Advanced grove designs and cultural systems for *Huanglongbing* management – a call to action

By Bill Castle, Ed Stover and Pete Spyke

Fig. 1. *A modern western New York apple orchard of trees spaced 2 x 10 ft on a 3-wire trellis (foreground) versus a conventional orchard with trees at 15 x 20 ft (background).*

In a recent conversation, a colleague of ours stated that HLB has been a serious problem in citrus for decades in some parts of the world. However, he stated, never in the history of the disease has such a team been assembled as today in Florida. The corps of scientists, growers and managers working on the disease and its vector is immense. The degree of funding support is equally impressive. All of this means that we can expect within a few years to have more knowledge than ever before about the psyllid vector, the causal bacterium, and solutions for controlling the disease, including new plants resistant to the disease.

Meanwhile, the citrus industry in Florida, and perhaps throughout the nation, is facing an unprecedented crisis. The procedures and techniques developed to manage HLB may not be adequate or available quickly enough to sustain the volume of fruit production necessary to maintain a viable industry. The financially successful approaches of producing citrus in the past will no longer be relevant as has been seen in other countries living with HLB.

CAN PRODUCTION REMAIN ECONOMIC IN THE PRESENCE OF HLB WITH EXISTING CONTROL MEASURES AND SUSCEPTIBLE VARIETIES?

At some point, the healthy tree population in an HLB-infected grove will be reduced to the point where it is no longer economical to continue with existing groves. If HLB infection exceeds a threshold, continued tree removal will no longer be a viable approach. Thus, when existing blocks are no longer capable of producing a net positive economic return, replanting at conventional densities will accentuate risk. By using high-density plantings and intensive cultural programs, risk can be transferred from the uncertainty of HLB infection, which is largely beyond grower control, to risks associated with the costs of more intensive management and horticultural practices, which are controllable factors.

China and South Africa have had HLB for decades after their citrus industries were originally decimated by the disease. However, they both have replanted in some infected areas. China recently passed the United States as the second largest citrus producing country in the world behind Brazil. The approach that has proven to be financially successful in both countries has been to increase the number of trees per acre and manage them intensively.

These tree-fruit industries have transitioned to more trees/area because research and commercial experience have shown that higher density orchards can maximize fruit quality and productivity, provide a convenient way to rapidly introduce new scion varieties, and enable different, less costly harvesting options. Therefore, as we face new economic realities, we are encouraging Florida growers to consider the same pathway followed by apple tree industries: Move the production curve forward in time by using more trees/area and smaller trees achieved with size-controlling rootstocks (Fig. 1). These orchards are managed more intensively with cultural practices that induce earlier and heavier cropping while containing canopy growth. The results of this approach are higher profit, improved production, fruit quality and harvesting efficiencies along with enhanced environmental responsibility.

In a citrus grove of closely spaced small trees, as in any grove, yield in the early years relates directly to the number of trees. As they mature, yield reaches a peak. In the higher density (HD) grove, the trees "mature" or reach that peak sooner. Important concerns in the HD grove are the sustainability of peak yield and whether such a grove would actually be more vulnerable to pests and diseases because of the close tree proximity.

One approach to the yield question is to look at projections of citrus production at several planting densities and tree loss rates with the assumption that trees can be completely protected from psyllids by imidacloprid for two years with no tree loss. Also, assume yields of 0.2 boxes/tree in Year 2, 0.4 boxes/tree in Year 3, 0.8 boxes/tree in Year 4, 1.2 boxes/tree in Year 5, 2.0 boxes/tree in Year 6 and continued increases of 0.5 boxes/tree in subsequent years with a maximum yield of 800 boxes/acre (Fig. 2). The reference planting densities are a conventional Florida grove planted at 15 x 25 feet (116 trees/acre), a modern grove planted at 10 x 20 feet (218 trees/ acre), and a HD grove planted at 6 x 20 feet or 8 x 15 feet (363 trees/ acre). We anticipate that the next generation of groves will be in the 300-400 trees/acre range. Note also that these examples assume that resets will not be planted since they would rapidly become infected with HLB due to off-cycle flushes before they could reach productive size.

