



Wisconsin Fruit News

Volume 1 Issue 12 – September 16, 2016

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Events this Week

September 23-25, 2016 – Warrens Cranberry Festival
Warrens, WI

General Information

UW-Madison/Extension Insect Diagnostic Lab update

By: PJ Liesch

The following insects were reported to the Insect Diagnostic Lab (IDL) as being active in the state between Sept 1st and Sept 15th, and have the potential to impact fruit production in the region. If you would like more information about the UW Insect Diagnostic Lab, you can visit [our website](#).

-Brown Marmorated Stink Bug reports are likely to increase in the coming weeks as adults move into buildings while seeking an overwintering spot. A report recently came in of several BMSB adults from Prairie du Sac in Sauk county, which marks the first time this species has been detected in Sauk County. Over a dozen counties have confirmed reports of BMSB, mostly in the southern part of the state and the Fox River valley.

-Spotted Wing Drosophila cases continue to come in to the UW Insect Diagnostic Lab from raspberries and blackberries. Observations indicate that this insect is can be found across much of the state.

-Pearslug Sawfly reports have recently come in to the UW Insect Diagnostic Lab. This species goes through two generations per year, with the second batch of slimy, slug-like larvae present in late August and September. Despite their name, these insects can also attack apple, roses, and many other plants from the rose family. The larvae of the pearslug sawfly skeletonize leaves, leaving a brownish, lace-like pattern behind. You can read more about pearslug sawfly larvae at [Wisconsin Horticulture](#).

-Fall Webworm: the silken "tents" of this species have been reported recently in both fruit trees and landscape trees and these pests feeds on a wide variety of plant hosts. Damage from these caterpillars typically isn't significant and the conspicuous tents can often be spot-treated as necessary.

-Secondary Pests such as **multicolored Asian lady beetles, yellowjackets, picnic beetles, ants, and others** are being reported in fruit that has been damaged. This activity will almost certainly continue for the coming weeks.

Blueberry Virus Survey

By: Patty McManus

If you are a blueberry grower, I encourage you to take advantage of a national survey being conducted on blueberry viruses by Bob Martin, a researcher with USDA in Corvallis, OR. Blueberry plants are known to host many viruses, and while some cause little or no apparent damage on their own, they can cause problems when they team up with other viruses or when plants are stressed by abiotic factors (e.g., winter injury). While there is no cure for viruses, the spread of some viruses can be minimized by controlling insect vectors (e.g., if the virus is spread by aphids). Also, if you learn that an old, declining planting has virus(es), then you might consider removing it before establishing a new planting nearby. If you would like to be included in the survey, please contact Bob Martin for sampling details:

Bob Martin
USDA-ARS Horticulture Crops Research Unit
3420 NW Orchard Ave.
Corvallis, OR 97330
Phone: 541-738-4041
Cell: 541-760-1023

Diversifying your fruit crops: Aronia

By: Janet van Zoeren, Christelle Guédot and Amaya Atucha

Aronia, a shrub native to the Midwest, bears dark purple-blue berries which have been described as one of the most promising new fruit crops to grow in Wisconsin (Secher 2008). Aronia bushes are native to North America, have few pest or disease problems, require minimal nutrient or water inputs, and exhibit extraordinary health benefits, which makes them a very attractive fruit crop to cultivate commercially.

Growing Conditions and Management

Aronia grows naturally in the Midwest in wet, marshy or boggy areas. However, in cultivation they grow well across a broad range of soil moistures. They do grow better in neutral to slightly-acidic soils. The plant is highly cold tolerant, to -40°F, and blooms late enough that the flowers are rarely affected by a spring frost.

Weed control is important during the first 3-4 years, while the plants are young. A mature aronia planting will fill in with suckers, similarly to raspberry brambles, forming an entire hedgerow which is thick enough to not require much weed control. Pruning is necessary from the third year on, to remove old growth, and maintain an open canopy to allow airflow.

Some Cultivars for Wisconsin Production

Aronia, although native to the Midwestern United States, has mainly been bred for consumption in Europe. Therefore, the most popular cultivars, such as Nero and Viking, were reintroduced into the United States in the past few decades. Genetic testing suggests that most of these cultivars are not very different from each other.

