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UMass Extension

Healthy Fruit

Prepared by the University of Massachusetts Fruit Program

Healthy Fruit, Vol. 27, No. 10, June 11, 2019

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CONTENTS

CURRENT DEGREE DAY ACCUMULATIONS

UMass Cold Spring Orchard, Belchertown, MA	10-June
Base 43 (NEWA, since March 1)	854
Base 50 (NEWA, since March 1)	458

UPCOMING PEST EVENTS

Coming events	Degree days (Base 43)
Black stem borer 1st flight subsides	832 to 1214
Cherry fruit fly 1st catch	755 to 1289
Codling moth 1st flight peak	566 to 986
Dogwood borer 1st catch	751 to 1215
European red mite summer egg hatch	737 to 923
Obliquebanded leafroller 1st catch	796 to 978
Oriental fruit moth 1st flight subsides	826 to 1098
Pear psylla 1st summer generation adults	737 to 885
Peachtree borer 1st catch	781 to 1313
Redbanded leafroller 1st flight subsides	609 to 893
Spotted tentiform leafminer 1st flight subsides	680 to 944
White apple leafhopper 1st brood adults 1st catch	679 to 1041

UPCOMING MEETINGS

Fruit twilight meeting, Tuesday, June 11, 2019. 5:30 PM. Bashista Orchards, 160 East Street, Southampton, MA. 2 pesticide recertification credits. Light supper served, no pre-registration necessary, $20 registration collected at the door. Meeting stars and UMass Amherst Faculty Autio, Cooley, and Pinero will speak on current horticulture, disease, and insect management. Extension Educators Clements, Schloemann, and Garofalo co-star.

Fruit twilight meeting, Wednesday, June 12, 2019. 5:30 PM. Tougas Family Farm, 234 Ball Street, Northboro, MA. 2 pesticide recertification credits. Light supper served, no pre-registration necessary, $20 registration collected at the door. In cooperation with University of Rhode Island Extension and Rhode Island Fruit Growers' Association. Meeting stars and UMass Amherst Faculty Autio, Cooley, and Pinero will speak on current horticulture, disease, and insect management. Extension Educators Clements, Schloemann, Garofalo and Faubert (URI) co-star.

July 10 (Wednesday). Massachusetts Fruit Growers' Association Summer Meeting. Sholan Farms, 1125 Pleasant Street, Leominster, MA

THE WAY I SEE IT

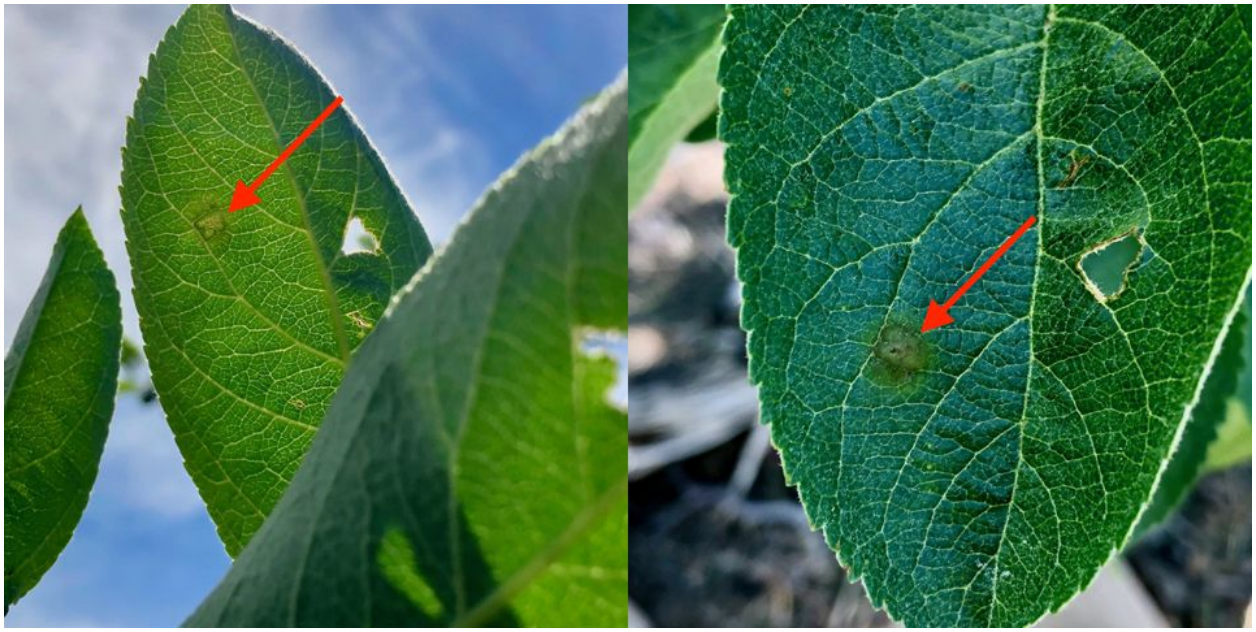
Apples are coming off. I have seen some outstanding thinning results, not sure what the combination was, but I suspect it was a bloom thinner, petal fall thinner and traditional thinner at 10 mm. (There was a nice chemical thinning window then.) Oh, and just maybe some dubious pollination which helped? (Or hindered in some cases?) Still, there is room for improvement, Honeycrisp, Gala, and other later blooming varieties TBD. And alternate bearing is a consistent problem. Please read the lengthy but very good Guest article on Alternate Bearing. If some more thinning is desired, it's not too late to use ethephon as a "rescue" thinner (Fact Sheet). And it's almost time to start using ethephon or NAA to enhance return bloom (Fact Sheet).

