Invasive Diseases and Fruit Tree Production: Economic Tradeoffs of Citrus Greening Control on Florida's Citrus Industry

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Abstract. An investment model of Florida oranges was used to evaluate various management strategies for controlling Huanglongbing, or citrus greening, a highly destructive disease. This analysis will enable the Florida citrus industry to make more informed decisions about the economic tradeoffs among current citrus greening management alternatives.

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Introduction

The Florida citrus industry is the second largest citrus producing region of the world following only the state of Sao Paulo, Brazil. In 2005, a new disease known as citrus greening (aka *Huanglongbing*) was found in the Homestead area of Florida. Although this disease was discovered in Brazil in 2004, and has long plagued citrus producers in Asia and Africa, it has not been found in North America until 2005. Wherever the disease has appeared, citrus production has been reduced and millions of trees have been lost (Brlansky et al., 2008).

Citrus greening is transmitted by the Asian pysllid, an insect that is found throughout Florida. Since being detected in the Homestead area, greening rapidly spread northward in Florida, and has now been detected in more than 30 citrus-producing counties, the vast majority of Florida's commercial citrus producing area. Trees may be infected with greening for 1 to 2 years before becoming symptomatic. Thus, many believe that greening was present in Florida years before it was officially discovered.

Greening causes fruit to not ripen or prematurely drop. Trees are stunted with leaves that exhibit a yellow and green blotchy mottle color. This may be confused with other nutritional deficiencies. Affected fruit are lopsided, contain aborted seeds, the central axis or the fruit is curved and the juice may be bitter or off-flavor. Mature trees that are infected become non-productive and infected young trees never become productive (Brlansky et al., 2008).

There is no chemical or biological control of the disease. Significant research efforts are being devoted to finding and implementing strategies to minimize and control the spread of greening. Currently, these include scouting, identification and removal of infected trees, and spraying to control psyllid populations. Experience in Brazil has shown that if greening is detected early enough and control practices are followed diligently, groves can remain productive with the disease incidence at low levels. The key is early detection, followed by effective control practices.

From an economic viewpoint, the two main consequences of citrus greening are increased tree mortality, and increased costs of production. Increased mortality stems from the recommended policy of immediate removal of infected trees. Increased production costs are associated with increased scouting costs to search for infected trees and increased spray costs to reduce the population of the Asiatic psyllid. For groves where greening is not being controlled, the main consequences are reduced fruit production from lower yields and increased tree mortality.

The Situation in Florida

Most Florida citrus growers who have found greening in their groves believe that they waited too late to develop survey and vector management programs. Thus, they are having difficulty reducing infection rates. The reality is that greening has spread throughout Florida’s citrus producing areas, and even if it cannot be detected in a specific grove, it is probably present but the trees are not symptomatic yet. Researchers in Brazil and Florida as well as growers who have field experience working with greening agree that whatever level of infection is determined by scouting, the true level of infection may be twice that because of asymptomatic trees. Also, while the overall infection rate for a large grove may be low, say about 1-2%, some blocks may have much higher rates. For example, some growers with less than a 2% infection rate overall are finding blocks with over 50% positive trees.

Learning curves about controlling greening are steep, much experimentation is going on and greening control strategies vary among growers. Some growers do not believe that greening is a serious threat or still are not well-informed about it and are following no control programs. Some know they have greening but rather than institute control practices, plan to take whatever profits can be made, then replant or sell the land. Other growers believe that because their neighbor is not controlling greening their efforts would be futile and decide to reap the profits remaining in their grove rather than destroy currently high-yielding trees. Some others are scouting from the ground and removing infected trees, but not aggressively. Some growers contract for scouting and identification services, which are still evolving. Prices for these contract services currently range from $16-$35 per inspection per acre and services vary. The most comprehensive provide GPS maps and location of each positive tree; send leaf samples to a lab, etc.