Iroquois Beauty (also known as Morton) is a U.S. bred cultivar. It grows to 3-feet-tall. It is especially attractive for



Aronia berries at Carandale Farms. Photo by Janet van Zoeren.

landscaping, but the berries are also edible.

Nero grows to 3- to 4-feet-tall, with a compact bush shape, making it hardy and easy to harvest. Nero is heavy yielding, and has attractive foliage. It was developed in Poland.

Viking grows taller than Nero, reaching 8-feet-tall if it is not pruned, and can be higher yielding. Fruit can be more difficult to harvest. Viking was developed in Finland in the 1980s. Attractive foliage can double up as a landscape plant.

Uses and Benefits

Aronia is harvested in September/October, and can be mechanically harvested using a modified blueberry harvester. The fruit is highly astringent, so is not a great fit for the fresh market. However, in value-added products, such as wine, jam, juice, and pies, aronia makes a great addition due to its dark, attractive color as well as its health benefits. Aronia berries have high concentrations of antioxidants, including both anthocyanins and flavonoids, which together have been shown to lower the risk of cancer, heart disease, inflammation, bacterial infections, and to slow aging. Aronia is also high in Vitamin C. Overall, aronia berries represent a low-input, potentially high-yielding value-added crop, which could make a great addition to your farm.

Pest management and Spotted Wing Drosophila

Aronia does not exhibit many issues with disease or insect pests, and often can be grown in the Midwest without insecticide or fungicide applications. However, a new pest of concern, changing the playing field for all Wisconsin berry growers, is the spotted wing drosophila (SWD). Several growers have reported infestations by SWD in their aronia. We have assessed the susceptibility of aronia to SWD and found that **aronia is resistant to SWD if the berries are intact** and susceptible if the skin is damaged or if the berries are destemmed. For more detail on our study, please refer to a previous issue of the Wisconsin Fruit News: [Issue 3](#). Based on the results of this study, we recommend monitoring fruit for damage and the presence of larvae rather than monitoring for adults. The presence of larvae can be assessed with a salt-water test by placing a sample of fruit in a Ziploc bag (~40-50 berries). In a separate container, dissolve 2 Tbsp. table salt in 2 cups warm water. Pour salt water into Ziploc bag so it covers the fruit, close, and lightly crush to break the skin and let sit for 30 minutes to 1 hour before examining. You can examine the fruit through the bag or pour the sample in a shallow glass baking dish with white paper underneath and a bright light shined on top in order to maximize visibility of larvae.

If larvae are present, management recommendations include removing damaged/infested fruit (and properly disposing by solarization or bagging fruit so larvae cannot develop to adulthood) or applying a registered insecticide. DO NOT compost fruit, it might actually speed up SWD development in warm areas of the compost piles. Freezing berries will kill SWD and refrigerating berries will stop further development of larvae inside the fruit and may kill larvae after longer refrigeration periods. It is thus recommended to keep berries cool as much as possible, from processor to market, to consumer as it will minimize the chance that larvae will continue developing in fruit.

If you decide to spray an insecticide to reduce adult populations, the only insecticide that I could find that would be effective against SWD and that is registered on aronia in Wisconsin is Sevin XLR Plus. Sevin is a carbamate with the active ingredient carbaryl. Sevin XLR Plus has a rate of 1-2 qts per acre, a REI (re-entry interval) of 12 hrs and a PHI (pre-harvest interval) of 7 days. It is highly toxic to bees. Here is a link to the [Sevin XLR Plus label](#).

To the best of our knowledge, we could not find any other insecticide effective against SWD (see article on SWD in grapes in this issue, pages 6-7) that were registered for use on aronia in Wisconsin. Insecticides against SWD target adults with the intent to eliminate flies before they mate and lay eggs. Make sure to calibrate your sprayers to provide thorough coverage, especially in the center of the bush where flies like to hide.

