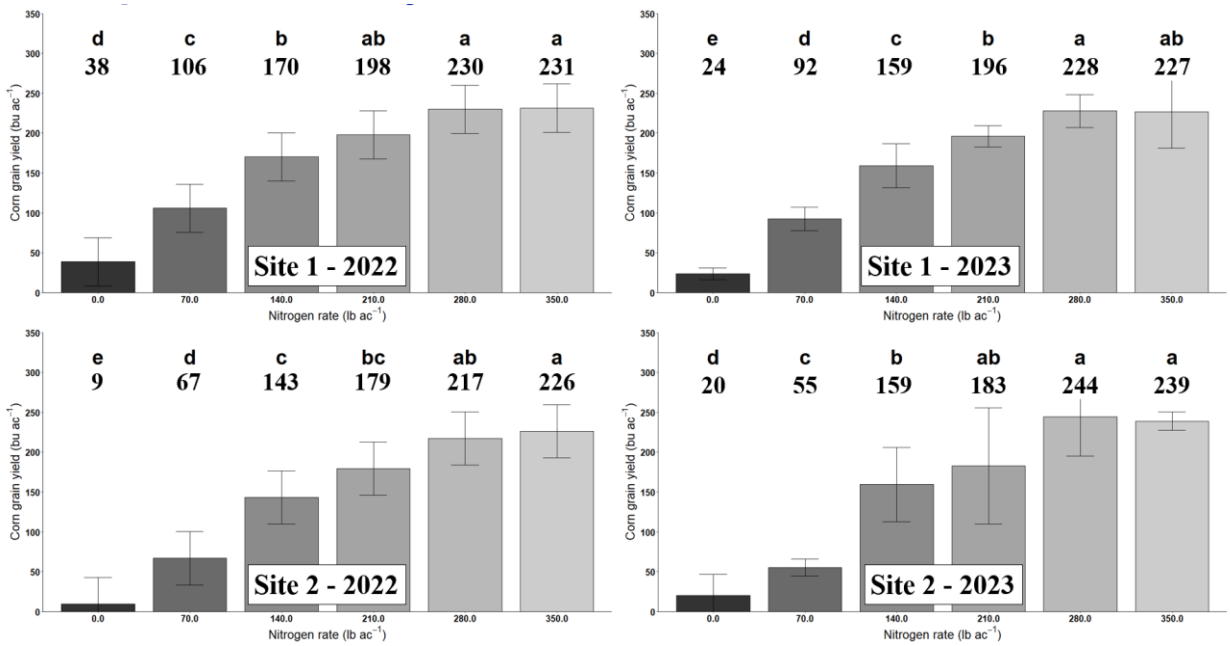


Fig. 1. The N rate treatment analysis using mean separation test.

- We noticed that the yield difference between 280 and 350 lbs N/acre was not significant when combined across years (Fig. 2).

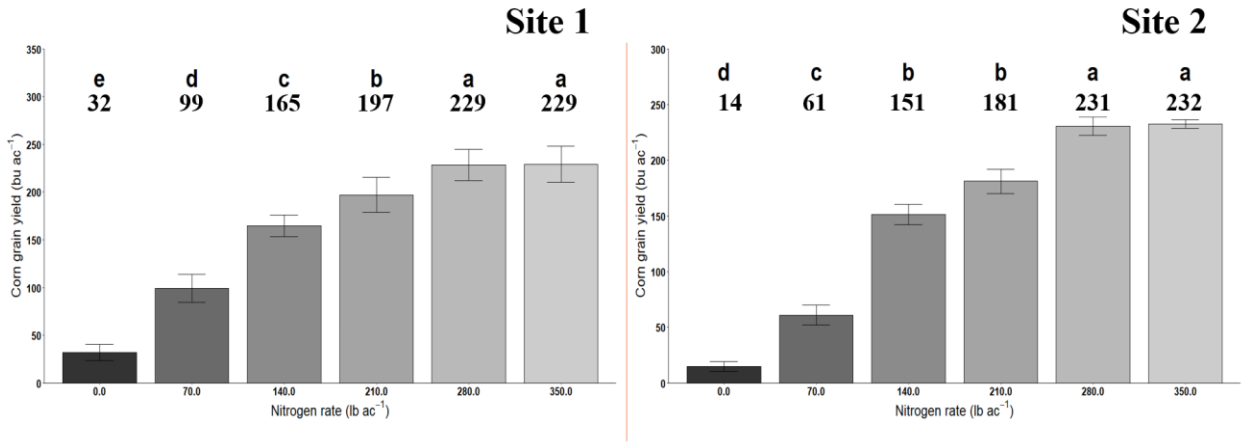


Fig. 2. N rate analysis with combined years 2022 and 2023.

- We have not received a complete dataset of results for soil and plant data, lacking soil nitrate-N and N uptake. Therefore, we were not able to analyze the data statistically. As soon as we received the remaining results, we will analyze the complete data set, including both sites and both years.
- The FY 2023-24 plan of work is **80% complete**.

Identified obstacles or challenges

- No challenges were identified during the second quarter.

5. **Optimizing Phosphorus Management for Snap Bean Production in North Florida** – Guodong (David) Liu – Horticultural Sciences, GNV

Activities and accomplishments

- Assessed bean plant biomass production by sampling plants 7 times from late September to early October.
- Measured leaf greenness (SPAD readings) and petiole sap to assess plant growth and tissue nitrogen (N) status six times from early October to early November.
- Sampled soil to evaluate nutrient status five times between early September and early November.
- Measured fresh bean yield on November 11.
- Successfully completed the field trial at the Hastings Agricultural Extension Center.

Significant findings and/or events occurring during the quarter

- Snap bean pod yield consistently increased as the P fertilizer application rate increased from 40 to 240 lbs P_2O_5/acre.

- The application of 40 lbs P_2O_5/acre resulted in significantly greater yield compared with the zero P application treatment.
- A P_2O_5 application of 120 lbs/acre led to a significant increase in pod yield.
- Beyond 120 lbs P_2O_5/acre, pod yield continued to increase up to 240 lbs/acre, although not significantly.

Activities planned for the subsequent quarter

- In March 2024, we are set to initiate a new field trial in Citra.

