Economies of HLB vector control and foliar nutrition

By Phil Stansly and Fritz Roka

Huanglongbing (HLB) or citrus greening is a bacterial disease vectored by the Asian citrus psyllid (ACP) causing tree decline and yield loss. Vector control and foliar nutrition are used in Florida to respectively slow the spread of HLB and mitigate debilitating effects of the disease. Our objective was to evaluate the separate and combined effects of these practices on yield and quality of orange fruit grown for the commercial juice market.

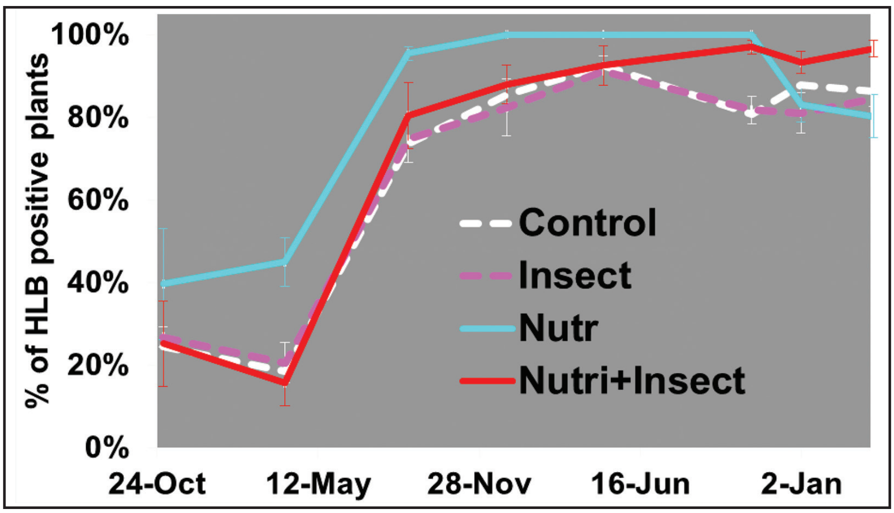
A four-year study was initiated in February 2008 in a 13-acre commercial block of Valencia orange trees planted in 2002. A randomized complete block factorial design was used to evaluate the following treatments replicated four times:

(1) insecticides alone
(2) enhanced foliar nutrition alone
(3) insecticide plus nutrition
(4) untreated control

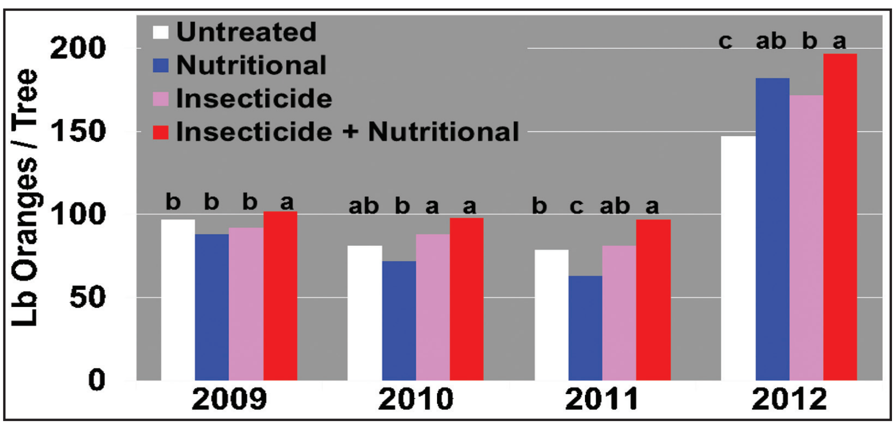
Insecticides recommended in Florida for ACP control by the University of Florida-IFAS were sprayed in designated blocks twice during tree dormancy and when psyllid populations exceeded a nominal threshold of 0.2 adults per stem tap sample. A total of four applications were made the first three years and seven were made in the fourth year. A mixture consisting primarily of micro- and macro-nutrients plus potassium phosphite, potassium salicylate and *Bacillus subtilis* was applied to the foliage in designated plots following the three principal foliar flushes each year. Ground-applied fertilizer and other standard practices were used throughout.

Asian citrus psyllid adults were monitored every two weeks from 10 randomly selected trees in the middle bed of each plot using the stem-tap sampling method. Incidence of HLB was estimated by real-time q-PCR (quantitative polymerase chain reaction) analysis of the most symptomatic leaf on every fifth tree throughout the block at regular intervals eight times between November 2008 and April 2011. Ripe fruit was harvested from all trees into 10-box pallet tubs that were weighed using a deck scale. Juice was extracted in 2010 and 2012 from a composite random sample taken from

Top left: *Plot plan, 13 acres. 1,728 Valencia orange trees on Swingle citrumelo planted in Collier County in 2001. Block was divided in February 2008 into 16 plots in a randomized complete block design with four replications and four treatments. Pink: insecticides only; blue: foliar nutrition only; red: insecticides + nutrition/SARs; white: untreated, no insecticides or nutrition.* ***Top right:*** *Oranges hand-picked into 10-box tubs by supervised crews. Each tub was weighed in the field using a Gator Deck Scale 500 ± 1 lb. and the net weight of oranges was recorded.*



Percentage of trees testing positive for HLB by PCR.



