GROWER RESEARCH REPORT

DECEMBER 2019

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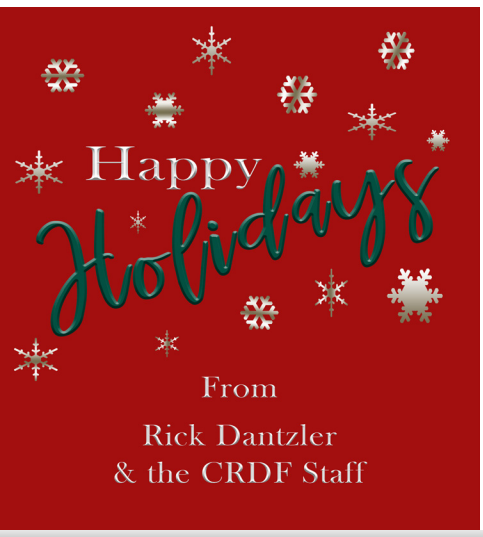


Eight New Projects Funded by CRDF

The last few months have been busy for us at CRDF as we fulfill the heart of our mission: to fund research for the benefit of the Florida citrus industry. Since it is grower and general taxpayer money that we spend, it is advisable to occasionally outline the process for how we award research projects to help assure those who fund our research that our process is above reproach and peer-reviewed.

Awards are most often given out pursuant to a Request for Proposals (RFP). CRDF works with industry stakeholders and growers to determine needed research topics, and formulates the RFP language to comport with these needs. The relevant CRDF committee, either the Research Management Committee or the Commercial Product Delivery Committee, passes judgement on the language and, if approved, recommends it for board approval.

Once the board approves the RFP, it is posted on the CRDF website for a prescribed period, during which preproposals may be submitted. Upon the expiration of the deadline, all the preproposals that were received are directed to the relevant CRDF committee for consideration.

Once they are received by the committee, every preproposal is reviewed at a public meeting. At this stage, the preproposals are not particularly detailed; they are basically a statement of the problem and what the researcher intends to do about it. The committee members then decide which of these they wish to learn more about, which they do by "inviting" the researcher who submitted the preproposal, a person known as the "principal investigator" (PI), to submit a much more detailed proposal for consideration. With the most recently concluded RFP, the PIs for 27 of 91 proposals were "invited" to submit a detailed proposal.

A very thorough, but relatively standard, template is used for the invited proposals. Virtually every part of the proposal is outlined, from which part of the RFP is addressed, to the hypothesis to be tested, to the scientific technique to be employed, to a detailed budget.

Once the full proposals are received, they are sent to several members of our list of "ad hoc" reviewers. These ad hoc reviewers, 40 in number, are scientists from across the world. Each reviewer is a leading scientist in his or her field, and the proposals are sent to them to take advantage of their expertise. The comments from the ad hoc reviewers and the proposals themselves are then sent to members of our Scientific Advisory Board (SAB), another group of leading scientists – 15 in number - from across the country, for their review. CRDF then pulls the SAB scientists together for a two-day meeting to discuss and rank the proposals.

It is important to note that the identities of the ad hoc reviewers and members of the SAB are not revealed in order to encourage candor and protect them from outside pressure.

The SAB scientists rank the proposals

The Mission of the Citrus Research and Development Foundation is to "Advance disease and production research and product development activities to insure the survival and competitiveness of Florida's citrus growers through innovation."

(Projects continued from page 1.)

during their two days of deliberation. These rankings and comments are then sent to the CRDF committee of jurisdiction. The committee debates the findings and makes recommendations for consideration by the CRDF board of directors. The board then decides which proposals will be funded.

As you can see, it is a very rigorous process, and it is less likely that a project submitted for consideration will be funded than more likely. In the 2019 RFP, of the 93 preproposals submitted, only eight projects were funded, so reviewers, committee members and the board are very discerning.

What follows is a brief description of the eight projects that were funded, projects that responded to an RFP that placed an emphasis on providing practical help to growers. The proposals receiving funding were:

1. A project to study the interactions between the causative agent of HLB and citrus parasitic nematodes and Diaprepes root weevil, all with an eye towards helping growers manage root damage.
2. Regardless of one's feelings regarding antimicrobials, they are legal and some growers are still using them. Consequently, CRDF has funded a project to determine which commercial adjuvants achieve optimal systemic delivery of antimicrobials.
3. While the Phytophthora root rot/HLB interaction has been well documented, the economic benefit of managing Phytophthora on HLB-affected trees is currently unknown, so CRDF has funded a proposal to determine new guidelines, based on economic analyses, for treating trees with low, medium and high levels of Phytophthora.
4. Some growers spray aggressively to kill psyllids, while others don't spray at all. Regardless, everyone can agree that a spray program should not include insecticide applications that don't produce more economic benefit than they cost. CRDF has funded a proposal that will ground truth what we believe these thresholds are, providing guidance to growers on when they don't need to spray.
5. Metabolites are the molecule products of metabolism. Metabolism converts food to energy to run cellular processes for synthesis of proteins, lipids, nucleic acids and certain carbohydrates. Metabolomics is the study of the unique chemical fingerprints that these cellular processes leave behind. UF researchers have developed a metabolomics platform which enables metabolomics profiling which will, hopefully, allow them to identify the metabolites that are present with HLB-tolerant citrus cultivars. If this can be perfected, new cultivars can be identified as HLB-tolerant without the need for years of field observation. CRDF has funded a project to do this.
6. HLB impacts on fruit can result in their rejection by packing houses and juice processing facilities because of inadequate size and poor quality. There are HLB-tolerant sweet orange/mandarin cultivars which, when blended with Valencia juice, make flavorful juice. Whether the industry wishes to move in this direction remains to be seen. In case it does, CRDF has funded a project to analyze sensory and consumer acceptance, identify more HLB-tolerant cultivars whose juice resembles the quality of Valencia juice, and identify a chemistry definition of consumer-accepted orange juice.
7. HLB-tolerant trees have less root damage than non-tolerant rootstocks. What is the mechanism of tolerance in the rootstock that prevents root loss, and could it be related to tolerant scions? We don't know, which is why CRDF has funded a project to find out.
8. An Israeli company has a biocontrol agent that has markedly reduced Liberibacter in carrots. Working with a UF researcher, the company has proposed testing the agent on Liberibacter in citrus. CRDF has agreed to fund preliminary work to see if this holds promise.

Missing from the list is research on nutrition, but we have assembled a working group of growers and researchers to determine knowledge gaps to guide the projects we fund. More on this later.

Dutt Project Update

In 2015, Dr. Manjul Dutt, an outstanding UF-IFAS scientist located at CREC, determined that transgenic Valencia and Hamlin trees containing the NPR1 gene from Arabidopsis (a small flowering plant) exhibited enhanced resistance against HLB. Building upon this research, Dr. Dutt came to CRDF in 2018 seeking funding to determine if placing the same gene in the rootstock, making it a transgenic rootstock, could confer HLB resistance to a non-transgenic Valencia scion. If successful, this could be a way to transfer resistance to CLas to a scion that is not otherwise resistant. It could also be argued that fruit coming from a non-transgenic scion is not genetically modified even though the rootstock is transgenic.

CRDF funded Dr. Dutt's proposal, and early results indicate that resistance has been upregulated (risen from the rootstock to the scion). However, this has been detected only at the molecular level, not in CLas titer levels, but, frankly, the trees are not old enough for such titer manifestations. In the spring, when titer levels are more meaningful and measurable, new samples will be taken. This is a project I'm following closely.

Bayer CropScience Project

Phase 1 of the most expensive project in CRDF's history is nearing an end, and CRDF is considering next steps.

In 2017, CRDF, Coca-Cola and Pepsi agreed to financially support a project by Bayer Crop Science. It was a three-year project at a cost of slightly more than $12 million.

The project is two-pronged. The first part is for Bayer to develop a plant defense modulator (PDM), a compound applied to the tree that switches on the tree's natural defenses, to fight liberibacter. The second part is for Bayer to develop an anti-bacterial microbial that attacks liberibacter directly.

Phase 1 ends on June 30, 2020, and the project is fully paid until then. Now, however, per the terms of the contract, CRDF must make the difficult decision of whether to continue funding the project.

Results to date are mixed. Work on the PDM is quite advanced, and Bayer is confident they are onto something that will work not just on citrus but also other commodities, which is important because bringing the product to market is expected to cost up to $250 million, and Bayer needs the product to work on other commodities to justify such large development costs. While it is good that Bayer thinks they have something that may work, we have been told that it could take as many as 12 years to actually get the product to growers. Still, it is a product that has cleared Bayer's rigorous internal review process for product advancement, and is showing promising results.

Work on the anti-bacterial product is not as mature. Bayer has a library of approximately 55,000 compounds they are running through a high-throughput system they have developed, testing them at a rate of roughly 500 per quarter. Of course, they subject the compounds to extensive pre-screening to get a sense of which ones to test first.

When PDM and anti-bacterial candidates are selected, they are tested in three field-trial testing sites Bayer started in Florida late this spring.

Here's where we are financially. Now that Bayer is up and running at full blast, the project is costing nearly $5 million/year, and there is simply no way that CRDF can keep funding the project at this level even with significant financial assistance from our private sector partners. We have 57 projects under contract, and the 2020-2021 expense of these projects is approximately $6.5 million. We were also directed by the Legislature last session to spend $2 million of our $8 million appropriation on large-scale field trials and expect a similar direction this session, making the money for our traditional portfolio $4 million lighter over a two-year period.