Progress made towards overall project objectives

- We are progressing toward the overarching objective and aim to formulate a recommendation by 2024.
- The FY 2023-24 plan of work is **50% complete**.

Identified obstacles or challenges

- During the fall 2023 growing season, rainfall totaling 7 inches on October 12-13 introduced more noise into the yield data than anticipated.

6. **Phosphorus Fertilizer Application Timing and Source Study for Potato in NE Florida** – Christian Christensen – Hastings Agricultural and Extension Center (HAEC), Hastings

Activities and accomplishments

- We finalized preparations for our research farming activities, cementing timelines with Drs. Zotarelli, Sharma, and Ester Ricken for Spring 2024's potato season.
- Site selections at HAEC are complete, and our experimental design, including sampling schedules and treatment distribution, remains as planned, ready for immediate implementation.
- Potato seed and fertilizer for the trials have been ordered.
- Pre-season soil sampling was conducted in November.

Significant findings and/or events occurring during the quarter

- None currently. Efforts are ongoing to review the results from the trials conducted during Spring 2022-2023 in Northeast Florida to identify opportunities for improved research outcomes during the Spring 2024 potato production season and trial.

Activities planned for the subsequent quarter

- Soil from three production sites at HAEC will be sampled in January, 30 days prior to planting. Potato planting is expected on February 6.
- Commercial-grade fertilizers (10-0-10 w/sulfur, 0-46-0, 8-0-8, and 11-37-0) will be ordered in preparation for the Spring 2024 production season.

Progress made towards overall project objectives

- Our experiments will provide multiple-year evidence to describe the optimum phosphorus fertilizer source and timing of application for potato production in northeast Florida considering soil P availability using either Mehlich-1 (M1) or Mehlich-3 (M3) soil testing. We are measuring total and marketable tuber yield, plant biomass and P uptake, and P-fertilizer use efficiency to support an update of the current UF/IFAS P-fertilizer management recommendation.
- At the time of this report, Spring 2024 potato production timelines and inputs have been finalized and procured from vendors (fertilizer, seed, chemistry, etc.).
- The FY 2023-24 plan of work is **50% complete**.

Identified obstacles or challenges

- HAEC's capacity to meet our anticipated planting date depends on two major factors currently: 1) Availability of seed from vendors in Maine and 2) Agreeability of weather closer to the projected planting date.

7. **Benchmarking Site-Specific Nutrient Management Practices in Florida Cropping Systems** – Emma Matcham – Agronomy, GNV

Activities and accomplishments

- Lauri Baker and Rachel Stormant created a draft survey intended for Certified Crop Advisers (CCAs) that is being tested and evaluated by team members and trusted colleagues. Editing and feedback has taken longer than expected, so survey distribution has not yet begun.
- Identifying a minimum data set for site-specific nutrient management (SSNM) research and management decision making will occur once the survey is distributed.
- Emma Matcham and two lab members (Danny Palacio and Lauren Geiss) began identifying common terms that should be considered for inclusion in a "Glossary of Terms for SSNM. Current BMP guidelines, SSNM reports, and SSNM grant proposals were used to find terms.
- A post doc candidate, Osvaldo Gargiulo, was hired in December to start developing a prototype decision matrix tool for one Florida crop. His first day was 5 Jan 2024.
- Across project objectives, the team met monthly to discuss timelines and tasks.

Significant findings and/or events occurring during the quarter

- We have no significant findings to share at this time.

Activities planned for the subsequent quarter

- The team meeting in January will focus on finalizing the CCA survey and planning focus groups for glossary development.

- The team will focus on distributing the survey that is essential for the continuation of the remaining objectives. We expect to identify the crop for the prototype tool in January, and we will focus on drafting the glossary in February.

Progress made towards overall project objectives

- The survey we are developing will help us understand current recommendation practices that agronomists are using for precision nutrient management across the state.
- Understanding current practices will allow us to identify future SSNM strategies that are well suited to the needs of farmers and consulting agronomists.
- Creation of a glossary will help standardize communication across nutrient management professionals.
- The FY 2023-24 plan of work is **20% complete**.

Identified obstacles or challenges

- None.

8. **Using Artificial Intelligence for Improved Crop Nutrient Management** – Lincoln Zotarelli – Horticultural Sciences, GNV

Activities and accomplishments

- A universal data template developed in collaboration with FDACS was tested using field trials observations reported by this project's lead investigator and colleagues. Later, data were used to calibrate a crop model (SUBSTOR-Potato model of DSSAT) and to generate additional DSSAT simulated data between sampling dates.
- The additional DSSAT simulated data were used to train a machine learning (ML) model (LSTM-Long short-term memory) to understand the nexus of soil mineral nitrogen (SMN) with changing weather conditions and fertilizer application rate-timings. Subsequently, progress was made using the SMN observations to fine-tune the LSTM model's parameters, improving its accuracy in estimating SMN between sampling dates.
- The combination of the DSSAT and the LSTM models was referred to as the hybrid-LSTM model. The features used for developing the hybrid-LSTM model were rainfall, average air and soil temperatures, applied N fertilizer rate-timings, and the DSSAT simulated SMN. Moreover, an additional feature to capture potential leaching was used in the hybrid model, calculated using fertilizer application rates and rainfall. After training, the hybrid-LSTM model was tested and its performance was compared with the DSSAT model.
- Since the hybrid-LSTM model depended on DSSAT simulations, we started exploring ways to reduce or eliminate our dependence on the DSSAT model. Hence, we developed several hypothetical scenarios and produced DSSAT simulations on them. The hypothetical scenarios included varied planting dates (10 weekly dates between Jan 1 and Mar 5), N-fertilizer application rates (0 to 196 kg/ha in 28 kg/ha increments) and

timing (applying at pre-planting/planting, emergence, and tuber-initiation), and irrigation depths (30, 40, 50, 60 cm) and threshold (50, 60, 70, 80, 90, 100%). These hypothetical scenario-based DSSAT simulations will be used to develop multiple ML models to capture the dynamics of crop response, yield, SMN in potato cropping system while reducing our dependence on the DSSAT model.

