DEFINING THE ECONOMIC "TIPPING POINT" IN THE MANAGEMENT OF CITRUS GREENING: FOLLOW THE STANDARD PROTOCOL OR SHIFT TO AN ENHANCED FOLIAR NUTRITIONAL PROGRAM

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Abstract

Florida citrus growers are confronting arguably the most serious threat to their industry - Huanglongbin, or citrus greening. Presently, their choices are to follow the "standard" protocol which involves removing infected trees, or switching to an enhanced nutritional program, which they hope will maintain the productive life of infected trees. While there is a dramatic visual improvement of tree appearance, production implications of an enhanced nutritional program are largely unknown. The enhanced nutritional program considered in this paper follows from a Florida grower who was the first to pursue this management option and increases production costs by approximately $1,000 per hectares. This paper estimates that annual losses of trees under the standard protocol are more than 5%, maintaining trees with an enhanced nutritional program would be higher, provided a nutritional program could maintain fruit production at pre-greening conditions for at least 10 years.

Keywords: Huanglongbin, citrus, costs, threshold, NPV

Introduction

Huanglongbin (HLB), also known as citrus greening, is considered to be the most serious threat to commercial citrus production. The bacterial disease is vectored by the Asian citrus psyllid, and if psyllids are abundant, HLB can spread quickly through out a citrus orchard. All citrus varieties are susceptible. In other areas around the world where HLB has become endemic, commercial citrus production has dramatically declined within a few years as mature trees become unproductive and young trees never become productive (Chung and Brlansky, 2005). To date, scientists have not been able to culture the HLB bacteria and effectively study the organism. Hence, antibiotics and other chemical treatments are not available to arrest or control HLB symptoms once a tree has been infected.

HLB was first discovered in Florida, USA, late 2005 (Halbert, 2005). The psyllid was already widespread and by early 2010, HLB had spread throughout Florida's citrus production areas (DPI, 2010). Citrus is the leading agricultural industry in Florida. If left unchecked, HLB could devastate an industry, which together with juice processing and fresh fruit packing, has an estimated total economic impact of more than $9 billion dollars on the state's economy (Hodges and Rahamni, 2009). Florida growers initially responded to HLB by following what this paper will refer to as the "standard protocol." The standard protocol is defined as a three-step process: 1) control psyllid populations; 2) inspect individual trees at least 4-times per year for HLB symptoms; and 3) if symptomatic trees are found, immediately remove infected trees (Yates, et al., 2008). This process follows the standard approach to control bacterial diseases, which is to simultaneously control the innoculum and the vector that spreads it.

Growers face two types of costs when following the standard protocol – higher production costs and loss of revenue from the removal of mature infected trees. Increased production costs include surveying trees, removing infected trees, and higher spray costs to reduce psyllid populations. Based on 2008/09 season citrus cost data, greening management activities from following the

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standard protocol increased fruit production costs by about $750 per hectare, from $2,500 more than $3,250 per hectare (Muraro, 2009). Break even costs to produce processed oranges increased to between $1.15-$1.20 per pound solids, an increase of 18-23% over non-greening levels.

If an infected mature tree is found prior to harvesting, the loss of fruit revenue is measurable and immediate. The value of future revenues from the removal of an infected tree is uncertain as it depends on the tree's age and number of seasons it would have continued to produce fruit in the presence of citrus greening. Data from Sao Paulo, Brazil, suggests that mature trees (more than 8-years old) can produce a sizable crop for at least 3 years after HLB is first detected if normal grove care practices are followed (Bassanezi, et al., 2008). For young trees (less than 7 years of age), however, citrus greening prevents them from ever reaching productivity maturity.

Several citrus growers in Florida have reported difficulty in keeping greening in check by following the standard protocol. This is particularly true among growers in southwest Florida, where the levels of HLB infection were relatively high when the disease was first confirmed in 2005. Further complicating this management approach is the fact that a tree may not express disease symptoms for several years after it has been initially infected. Hence, tree eradication efforts may take many years until innoculum levels are under sufficient control, and more importantly, eradication of infected trees may claim the entire grove. Even for growers with low initial incidences of greening, some have seen their disease rates advance despite following the standard protocol because in part to neighbouring groves, which are either abandoned or where innoculum levels and psyllid populations are not being aggressively managed.

In 2006 Maury Boyd, a grower in southwest Florida, rejected the proposition that removal of infected HLB trees was the only management option. He noted that HLB attacks the phloem of a tree and the disease expresses symptoms as various signs of micro and macro nutrient deficiencies. Mr. Boyd theorized that his trees could live with the infection if the nutrient deficiencies were treated with a foliar mixture of nutritional elements and SARs (systematic acquired resistance), compounds that may activate a tree's disease resistance mechanisms. After a year of applying his nutritional cocktail, the visual appearance of Mr. Boyd's trees improved dramatically. Despite an infection rate that has climbed to nearly 100% of his trees, Mr. Boyd harvested a fruit crop since 2005 at levels equal or greater than average production in southwest Florida region.