Many large growers are aggressively following integrated practices to manage greening (Rogers et al., 2008). This includes scouting and identification of infected trees (from ground and from elevated platforms for taller trees) four times a year; prompt removal of infected trees;

application of systemic insecticides such as Temik for mature trees and Admire for young trees; and spraying with foliar insecticides at least five times a year. Three of these sprays are in addition to the grove's regular spray program. If high psyllid populations are observed, additional sprays would be needed. In Florida, the optimum number of spray applications and the level of tree loss that can be consistently achieved have not yet been determined. In well-managed Brazilian groves, young trees are sprayed up to 24 times a year and mature trees 12 times a year.

Objective

The overall objective of this paper is to incorporate the likely effects of citrus greening, a new, highly destructive disease, into an investment model of Florida oranges for processing. This analysis will allow quantification of alternative strategies being used to manage greening in existing groves and impact of the disease on the financial performance of alternative new groves.

Greening Management Scenarios

The first scenario analyzed was no control versus following management practices to control greening. Experience in Brazil has shown that once a grove is infected with greening, it only has a few years left as an economically viable grove. While the economic consequences of this are evident, it was analyzed and compared to a similar grove where greening was being controlled to quantify the benefits of an effective greening control program.

When management practices to control greening are being followed, once infected trees are removed, two alternative strategies can be followed. One is to reset, or replace, trees that were removed. The other is not to reset the trees, but continue to remove infected trees until reduced tree numbers make the grove economically unproductive. Once the grove becomes economically unproductive, the remaining trees are removed and the grove is replanted.

There are advantages and disadvantages to both of these strategies. Young trees that produce multiple flushes throughout the year are at greater risk of infection than mature trees, which produce fewer flushes, and young resets in a grove with mature trees supporting psyllids are at greater risk than solid set young trees. Thus, it may not be possible to successfully grow resets in a grove with greening. In this case, removal of infected trees until the grove is economically unproductive followed by replanting is the preferable strategy.

Alternatively, if resets can be protected with aggressive application of systemic and foliar insecticides, and tree losses from greening can be reduced to levels at or near those being achieved in Brazil, then resetting gives perpetual life to the grove and does not require the investment of capital and lost income of replanting.

Finally, it was assumed that groves not being reset would be replanted once the grove becomes economically unacceptable from loss of producing trees, and under this scenario, that it was not possible to grow resets in a grove with greening. Groves with higher densities of trees cost more to plant and establish, but the greater tree numbers provide increased fruit production to offset tree losses from greening. Consequently, groves with medium and higher densities were analyzed to compare the impact of higher density plantings on financial performance in groves loosing trees from greening.

Data and Methods

The income approach to asset valuation was adopted as the methodology using a citrus investment model developed in Excel. Annual revenues and costs associated with an orange grove whose fruit is produced for the processing market were estimated over time under two likely fruit price scenarios for each of the management control strategies previously discussed. Revenues less costs were computed into net revenue streams for each strategy. Net revenue streams were then discounted and summed to provide an estimate of the net present value (NPV) of the different management control strategies in existing blocks of citrus. Net present value enables comparing different future income streams among alternatives on an equivalent financial basis. It converts a future income stream to an equal single current value at a rate of return equal to the discount rate. Net present value can be defined mathematically as:

where NR_t = Net Revenue in period t

r = discount rate

NPV = Net Present Value of the investment

N = evaluation period of the grove

And can be expressed in equation format as:

$$NPV = \sum_{t=0}^{n} NR_t \, (l + r)^{-t}$$

The financial performances of newly planted groves were compared using internal rate of return rather than net present value because growers typically evaluate investments in planting groves using measures of return on investment. The internal rate of return is the discount rate that equates the net present value, as defined above, to zero.

A 12% discount rate was used for present value analysis. This rate is in the range of rates investors are using to evaluate alternative citrus investments in Florida, and reflects a mix of equity and borrowed capital. Mature groves being reset were analyzed over a 15 year time period, and since they are perpetual income producers, the last three years of net revenues were averaged and capitalized at 12% to estimate a terminal value. Groves not being reset experienced declining net revenues annually due to tree losses. These were operated until net revenues approached zero, which typically extended beyond 15 years.