Plum curculio are still active. (Or are they? Maybe you should read Insects.) NEWA says we have not reached the 308 DD threshold (Base 50, from petal fall). NEWA goes on to say "Adult oviposition decreasing. Plum curculio activity is beginning to decline and any curculio remaining in trees will usually not move to other locations. Plum curculio only need to be controlled until 308 DD have accumulated after petal fall. Make sure that the predicted residual coverage (10-14 days) from the last spray will protect fruit until DD accumulation reaches this value." FYI, depending on when you call petal fall (when is that anyways these days?) we are at about 280 DD's Base 50 from petal fall. It's getting close, still, keep your guard up.

Apple scab should be easy to spot now if you have any. URI's Heather Faubert told me to look up into the canopy as the lesions are easier to spot from the bottom of the leaf with the sky shining through. It works! If you see any scab, yea, I know, keep spraying fungicides. Wet weather obviously will exacerbate the spread of scab. Soon we'll have to be covering for summer diseases. Let's hope it's a dry summer, we could use it.

Hope to see you at one of the fruit twilight meetings this week, It seems like it's been an active spring and there should be plenty to commiserate over and maybe turn the leaf now?

"Nice" June drop pf Zestar! apples on 10-June, 2019



“You got scab!” Looking skywards through the apple canopy is a good way to spot primary scab lesions. (Thanks Heather Faubert of URI for the tip!)

NEW ENGLAND TREE FRUIT MANAGEMENT GUIDE

The New England Extension tree fruit specialists -- which include myself, Dan Cooley, Jaime Pinero, and Elizabeth Garofalo at UMass. Mary Concklin at UConn, Heather Faubert at URI, Terry Bradshaw at UVM, George Hamilton and Anna Wallingford at UNH, and Glen Koehler and Renae Moran at UMaine -- have officially launched, and updated for 2019 -- an online edition of the **New England Tree Fruit Management Guide**. Note that is it easy to print any of the sections, if you want to have old-school reference, for example, to hang on your spray shed wall. Also, it is quite mobile-friendly so make a home screen shortcut to here: http://netreefruit.org. Finally, if you really, really want a printed version, order here: https://www.umassextensionbookstore.com/products/29.

INSECTS

Jaime Pinero

How ‘normal’ was the 2019 season for plum curculio?

As everyone knows, the spring of 2019 has been cool and wet. Such a weather pattern resulted in an extended period of PC activity which, for the first time in several years, was difficult to monitor using odor-baited traps.

The table below shows that 2019 had the lowest average air temperature for the month of May, when compared to the three preceding years. For example, in 2018 the average temperature during May was about 7 degrees higher, with more comparatively 'warm' days. It seems that the 2019 May weather was similar to 2017 in terms of temperature (both years were similarly cool), although in 2017 the amount of precipitation during May was nearly twice as much the amount received in 2019.

	Avg. temperature (May)	# of days with max. temp ≥ 70°F	# of days with max. temp ≥ 80°F	Total rainfall (inches)
2019	**55.5**	**9**	**1**	**3.3**
2018	62.0	20	9	1.6
2017	56.3	9	3	6.7
2016	59.0	16	6	2.5

Relevance of the above weather data for plum curculio monitoring and management.

Cool, wet weather has implications for insect pest management. Below are some thoughts concerning PC activity and its relationship with weather.

- **PC population density.** In 2019, odor-baited traps didn't capture high numbers of PCs for the entire month of May and June in the unsprayed block of the UMass Cold Spring Orchard. Only 40 PCs were captured in 8 odor-baited traps in 30 days (May 10th - June 8th, 2019). This doesn't mean that the PC population was low. Rather, it seems that the lures used for PC monitoring (in traps) and for trap trees didn't perform as expected due to the long period of cool weather, which may have decreased the dispersion (volatilization) of the plant volatiles and pheromones. In other words, PCs may have skipped the traps.

- **PC behavior**. It is conceivable (yet unproven) that PCs may not be present within tree canopies during cool, rainy weather. Rather, they may spend most of the time at the soil-line, protected underneath leaf litter. If this is true, then insecticide applications taking place during cool weather may be less effective when compared to sprays that occur during warm weather - *more conducive for PC activity within tree canopies.*.

- **Visual observations of fruit** indicated that heavy PC damage (> 45% of fruit sampled was infested) took place in the unsprayed sentinel block for the last 2 weeks. A recent visual inspection revealed very little fresh injury, an indication that most of the PC activity already took place.

- **Oviposition model predicting end of PC oviposition.** PC only need to be controlled until 308 DD (base 50) have accumulated after petal fall. At the UMass CSO, the petal fall date was May 20th. As of today (June 211th), 281 degree days (base 50°F) have accumulated since petal fall. So, if you haven't sprayed against PC in the last 5-7 days and fresh injury is present, then one perimeter-row spray would be advised to protect the fruit.