Literature Cited:

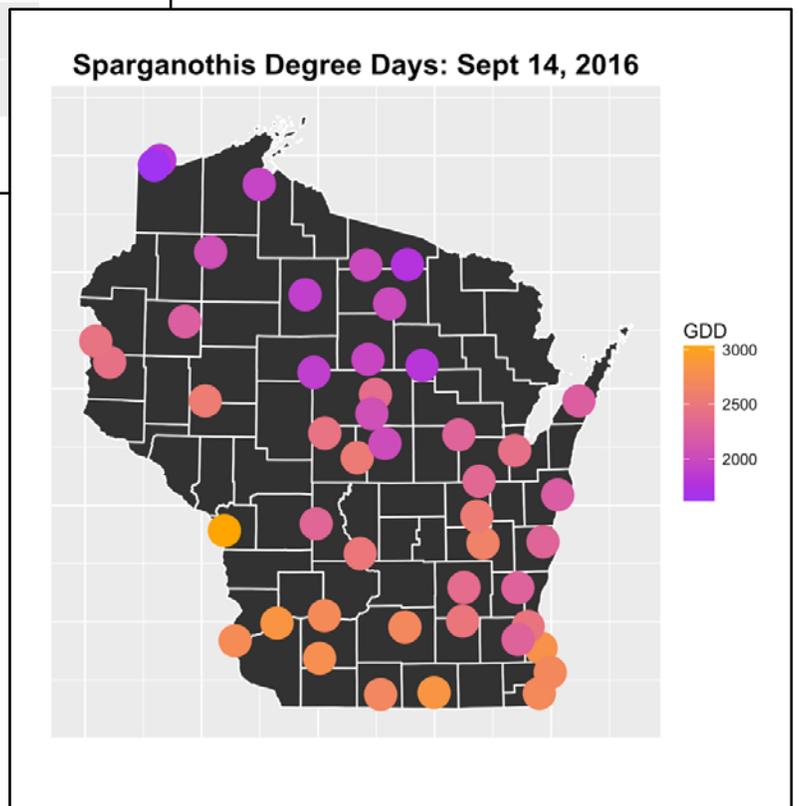
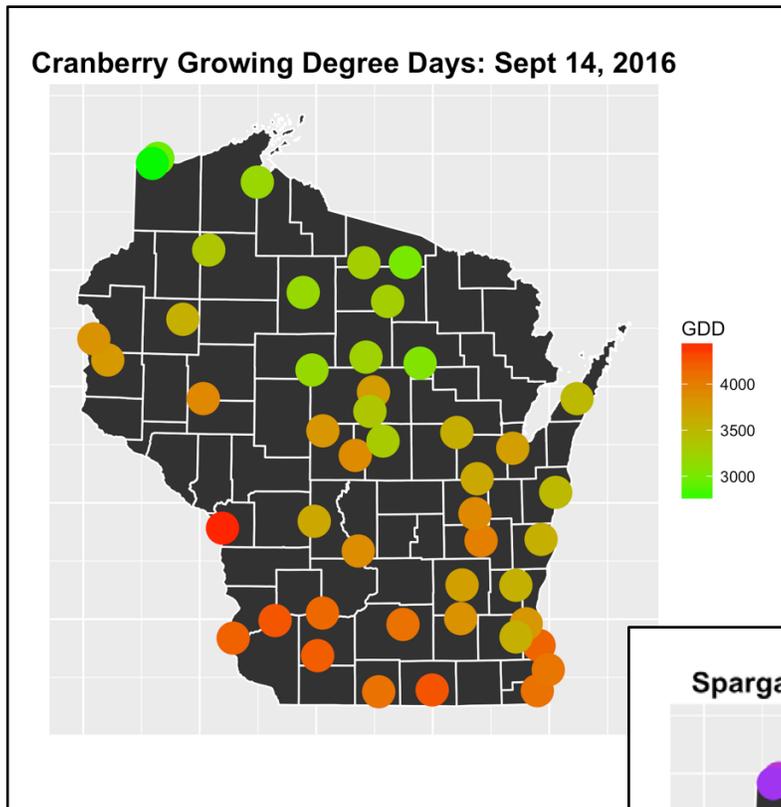
Secher, D. 2008. Fruit with Potential for Wisconsin Farms. (<http://www.cias.wisc.edu/wp-content/uploads/2008/07/carandale.pdf>).

Cranberries

Cranberry Degree-Day Map and Update: as of September 14, 2016

By: Elissa Chasen and Shawn Steffan, USDA-ARS and UW Entomology

Welcome to fall! The maps below show degree-day accumulations for cranberry plants and Sparganothis fruitworm across Wisconsin up through September 14, 2016. Temperature thresholds used for these calculations are 41 and 85 °F for the plant, and 50 and 86 °F for Sparganothis.