If the tree loss rate is 3% per year — a situation only slightly worse than is historically typical in Florida citrus production — at the end of Year 12, the grove planted to 400 trees/acre has declined to 300 trees/acre and the grove planted at 200 trees/acre has declined to 150 trees/acre (Fig. 2). These are still above the current Florida average trees/acre. However, note that the grove planted with 400 trees/acre reaches 500 boxes/acre in Year 5 and remains above this level through Year 12 while the grove planted at 200 trees/acre takes an additional three years to pass this threshold.

A tree loss rate of 30% is a situation reflecting catastrophic loss of trees to HLB. At the end of Year 12, the grove planted to 400 trees/acre has declined to 50 trees/acre and the grove planted at 200 trees/acre has declined to 25 trees/acre (Fig. 3). The grove planted to 400 trees/acre approaches 350 boxes/acre in Year 6 and declines through Year 12, while the grove planted at 200 trees/acre reaches a maximum of 170 boxes/acre.

Even with the extremely high loss rates, the HD grove has a greater chance of returning establishment costs which

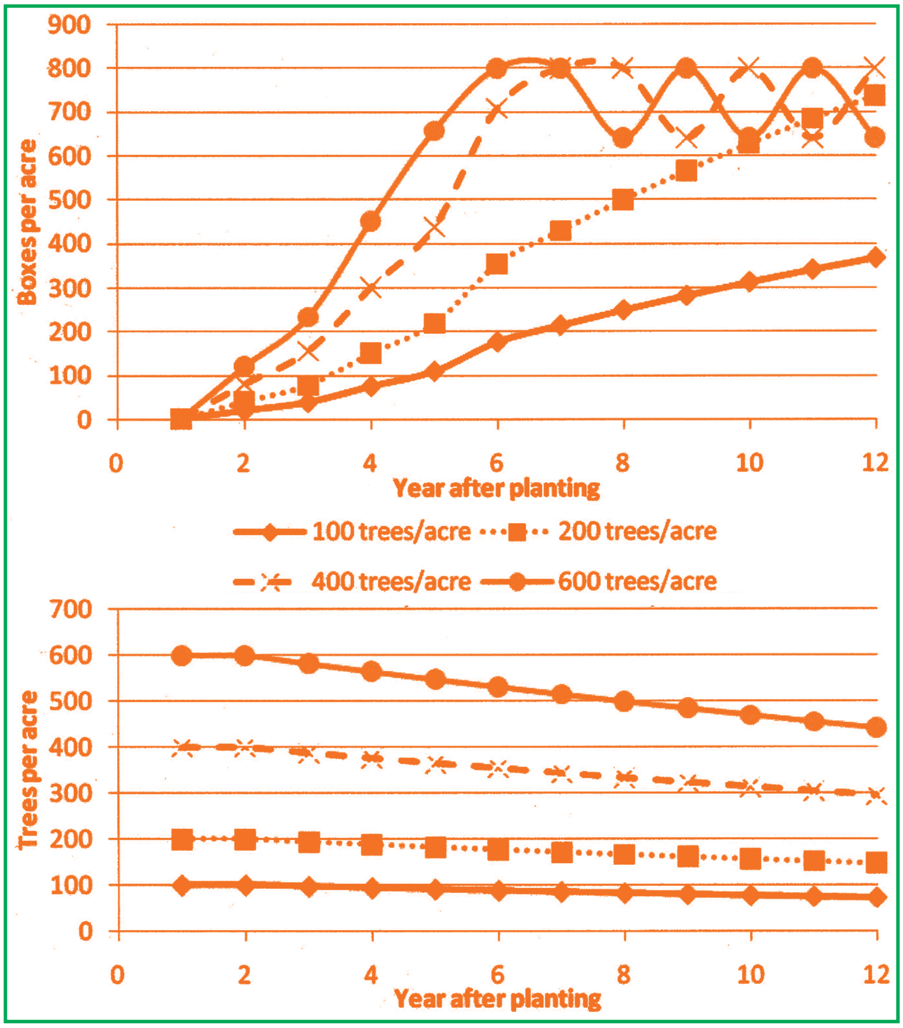

Fig 2. Projections of citrus production (upper graph) and trees/acre (lower graph) at an annual tree loss rate of 3% and assuming that trees can be completely protected from psyllids by imidacloprid for two years with no tree loss and yields of 0.2 boxes/tree in Year 2, 0.4 boxes/tree in Year 3, 0.8 boxes/tree in Year 4, 1.2 boxes/tree in Year 5, 2.0 boxes/tree in Year 6 with continued increases of 0.5 boxes/tree in subsequent years with a maximum yield of 800 boxes/acre.