- Moreover, we planned to include multispectral imageries from 2022 and 2023 field trials conducted in Hastings to estimate plant growth and N content, and possibly yield prediction using ML models.

Significant findings and/or events occurring during the quarter

- The hybrid-LSTM model outperformed the DSSAT model for most farms and years to provide improved SMN estimates, reducing normalized root mean square error (nRMSE) from 18 to 31% compared with DSSAT-simulated SMN. The hybrid-LSTM model was able to improve upon calibrated and uncalibrated DSSAT simulated SMN daily values consistently for all the farms and years.
- We successfully performed DSSAT simulations under all the hypothetical scenarios for 22 years (2001-2022). We ran about 4.5 million simulations containing about 610 million rows of data. The big data included daily values of plant/tuber growth, SMN, N leaching, N uptake, soil moisture, and irrigation rates.
- A promising baseline transformer ML model was developed using a small subset of the big data to generate DSSAT-like SMN values for a specific scenario.
- The data pipeline has been developed to preprocess raw multispectral drone imageries into ML usable format. The data pipeline includes image stitching, georeferencing, ground truth labelling, and extracting plot-level vegetative indices.

Activities planned for the subsequent quarter

- We plan to continue improving the transformer-based generative ML model to reduce DSSAT dependency using hypothetical scenarios-based DSSAT simulations.
- We plan to build an ML model using multispectral data to predict plant biomass and tuber yield. Moreover, we will collect more frequent drone data (hyper/multispectral data) for the upcoming crop cycles starting Jan 2024 to aid in the ML model training.
- We plan to combine/fuse all the ML models developed incorporating the knowledge of different sources of data to improve the overall understanding of potato cropping system and provide nutrient management recommendations under varied climate conditions. The approach will be used for creating a web-based decision support system for crop nutrient recommendations later.

Progress made towards overall project objectives

- Our earlier analysis showed that soil N had a major impact on tuber yield. However, the observed soil N data were limited and could not be used directly to train ML models to estimate daily soil N. Hence, we developed a hybrid-LSTM model that could estimate daily soil N between sampling dates.

- Currently, we are developing various ML models to estimate the response to weather conditions and soil N dynamics on plant growth and N leaching using multispectral drone data and hypothetical scenarios based DSSAT simulations. This approach could aid in developing standalone ML models, minimizing the DSSAT dependency. The approach would be used to provide crop nutrient recommendations under different climate conditions, and possibly simplified tools for decision support systems. The methodology developed would extensively be used for other crops and nutrients like phosphorus, potassium, sulfur.
- The FY 2023-24 plan of work is **40% complete**.

Identified obstacles or challenges

- None.

9. Evaluation of Site-Specific Plant P Bioavailability and Lab Accuracy on Mehlich-3 P Fertilizer Recommendations – Vimala Nair – Soil, Water, and Ecosystem Sciences, GNV

Activities and accomplishments

- We have completed Mehlich 3-Phosphorus (M3-P) analyses for more than 600 soil samples received from January through August 2023 (Table 1). Samples came from seven locations including Arcadia, Clewiston, Balm (GCREC), Hastings, Immokalee, Lake Wales, and Live Oak (NFREC).
- All samples were analyzed by Waters Agricultural Laboratory (analyses done on an ICP that measures total P in the M3 solution) and the Environmental Soil Chemistry Laboratory (ESCH) at UF (using a UV spectrophotometer which measures inorganic P) to compare the data received using these different instruments for the same M3-P solution.
- Data were analyzed statistically to determine the difference in M3-P by the two procedures. Colorimetrically-analyzed P measures the inorganic P in solution while ICP measures Total P (TP) in solution, including inorganic P and other P forms extracted by M3. Therefore, **the M3-P recommendation must specify the instrument used to determine P**.

Table 1. Locations, number of samples, and crops grown on the soil samples that were analyzed for M3-P in ESCH lab during the reporting period.

Locations	Number of samples	Crop
NFREC	21	Carrot
Gulf Coast	24	Green bean and potato
Immokalee	51	Tomato, potato, bean
Lake Wales	80	Citrus (oranges)
Hastings	375	Artichoke
Clewiston	40	Citrus (oranges)
Arcadia	40	Citrus (oranges)

- H3A-P analyses of 400 soil samples [200 from the recently completed FDACS (USDA) project, contract number 27155 and 200 composited soil samples collected during the first year of legislative nutrient management funding] was conducted in our lab. The extracted solutions were sent to the IFAS Analytical Research Lab for metal analyses to compare with M3-P analyses.
- Preliminary research results were presented at the American Society of Agronomy/Crop Science Society of America/ Soil Science Society of America Meetings in late October/early November.

Significant findings and/or events occurring during the quarter

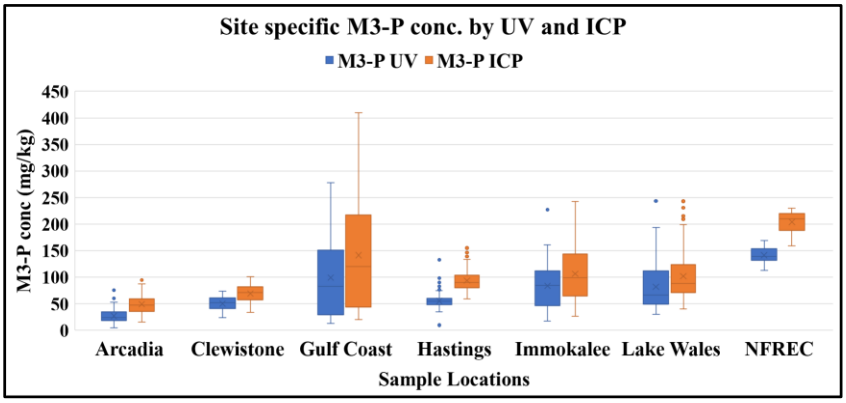


Fig. 1. M3-P concentrations analyzed by UV Spectrophotometer (ESCH lab) and ICP (Waters lab) from more than 600 soil samples collected from seven locations in Florida.