Plant DDs throughout WI range from 2,741-4,489. The central WI growing region has accumulated near 3,900, while the northern WI growing region has accumulated around 3,300 DDs.

Throughout WI, Sparganothis degree-days range from 1,633-3,030 DD. In central WI, Sparganothis DDs are near 2,500, while in northern WI, Sparganothis DDs are around 2,000. The image below details life history benchmarks of interest for Sparganothis fruitworm and associated degree-day estimates.

Event	DDs from March 1 (approximate)
 Flight initiation	595.7
 First eggs laid	681.0
 Peak flight	884.12
 First egg hatched*	895.4
 End of egg laying	1,634
 Last egg hatched*	1,890

* Egg hatch window: 895 – 1,890 DDs

The table below allows for comparison of degree-days over the last three years.

Sept 14	Cranberry Growing Degree Days			Sparganothis Degree Days		
	2014	2015	2016	2014	2015	2016
Central WI (Wisconsin Rapids)	3,505	3,799	3,899	2,236	2,426	2,534
Northern WI (Minocqua)	3,007	3,150	3,262	1,831	1,888	1,998

Deutsch, A. E., C. R. Rodriguez-Saona, V. Kyryczenko-Roth, J. Sojka, J. E. Zalapa, and S. A. Steffan. 2014. Degree-Day Benchmarks for *Sparganothis sulfureana* Development in Cranberries. *Journal of Economic Entomology* 107 (6): 2130-2136.

If you would like to read more articles and find more information specific to cranberry production in Wisconsin, be sure to read the most recent [Cranberry Crop Management Journal](#), also published by the University of Wisconsin-Extension. In the September 9th, 2016 issue of the Cranberry Crop Management Journal you will find information about: atmospheric nitrogen fixation update, flea beetle management, building next year's reserves, observations from the field, and grower updates.

Spotted wing drosophila management for Wisconsin grape growers

By: Christelle Guédot, Emma Pelton and Janet van Zoeren – Department of Entomology, University of Wisconsin

On September 9, 2016, we visited the Peninsular Agricultural Research Station in Door County, and while collecting grapes we saw thousands of spotted wing drosophila (SWD) adults in pretty much all of the varieties we visited. Spotted wing drosophila is a vinegar fly that was first detected in Wisconsin in 2010 and as now spread throughout most of the state. SWD prefers soft skinned fruit such as raspberry, blueberry, strawberry, cherry, and blackberry. SWD females lay their eggs under the skin of the fruit after cutting a slit in the skin of intact, ripening fruit. Larvae feed on the flesh of the fruit, causing soft spots on the surface of the berry (Figure 1A and B) and a wrinkling of the fruit skin. The fruit will subsequently collapse (Figure 1C).



Figure 1: Damage from SWD larvae feeding on grape, 3-4 days after egg laying. A) Dark area in light-colored fruit and B) light area in darker-colored fruit (white arrows). C) Damage from SWD larvae feeding on grape, more than 5 days after egg laying with emerging larvae (black arrow). Photos: Parent, Whitney, Shearer, Reitmajer, Dalton and Walton; USDA-ARS Corvallis and Oregon State University.

Work in our lab during the summer of 2014 by graduate student Emma Pelton found that cold hardy wine grape varieties are largely resistant to SWD if fruit is intact, but highly susceptible if the skin is damaged, even slightly. The study consisted of 1) field monitoring for adults and larvae and 2) laboratory no-choice assays to understand if there were varietal differences. Varieties assessed included cold hardy wine grapes: four reds (St. Croix, Marquette, Frontenac, and Marechal Foch) and two whites (La Crescent and Edelweiss). Monitoring occurred in conventional vineyards in southern Wisconsin. Adults and larvae were found in all varieties and vineyards throughout the season. However, larval infestation was quite low on intact fruit (2 larvae/kg fruit) compared to raspberry (480 larvae/kg fruit). There was no difference in the number of larvae between varieties. There were statistically higher numbers of adults in the white variety Edelweiss; however, this may be due to the earlier harvesting of this variety.