- **Impact of temperature on insecticide toxicity.** Temperature often has a significant effect on the efficacy of insecticides when used in the field. Some insecticides (e.g., organophosphates) become more toxic with the increase in temperature whereas other insecticides (e.g., pyrethroids) usually become more toxic at lower temperatures. So, if Imidan was sprayed against PC during cool weather, there are some chances that the toxicity may have been somewhat reduced due (1) lower metabolic activity of adult PCs, and (2) the comparatively less rainfast properties of organophosphates.

- **Impact of rainfall on the performance of insecticides.** In the May 14th issue of Healthy Fruit, an article on the impact of rainfall on the performance of insecticides on fruit crops was presented. If you didn't have a chance to read it, and are interested in the topic, click here. ***Bottom line***:

    - In general, organophosphate insecticides have the highest susceptibility to wash-off from precipitation but following light rainfall their high field-rate toxicity to most target pests overcomes the necessity for immediate re-application.

    - Neonicotinoid insecticides are moderately susceptible to wash-off with residues that have moved systemically into plant tissue being highly rainfast, and surface residues less so.

    - Carbamate, IGR and oxadiazine insecticides are moderately susceptible to wash-off and vary widely in their toxicity to the range of relevant fruit pests.

    - Diamide, spinosyn, and pyrethroid insecticides have proven to be moderate to highly rainfast on most fruit crops.

- **Can insecticides have some curative activity against PC?** This is possible, according to Dr. John Wise from Michigan State University: "*Neonicotinoids such as acetamiprid, and thiamethoxam were exceptionally active curative agents, and organophosphates can also be used as rescue treatments because they have a curative action that can kill eggs and larvae that are already present in the fruit*".

DISEASES

Dan Cooley and Liz Garofalo

Apple scab

As Jon showed above, there are scab lesions in many orchards around the state. In some places there's quite a bit. Like here.

This isn't surprising, given the amount of rain and tough spraying conditions in Massachusetts and the rest of New England during primary scab season. The question now is, what to do if you have scab?

The good news first. As apple growth slows, and fruit get more mature, they become more resistant to new infections. This is particularly true of fruit. And only the new leaves are susceptible to new infections. Basically, in August longer wet periods are needed to cause infections than are needed in June.

Still, with regular rain, infections in a block, and new tissue, new infections happen, even on older fruit. Ideally, we'd like a guaranteed way to completely eradicate the infections. Unfortunately, there isn't one. The goal is to protect fruit. Existing infections can't be completely burned out, but the number of spores in them can be reduced. At the same time, fungicide on fruit will reduce the chance that any surviving spores cause problems.

The basic approach. If you have scab, and especially if you have quite a bit of it, protect the fruit with fungicides. The key fungicide is Captan, and coverage is critical. Use as much volume per acre as you can, and spray before predicted rain. Protect. Use 4.5 to 6 lb./A of 50 WP formulations, or 3 to 3.75 lb./A of 80 WDG formulations. Sprays when temperatures are above 80 F appear to be most effective, so target hotter days if you can.