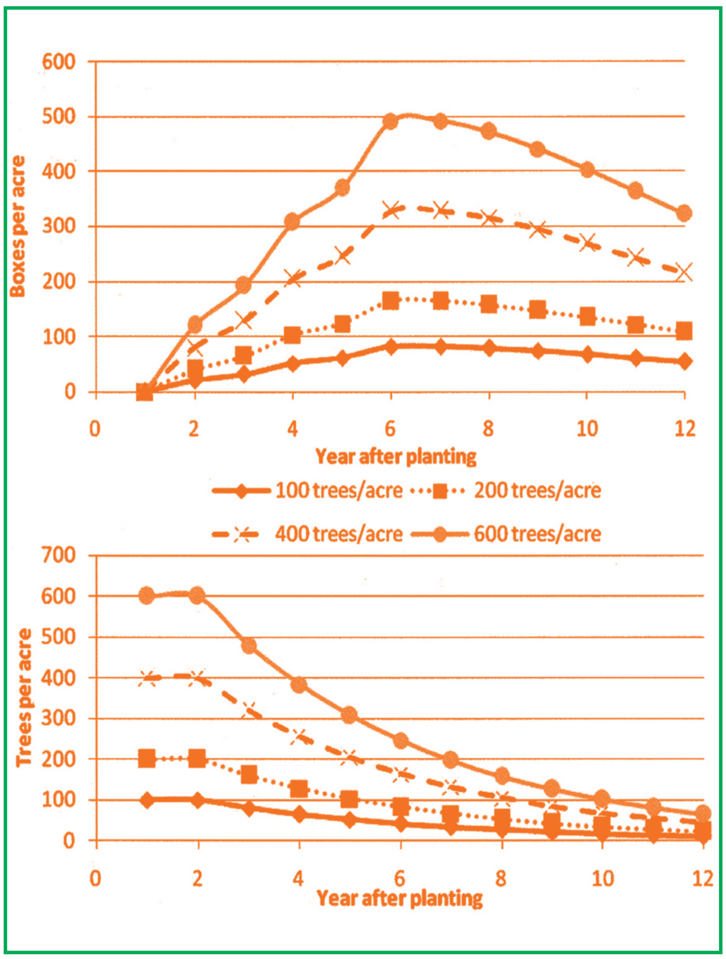

Fig 3. Projections of citrus production (upper graph) and trees/acre (lower graph) at an annual tree loss rate of 30% and assuming that trees can be completely protected from psyllids by imidacloprid for two years with no tree loss and yields of 0.2 boxes/tree in Year 2, 0.4 boxes/tree in Year 3, 0.8 boxes/tree in Year 4, 1.2 boxes/tree in Year 5, 2.0 boxes/tree in Year 6 with continued increases of 0.5 boxes/tree in subsequent years with a maximum yield of 800 boxes/acre.

significantly mitigates the risks associated with HLB for new plantings. The primary reason is that the cost per tree for establishment and grove care is so much less than with conventional groves. The cost per acre is higher, but if the same number of trees were planted with conventional spacings, the additional number of acres required increases the cost per tree dramatically. Since yields in the first few years are directly related to the number of trees, the same or higher yield per tree with a lower per-tree cost increases early annual profitability.

Many industry members and researchers will recall that higher density citrus production has been tested in Florida. However, demonstrating that closely spaced trees could produce high yield did not compel commercial adoption of these practices. This was partly because these trials were conducted with standard production methods and expectations of groves surviving 20-30 years. Furthermore, there are lingering concerns about the availability of appropriate scion/rootstock combinations for the HD grove and whether such orchards can be managed and harvested with conventional equipment.

FLORIDA CITRUS IN THE FUTURE: A NEW MODEL

Our proposed new model for Florida citrus production, Advanced Production System (APS), begins with grove design factors such as spacing and scion and rootstock choices that, once decided, are not usually changed following implementation.

