

Relevance Statement

Biologically-based management of the citrus leafminer, and other key citrus nursery pests in Puerto Rico: A Research and Education project

A Joint Research-Extension Proposal by

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A Joint Research and Extension Project by
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Problem

The citrus leafminer (CLM), *Phyllocnistis citrella* Stainton, was first found in Puerto Rico in 1994 and has become a serious pest in citrus nurseries and new orchards. Control methods used in local island nurseries often require weekly pesticide applications, and intensively use traditional crop protection chemicals. Unfortunately, some of these traditional pesticides are detrimental to CLM's usually effective natural enemies, and often lead to leafminer outbreaks. Further, most citrus nurseries are located in mountain regions, often near small rivers and creeks feeding drinking water reservoirs. Nurseries' runoff-laden waters, containing chemicals and fertilizers often end up in these important waters, and constitute an important source of drinking water pollution. Effective and more environmentally friendly biologically-based alternatives are often ignored.

Background

In Puerto Rico, the pest has reached high population levels, and causes extensive damage to leaf flushes, particularly in young trees, nurseries, and top-worked trees. Leafminer adults oviposit on young tender leaves, and larvae produce serpentine galleries as they feed on the epidermis. An Economic Injury Level has been determined of one active mine per flush leaf in 'Tahiti' lime from southern (e.g., Florida and China). In nurseries, *P. citrella* damages rootstock material by breaking apical dominance, and by producing plants unfit for grafting. CLM also severely damages and delays normal growth of grafted material. In young plantations, severe attacks damage future canopy development for fruit production. Conversely, studies have found no significant effects of CLM damage on established orchards, where flushes are no continuous but separated in time.

To cope with CLM, the initial response has usually been to use aggressive chemical controls. New evidence has demonstrated its susceptibility to natural biological control by native and introduced parasitoids, which maintain CLM below EIL. Current state of affairs allows for relaxing chemical control tactics in favor of strategies which protect these natural enemies. Currently, there is a great need for validation and implementation of CLM biologically-based population management techniques in Puerto Rico and elsewhere. We contend that these methods can be effective, and that island nurserymen want to be engaged with implementing newer pest management ideas.

Justification

Citrus is the second most important fruit crop grown in Puerto Rico (bananas is number one). Puerto Rico's citrus production has steadily increased during the last five years from 10,000 metric tons in 1999 to 20,120 metric tons in 2004. Over 1.2 million bearing and non-bearing trees exist in the island. Citrus farms increased between 1999 and 2002 from 3,900 to 4,250. Farm gate value for citrus is estimated at \$20.5 million per year,

making it a significant contributor to the farm economy. Between 150,000 and 300,000 seedlings are produced per year by the state and by smaller private sector producers.

Objectives, Approach and Procedures

We offer that there is the need and the desire by nurserymen for research that validates the effectiveness of biologically-based pesticides. Evidence indicates that CLM can be effectively managed with the use of *Bacillus thuringiensis*, abamectin and azadirachtin. Thus, the objectives of this proposed work are: (1) to conduct validation research for CLM bio-based management tactics in citrus nurseries, using commercially available *Bacillus thuringiensis* (*Bt*) formulations, and other biologically-based pesticides (e.g., abamectin, rosemary oil, and azadirachtin); (2) to determine the effects of these tactics on CLM natural enemies, and those of other pests (e.g., aphids, other lepidoptera.) ; and (3) to prepare demonstration nurseries at two locations that will be used as a platform for farmer's training through presentations, displays, and educational materials.

Validation of bio-based CLM management options at nurseries: Two ecologically disparate locations will be chosen to conduct validation testing: Adjuntas (mountain subtropical moist forest) and Lajas (subtropical dry savanna). CLM is a serious problem at Lajas, it is almost absent from Adjuntas. Four bio-based pesticides, *Bacillus thuringiensis* subsp. *kurstaki*, *B.t.* subsp. *aizawai*, abamectin, and azadirachtin (all as formulated plus and an organosilicate surfactant), a surfactant check, and a water check will serve as treatments. Four replicates of 15 one-year old plastic-bagged 'Tahiti' lemons and 'Encore' tangerines will be arranged in a randomized complete block design, will be used, and the whole experiment will be replicated 3 times at each location. Randomly selected leaf flushes (~6 inches) will be collected at day 7, 14, and 21 after treatment from each block, and taken to the laboratory for ascertaining number of eggs and larvae per leaf. Efficacy will be determined using Abbott's formula, and means compared using ANOVA. Application costs will be recorded and a cost-benefit analysis developed that includes data generated above.