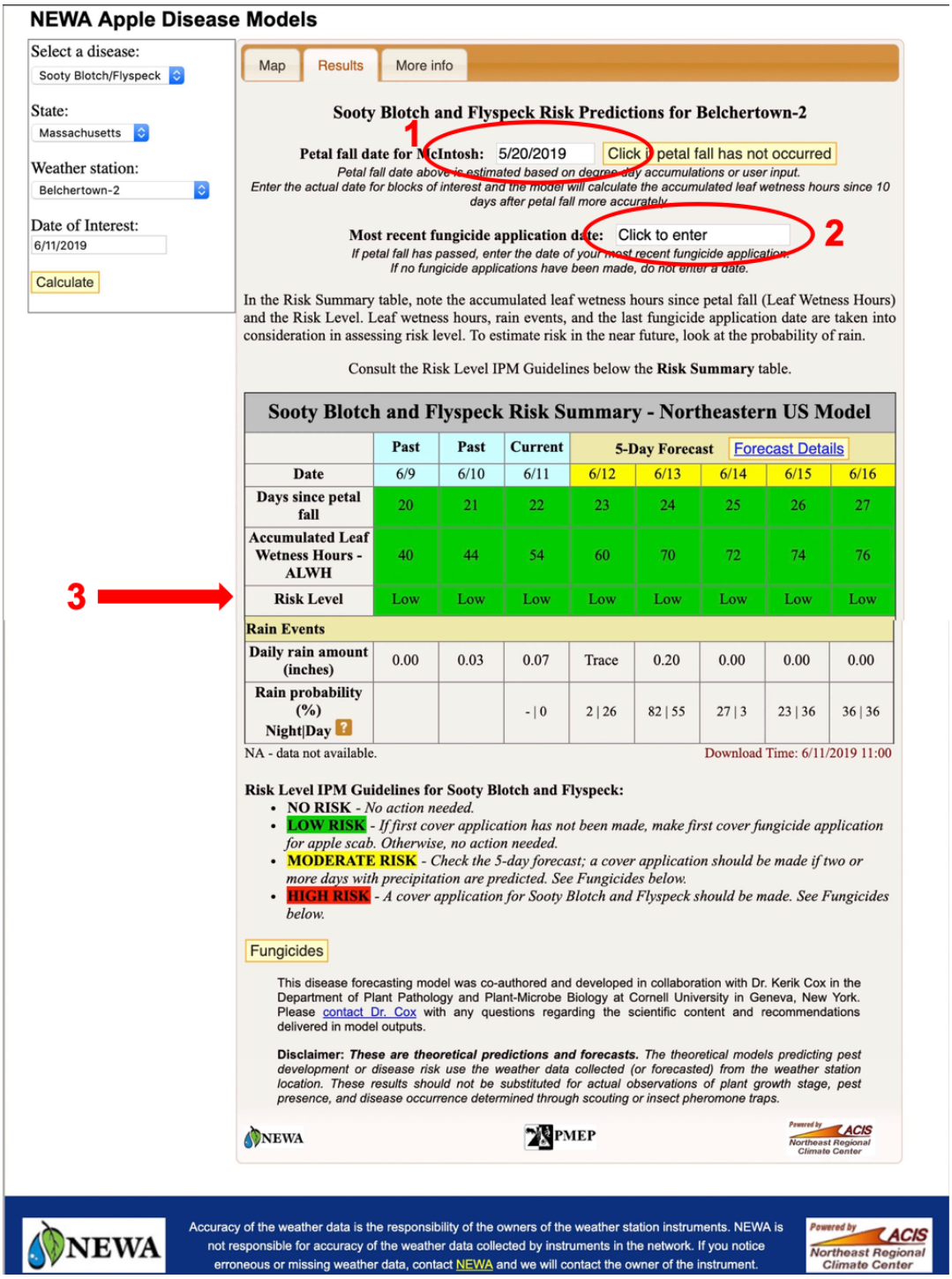
Are there other options? The answer is complicated, and it's about resistance. The very best way to select resistant strains of scab is to spray a fungicide on visible infections. In several parts of the country, scab has already developed resistance to many of the single-site fungicides. These include the DMI's (FRAC 3) and QoI's (FRAC 11). The AP's (FRAC 9) aren't much use past pink. Syllit isn't labelled after pink. There is no field resistance reported for the SDHI's (FRAC 7), but it isn't clear that adding them to Captan improves eradication. Finally, there are label restrictions on how much of any one FRAC group can be used in a season. So, adding these up, my answer is that we really don't have good options to a Captan program for secondary scab.

However, if you do use one of the single-site fungicides, either for other diseases like rots or sooty blotch / flyspeck, or for scab, make sure to use it with Captan at the rates listed above. Also, watch out for phytotoxicity issues when tank mixing Captan, not just with other fungicides, but with insecticides and spreader-stickers as well.

Protection. Did I emphasize, put Captan on as a protective spray before rains? The other part of this is keeping track of how much captan is left when the forecast is for rain. This means keeping track of how much rain has fallen, and how long it has been since the last spray, in order to estimate whether there's still enough captan left to protect fruit. Rain washes Captan off. Fruit growth spreads it out. A good rule is that in June, reapply no longer than every 10 days, or every 1.5 inches of rain, whichever comes first. In July, that can be bumped up to no longer than every 14 days, or every 2 inches of rain. Keep in mind, if you've had 1 inch of rain since the last spray, and the forecast is for 1.5 inches, it's safest to put on a spray before the rain. Protect.

Sooty blotch/flyspeck (SBFS)

Why yes, yes there *is* a model for that too. Dig up this year's petal fall date for your orchard and go to the NEWA website and navigate to the apple disease page (take a look back to **Healthy Fruit: No. 7, May 21, 2019** for a quick reminder on how to navigate through NEWA if needed). Once you are there, **1)** put the petal fall date into the model, remember, this will estimate a date based on degree day accumulation that may or may not reflect what actually happened on site. This potential inaccuracy makes using *your* observed petal fall date important.



2) Input your most recent fungicide application date to reset the risk estimate, if necessary. As usual, NEWA has a handy, easy to follow color code risk table for you to look at. In the photo above, you see all green, indicating that, given a proper cover spray, there is no risk for infection at this time. **3)** Risk level is measured in “No Risk”, “Low Risk”, “Moderate Risk” and “High Risk”. Traditionally, in the Northeast, fungicide applications targeting SBFS are not

recommended until 250 leaf wetness hours are accumulated (beginning 10 days after petal fall). However, in wetter years, earlier management is necessary.

HORTICULTURE

I will save your reading time and defer you to the excellent Guest article on Alternate Bearing. Please read and take it into account when making your management decisions. Still too many apples? Ethephon (1.5 to 3 pints per acre) plus carbaryl (1 to 2 pint per acre) are indicated. Otherwise, have fun hand thinning! Oh, and calcium spray should be starting if you have not already. JC

SMALL FRUIT UPDATE

Sonia Schloemann

2019-2020 New England Small Fruit Management Guide: available online at - http://ag.umass.edu/fruit/ne-small-fruit-management-guide. Print copies are also available $16 plus shipping by ordering from your state's Extension Office or by going to https://www.umassextensionbookstore.com/products/108.

