Overview of flower bud induction in Florida

Citrus flower bud induction starts in the fall and usually is completed by early January. Low temperatures first stop growth and then promote induction of flower buds as more hours of low temperatures accumulate (below 68° F or 20° C). Periods of high temperatures in winter can then initiate bud differentiation which after sufficient days of warm temperatures leads to bloom. Other conditions that can interfere with good flower bud induction include: 1) exceptionally high previous crop or 2) excessive leaf loss from hurricanes, freezes or other causes (canker, HLB) where tree recovery is not complete. Excessive leaf loss leads to low carbohydrate levels in developing buds which reduces their ability to become flower buds and/or to set. Further, continual warm weather after leaf loss stimulates new shoot growth. These new shoots would otherwise be potential flower buds in the spring thus reducing next year's crop potential.

Under normal Florida weather conditions but with a moderate to heavy previous crop, sufficient flower bud induction should be achieved when total accumulated hours of low temperatures (below 68 °F) exceed 800-850 hours. If the crop load is light and trees are healthy, sufficient flower bud induction may occur after 700-750 hours of accumulated low temperatures. A warm period of 7 to 12 days with temperatures from 80 to 85 °F can trigger growth (bud swelling) if 350-450 hours of low temperatures (below 68 °F) have accumulated. Later in the winter when the accumulated cool temperature induction hours are higher, fewer days (5-7 days) and lower daytime high temperatures (75 °F or above) are required to stimulate growth of buds. Weather information relative to Florida citrus flower bud development for the current and several previous years (back to 1998) can be obtained and evaluated with the Citrus Flowering Monitor System using data from the Florida Automated Weather System (fawn.ifas.ufl.edu) for locations near you. A 6-8 day forecast from the National Weather Service predicts Florida weather for several sites around the citrus belt for the next week. Find this information at: https://www.cpc.ncep.noaa.gov/. The Weather Channel has a 10 day forecast available as well. These are easy ways to see if a warm period is predicted for your specific area in Florida which could trigger flower bud growth.

Some flower buds will be induced in the range of 350 to 450 accumulated hours below 68 °F. Warm events after these levels of induction are met results in weak flowering intensity, and therefore many buds remain that can be induced by later cool periods, or these buds may sprout as vegetative shoots if warm weather continues and the trees are well irrigated. The first situation results in multiple cohorts of flower buds developing to different bloom dates or in simple terms extended bloom period. The second condition leads to low flowering-fruit set and excessive early spring, late winter vegetative growth. The time period in which an early warm period (7-12 days) can lead to an initial low number of buds growing and flowering is roughly mid-November to early December. Then after more cool temperatures additional flower buds are induced and a later warm period starts their growth and repeats of this temperature cycle result in multiple blooms, usually two to three, but all in the mid-February to early April normal spring flowering period.

For healthy citrus trees only two management tools are available to eliminate or reduce the chance of multiple blooms:

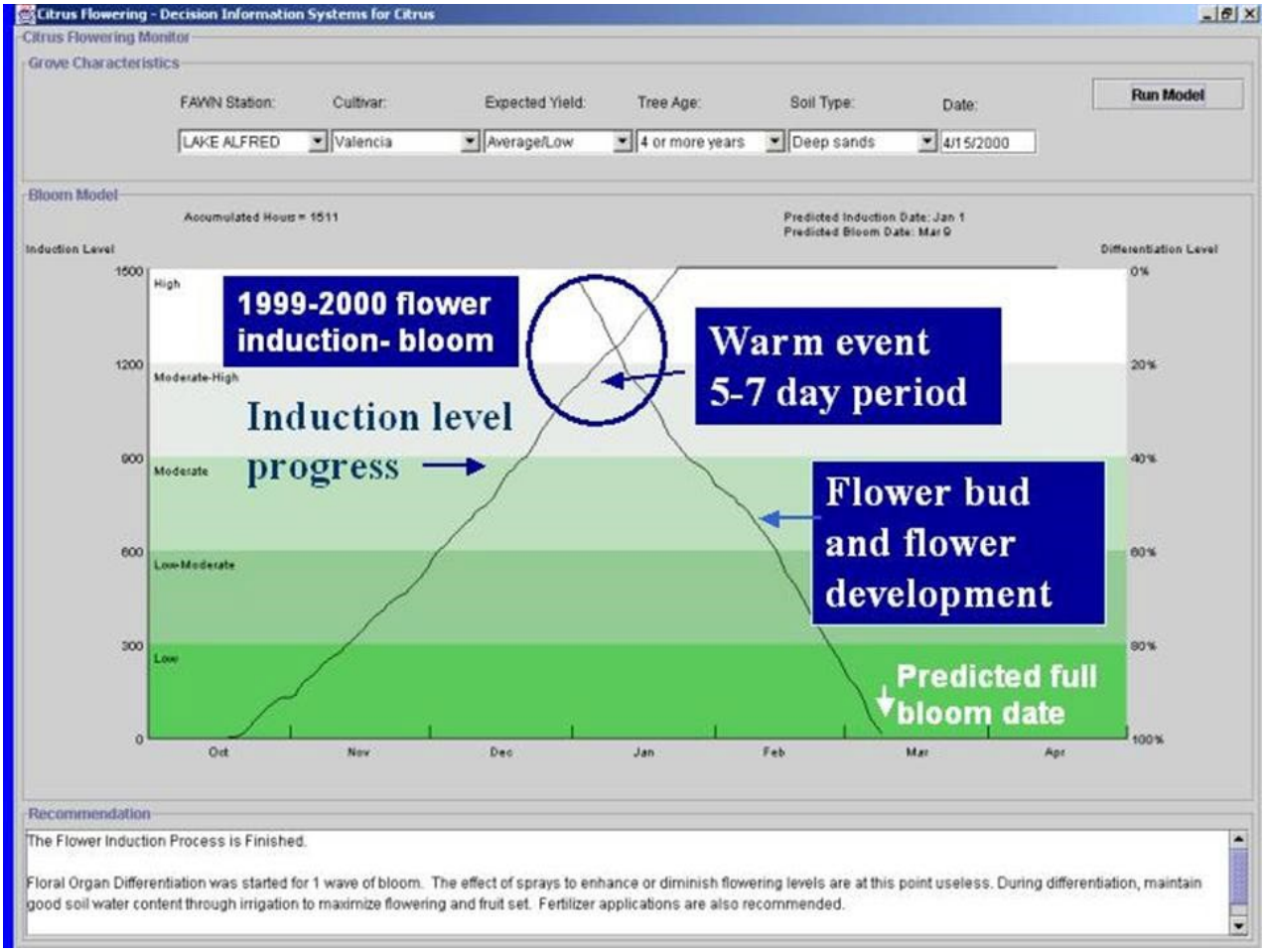
(1) Sufficient drought stress to boost induction and stop growth: Water stress may be provided by stopping irrigation well before the predicted warm period occurs. If the warm periods(s) are of the typical 7 to 10 day duration, a coincident short period of drought stress will have little impact on current crop development or quality in healthy trees. If no rains interrupt a water stress condition in citrus trees, buds will not grow in response to high temperatures. If a warm period has passed, trees again can be irrigated to minimize current crop stress. Although no weather prediction is guaranteed, rains in the winter usually come on the fronts of cool periods. Sufficiently cool temperatures (below 68 °F) after a cold front rain will usually prevent growth even though soil moisture is adequate for growth. **Normal healthy trees could have their induction boosted by applying some drought stress. Unfortunately, with weak root systems associated with HLB you shouldn't risk heavier preharvest fruit drop of the current crop by using water stress to prevent unwanted early vegetative growth and enhance induction of flowers. Do Not drought stress HLB-affected trees. In fact due to limited (small) feeder root system in HLB affected trees, the trees do experience some level of water deficit, any more water deficit cannot be beneficial for diseased trees.**