Data on cost of production including cost of new grove establishment and grove maintenance is compiled annually (Muraro). Grove maintenance budgets were modified to account for the additional costs associated with additional scouting to search for evidence of greening and increased sprays to suppress psyllid populations. Currently, these costs are estimated to increase the costs of caring for a mature Florida grove by 41%, or $378 per acre **(**Table 1**).**

As the exact effect of greening on tree mortality is not yet known, a most likely scenario based on growers' experience with greening control programs in Brazil was used to estimate tree mortality. Increased tree mortality not only affects the current crop, but by reducing the effective bearing area of a unit of land, future productivity is also affected.

Analysis and Results

The economic performance of the greening management strategies was analyzed under two price scenarios: delivered-in prices of $1.25 and $1.50 per pound solids[1]. Pound of solids is a measure of the juice content of fruit and the unit of payment to Florida growers selling fruit for processing. A Valencia Flatwoods grove was used for the analyses. For groves where greening was being controlled, it was assumed that attrition rates due to greening increased 150%, 100% and 75% over normal attrition rates for trees 1-3, 4-11, and 12 years old and older, respectively.

[1] This is the price paid by the processing plant for oranges delivered to the plant. Samples are taken to establish the pound solids content.

This equates to attrition rates that include greening of 2.5%, 3.0%, and 6.1% for trees 1-3, 4-11, and 12 years old and older, respectively. Based on the age distribution of trees in the grove used in the analyses, this resulted in a weighted average attrition rate from greening of 2.3% (Table 2).

The no control strategy assumes an average mature flatwoods grove producing 379 boxes per acre before greening is discovered. Once it is discovered, nothing is done to control greening, but normal caretaking activities are continued. Box yields decline rapidly and the grove is no longer covering costs by year 4 or 5, depending on prices (Figure 1). These rates of attrition were similar to those observed in Brazil in groves where no control was undertaken.

This no control strategy was then compared to the same average grove where management practices to control greening were being followed and removed trees were being reset. The resetting program consists of resetting 100% of annual attrition every other year for trees that were 1-10 years old and 50% of annual attrition every other year for trees that were 11-15 years old. The net present values of these alternatives are shown in Table 3. Even with the costs of scouting, spraying and tree removal, controlling greening was almost twice as valuable as not controlling it at delivered-in prices of $1.25 and 2.4 times as valuable at $1.50. Once this grove is economically unviable the owner must invest the capital to replant if he wants to remain in citrus production.

The reset versus no reset scenario assumes a more productive mature Flatwoods grove, yielding 476 boxes per acre before greening is discovered. The reset program is the same as that for the average grove in the previous scenario. The net present values of the reset versus no reset scenario are close, but resetting does show an economic advantage over not resetting, particularly at higher prices (Figure 2; Table 4). If reset trees can live to become productive, the main advantage is a grove that produces a perpetual income stream and does not have to be completely replanted at some future date.

Once a grove becomes economically unproductive it was assumed that it would be replanted. The scenario evaluated here shows returns on investment for replanted groves of three different densities: 145 trees per acre (TPA), 207 TPA, and 270 TPA (Figure 3; Table 5). Data for the higher density groves are based on historical data from commercial plantings of Valencias in Hendry County (207 TPA) and Polk County (270 TPA). Groves were reset only through year four of age, to examine the financial performance of higher density groves if resets can not survive in a mature grove. The investment for replanting included tree removal, land preparation, re-establishment and/or modification of the irrigation system, and costs for trees and planting. A price for land was not included in the investment because it was assumed that the land was already owned by the grower that is replanting and has no competing opportunity costs.