Massachusetts Cultivated Blueberry Growers Association Summer Meeting - June 16, 2019. 12:30-3:00. Sunburst Blueberry Farm, 44 Rawson St., Uxbridge MA. No cost to association members, $15 others. Bring lunch and a chair. 1.5 Pesticide Credits. See: http://www.mcbga.com.

SARE Grower Grant Twilight Meeting - June 20, 2019. 5:30-8:00. Red Fire Farm, 184 Meadow Rd., Montague MA. Red Fire Farm received a NE-SARE Grower Grant to look at some innovative weed management systems for organic strawberry production. Come see what was learned through this project. Meeting is free but bring $10 if you would like to purchase a simple supper. RSVP to umassfruit@umass.edu is required for planning purposes. More info at: https://ag.umass.edu/fruit/events/umasssare-organic-strawberry-twilight-meeting.

Spotted Wing Drosophila (SWD) - The first trap captures for SWD have been reported in the last couple of weeks. These are isolated captures and mostly not sustained for consecutive weeks, yet. However, this marks an earlier start to regular captures of SWD than previous years. What does this mean? Well, it means we have to be ready for action earlier than before, especially in crops like strawberry that have not needed SWD protection in the past. More on this next week but for now, check out updated recommendations from Cornell at: http://blogs.cornell.edu/swd1/2019/06/08/ipm-guides-for-swd-now-available/.

CROP CONDITIONS: **Strawberries**: Harvest in June-bearing varieties continues. Sunny weather this past weekend was welcome for PYO operations. Last week's crop summary still holds true this week. That is, things to keep an eye out for during this period are Two-Spotted Spider Mite (TSSM), Strawberry Sap Beetle, Anthracnose, Botrytis and Slugs. Despite the prevailing wet cool weather, a few spots have reported TSSM above threshold. These were older fields. Scout your older fields to see if TSSM have spiked. Predator releases at this time would be a good way to go. Finally, you might see slime molds showing up on the mulch and plants. This is a superficial fungus that does not infect the plants but can look alarming. Potato Leafhopper hasn't been reported yet, but could come in soon. Damage is most apparent on newly planted fields. See the NE Small Fruit Management Guide for recommended materials and rates for managing all of these problems. **Brambles**: Floricane raspberry varieties are blooming. Tarnished Plant Bug (TPB), Strawberry Clipper (SBW), and Botrytis Gray Mold can be a problem now, especially if bramble fields are weedy or near strawberries. Potato Leafhopper (PLN) has not been reported yet but can come in soon. Check the link to see what hopper burn looks like on raspberries. If Two-spotted Spider Mites (TSSM) are being found in strawberries, they may also be active in raspberries. Check older leaves for signs of TSSM feeding or webbing. Primocane varieties are growing well except where fields are excessively wet. **Blueberries**: Bushes are in the green fruit stage. Some locations have seen tip dieback from winter injury, but many locations seem to have a very good crop this year. Every year we have some reports of stems or whole bushes with a lot of fruit and very few leaves. The collective wisdom on this is that it's a sign of root damage. It seems to help to strip half the fruit off these stems (since they probably won't fully ripen without leaves), and allow the bush to focus energy on trying to ripen fewer berries and recover better growth. As mentioned last week, Cherry/Cranberry Fruitworm (CBFW/CFW) may be approaching the egg hatch period. See last week's HF for more on this pest. Plum Curculio and Scale are also insect pests that can be active now. See the NE Small Fruit Management Guide for recommended materials and rates for managing all of these problems. **Minor Crops**: Lingonberries are in bloom-fruit set. Gooseberries fruit are coloring and will be ripening in the next 7-1- days. Haskaps are coloring and should ripen soon.

Berry Growth Stages: Left, Black Raspberries in bloom; Center, ‘Reka’ Blueberry with green fruit (berry-touch); Right, ‘Borealis’ Haskap w/ ripe fruit.

HAWKEYE’S CORNER (notes from the field)

Liz Garofalo

Marssonina coronariae (and plenty of scab too) symptoms are beginning to show up in low/unsprayed apple trees. While crab apple (pictured below) may not be a management focus, it can provide a breeding ground for spore that can subsequently make its way into your commercial trees. (Ok, so, technically, *M.coronariae* isn’t *breeding,* per se as the inoculum causing infection now is asexual, but you get my gist, right?) Infection can occur, especially once mancozeb (77 day PHI) covers are done for the season, where fungicides effective against this pathogen are not used. The trouble, of course, is that nothing is labeled for use

against *M. coronariae* in Massachusetts.

Thanks to Nick Brazee Director of the UMass Diagnostic Lab for the heads up on where to find these symptoms!

GUEST ARTICLE

Apple Crop Load Management - Alternate Bearing

(Reprinted from Penn State Extension, https://extension.psu.edu/apple-crop-load-management-alternate-bearing)

Alternate Bearing (AB) refers to an alternating cropping pattern that is internally regulated by the plant. This phenomenon is widespread throughout many perennial trees and shrubs, but is not universal. Perennial fruit crops initiate flower buds for next season's crop in the current season,

and for most deciduous fruit species, the alternation of large and small crops is caused by competition between the current season’s crop and the coming season’s flower buds.