Identification and importance of natural enemies attacking CLM. Unsprayed plots of 'Encore' tangerines and of 'Tahiti' lemons will be established at each of the locations to serve as reservoir for CLM and natural enemies. Presence of natural enemies will be determined by collecting 10 developing new shoots containing different stages of the CLM each week. Leafminers density (larvae/leaf/flush) will be determined, and susceptible stages will be observed under a stereomicroscope to detect the presence of parasitoids. Immature parasitoids found in the mines will be isolated and allowed to develop to adult stage for identification. Percent parasitism will be determined. Also, common predators such as lady bugs will be collected and tallied from these plots. Predators will be tallied, and samples collected and sent for identification.

Education and Demonstration: Approach and Procedures. Simultaneously with the experimental phase, we propose to begin the preparation of the education and demonstration components of this proposal. Thus, the goals of this component are: (1) to

promote the adoption and implementation of effective biologically-based management strategies to control citrus nursery insect pests, (with emphasis on the citrus leafminer) by means of educational material and field demonstrations; and (2) to show producers the advantages of protecting natural enemies and the environment from unnecessary pesticide applications. To achieve these goals we propose to create educational materials about CLM population management (and other nursery pests), under the advisement of a guidance committee. We propose to offer three workshops for growers and other agricultural agents, showcasing the field demonstration. These demonstrations seek to compare an unsprayed control and biologically-based management and to show the results of our experimental tests. Participants will include Extension agents, agronomists of the PR Department of Agriculture and other educators related to the citrus commodity. A validation analysis will assess farmers' reactions, likelihood of implementation, and a statistical analysis will serve as a tool to plan future demonstrations.

Addressing Southern Region Priorities

(a) Multi-state: Our application strives to produce tangible impacts that are important to manage citrus nursery pests in areas invaded by CLM (e.g., Florida and Texas). One advantage of our situation is an excellent collegial relationship with colleagues in Florida that have published widely on the subject. For example, Dr. Segarra has recently submitted a proposal for USDA Special grants with Dr. Peña of IFAS for control of avocado pests. This type of relationship is typical dozens like it fostered through the Tropical/Subtropical Agricultural Research program for over 20 years.

(b) Biologically-based: Our project addresses the use biologically-based approaches to IPM by using more environmentally friendly bio-pesticides and, because of their use we help protect highly effective natural enemies. We feel that the real challenge of this proposal is to compete with the traditional pest control approaches used by farmers under the intensive pest pressure of the nursery environment. We feel that this research could lead to research that manages leaf flushes by inducing and grafting when CLM populations are low, and by developing ways to more effectively attract natural enemies to the nursery environment.

(c) Stakeholder-identified IPM priorities: Control of nursery pests, including the CLM has been identified at College of Agriculture stake holder's meetings as a research priority. The PD as well as the Co-PDs are active participants at these meetings. Currently, the nature of the citrus nursery industry is that of hundreds of small size farms, each managing a few dozen plants, and large producers such as the PRDA. In addition, owners of larger nurseries have conveyed to our College their need to find control alternatives to CLM and other citrus pests. More pressing, they need to receive accurate and timely information on managing nursery pests. Unfortunately, there are no Pest

Management Strategic Plans (PMSPs) have been prepared in Puerto Rico. Research and education proposed in this document could be the seed for a PMSP for citrus and other fruit crops in PR. In fact, one of our outputs calls for the preparation of a 'Citrus Profile' for Puerto Rico.

(d) IPM issues important to the Southern Region: Citrus is an important crop in Puerto Rico, as it is in other southern states. However, unlike other states there are no large and powerful grower's associations to assist in funding applied IPM research and extension. Undoubtedly, nurseries are an important sector in this industry, especially for orchard renewal and reconstruction, especially after storms and hurricanes. We argue that CLM is a key pest in nurseries and that this project offers the opportunity to create a research/extension framework that can be duplicated in Puerto Rico and elsewhere.