Table 1. Production records from the Orange Hammock Grove in Hendry County, Florida. A grove that has had HLB infected trees since 2005. Infected trees have not been removed. All trees have been maintained with an enhanced nutritional program.

Season	Hamlin tons/ha	Valencia tons/ha
2009-10	45.3	41.5
2008-09	72.5	44.4
2007-08	60.8	61.7
2006-07	54.0	40.4
2005-06	54.4	40.8
2004-05	60.5	50.6
2003-04	68.8	63.4
2002-03	53.6	45.2
2001-02	54.9	47.2
2000-01	55.6	33.9
1999-00	48.0	36.2

Note: 50 hectares of Hamlin, 83 hectares of Valencia planted in 1989.

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University of Florida/IFAS scientists have initiated several field trials to determine at what level and for how long can an enhanced nutritional program maintain HLB infected trees. If a nutritional cocktail provides significant economic benefits, what is the appropriate mix and quantity of materials? Finally, an equally important question is whether nursery trees can be replanted into citrus blocks where the innoculum has not been controlled. Despite not having definite answers to these questions, many citrus growers in Florida are implementing versions of Mr. Boyd's nutritional cocktail.

This paper explores the economic tradeoffs between following the standard protocol of removing infected trees and maintaining HLB infected trees with an enhanced foliar nutritional program. Specifically, this paper addresses the level of HLB infection at which the potential value of maintaining infected trees offsets the cost of an enhanced nutrient program.

Assumptions and Methodology

Two hypothetical blocks of sweet orange trees with the same rootstock/scion combination are described with an identical set of initial production, cost and revenue conditions. Both blocks are the same size and of uniform tree density at 375 trees per hectare. All trees are fully bearing at 10 years old and assumed to yield 3.5 boxes (45 kilogram) per tree, or a total yield of 1,313 boxes per hectare. There is an assumed 2% annual tree attrition rate and a removal cost of $6 per tree.

Both blocks start with zero incidence of citrus greening. At the start of year one, citrus greening is introduced. One block follows the standard protocol, while the second block follows the enhanced nutritional program. Costs and returns are tracked for 10 years and the cumulative net present value is calculated using a 10% interest rate.

Grove care costs (Table 2) are identically in both blocks with respect to weed control, maintenance of the irrigation system, hedging/topping of tree canopy, and canker decontamination costs. With the introduction of greening, both blocks implement the same psyllid control strategy and pest management costs increase to more than $1,000 per hectare. Total production costs from following the standard protocol are estimated to be $3,410 per hectare. The materials and application of the enhanced nutritional program is estimated to be $1,510 per hectare. However, since HLB infected trees will not be removed under the enhanced nutritional strategy, there are no costs for HLB tree inspections. In addition, approximately 45 kilograms of nitrogen per hectare is a part of the nutritional program. Hence, dry ground fertilizer is reduced from 250 to 205 kilogram per hectare under the nutritional program. The net increase in annual production costs from the enhanced nutritional program is slightly more than $1,000 per hectare.

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Table 2. Cost Comparison between the Standard Protocol and the Enhanced Nutrient Management Program.

Activity	Standard Program	Enhanced Nutritional Program
	$/ha	$/ha
General Production Costs	$1,260	$1,260
Spray/Pest Management with canker & HLB	$1,000	$1,000
Dry Fertilizer (material & spreading)		
STD Program: 220 #N/ac	$830	-
HLB Program: 180 #N/ac	-	$650
Nutritional amendments	$60	$1,510
HLB Field Inspections	$260	$ -
Total Production Costs ($/ac-yr)	**$3,410**	**$4,420**
Added Costs with enhanced nutritional program:		**$1,010**

Notes:

1. "Standard" program defined as aggressive psyllid control, field inspection of trees for HLB, and removal of HLB infected trees. Costs presented by Muraro, Southwest Florida Production Costs per acre for Processed Oranges, Sep 2009.
2. "Foliar HLB" program defined as the same pest management practices as in the "Standard" program, increase application of major and minor nutrients through foliar sprays, incorporation of SAR products, and NOT removing HLB infected trees.
3. Since HLB infected trees are not removed, Foliar HLB program does not incur the costs of "Field Inspections." Scouting for psyllids and other pests continues through the standard pest management practices.
4. General production costs include weed management, hedging/topping, irrigation, and canker decontamination.