Excessive crop in the "on year" depletes the nutrients needed to form new fruit buds; however there also is evidence that seed-produced hormones exported from the developing ovules have a direct inhibitory effect on flower development. Apple is a heavily-studied species with regard to alternate bearing (AB), and research indicates that floral inhibition is caused by seed produced hormones, especially gibberellins (Jackson, 2003), while the data for pear are much less clear in this matter (Dennis, 2003).

This "on-off" sequence does not always follow a regular biennial pattern. For example, Bosc pear, a cultivar that is highly susceptible to AB, may exhibit two consecutive off-years following a heavy crop. For this reason, the term "biennial bearing" is a less appropriate label for this phenomenon.

While internally regulated, AB is often triggered by an external factor (such as unfavorable weather or poor crop management). Once triggered, the fluctuation is likely to continue for years after the triggering event. This "ripple effect" differentiates AB from other cropping irregularities.

Alternate bearing is a significant economic problem for a number of fruit and nut industries worldwide. In a heavy "on-crop" year, the problem is too many small fruit that have a low cash value because of their small size and over-abundance. In an "off-crop" year, fruit are generally too large and of poor quality, with increased potential for physiological disorders. Net return to the grower is low in an off-crop year because there are too few fruit. Thus, AB results in price instability and erratic annual returns to growers. The limited supply of fruit in the off-crop year also can lead to loss of market share that is not always regained the following year.

The severity of AB can be calculated in two ways (Monselise and Goldschmidt, 1982):

Formula 1: Alternate bearing index (I) = (year 1 yield) - (year 2 yield)/(year 1 yield + year 2 yield), where I = 0 is no alternate bearing and I = 1.0 is complete alternate bearing; and

Formula 2: Alternate bearing = (current year's yield) - (5-year running average yield)/5-year running average yield; when the current yield is 20% greater than the 5-year average yield, it is an on-crop and when the current yield is 20% less than the 5-year average, it is an off-crop.

Among deciduous fruits, AB is documented in apple, pear, plum, prune, apricot, cranberry and blueberry (Monselise and Goldschmidt, 1982). Cultivars (varieties) within a given species vary in the degree of crop regularity, along the full spectrum of regularity. Comparing several commercial apple cultivars for example, Gala, Jonagold, Granny Smith and Idared have a low AB index, Rome shows mild susceptibility to AB, Delicious and McIntosh show moderate susceptibility to AB, Golden Delicious shows strong susceptibility, and Fuji is highly susceptible to AB. Additionally, specific strains of a given cultivar may differ in susceptibility to AB. A typical

example of this variation would be standard growth habit (more regular) versus spur type (more alternate) strains of Delicious.

Other crops, especially peach (including nectarine), have the internal capacity for a full crop every year. Peach flower buds are not as cold hardy as apple in winter and bloom earlier, thus are more susceptible to crop losses caused by unfavorable weather. However these increased risks for crop irregularity are strictly due to unfavorable weather, and peach has the potential to return to a regular pattern of full crops unless winter cold injury is so severe that it damages the perennial parts of the tree. Peach yields are influenced only by external factors in the previous winter and current growing season.

Role of Cultural Practices and Pollination

Since AB is a naturally occurring and internally regulated process, good management practices are necessary to minimize its occurrence. Generally speaking, flower formation in perennial deciduous fruit crops is promoted under growing conditions that contribute to good plant health and promote moderate vigor. It is cliché, but moderation is truly a key to production of annual crops. For example, both extremes--excessive fertilization (especially nitrogen) or mineral nutrient deficiencies--can lead to reduced flowering and low productivity (Dennis, 2003). Adoption of a production philosophy that promotes the principal of moderation can help to alleviate loss of profitability caused by AB and other cropping irregularities.

Practices that promote plant health and moderate vigor include annual pruning, irrigation to prevent water stress, regular testing for leaf and soil mineral nutrient content, use of fertilizer to maintain optimal nutrient levels, timely mowing and irrigation to minimize water stress and maintenance of tree health through the judicious use of herbicides and crop protectant sprays. While none of these practices are sufficient to promote annual cropping, it would be difficult to prevent AB if these preconditions were not adequate.

All deciduous fruit crops are pollinated by insects, thus providing for adequate pollination by bringing bees into the planting at bloom is a standard management practice. As with the cultural practices listed above, providing bees for pollination does not directly influence AB, rather it reduces the risk of cropping irregularities, which could trigger AB.

Site Selection and Pre-Plant Practices

Site and cultivar selection can contribute to reducing the risk of AB and other cropping irregularities. Spring flowering deciduous orchards are preferentially planted on sites with low risk of frost or freeze damage. Upland sites with slope and elevation greater than the surrounding land allow cold air drainage and are preferred, as are sites situated near large bodies of water that moderate springtime temperatures. Woodlands, windbreaks or other obstructions below orchards may prevent good air drainage and increase the risk of frost damage.

Orchards perform best on fertile, well drained soils with adequate aeration to promote root health. Among deciduous tree fruits, pear is the most tolerant of excess soil moisture and peach is the least tolerant. Because of the fairly exacting site requirements, most new orchards are situated on existing orchard land. Orchard replant sites should be tested for adequate soil physical and chemical properties, and for the presence of replant disease organisms. Pre-plant remedial action should be taken when testing shows it is warranted.