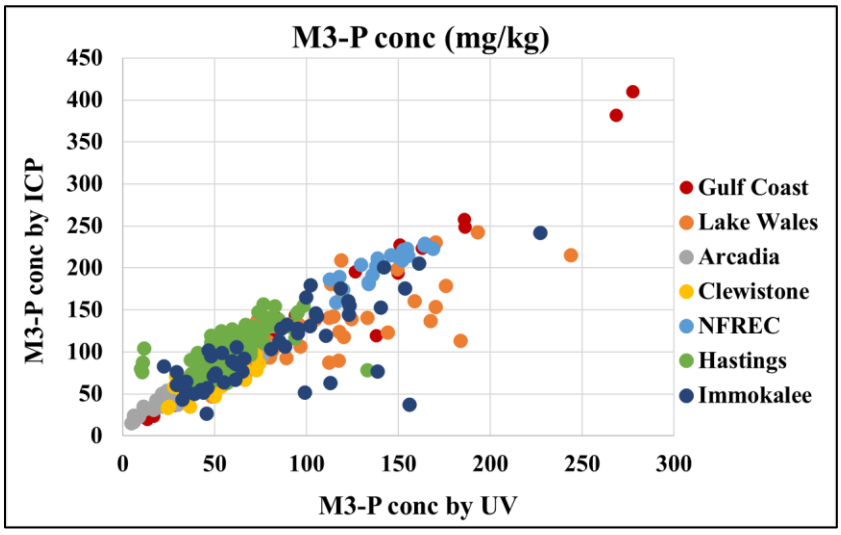
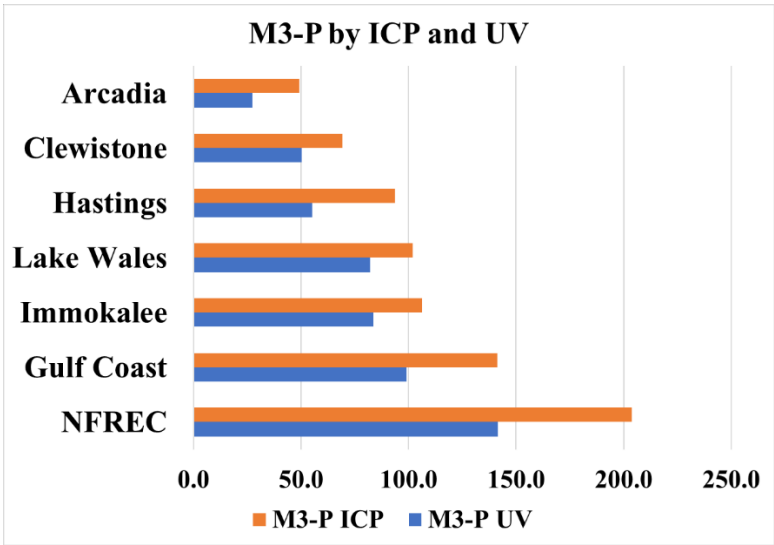


Fig. 2. Relationships of M3-P concentrations by ICP amd UV (colorimetrically by spectophometric analysis). Note that we will be including the USDA samples and the composited soil samples to verify that the scatter at higher P concentrations is site-specific. The lower ranges could be used to recommend M3-P concentrations for plant uptake.



Locations	M3-P UV (mg/kg)	M3-P ICP (mg/kg)
NFREC	141.5	203.9
Gulf Coast	99.0	141.4
Immokalee	83.7	106.4
Lake Wales	82.1	102.1
Hastings	55.3	93.5
Clewistone	50.3	69.3
Arcadia	27.2	49.1

Fig. 3. Average concentrations of M3-P from different sites of Florida analyzed by ICP and UV. Note the variation in M3-P concentrations for the various locations. Fig. 2 shows that the relationship between M3-P concentrations by the two procedures is more scattered as P concentration increases. Additional samples from other locations and under different cropping systems will be included as data become available.

Activities planned for the subsequent quarter

- When H3A analyses for the samples in Table 1 are completed, we will evaluate the relationship between H3A-extractable P, major and micronutrients with those for M3-P extractable P, and major/micronutrients as an indicator of available vs. extractable plant nutrients. Comparison of P in H3A and M3 extractants with FeO-P will also be evaluated to identify plant-available P in the various solutions.

- We will perform M3-TP analyses using the same M3-P extractant, digesting it in acid and analyzing for TP (all done in-house, colorimetrically) for 800 new soil samples (received in 2023 from various Florida locations: Lake Alfred (citrus group) and Immokalee/Balm/Hastings (vegetable group). A subsample of the M3-P extracted solution will be sent to ARL for TP analyses by ICP. We anticipate that the analyses for TP will be similar for the in-house digested samples and ARL analyses.
- We will identify P in the solid state via X-ray diffraction on representative soil samples, especially when there is underlying calcareous material below a thin surface soil layer.
- We will study the relationship of M3-P with other soil components (particularly Ca and Mg) to address variability in bioavailable P under *site-specific* conditions.

Progress made towards overall project objectives

- Lab accuracy of M3-P determination is of fundamental importance before any crop fertilization recommendations can be made. Suggestions based on findings so far:
    - Relationship between M3-P determined by ICP and colorimetrically will likely be less scattered at lower P concentrations when Fe and Al are responsible for holding on to P.
    - At higher P concentrations, M3-P determined by ICP (TP in the solution) will depend on other soil components that are site-specific.
- The FY 2023-24 plan of work is **40% complete**.

Identified obstacles or challenges

- Delays in obtaining field soil samples.
- Year-to-year funding makes it difficult to recruit trained personnel.
- Lack of timely reporting of lab results by analytical and commercial labs.
- We obtained new lab facilities that caused additional time devoted to cleaning and rearranging lab space.

10. Developing Optimal Nitrogen Fertilizer Recommendations for Sod Producers in Florida – A.J. Lindsey – Environmental Horticulture, GNV

Activities and accomplishments

- Established research plots at each sod location.
- Performed initial and subsequent monthly fertilizer applications.
- Collected initial field soil and tissue samples that were sent for nutrient analysis.
- Monthly field data collection (turfgrass quality, NDVI, percent cover, etc.).

Significant findings and/or events occurring during the quarter

- Initiation of treatment applications.
- Soil and tissue nutrient analysis.