An Excel spreadsheet tracks annual net returns for both blocks under a given delivered-in price of $1.25 per pound-solids. The net present value of annual returns is determined using a 10% interest rate (growers' opportunity cost of capital) and total value of NPV is summed for ten years. Initially, cumulative NPV for both blocks are based on the same base annual tree loss rate (2%). and the NPV for the block receiving the enhanced nutritional program is lower due to the added $1,000 per hectare of annual costs. Tree losses in the block following the standard protocol are incrementally increased until the cumulative 10-year NPV is equal in both blocks. The goal of the analysis was to determine the rate of annual tree attrition for greening where switching to an enhanced foliar nutritional program was financially preferable. The analysis considered three price levels; $1.10, $1.25 and $1.40 per pound solids.

This analysis did not include the costs and returns from replanting of nursery trees. While the long-term economic sustainability of a commercial citrus grove depends on resetting or replanting new trees, at the present time very little is known about the viability of young trees in an HLB environment even when the innoculum is controlled with eradication of infected trees. The expectation is that young tree survival is more likely when the HLB innoculum pressure is lowered, but growers and scientists are still debating the appropriate time when to replant young trees and

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whether they should be planted and managed as a solid planting or individually reset into an existing block. The results presented below are based on the presumption of no resetting of young trees.

Results and Discussion

Assuming the enhanced nutritional program can maintain existing production of infected trees at 3.5 boxes per tree, the 10-year NVP for the nutritional management strategy increases from -$3,540 to $10,395 per hectare as fruit prices increase from $1.10 to $1.40 per pound-solids (Table 3). The "tipping point" between staying with the standard protocol and shifting to the enhanced nutritional program is 4.4% when fruit prices are $1.10. In other words, if the standard protocol is removing HLB infected trees at a rate greater than 4.4%, the 10-year NPV of maintaining infected trees with the enhanced nutritional program is greater. As fruit prices increase, the value of a tree increases and the HLB tree loss threshold or tipping point decreases to 3.7%. A second scenario was considered for lower initial tree production, 3.0 boxes per tree. As expected, since the economic value of a tree falls with lower production, NPV decreases and the threshold HLB tree loss rate increases (Table 3).

Table 3. 10-year cumulative net present value (NPV) of Enhanced Nutritional Management Strategy and annual tree loss thresholds that equate the NPV of the Standard Protocol with the Enhanced Nutritional program by delivered-in price and production level.

Production: 3.5 bx/tree * 6.2 ps/bx	**Delivered-in Prices**		
	$1.10/p.s.	**$1.25/p.s.**	**$1.40/p.s.**
10-yr NPV ($/ha)	$(3,540)	$3,428	$10,395
Annual tree loss threshold	4.44%	3.99%	3.68%
Production: 3.0 bx/tree * 6.2 ps/bx	**Delivered-in Prices**		
	$1.10	**$1.25**	**$1.40**
10-yr NPV ($/ha)	$(7,875)	$(1,9031)	$1,628
Annual tree loss threshold	4.83%	4.31%	3.96%

Figures 1 and 2 compare NPVs and HLB tree loss thresholds, respectively, at three levels of fruit prices. Tree loss thresholds decrease with higher prices and higher production. In other words, the financial outcome of an enhanced nutritional program improves relative to the standard protocol as prices and average tree yields increase. Under the lowest price and production considered, HLB infections need to increase by more than 4.83% per year before the enhanced nutritional management strategy returns more net income to a grower than a strategy of tree removal. Alternatively, if rate of infection can be held to less than the threshold percentage, following the standard protocol and removing infected trees would return more income.

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Figure 1. Changes in cumulative net present value per acre at two production levels (Blue: 3.5 bx/tree and Red: 3.0 bx/tree) for a block managed with the enhanced nutritional program as delivered-in prices increase from $1.10 per pound-solids to $1.40 per pound-solids.