Because of these funding realities, we asked Bayer for a scaled-down scope of work. They complied, and have gotten the cost down to $3,375,400 per year, still an awful lot of money. Consequently, we contacted the California Research Board, seeking financial assistance, and the reception was encouraging. We are also open to additional private sector funding partners.

Nevertheless, even with assistance from all these partners it will be difficult for CRDF to bite off much more contractual obligation, which is why we have been in Washington, DC twice in the last month seeking federal assistance through the NIFA program. NIFA distributes $25 million of citrus research monies each year via the Farm Bill, and the Bayer project fits like a hand in a glove for a particular category of funding in the NIFA portfolio. Long term, it is my view that federal funding is the best option for the Bayer project.

CRDF Research Projects by Category

Over its ten year history, CRDF has funded 453 projects. These are the number of projects per category:

- Consequences of HLB infection: 5
- CLas culture, genomics, molecular biology, and Koch's postulates: 36
- Citrus response to infection: symptoms, defense, CLas spread in the plant, systemic acquired resistance: 43
- HLB pathogen and disease detection: 21
- HLB epidemiology and mitigation of HLB by cultural practices: 111
- ACP monitoring and behavior, cultivation and relationship to CLas: 27
- ACP chemical, biological or biochemical management chemical attractants and repellants: 66
- ACP trapping and repelling plants: 1
- Citrus genomics and transcriptomics: 7
- Conventional citrus breeding for resistance: 49
- Transgenic and viral/bacterial vector mediation of citrus resistance to HLB: 55
- Model systems, including chemical screening: 11
- Unclassified: 6
- Other diseases and pests: 15

If you have thoughts about the list or suggestions to make, please let me know.

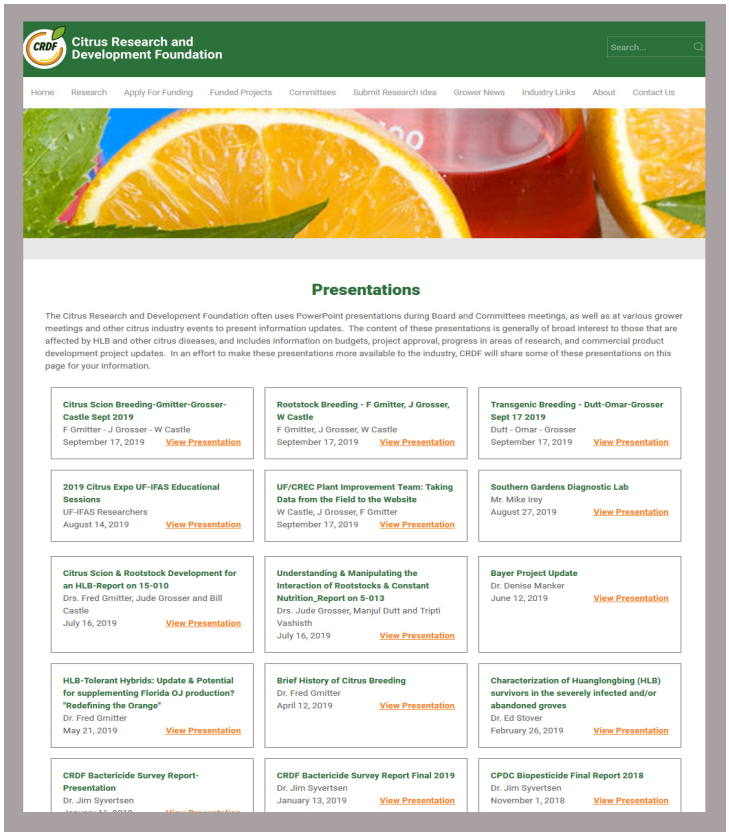
CRDF Elects New Leaders for Board and Committees

At the last board meeting, CRDF had a changing of the guard. Beginning January 1, 2020, this is the list of board members and committee chairpersons:

- David Howard, President
- Rob Atchley, Vice President
- John Updike, Secretary
- Ron Mahan, Treasurer
- Pat Ouimet, Chair of the Research Management Committee (RMC)
- John Updike, Chair of the Commercial Products Delivery Committee (CPDC)
- Larry Black, Chair of Governance Committee (for one year)

Of course, bringing on new officers and board members means that others are leaving their posts. I wish to thank our outgoing officers and chairpersons for the time they have given to CRDF, the citrus industry, and me personally. Serving on CRDF takes an inordinate amount of time, almost too much for volunteer work. Nevertheless, they do it out of their love for the industry and to keep Florida citrus the king of all agricultural commodities.

Visit citrusrdf.org for Updates and Presentations



Upcoming Meetings

Nutrition Working Group – Mon., Jan. 6, 2020, 1:30 pm

Select Committee on Plant Improvement – Tues., Jan. 7, 2020, 10:00 am (in Lake Placid)

Board of Directors Annual Meeting – Tues., Jan. 28, 2020, 10:00 am (in Fort Pierce)

Please check citrusrdf.org for updates.