Activities planned for the subsequent quarter

- Continue the treatment applications and data collection.
- Statistically analyze soil and tissue nutrient analysis results.

Progress made towards overall project objectives

- The project is underway and following the expected timeline.
- Initial soil and tissue nutrient analysis was conducted.
- The FY 2023-24 plan of work is **20% complete**.

Identified obstacles or challenges

- The weather caused some fields to be flooded at times. However, all treatment applications and data collection were accomplished after the fields dried.

11. Developing a Guideline on Nitrogen-Phosphorus-Potassium Application Rates and Timing for Low-Chill Peaches Grown in Florida – Ali Sarkhosh – Horticultural Sciences, GNV

Activities and accomplishments

- Leaf and soil samples collected from research plots in the fall were analyzed for nutrient concentrations.
- Leaf and soil sample data were analyzed.
- Orchard maintenance was carried out, including the foliar application of 15% zinc sulfate to defoliate peach trees in the research plots (a recommended cultural practice in Florida peach orchards).

Significant findings and/or events occurring during the quarter

- The 3 lbs NPK fertilizer treatment showed the highest nitrate (NO_3^-) and ammonium (NH_4^+) concentrations at a soil depth of 30-60 cm, whereas the lowest concentrations were observed at 0-30 cm depth in the 1 lb NPK fertilizer treatment.
- The phosphorus (P) concentration peaked in the 3 lbs treatment at the 0-30 cm soil depth and in the 2 lbs treatment at the 30-60 cm soil depth. Potassium (K) reached its highest concentration at the 0-30 cm soil depth with the 3 lbs fertilizer treatment and at the 0-60 cm depth with the 2 and 3 lbs treatments.
- The 3 lbs treatment exhibited the highest sulfur (S) concentration in the top 30 cm of soil.
- The highest concentrations of leaf nitrogen (N) and iron (Fe) were observed at the 3 lbs treatment, while the lowest leaf N concentration was noted in the control treatment.
- The lowest leaf zinc (Zn) concentration occurred at 3 lbs. No significant differences were found among treatments for S and copper (Cu).
- The 2 lbs treatment exhibited the lowest Ca concentration in the leaves.

Activities planned for the subsequent quarter

- We will collect leaf and soil samples prior to the first fertilizer application in 2024.

- First application of fertilizer treatments.
- Orchard maintenance, including fruit thinning.
- Collect additional leaf and soil samples prior to the second fertilizer applications.

Progress made towards overall project objectives

- Highest fruit quality was observed in the 2 and 3 lbs NPK fertilizer rate treatments, with no significant difference between the two.
- Highest NO_3^- and NH_4^+ concentrations were observed at a soil depth of 60-90 cm in the 3 lbs NPK treatment.
- A draft of an Extension publication entitled " Fertilizer Management Guidelines for Peach Production in the Subtropical Climate of Florida" is in development.
- The FY 2023-24 plan of work is **55% complete**.

Identified obstacles or challenges

- None.

12. Determining Nitrogen Fertilization Requirements for Commercial Blueberry Production in Florida – Jeff Williamson – Horticultural Sciences, GNV

Activities and accomplishments

- Meetings with the grower-cooperators (Kyle Straughn and Chuck Allison) were conducted to coordinate field activities and management practices.
- Individual plots were marked at the Wild Goose Farm according to the previously determined randomization pattern. A randomized complete block design is used at both research locations.
- Pine bark samples were collected from the Wild Goose Farm site in October to measure baseline nutrient content.
- Leaf tissue samples were collected from each of the 30 plots for initial leaf nutrient analyses.
- Two representative data plants from each plot were marked for later fruit yield determination.
- Canopy volume was measured for the data plants in each plot by measuring plant height and canopy width perpendicular to the row. The in-row plant width was assumed to be equal to the in-row plant spacing because the plants had grown together, and branches were intermingled.
- A post-doctoral associate was hired and will begin working on the project on in January.

Significant findings and/or events occurring during the quarter

- The project has not entered its first growing season so there are no significant findings to report.

Activities planned for the subsequent quarter

- The project is still in the beginning stages due to the blueberry growth cycle occurring mainly in the spring and summer. Nitrogen rate treatments will be applied at both grower/research sites (Wild Goose Farm in Umatilla, and Straughn Farms in Archer).
- Leaf and soil samples for each treatment will be collected and analyzed at both research locations.
- Leaf area by N treatment will be determined at both locations.
- Fruit harvest may begin near the end of the quarter depending on weather and other factors. When fruit ripening begins, fruit will be harvested from pre-selected representative data plants from each research plot at both locations. Data plants will be covered with netting to prevent bird predation and/or unintentional harvesting by pickers.

Progress made towards overall project objectives

- The experimental plots have been marked and data plants have been identified. The post-doctoral associate has been hired and is becoming familiar with the project and the two research sites. Initial data collection for soil and leaf analyses has been completed.
- The FY 2023-24 plan of work is **20% complete**.

Identified obstacles or challenges

- None.

13. Developing Site-Specific Nitrogen and Phosphorus Rates for Young and Mature Sweet Oranges, Grapefruits, and Mandarins in Florida – Davie Kadyampakeni – CREC, Lake Alfred

Activities and accomplishments

- Applied fall fertilization treatments to citrus trees.
- Presented research results at the Soil Science Society of America conference, October 29-November 1.
- Disseminated results and findings regionally at the Southern Fruit Workers Conference in Quincy in November.

Significant findings and/or events occurring during the quarter

- Helped conduct a field day centered on cold-hardy citrus production at NFREC-Quincy on October 26, where co-investigator Shahid and postdoc associate Atta presented their work.
- Completed harvesting Hamlin oranges in Arcadia, Lake Wales, and Clewiston, plus the harvest of north Florida Satsuma mandarins in November and December.

Activities planned for the subsequent quarter

- Harvest Valencia oranges in March.

- Co-investigators Dr. Kadyampakeni and Dr. Shahid will present research updates at the Citrus Health Forum in Quincy in February.
- Process fruit quality samples.
- Economic evaluation of the various nutrient management treatments.
- Seasonal data collection to include soil and leaf samples, truck cross-sectional area, and canopy volume.
- First fertilizer treatment applications for 2024.