Yields per tree were lower for the higher density groves during mature years (years 8 and older) but greater per acre, averaging 593 (270 TPA) and 512 (207 TPA) boxes per acre, respectively, for the high density groves compared to 388 boxes per acre for the lower density (145 TPA) grove. The medium density grove showed internal rate of return (IRR) on the $4,951 investment in infrastructure of only 6.8% at $1.25 and 11.7% at $1.50, the lowest of the three densities analyzed. The best financial performance was exhibited by the highest density grove (270 TPA). It showed IRR of 11.8% and 16.1% on the $6,533 investment in infrastructure at prices of $1.25 and 1.50, respectively. Thus, the added yields for the higher density (270 TPA) more than offset the added investment in trees and planting, and was important in maximizing net revenues given the tree attrition from greening.

Conclusions

The decision not to control greening compromises the effectiveness of neighboring growers following control practices, and is the least profitable strategy in an environment of greening. If trees can be obtained and resets can grow to maturity in a mature grove under greening control, resetting is the preferred strategy. If not, when the grove becomes economically unproductive, replanting to a higher tree density provides added returns to offset higher costs from tree attrition and greening management.

According to researchers and citrus industry veterans, citrus greening is one of the greatest challenges the Florida citrus industry has ever faced. This analysis enables Florida citrus growers to make more informed decisions about the economic tradeoffs among current citrus greening management alternatives.

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Table 1. Costs of Greening Control Program for Valencia Oranges

		$ Per Acre
Base Grove Care for Mature Grove (Includes canker decontamination)		911.48
Additional Costs for Greening		
Additional Spraying (3 sprays + Temik)	287.82	
Scouting (4 times/Year)	90.01	
Sub-Total	377.83	
Grove Care Costs with Greening		1,289.31
Cost of Nursery Trees		$8.25/Tree
Pick, Roadside and Haul Costs		$2.52/Box

Source: Ronald P. Muraro, CREC, UF/IFAS

Table 2. Tree Loss Rates from Greening

Tree Age	No Greening	Increase in Loss Rates from Greening	Loss With Medium Greening
1-3	1.00%	150%	2.50%
4-11	1.50%	100%	3.00%
12+	3.50%	75%	6.13%

Weighted. Average Loss Rate from Greening in Mature Groves Analyzed: 2.3%

Grove Used for Analysis: Processed Flatwoods Valencia Grove

Table 3. Financial Analysis of Valencia Orange Grove – No Control VS Greening Control

Tree Density: 145 TPA (12’ x 25’)

Pre-Greening Boxes/Acre (Average Valencia Grove): 379

	No Control Rapid Decline		Control with Resetting	
Price/P.S.	$1.25	$1.50	$1.25	$1.50
Net Present Value	$2,605	$4,324	$5,129	$10,430

Note: For no control, greening losses begin in second year. Grove no longer producing after 6 years.

Table 4. Financial Analysis of Valencia Orange Grove with Greening Control– Resetting VS No Resetting

Tree Density: 145 TPA (12’ x 25’)

Pre-Greening Above Average Valencia Grove Boxes Per Acre: 476

	Reset		No Reset	
Price/P.S.	$1.25	$1.50	$1.25	$1.50
Net Present Value	$9,746	$16,350	$9,024	$14,479

Reset Program: 100% of trees lost annually reset every other year for trees 1-10 years old. 50% of trees lost annually are reset every other year for trees 11-15 years old.

Table 5. Financial Performance of Replanted Valencia Grove: Medium VS High Density Grove Without Resetting

Tree Density	145 TPA (12’ x 25’)		207 TPA (8.75’ x 24’)		270 TPA (8’ x 20’)	
Yield Avg. in Years 8-15 of Grove	388 BX/Ac		512 BX/Ac		593 BX/Ac	
Investment Per Net Acre W/O Land	$4,951		$5,463		$6,533	
Price/P.S.	$1.25	$1.50	$1.25	$1.50	$1.25	$1.50
IRR	6.8%	11.7%	10.7%	15.1%	11.8%	16.1%

Reset Program: 100% of trees lost annually reset every other year through year 4.