Cultivar selection is primarily a marketing decision; however consideration should also be given to crop bearing potential, as certain cultivars are known to produce more reliable crops. A listing of cultivars that are considered to be regular croppers and well-adapted to the region can be found in the Penn State Extension Tree Fruit Production Guide .

Most cherry cultivars, many plum cultivars, and almost all apples and pears are self-incompatible (Westwood, 1978). In these instances, reliable annual cropping is greatly promoted by the placement of adequate pollinizers in the planting. By contrast, most peach and nectarine cultivars are self fertile. The nursery can provide specific information on pollinizer requirements when fruit plants are purchased.

Crop Load Management

The single most important practice for minimizing alternate bearing is judicious crop load management. Perennial fruit crops tend to set more fruit than a) can be matured to adequate size and quality to meet market expectations; and b) than can allow for adequate flower production for the subsequent season. Thus adjusting crop load is important not only for annual bearing, but for economic sustainability in the current season as well as the next. Several production practices can be used to reduce crop load, but the chief practices for doing so are fruit thinning and pruning.

In order for fruit thinning to increase return bloom, it must be done in the four to six weeks following petal fall. This window of time is thought to correspond to the period when floral initiation occurs, and no amount of crop removal after this time can be relied upon to promote flowering in any but the most annual cultivars. There is evidence that this window of opportunity is shorter for strongly alternating cultivars and longer for more annual bearers. Early thinning timing also is the most beneficial for enhancing fruit size and quality in the current season.

Apple and pear can be thinned chemically using several materials labeled for this purpose (Agnello, et al., 2004). These materials are applied during or shortly after bloom by means of conventional air-blast spray equipment. The following paragraphs summarize the characteristics of the most commonly used chemical thinners, and are not intended to be used as guidelines for the application of these registered compounds. Refer to the Penn State Extension Tree Fruit

Production Guide and your local crop advisor for details on the regulatory status and current recommendations for use of chemical thinners.

Certain carbamate insecticides have thinning activity, and carbaryl (e.g., Sevin®) and oxamyl (Vydate®) are labeled for this use. Carbamates at concentration of about 600 parts per million (PPM), have an established track record of being mild but dependable chemical thinners with a relatively wide window of time for efficacy. Being mild thinners, carbamates are often used in combination with stronger thinners, or tank mixed with oil to boost thinning response.

Napthaleneacetic acid (NAA) is a synthetic auxin (a class of plant hormone) with strong thinning activity at concentration between 2.5-20 PPM. NAA (e.g., Fruitone®) has been labeled as a thinner for both apple and pear for several decades, and detailed recommendations have been developed for specific cultivars and different regions. Apple thinning activity is strongest when fruit diameter is between 10 and 15 mm, and progressively milder when applied earlier. Thinning activity becomes less certain as fruit diameter exceeds 17 mm, and fruits become insensitive to NAA when diameter exceeds 20 mm. Pears also are responsive to NAA, but typically require earlier timing (4 to 7 days after petal fall) and higher rates (7.5-15 PPM) than most apple cultivars. NAA can have negative side effects of growth retardation and leaf chlorosis with certain cultivars of apple and pear, and an amide salt formulation (Amid Thin®) is labeled for use with sensitive cultivars. In addition to fruit thinning, NAA has a direct promoting effect on flower formation (see the following section on Return Bloom sprays).

Benzyladenine (6BA) is a synthetic cytokinin also known for strong chemical thinning efficacy at 75-175 PPM. 6BA was registered as an apple thinner in the mid-1990s, and several formulations are now labeled as chemical thinners for apple (MaxCel®, Excelis Plus®, and RiteSize®). MaxCel® was registered for pear in 2007. For thinning apple, 6BA is usually tank-mixed with a carbamate as the combination is more effective than either product applied separately. 6BA has none of the negative side effects of NAA, and promotes cell division in developing fruit, an effect which can increase fruit size over that obtained from thinning alone. 6BA does not stimulate flowering, thus return bloom is only enhanced by the resulting reduction in crop load.

Ethephon (e.g., Ethrel®) is an ethylene releasing plant growth regulator used for apple thinning at 150-600 PPM. Ethylene is a naturally-occurring plant growth regulator that directly stimulates fruit abscission as well as flower formation. Thinning results with ethephon can be unpredictable, and the potential for over-thinning is perhaps the strongest with this material. Ethephon is a strong thinner out to about 23 mm fruit diameter, and frequently is used as a "rescue" treatment when earlier attempts to adjust crop load have failed to remove enough fruit. Ethephon also may be applied after fruits become unresponsive to chemical thinners for its direct promotion of flower formation (see the following section entitled "Return Bloom Sprays").

Obtaining the optimal crop load for fruit size, quality and return bloom with chemical thinning is challenging. Any factor that influences tree health or vigor also will have an impact on fruit set,

thus it is challenging to determine the amount of chemical thinning that is required to supplement the endogenous crop load adjustments that are taking place naturally. Weather, especially incident sunlight and air temperature have a profound effect on both natural and chemical fruit thinning. Choice of materials, rates used, timing and spray application method all influence the outcome. Many fruit growers consider chemical thinning to be the single most important and most challenging practice they perform each season.