Progress made towards overall project objectives

- We are making good progress documenting impacts of fertilizer rates, nutrient loads to the environment, and leaf nutrient status in space and time. Our early data analysis (Figs. 1 and 2) revealed no differences between fertilizer treatments.
- The FY 2023-24 plan of work is **60% complete**.

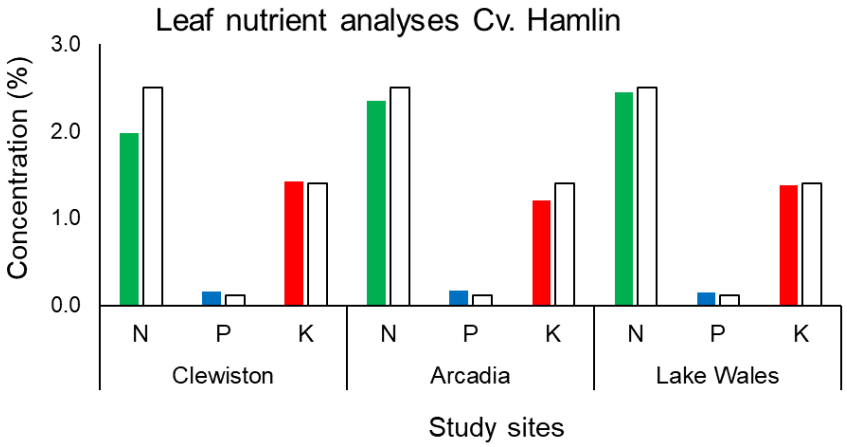


Fig 1. Open bars are optimum ranges for interpreting sweet orange tree leaf analysis for mature spring flush leaves from nonfruiting twigs.

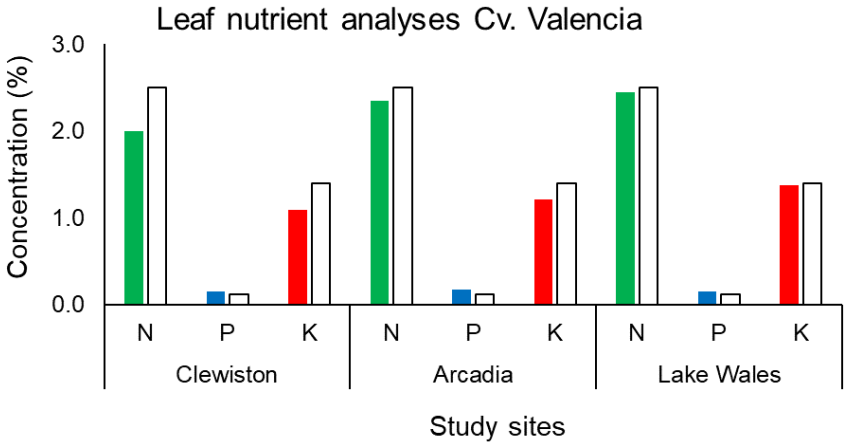


Fig 2. Open bars are optimum ranges for interpreting sweet orange tree leaf analysis for mature spring flush leaves from nonfruiting twigs.

Identified obstacles or challenges

- None.

14. Refining Phosphorus Fertilization Recommendations for Limpograss in South Florida – Joao Vendramini – RCREC, Ona

Activities and accomplishments

- Laboratory analysis of membranes, water, and plant tissue were completed, and the graduate student is compiling and analyzing the data.
- Soil samples collected from various depths at the termination of the experiment were submitted to the laboratory and the results will be completed in late January.
- The graduate student has completed the introduction and materials/methods section of a scientific article. He is waiting for soil analysis data to continue the document.
- A new forage harvester was ordered. It is expected to be delivered in May 2024.

Significant findings and/or events occurring during the quarter

- There were no new significant findings during this quarter. We are waiting for the final soil test results and will analyze the 2-year data of all response variables for the final report.

Activities planned for the subsequent quarter

- We will have the 2-year data for all response variables analyzed and completed in the next quarter. The graduate student will have the first draft of his publication completed as well.
- The research trial will be toured and the results shared with County Extension Agents during the 2024 Range Cattle REC In Service Training to be held in May 2024.

Progress made towards overall project objectives

- We analyzed the 1st and 2nd year (selected response variables) separately. We observed that the current IFAS fertilization recommendation is sufficient to maintain limpograss productivity with no impact on soil P concentrations and water quality.
- The analysis of 1st and 2nd year combined will provide further information about P dynamics and hopefully will confirm the previous findings.
- The FY 2023-24 plan of work is **60% complete**.

Identified obstacles or challenges

- None.

15. Agronomic P Recommendation for Bahiagrass Pastures Fertilized with Biosolids – Maria Silveira – RCREC, Ona

Activities and accomplishments

- The experimental area has been consistently maintained.
- Forage and water samples were collected during the reporting period and laboratory analyses are currently underway.
- A rainfall simulation was conducted in mid-September. All leachate and runoff samples have been analyzed. Additional rainfall simulation and a greenhouse study will be conducted in the next quarter (January).

Significant findings and/or events occurring during the quarter

- A peer-reviewed paper was accepted for publication in Agronomy Journal.
- An abstract was presented at the 2023 Agronomy, Crop Science, Soil Science Society of America annual meeting.
- An abstract was submitted to the 2024 American Forage and Grassland Council Annual Conference.
- An educational webinar was offered in November.

Activities planned for the subsequent quarter

- Continue data collection (forage and soil responses) and finalize laboratory analysis.
- A second rainfall simulation and a greenhouse study will be conducted.
- Disseminate information through peer-reviewed publications, newsletter and extension articles, and extension presentations.