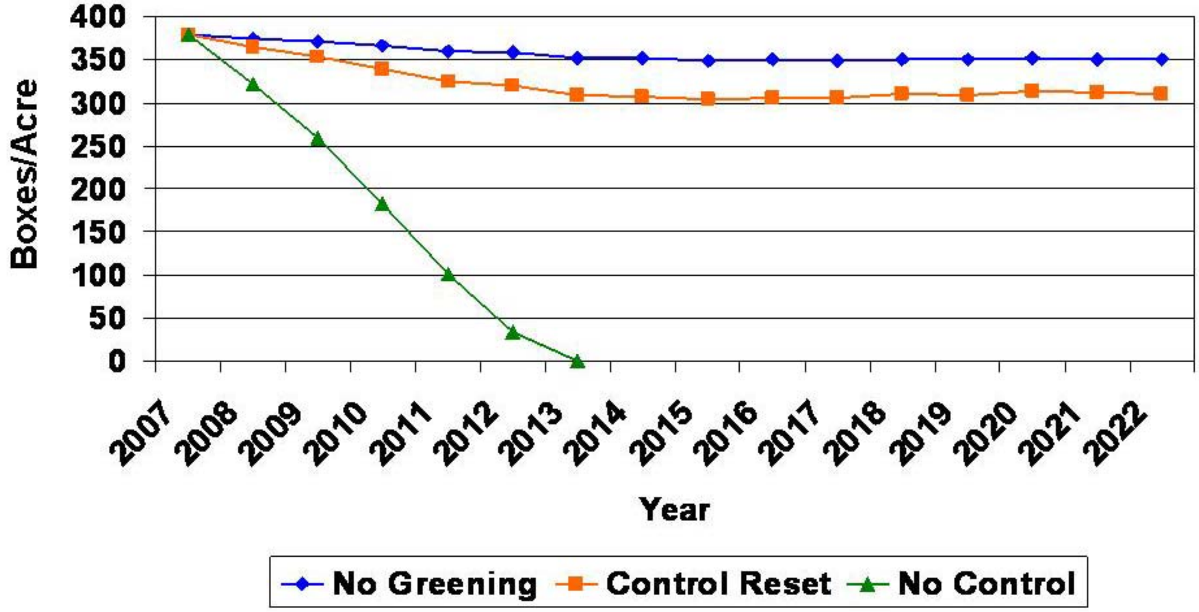

Figure 1. Greening Control vs. No Control: Typical Grove

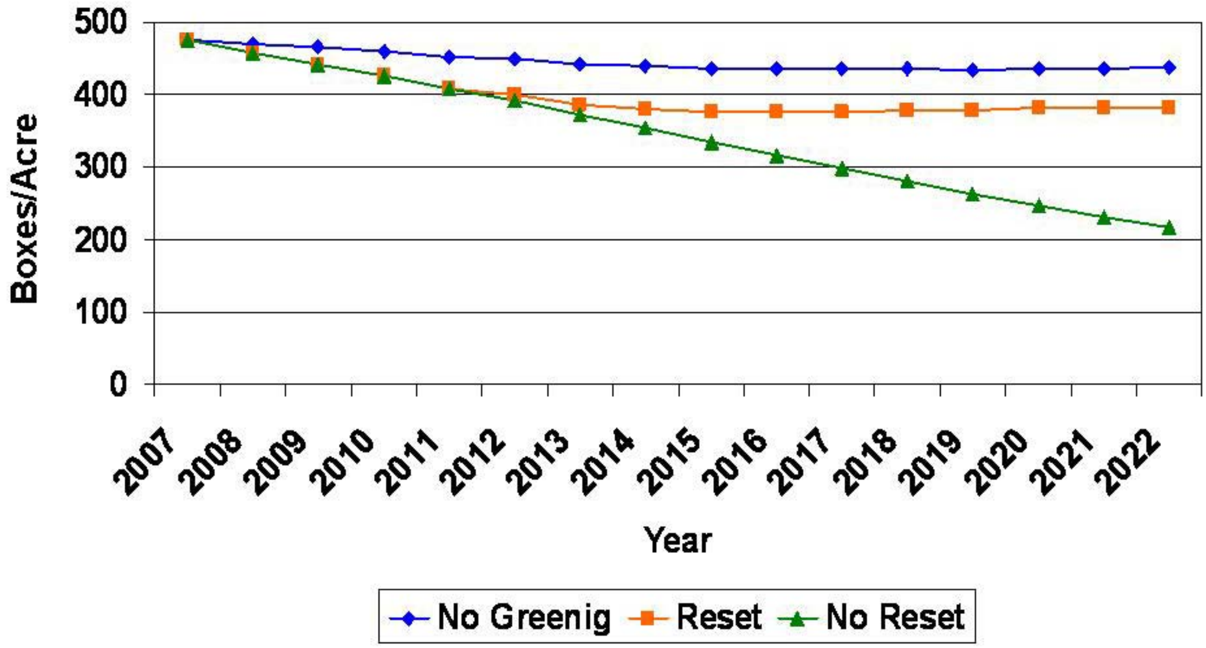