Varieties assessed in laboratory no-choice assays included cold hardy wine grapes: six reds (St. Croix, Marquette, Frontenac, Marechal Foch, Leon Millot and Concord) and two whites (La Crescent and St. Pepin). Grapes were sourced from no-spray vines to minimize the impacts of insecticides and fungicides. Each variety was exposed to adult SWD for 48 hours and then placed in a growth chamber for three weeks to determine if any eggs, larvae, or adults developed. Half the grapes were “damaged” by creating a cut in the skin of the grape and the other half of the grapes were “undamaged”. Raspberries were also included in the study as a positive control. The results of the study showed that, while females did attempt to lay eggs on undamaged grapes, the eggs were not viable and did not develop into larvae or adults. However, on the damaged grapes, eggs developed at rates similar to SWD on raspberries. These results suggest that undamaged fruit is highly resistant to SWD, but damaged fruit is similarly suitable to infestation as raspberry, one of the favorite hosts of SWD.

Based on the results of this study, the best recommendation for vineyard management is monitoring fruit for damage and larvae rather than for adults. The presence of larvae can be assessed with a salt-water test by placing a sample of fruit in a Ziploc bag (~40-50 berries). In a separate container, dissolve 2 Tbsp. table salt in 2 cups warm water. Pour salt water into Ziploc bag so it covers the fruit, close, and lightly crush to break the skin and let sit for 30 minutes to 1 hour before examining. You can examine the fruit through the bag or pour the sample in a shallow glass baking dish with white paper underneath and a bright light shined on top in order to maximize visibility of larvae.

If you find damaged fruit and/or larvae, management recommendations include removing damaged/infested fruit (and properly disposing by solarization or bagging fruit so larvae cannot develop to adulthood) or applying a registered insecticide. DO NOT compost fruit, it might actually speed up SWD development in warm areas of the compost piles.

Freezing berries will kill SWD and refrigerating berries will stop further development of larvae inside the fruit and may kill larvae after longer refrigeration periods. It is thus recommended to keep berries cool as much as possible, from processor to market, to consumer as it will minimize the chance that larvae will continue developing in fruit. Low larval infestations may not necessitate management actions if fruit will be made into juice or wine as the larval would be filtered out and there are no known taste or human health impacts of low levels of SWD.

Please note that table grapes were not assessed in this study. As table grapes may have a thinner skin than wine grapes, they may be more susceptible to SWD. Follow-up work will aim to assess some of these table grape varieties for their susceptibility.

If you decide to spray an insecticide to reduce adult populations, below is a list of insecticides that have been shown to be effective against SWD in grape. So far, there are no registered insecticides that will control larvae within fruit. The insecticides listed below target adults with the intent to eliminate flies before they mate and lay eggs. Make sure to calibrate your sprayers to provide thorough coverage, especially in the center of the bush where flies like to hide. This is not a comprehensive list. Trade names are provided as examples of specific active ingredients.

Insecticides effective against SWD and registered on grape:

Class (IRAC)	Trade name	Active ingredient	REI	PHI (days)	Rate (per acre)	Efficacy against SWD
Carbamates (1A)	Lannate SP	Methomyl	6 days for girdling and tying; 2 days other activities	7	1-2 quarts	Excellent. Highly toxic to bees
	Sevin XLR Plus	Carbaryl	6 days for girdling and tying; 2 days other activities	7	1-2 quarts	Highly toxic to bees
Organo-phosphates (1B)	Malathion	Malathion	Check the label	3	Check the label	Highly toxic to bees
	Imidan 70W	Phosmet	7-14 days	7-14	1½ – 2½ lbs.	Excellent Highly toxic to bees
Pyrethroids and Pyrethrins (3A)	Brigade	Bifenthrin	12hrs	30	3.2-6.4 fl. oz.	Good. Highly toxic to bees
	Danitol 2.4EC	Fen-propathrin	24hrs	21	5-½ – 21-½ fl. oz.	Good Highly toxic to bees
	Mustang Max	zeta-Cypermethrin	12hrs	1	2 – 4 oz.	Good Highly toxic to bees
	Pyganic OMRI	Pyrethrum	12hrs	12hrs	16 – 64 oz.	Fair Moderately toxic to bees
Spinosyns (5)	Delegate WG	Spinetoram	4hrs	7	3 – 5 oz.	Excellent Moderately toxic to bees
	Entrust OMRI	Spinosad	4hrs	7	1.25 – 2.5 oz.	Good Moderately toxic bees

REI: Re-entry interval

PHI: Pre harvest interval

HT: Highly toxic; MT: moderately toxic

Late Season Downy Mildew Management

By: David S. Jones and Patty McManus

As we quickly approach the end of the growing season, disease management often falls by the wayside for growers as responsibilities elsewhere pick up. Understandably, harvest preparation and completion tend to take over the list of priorities for most growers at this time of year. Unfortunately, a couple of weeks of lapse in attention to disease management can lead to problematic late season downy mildew outbreaks.