Progress made towards overall project objectives

- Despite the numerous agronomic benefits, land application of biosolids presents some environmental risks if not managed properly. Many of these issues are minimized through the adoption of BMPs. Recent changes in biosolids regulations in Florida are expected to force a larger portion of Class B biosolids to be disposed of in landfills or converted to Class AA materials. Although the totality of impacts of the new regulations are still uncertain, from an agronomic standpoint, pasture productivity is expected to be detrimentally affected. In addition to the reduced biosolids rates, nutrients (including N and P) in biosolids are much less bioavailable than those present in inorganic fertilizer sources. Thus, if applied at equivalent rates, a biosolid is expected to be less effective than inorganic fertilizer in improving forage productivity. Farmers who have historically relied on biosolids as the main source of fertilization for their pastures and hayfields will be forced to seek other sources of nutrients to sustain forage yields. The unintended consequence is that if biosolids are replaced by commercial fertilizer, production costs will increase as will the likelihood of off-site nutrient transport.
- This long-term, instrumented field trial was designed to evaluate the risks and benefits of land application of biosolids to pastures in Florida. Our preliminary data demonstrated that reduced biosolids application imposed by new regulations

detrimentally impacted forage production, nutritive value, and crop N and P recovery, mainly due to limited N and P supply.
- The FY 2023-24 plan of work is **50% complete**.

Identified obstacles or challenges
- Severe drought experienced during the 2023 growing season limited forage production.
- Low soil potassium may have also contributed to the relatively low bahiagrass productivity reported in 2023.

16. Developing Phosphorus Recommendations and Site-Specific Management for Tomato, Potato, and Green Beans through Large-Scale Participatory Research with Stakeholders – Sanjay Shukla – SWFREC, Immokalee and Shinsuke Agehara – GCREC, Balm

Activities and accomplishments
- Yield and plant tissue/soil nutrient concentration data from previous seasons (2021-2023) were processed and integrated into a master database. Formatting the data for statistical analyses continued. QA/QC of data is continuing.
- Hydrologic data (soil moisture, groundwater, rainfall, and irrigation) from previous experimental sites (2021-2023) were processed.
- Drone imagery analysis to aid in evaluating treatment effects is ongoing.
- Started four field experiments (one tomato, two bean, one potato) in south Florida (SFL) and four experiments (one tomato, one bean, two potato) in central Florida (CFL).
- Four P_2O_5 rates were applied to bean in CFL (0, 40, 80, 120 lbs/acre) while five rates were used in SFL (0, 40, 80, 120 lbs/acre plus a grower standard that includes a liquid P application). Setting up SFL bean experiments was time consuming due to use of liquid fertilizer.
- Depending on land availability and planting schedule at the cooperating farms, efforts were made to discuss the availability of more than one field for the experiment with the grower-cooperator. Where possible, additional background sampling was conducted in multiple fields to measure soil test P and discuss the results with the cooperator to select the fields for the experiment. Where soil sampling for field selection was not available, cooperator's past data for the field was used to select the field.
- Yield data were collected from two completed (one bean and one tomato) and one ongoing (tomato) experiment in CFL and SFL.
- Plant and soil sample collection, processing, and shipping to a commercial lab for analyses of nutrient levels continued for the eight ongoing experiments in SFL and CFL.
- Hydrologic data collection instruments such as rain gauges, groundwater level recorders, soil moisture probes, and irrigation flowmeters were installed and maintained at all experimental sites. Data have been compiled for two experiments from the 2023-24 season.
- Drone aerial imagery was collected for all the experiments that were completed.

- Photosynthesis/gas exchange measurements were conducted at the end of the first tomato experiment in SFL.
- Soil sampling and root gall ratings were conducted to analyze for nematodes in one CFL tomato experiment.
- Nine visits were made during the current season to tomato and potato sites to scout for diseases.
- Soil samples were analyzed for iron oxide phosphorus (FeO-P).
- Meetings with grower cooperators and extension agents were conducted to disseminate results from the past seasons and to plan future experiments.

Significant findings and/or events occurring during the quarter

- Preliminary analyses showed that marketable tomato yields increased linearly with P rates in CFL. Leaf P concentrations also increased with P rates.
- Preliminary analyses for the bean experiment in CFL also showed increasing yields with addition of P fertilizer. There was up to 64% increase in marketable yield in CFL compared with the control (no fertilizer P). The yield pattern followed a linear trend.
- Diseases were either not observed during the scouting of the plants or the incidence and severity were extremely low (less than 1% for all sites).
- There was no significant root-knot nematode damage (gall index) in the CFL tomato experiment.
- Average FeO-P in soil at tomato sites in SFL was 45 mg/kg and at potato sites in SFL it was 70 mg/kg.
- There are no other significant findings to report as the major portion of the experiment and data collection for the 2023-2024 is ongoing.
- Dissemination/Extension Activities:
    - Investigator Dr. Shukla provided an update on IFAS nutrient management research projects and plan for the next year to the Florida Fruit and Vegetable Association (FFVA) meeting in Wimauma.
    - The project team continues to discuss the goals, experimental designs, and the results from previous seasons and consult with the grower-cooperators to receive their feedback in designing and implementing experiments.

Activities planned for the subsequent quarter

- The plant and soil nutrient results from the analytical labs will continue to be compiled and QA/QC-ed as they are received and processed.
- One potato experiment and one tomato experiment in SFL, and two potato experiments in CFL will be started.
- Plant and soil sample collection, processing, and shipping to a commercial lab will continue for all the ongoing and future experiments.
- Several ongoing experiments (three tomato, one potato, one bean) in SFL will be harvested.
- Hydrological instruments will be installed at new sites as they become active and monitored/maintained at sites that remain active.

- Drone missions will continue at the ongoing experimental sites.
- Photosynthesis/gas exchange measurements will be conducted on at least one bean site, one potato site, and one tomato site in SFL.
- Scouting for pests and disease will continue. Soil samples will continue to be extracted and counted for nematodes at two tomato sites in SFL.
- Statistical analyses of yield and soil P will begin.
- As available, significant updates will be presented to stakeholders and UF/IFAS Plant Nutrient Oversight Committee.

Progress made towards overall project objectives

- Preliminary results from one bean and one tomato experiment in fall 2023 seem to support the results from last year that showed positive yield response to added fertilizer P for fields with soil Mehlich-3 P concentrations greater than 45 ppm. The current recommendations may need to be revised for bean, potato, and tomato.
- The FY 2023-24 plan of work is **30% complete**.