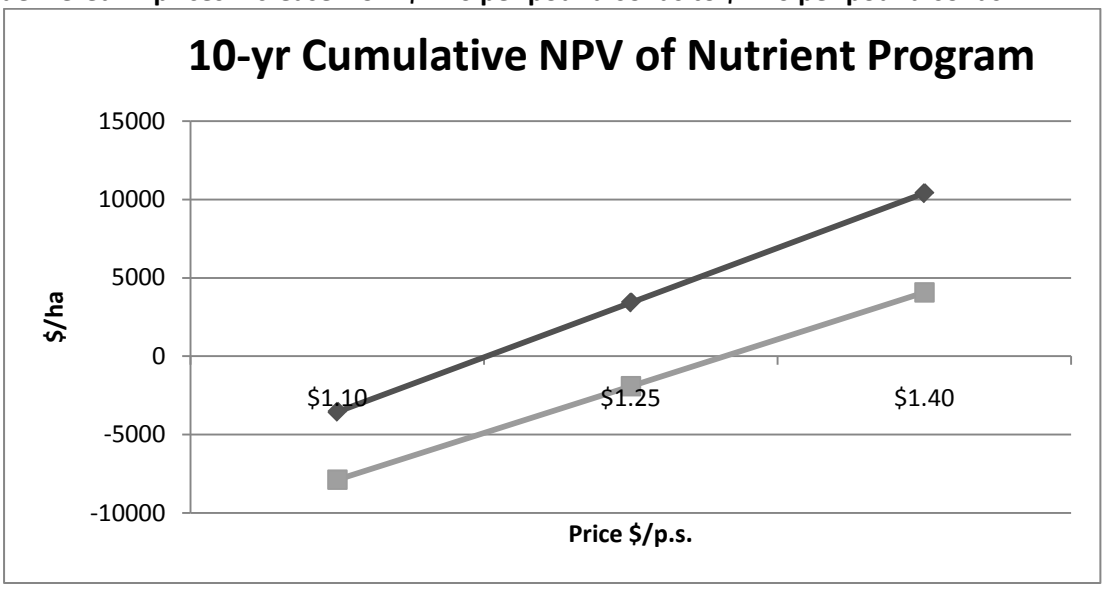
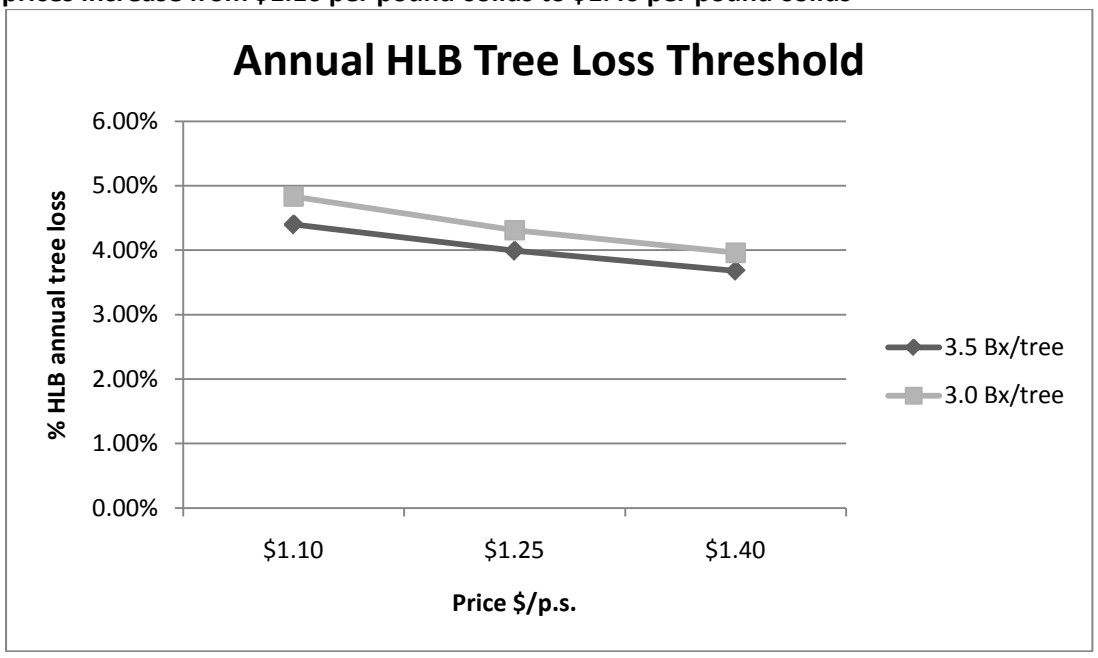


Figure 2. Changes in the HLB tree loss threshold above which the NPV from an enhanced nutritional program is greater than the NPV of following the standard protocol as delivered-in prices increase from $1.10 per pound-solids to $1.40 per pound-solids



As data from field trials and grower experiences are compiled, the production trends from an enhanced nutritional program will be more precisely defined and refine this analysis. As stated previously in this paper, many growers are adopting versions of the enhanced nutrient program without full knowledge of the ultimate outcomes. If HLB innoculum levels rise unabated and an enhanced nutritional strategy does not prove to provide long-term economic value, the risk to the future Florida citrus industry may be even greater. Some growers have determined that their individual HLB infection rates have reached a point where eradication efforts would only lead to complete removal of their groves. For these growers, any strategy other than eradication would be more attractive. For other growers, whose initial infection rates are low and below a threshold point,

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continuation of the standard protocol and removing infected trees may be their best long-term economic strategy.

The tipping point between staying with the standard protocol and shifting to the alternative enhanced nutritional program will increase as either annual yields or productive longevity of infected trees decline. Further, if the ability to replant young trees improves by following the standard protocol, long-term NPV increases and the threshold that HLB tree losses can be sustain improves as well.

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