Figure 2. Reset vs. No Reset: Above Average Grove

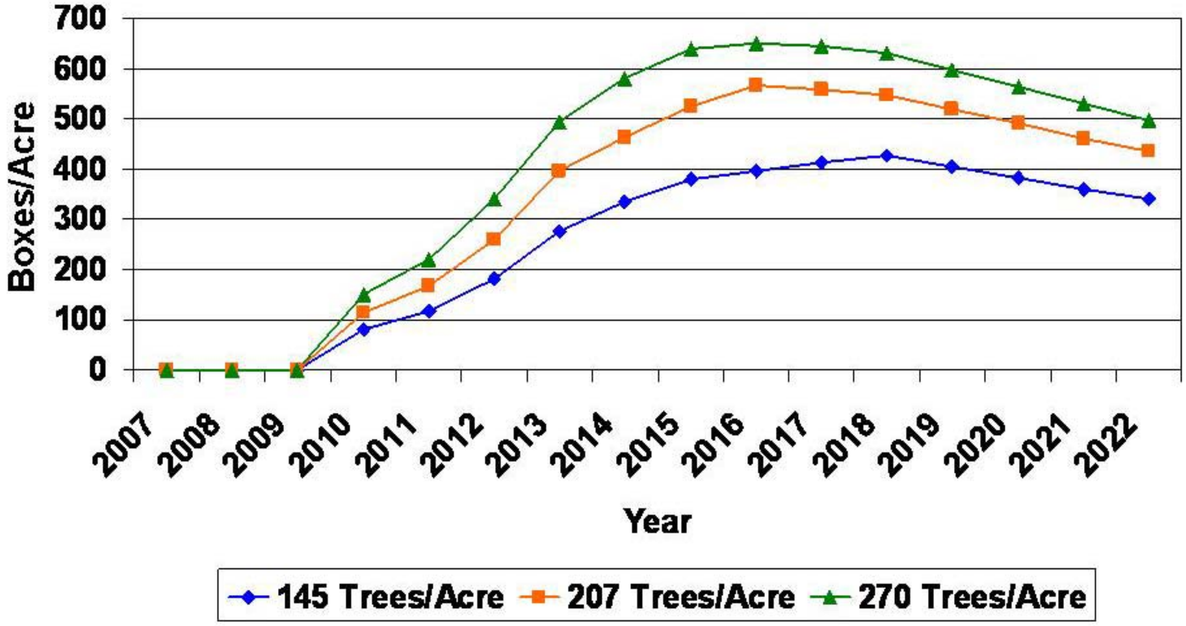

Figure 3. Replanted Solidset Valencia Grove with Greening: Medium vs. High Density