Identified obstacles or challenges

- Hiring personnel has been delayed due to combination of delays in getting the funds and administrative delays in hiring. This has significantly delayed the project especially the data QA/QC and analyses. Several positions could not be advertised until the end of December.
- Selecting suitable experimental sites, based on several background soil sampling events and analyses, at various farms has been time-consuming.
- Maintenance and quality control of a large database and metadata continues to be a challenge due to personnel shortage.
- Drone missions were disrupted by lengthy repairs to the faulty multi-spectral camera.
- SFL experienced an unusual wet winter starting in mid-November. Excessive rainfall and the resulting saturated conditions caused varying levels of effects at all five SFL experiments from repeating the soil sampling to abandoning the experiment. Rain continued to be an issue and kept fields saturated throughout December. It delayed planting of the two bean experiments and harvesting of the tomato experiment. Sampling of soil, especially below 6 in, was challenging due to near saturation conditions caused by the shallow water table.
- The first SFL potato experiment this year was flooded by historic rainfall. Although the experiment was replanted, the experiment was delayed by 3 weeks. At-planting soil sampling was repeated. Although the experiment suffered these challenges, results from this potato experiment will be representative of wetter than normal growing conditions and will help develop a robust dataset for evaluating P recommendations.
- Like potato, the bean experiment in Palm Beach County also received historic rainfall. Additional rainfall during the latter part of December to the fields that were already wet from rainfall from mid-November to early December caused the entire field to go under water. Flooding had significant negative impact on plant emergence. The loss of plants was so significant that the grower-cooperator decided to discontinue the experiment on

December 23rd. The loss of this bean experiment was unfortunate considering that it required more than 2 weeks to plan and implement due to logistical challenges including the relatively large area (~20 ac) and transportation of a tractor and fertilizer spreader to the farm.

17. Phosphorus Recommendations for Lettuce Grown on Muck Soils – Germán Sandoya Miranda – EREC-Belle Glade

Activities and accomplishments

- A field experiment has been planned.
- A postdoctoral associate position is under recruitment.
- A verbal offer was made to a postdoc candidate.

Significant findings and/or events occurring during the quarter

- No findings or events to report at this time.

Activities planned for the subsequent quarter

- Plant experiments and collect plant/soil samples.

Progress made towards overall project objectives

- The experimental design will result in improved P recommendations for lettuce growers.
- The FY 2023-24 plan of work is **5% complete**.

Identified obstacles or challenges

- Hiring a postdoctoral researcher has taken longer than expected.
- Difficulty arranging an experiment at a commercial farm. Growers have had less ability to cooperate because the crop season has been challenging due to unusual weather conditions. Most of the season has been a wet and rainy, severely complicating field preparation.

18. Optimizing Phosphorus Management for Snap Bean Production on South Florida Calcareous Soils – Haimanote Bayabil – TREC, Homestead

Activities and accomplishments

- Commercial field experiment:
    - Snap bean research was completed with six P fertilizer treatments (0, 25, 50, 75, 100, and 200 lbs P_2O_5/acre).
    - Snap beans were harvested in November.
    - Preliminary yield data analysis was performed and results were shared with the commercial grower.
    - Soil and tissue sample analysis began.

- Experimental activities at TREC:
    - Pre-plant soil samples (n=136) were collected and analyzed for background soil test P.
    - Snap bean was planted to 48 plots in October with six P_2O_5 rates (0, 40, 80, 120, 160, and 200 lbs/ac) under two irrigation schedules (grower standard vs. evapotranspiration-based).
    - Suction lysimeters and soil moisture sensors were installed.
    - Porewater samples were collected opportunistically.
    - In-season soil samples and plant tissue samples were taken every 14 days.
    - Plant height, canopy cover, above-ground biomass, stomatal conductance, leaf greenness (SPAD reading), and leaf water potential data were collected.

Significant findings and/or events occurring during the quarter.

- There was very high background soil test P (471 ppm on average) in the commercial field experiment.
- Preliminary results from the commercial field showed that the 50 lbs P_2O_5/acre rate resulted in the highest snap bean yield compared with the control and other P rates. However, it should be noted that the grower applied side dressing and foliar application of P and micronutrients.

Activities planned for the subsequent quarter

- At TREC, Homestead:
    - Continue collecting soil, water, tissue, and other phenological and physiological data.
    - Harvest snap beans at maturity and measure yield.
    - Prepare soil, water, and tissue samples for lab analysis.
    - Start a second experiment at TREC and collect pertinent data for soil, water, and plant parameters.

Progress made towards overall project objectives

- On track to recommend BMPs for snap beans for Krome soil based on research plot studies.
- However, commercial field results are not consistent, and it is critically important to do more experiments on multiple fields to capture field-to-field variability. In addition, sidedressing and foliar application, including micronutrients, are practiced by commercial growers, which makes it difficult to compare our results from research plots as well as commercial field (based on pre-planting basal P application) with the grower's plots.
- The FY 2023-24 plan of work is **40% complete**.

Identified obstacles or challenges.

- Background soil test P in most samples remains very high, especially in commercial fields.

- Growers' practice involves sidedressing and foliar application of P fertilizer and micronutrients, which makes it difficult to perform direct comparisons of results solely based on basal application of P fertilizer prior to planting. Additional studies are needed on multiple commercial fields mimicking growers' fertilizer application practices at different rates.

19. Visibility for Hemp Fertilizer Research and BMP Development – Zachary Brym – TREC, Homestead

Activities and accomplishments

- Preparation and submission of a hemp nutrient management recommendation.
- Bi-weekly research team meetings.
- Developing rate and timing studies for three locations.

Significant findings and/or events occurring during the quarter

- Two student presentations at American Society of Agronomy national meeting.
- A research paper was accepted: Kaur N, Griffin W, Sandhu A, Sidhu S, Brym ZT, and Sharma L. Nitrogen Application and Cultivar Effects on Industrial Hemp Yield Dynamics. Agronomy Journal.

Activities planned for the subsequent quarter

- Seed acquisition.
- 2024 research trial design.
- Cover crop planting and land preparation.

Progress made towards overall project objectives

- The target for hemp projects this year is primarily outreach to industry participants and allies. A partnership with a hemp processing company and associated farmers is underway along with seed companies benefiting from nutrient recommendations with their genetics.
- The FY 2023-24 plan of work is **50% complete**.

Identified obstacles or challenges

- None to report.