Still, there is evidence that AB has become a less significant problem for apples and pears than it once was (Monselise and Goldschmidt, 1982). This may be attributed in part to selection of annual bearing cultivars, but far more so to the commercial development of effective chemical thinners. Chemical thinning provides apple and pear growers with an economical means of removing excess crop early enough in the season to permit adequate floral induction for the coming year. It is the first line of defense against AB in apple and pear, and without an adequate thinning program, no other practice can be relied upon to provide adequate numbers of flowers for annual cropping.

Crop load management also can be accomplished by pruning and by hand thinning. While these methods, especially pruning, are used for apple and pear, the role of these alternative methods is somewhat diminished on these two crops because chemical thinning is both timely and more labor efficient. These practices remain vitally important for adjusting crop load of most other deciduous fruit crops. Most commonly, both practices are utilized as a crop load management system to obtain an optimal crop load reduction with maximum labor efficiency.

Pruning removes bearing surface (fruit buds) and stimulates vegetative growth from remaining buds. This promotion of vegetative vigor prevents many of the remaining buds from becoming floral. Thus pruning reduces cropping by two mechanisms. Pruning is a non-selective mass-thinning technique, and therefore is reasonably labor-efficient compared to hand thinning.

Environmental factors, especially sunlight, play an important role in flower induction. Apple buds and especially the supporting spur leaves must receive at least 30% of incident solar radiation in order to initiate flowers (Dennis, 2003). Proper pruning practices for maintaining the fruiting potential of tree fruit include the use of thinning cuts, in which whole branches are removed to open the canopy to light penetration (Ferree and Schupp, 2003). By contrast, excessive pruning or the use of heading cuts can lead to invigoration of vegetative growth and insufficient flowering. Size-controlling rootstocks also play a role in maintaining good light distribution in apple tree canopies (Dennis, 2003).

Hand thinning serves one of the same purposes as chemical thinning--that of removing a portion of the crop, thereby alleviating some of the competition between an excessive crop and its inhibitory effect on flower formation. Hand thinning is labor-intensive, and it must be done early in the growing season in order to have a beneficial effect on AB. Hand thinning can be done by selectively plucking individual fruits from a branch, a technique commonly used with larger fruited species, or by striking the limbs with a rubber- or cloth-covered stick. The latter

method is more labor efficient, being a non-selective technique; however it is difficult to obtain consistent results with limb tapping. Large-fruited species may be "pre-thinned" using a combination of pruning and limb tapping, to reduce the cost of selective hand thinning to make the final crop load adjustment.

Return Bloom Sprays

Chemical thinning alone may not be sufficient to promote annual bearing for several commercially important apple cultivars that possess a strong genetic tendency to AB. Examples include York Imperial, Mutsu, Fuji, Macoun, Honeycrisp and spur-type strains of Delicious. In these special cases, plant growth regulators that directly stimulate flower formation should be considered. Two thinner chemistries are labeled for this use (Figure 1). Several weekly or bi-weekly sprays of 3-5 PPM NAA, or 100-200 PPM ethephon may be used, starting when fruit diameter has exceeded 24 mm, (about five weeks after bloom), and up until eight weeks after bloom. These low rates of chemical are recommended to avoid undesirable side effects of these treatments, such as reduced fruit size and premature fruit ripening.

Cropping and Tree Age

Yields of deciduous fruit crops tend to decline gradually with plant age. Although this decline is not solely attributed to AB, the additional tree stress and limb breakage from excessive over-cropping in repeated "on" years can shorten the productive life of an orchard. This decline can be attributed either to a decline in plant vigor and tree health as exhibited in both fruit number and size, or to a decline in plant number per acre caused by mortality. These two mechanisms are not mutually exclusive, but the extent to which each mechanism contributes to yield decline differs by crop. For example, pome fruit (apple and pear) yield decline is attributed mainly to declining number and size of fruit, and is very gradual. Yield decline of these crops may only become evident after 40 years in well-maintained orchards. On the other hand, peach trees tend to have a shorter life (Westwood, 1978), and tree mortality often closely follows any perceived decline in fruiting. Peach orchard yields decline much more rapidly, due primarily to tree mortality.

Summary

Alternate Bearing (AB) is an alternating pattern of large and small crops occurring in many fruit species that is internally regulated by the plant. AB has a number of undesirable consequences that cause economic losses to fruit growers. Cultural and pollination practices, and variety and site selection are important preconditions to achieving annual production, but are not adequate in themselves to prevent AB. Adjusting crop load to a moderate level early in the growing season is the single most important key to preventing AB. Crop can be adjusted by a variety of methods, depending on the fruit type, and often several methods are used in combination. The development and use of effective chemical thinners has been successful in reducing AB in apple and pear production over the past 50 years. Apple varieties that are strongly AB can also benefit from sprays of growth regulators that promote flowering.

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Some pretty good chemical thinning action going on here with these Gala apples...

Scott Palmer, Mark Boyer and 1 other — 1 Comment

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The next Healthy Fruit will be published on or about June 18, 2019. In the meantime, feel free to contact any of the UMass Fruit Team if you have any fruit-related production questions.

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