In addition, the APS uses intensive fertigation practices (Open Hydroponic System-OHS) that can be adjusted after planting. OHS was developed in Spain, Israel and South Africa and results in more rapid tree growth, earlier production, higher yields and better fruit quality than conventional production practices by maximizing control over tree-water relations and nutrient status. By fertigating daily with drip irrigation to train the effective root system into a limited volume using a daily ration of water and nutrients, the goal is to provide tight control over plant growth and development.

Although trees can be grown rapidly with micro irrigation systems, the clustering of roots under drip emitters allows more control over tree growth events, a critical component in promotion of heavy cropping and fruit quality.

HOW WILL APS/OHS WORK IN FLORIDA?

There is no established understanding of how trees in Florida will grow and produce with APS/OHS. What information is missing for implementation of high density intensively managed Florida citrus production systems?

➤ Scions and rootstocks need to be tested for their suitability in the proposed model based on growth and productivity data in Florida under OHS conditions in major citrus soil types to establish appropriate in-row spacing.

➤ Developing techniques to induce high early production is essential for shorter-cycle citrus production. These techniques may include combinations of girdling, control of water and nutrients, and growth regulator application during flower induction and/or flowering.

➤ Will young trees produce fruit with good quality? Conventional wisdom is that fruit on young trees that are being pushed to develop canopy volume have low quality. If cultural practices are used to promote heavy cropping as well as canopy growth, experience in other countries and early observations in Florida suggest that fruit acceptable for the fresh and juice markets can be produced using the proposed system.

➤ A key part of the OHS is management of a drip irrigation system so that roots concentrate under each dripper. These high density "root balls" are crucial because they rapidly take up water and nutrients and provide maximum control over tree development when fertigated with daily pulses to supply the tree's needs. Early results show that roots do concentrate under drip emitters in Florida, but will it be sufficient to provide the tree control seen in climates with less rainfall than Florida? Can this control be improved with different management approaches? What nutrient regimes will work best for Florida conditions and varieties to enhance desired performance at specific tree and fruit stages of development?

➤ Early heavy cropping helps control vegetative growth, keeping trees in check and reducing the cost of pruning while also promoting higher young-tree fruit quality and providing earlier cash flow. Apple growers routinely "renew" their trees by removing any branch that approaches one inch in diameter. Selective pruning may also prove effective in Florida HD citrus production.

HOW WILL WE TEST PRIORITY PRACTICES IN TIME TO PROVIDE CRITICAL GUIDANCE?

The research community has already initiated a number of experiments and demonstration trials in Florida to provide answers to the questions above and to others. Clearly it will be critical to include economic analyses and provide frequent updates so that early-adopters will be in the best position to choose which planting system makes sense and provide positive results which will encourage more widespread adoption. Our Florida industry needs to get involved by establishing plots in collaboration with researchers and sharing results. Additional trials will likely be funded within the HLB grants through FCPRAC/DOC to provide earlier experimental results on HD production practices.

There are also positive environmental effects from the APS/OHS model. The Arapaho trial in Fort Pierce being conducted by Pete Spyke is using considerably less water and fewer nutrients while achieving rapid tree growth rates. While environmental issues such as Total Maximum Daily Load seem distant compared to HLB, they must be accommodated in the successful production model.

The APS/OHS approach has proven to be the most viable response to HLB in other countries. We urge Florida growers to consider the system and to talk to the Florida team as we investigate the new model and develop the principles and guidelines needed to fit Florida conditions as quickly as possible.

RESOURCES AVAILABLE TO HEIGHTEN YOUR INTEREST

• *http://swfrec.ifas.ufl.edu/events/expo/*: Visit EXPO archives at the IFAS Center, Immokalee, to review the APS/OHS presentations given in 2007.

• *http://www.arapahocitrus.com/*: Visit here for the latest news on the oldest Florida APS/OHS grower site, and to download an OHS Comparison Spreadsheet to see the profitability comparisons of APS/OHS and conventional groves.

• *bcastle@ufl.edu*: Bill Castle can provide a complete list of participating researchers, a disk containing important APS/OHS documents and a summary of grower sites visited during a grower/researcher 2006 trip to South Africa.

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