Sufficient drought stress may be interpreted as leaf wilt observed by 10 or 11 am, but leaves recovering by early the next morning. In the shallow soils of bedded groves, it is relatively easy to create sufficient water stress to suppress growth by withholding irrigation for a few days if no rains occur. In deeper, sandy soils, 2 or more weeks without irrigation or rainfall may be required. To minimize the time required for soil to dry sufficiently to initiate water stress, the soil should be allowed to dry out by mid-November so that trees show wilt by mid-day. For bedded groves, minimum irrigation can then be applied at low rates as needed until a weather prediction indicates a warm period is expected. At this time, irrigation should be shut down. For deep sands, the soil needs to be dried out and kept nearly dry below 6 to 8 inches of depth until at least Christmas so that no growth can occur. Minimum irrigations that re-wet perhaps the top 6 to 8 inches of the root zone may minimize excessive drought, while allowing quick return to a water stress condition if a high temperature period is forecasted. Soil moisture monitoring can help to achieve these goals. Prolonged late-fall, early-winter drought may be risky for 'Hamlin' or other early maturing cultivars not yet harvested that tend to drop fruit near harvest.

(2) A timely gibberellic acid (GA) spray before warm weather triggers growth. GA will reverse induction and knock out a weak first flower initiation, but it has to be applied just before or as the warm period starts. If induction level is above 600 or 650 hours the spray will not completely stop all of the flowering, but a more concentrated flowering should occur after the second warm period. In HLB-affected trees GA application has been shown effective in suppressing early flowering and narrowing down the flowering period. GA application will reduce the total number of flowers on tree. Under HLB conditions, reduced number of flower does not seem to affect final yield.

Much of what has been stated above has now been incorporated into the 'Citrus Flowering Monitor Expert System for Florida'. Figure 1 represents the different aspects of flower induction as depicted by the software program. The program gives an average bloom situation represented by the shades of green to white, vegetative to heavy flowering, respectively. The left side line tracks low temperature accumulation. If the current crop is very heavy, then more cool induction is needed to compensate for the crop load effect. If the current crop is lighter or tree condition is

better, then fewer total cool temperature hours are needed for an equal level of flowering. The right side line(s) track flower bud initiation and development to full bloom. Recommendations (text below graph) consider the current crop level in assessing when action should be taken to try to reduce or to enhance initiation in the flower bud development process. The system is available on-line: http://disc.ifas.ufl.edu/bloom . The on-line version can be used to evaluate any previous year back to 1998-99 by putting in a March or April date for a FAWN location of your choice in the menu. This program does not work if May through September dates are entered.



Additional uses of the 'Citrus Flowering Monitor System-

1. **Timing initial spring psyllid spray** – Initial bud growth in the spring is indicated by the 'Citrus Flowering Monitor System'. Until the leaves in those buds are visible (begin to unfold) there is no available plant material for adult psyllids to lay eggs and begin the cycle of a new population. An adult psyllid spray at this time is an effective way to disrupt the new psyllid population cycle and this timing provides much longer control. Bud break usually occurs about 2 to 3 weeks after initiation of bud growth (beginning of differentiation). You can follow this with the 'Citrus Flowering Monitor System'. Most growers cannot cover all of their citrus blocks quick enough with their ground equipment to get all blocks covered before feather flush is available for adult

psyllids to lay eggs. An aerial application is more likely to meet the required timing even though canopy coverage is not as efficient. As this time approaches in December-January further details will be posted.

2. **Appropriate time for bee movement into and out of citrus blocks** – The 'Citrus Flowering Monitor System' can also be used to judge when 10% open flowers is likely to occur. In 2015 and 2016, early and late flowering years, respectively, 54 to 53 days occurred from initiation of bud growth until 10% open flowers. Further, when 17 years of flowering data were evaluated it was determined that the weeks until bloom from initiation of bud growth varied by 3 weeks and mean weekly temperatures for the first 4 weeks determined the length of the flower development period. Based on the data available, it appears that the time until10 % open flowers should increase about 7 days per each 5 degrees F above 60 degrees F. We will evaluate these timing predictions for growers to stop spraying more effective, harsher, pesticides for psyllid control and for beekeepers to move bees into citrus this coming spring. Bee removal timing appears to be about 11 to 15 days after full bloom. Again we will visit this issue as the model indicates that growth of the first wave of spring flowers has been initiated.