Our trials indicate that downy mildew is the main pathogen that causes defoliation in cold-climate wine grapes, making scouting and management at this time of year critical. Ripening of fruit can be significantly slowed down by severe damage. For example, the brix in the La Crescent in our no-spray blocks is several days behind the La Crescent grown using fungicides, due to extreme loss of the canopy in the no-spray block. In a short growing season, even a few days of difference can mean the difference between a good harvest and a bad one. In addition to the risk associated with delayed ripening, premature loss of canopy can result in poor overwintering. At this time of year, vines are sending sugars down into storage within the roots of the plant to utilize throughout the winter when photosynthesis is not occurring. Loss of foliage prior to natural abscission of the leaf interrupts this process, potentially leading to reduced food reserves within your vines. Reduced food reserves within the vine often results in death of canes and buds.

Effects of premature defoliation can often be best observed the following spring at bud break. Poor bud emergence and death at tips of pruned canes are common when vines have been heavily stressed by defoliation in the previous season. Successive seasons in which vines are cropped heavily and prematurely defoliated can lead to a general decline or death of the vine.



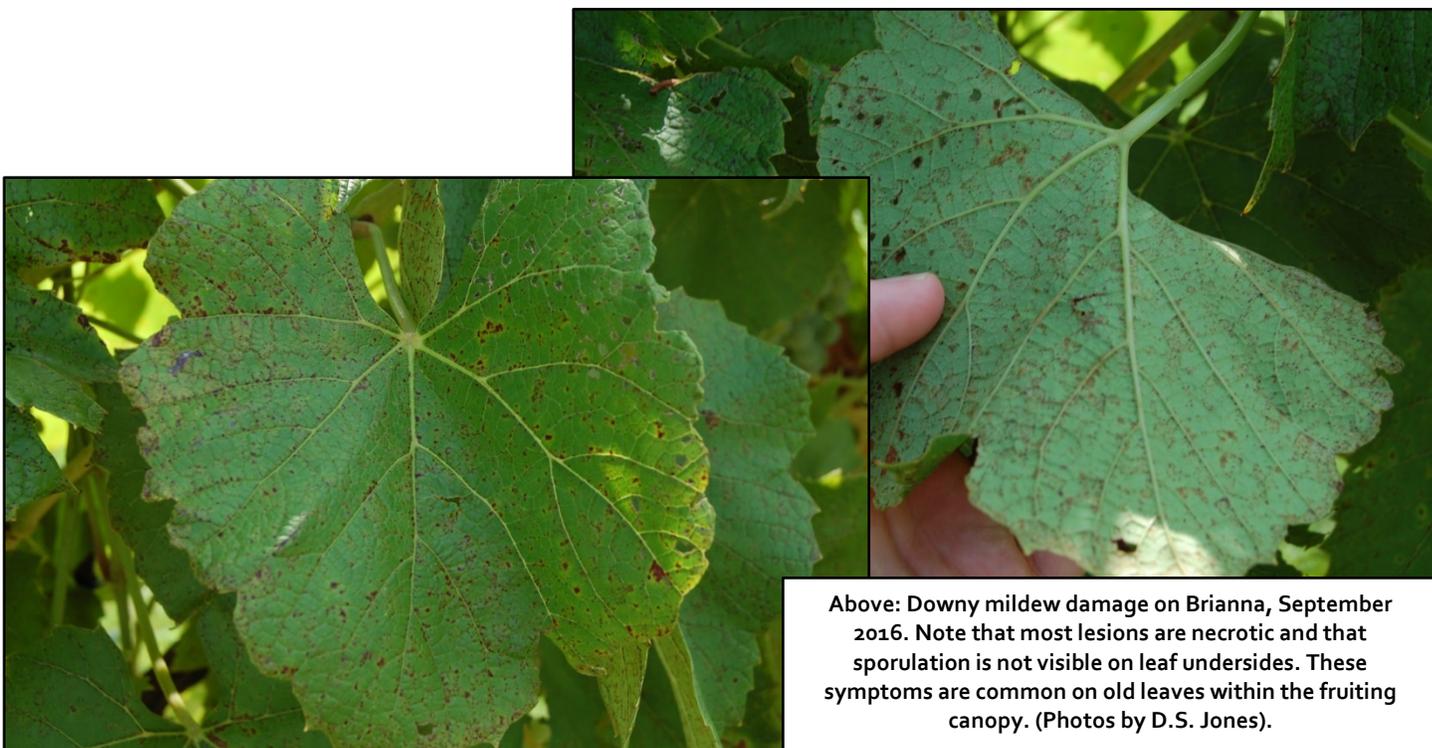
Above: winter damage on a prematurely defoliated Valiant vine. Normally exceptionally winter hardy, Valiant was heavily damaged by winter following the 2015 growing season in which it was severely defoliated by downy mildew. (Photo by D.S. Jones).