Yield in pounds/tree from large replicated plots receiving either a foliar nutrient mix three times a year, insecticide sprays to control ACP four to seven times a year, both nutrition and insecticide or an untreated control. Columns within the same year with same letter above are not significantly different.

the tubs, and de-aerated under vacuum for two to three minutes. Soluble solids content was measured by hydrometer and titratable acidity as citric acid, pH endpoint 8.2.

ACP numbers during the course of the experiment ranged between five- to 13-fold higher in untreated or nutrient plots compared to the remaining plots receiving insecticides. Initial incidence of HLB averaged 26 percent in plots designated for three of the four treatments, compared to 40 percent in plots receiving only nutrients. High initial incidence in nutrient plots may have been due to their chance location on block margins. Nevertheless, HLB incidence rose to 95 percent across all treatments within 18 months.

In 2010, solids were lowest in juice from trees treated with nutrition alone, and acid was highest in the untreated check, whereas no treatment effects on quality parameters were seen in 2012. Greatest yields were seen all four years from trees receiving both foliar nutrition and insecticides. Main effects for insecticidal control were significant in the second through fourth year and across all years, while nutrient effects were significant only in the fourth year.

The combined regime of nutrient/systemic acquired resistance (SAR) products plus insecticides consistently produced the highest yields in each year of the experiment, and in 2012 came close to achieving the production average for a Southwest Florida flatwoods grove pre-greening for 10-year-old Valencia on Swingle trees.

However, the nutrient/SAR plus insecticide treatment added $911 of additional cost per acre. If fruit were sold for $2 per pound-solid, returns would have increased by only $19 per acre as compared to returns from the untreated control. Extra costs associated with the nutrient/SAR treatment or the combined treatment minus the SARs would have been compensated for at prices of $1.75 per pound-solid. In contrast, the insecticide treatment alone would have increased grower returns at prices as low as $1.25 per pound-solid.

Results of this experiment indicate a clear economic benefit from controlling ACP in spite of high HLB incidence. Beneficial effects of the foliar nutrition plus SAR treatment were low initially in concert with high HLB incidence, but increased significantly in the fourth year. Hopefully, this experiment can continue for several more years, enabling us to assess cumulative long-term and possible synergistic effects of ACP control and foliar nutrition. More information is also needed on the value of individual components to optimize nutrient and insecticidal programs under different growing and market conditions.

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Table 1. Composition of the nutrition plus systemic acquired resistance (SAR) inducer blend used during this trial.

Product	Quantity unit/ac.	Cost $/unit	Function	Company
Serenade Max WP (*Bacillus subtilis*)	2.25 lb.	$11.75	SAR inducer	AgraQuest, Inc.
SAver (Potassium salicylate)	1 qt.	$5.50	SAR inducer	Plant Food Systems
3-18-20 with K-Phite	8 gal.	$12.00	Macronutrients	Plant Food Systems
13-0-44 fertilizer	8.5 lb.	$0.72	Macronutrients	Diamond R
Techmangam (Mg Sulfate)	8.5 lb.	$0.75	Micronutrients	Diamond R
Zinc Sulfate	2.8 lb.	$0.90	Micronutrients	Diamond R
Sodium Molybdate	0.85 oz.	$1.50	Micronutrients	Diamond R
Epsom Salts	8.5 lb.	$0.30	Micronutrients	Diamond R
435 oil	5 gal.	$5.50	Adjuvant	PetroCanada
Number of applications:				3 per year
Nutrient material costs:				$428/acre
SAR material costs:				$96/acre
TOTAL COST, MATERIAL PLUS APPLICATION COSTS				$643/acre

Table 2. Date, product, active ingredient (a.i.), amount applied per acre, and unit cost of in U.S. dollars for insecticides sprayed in designated treated plots during 2011-2012. Growing season applications were made when scouting results indicated *D. citri* populations exceeded 2 per 10 taps.

Season	Date	Product	A.I.	Rate oz./ac.	Cost $/oz.	Source
Growing	28 April 11	Dibrom 8E	nayled	16	$0.83	AMVAC Chem. Corp
Growing	12 May 11	Delegate WG	spinetoram	5	$6.50	Dow AgroSciences
Growing	7 June 11	Movento MPC	spirotetramat	16	$6.28	Bayer CropSciences
Growing	19 July 11	Agri-flex	abamectin+ thiamethoxam	5	$3.40	Syngenta Crop Protection
Growing	12 Sept 11	Dimethoate 4E	dimethoate	16	$0.38	BASF Corp.
Dormant	7 Dec 11	Imidan 70 W	phosmet	12	$8.30	Gowan Co.
Dormant	2 Feb 12	Danitol 4EC	fenpropathrin	12	$1.01	Valent USA Corp.

Table 3. Costs and estimated revenues at four delivered in prices for three treatment regimes.

Treatment	Cost	Estimate per acre returns			
	($/ac.)	Fruit Price ($/lb. solids)			
		$2.00	$1.75	$1.50	$1.25
Insecticide	$279	$186	$128	$70	$12
Nutrient/SARS	$643	$154	$55	($45)	($145)
Insecticide + Nutrients/SARs	$911	$19	($97)	($213)	($330)