Above: In extreme cases, no buds on spur pruned vines survive. In this case, only buds at the very base of the spur have survived. The reduced number of buds will mean reduced fruit productivity for the growing season. (Photo by D.S. Jones).

Late season disease management can be difficult due to confusion as to the pathogen responsible for damage. Diseases at this time of year can look very different from earlier in the growing season, so familiarizing yourself with late season downy mildew symptoms is important in correctly identifying the appropriate measure of control.

Downy mildew lesions are commonly mistaken for black rot or anthracnose at this time of year due to the necrotic appearance of its late season lesions. While most people associate downy mildew symptoms with “oil spots” and white spores on leaf undersides, downy mildew infections observed at this time of year frequently display neither.



Above: Downy mildew damage on Brianna, September 2016. Note that most lesions are necrotic and that sporulation is not visible on leaf undersides. These symptoms are common on old leaves within the fruiting canopy. (Photos by D.S. Jones).



Above and at right: Downy mildew damage on Brianna, September 2016. These symptoms are common on young growth at the growing tips of both canes and axillary shoots. Note that some lesions on the underside of the leaf display sporulation while others do not. In many cases, sporulation will be difficult to find. Note that these lesions differ from black rot in that they lack the small black "pimples," called pycnidia, which are found on all black rot leaf lesions. (Photos by D.S. Jones).



At left: Rupestris speckle is another common late season downy mildew lookalike. Our trials indicate that while Frontenac and Frontenac Gris commonly get moderate to severe rupestris speckle, they are minimally susceptible to downy mildew and are therefore unlikely to have damage that is this severe. Remember that these lesions lack sporulation on leaf undersides (which would indicate downy mildew) and pycnidia (which would indicate black rot). (Photo by D.S. Jones).

Addressing downy mildew damage at this time of the year can be challenging, as few sprays are available to close to the time of harvest. The best options close to harvest are phosphorous acid fungicides, which typically have a minimal re-entry interval (REI) and a zero-day pre-harvest interval (PHI). Michigan State University Extension has noted that a second application of phosphorous acid fungicide 5 days following an initial application of phosphorous acid fungicide maximizes the efficiency of these products and provides curative effects.

Following harvest, fungicides that have lengthy pre-harvest intervals such as mancozeb, Ridomil Gold MZ, and Ridomil Gold Copper become options once again. These products are highly effective in managing downy mildew, and may be useful, particularly for cultivars such as Brianna that are harvested early in the fall, several weeks before leaf drop. Remember that the goal here is for the vines to retain leaves until they naturally fall from the plant later in the fall. These sprays are targeted at preventing premature defoliation.

Our trials suggest that LaCrosse, La Crescent, St. Croix, Brianna, and Valiant are all at risk for severe downy mildew damage and potential defoliation at this time of year. Frontenac, Frontenac Gris, Petite Pearl, Marquette do not appear to be at risk for defoliation by this pathogen. Protection may only be necessary on certain cultivars, so make sure to effectively scout and identify the pathogen prior to making applications of fungicide.

Having scouting troubles? Don't forget about our diagnostic resources!

UW-Madison Plant Disease Diagnostic Clinic: <http://labs.russell.wisc.edu/pddc/>

UW-Madison Insect Diagnostic Lab: <http://labs.russell.wisc.edu/insectlab/>

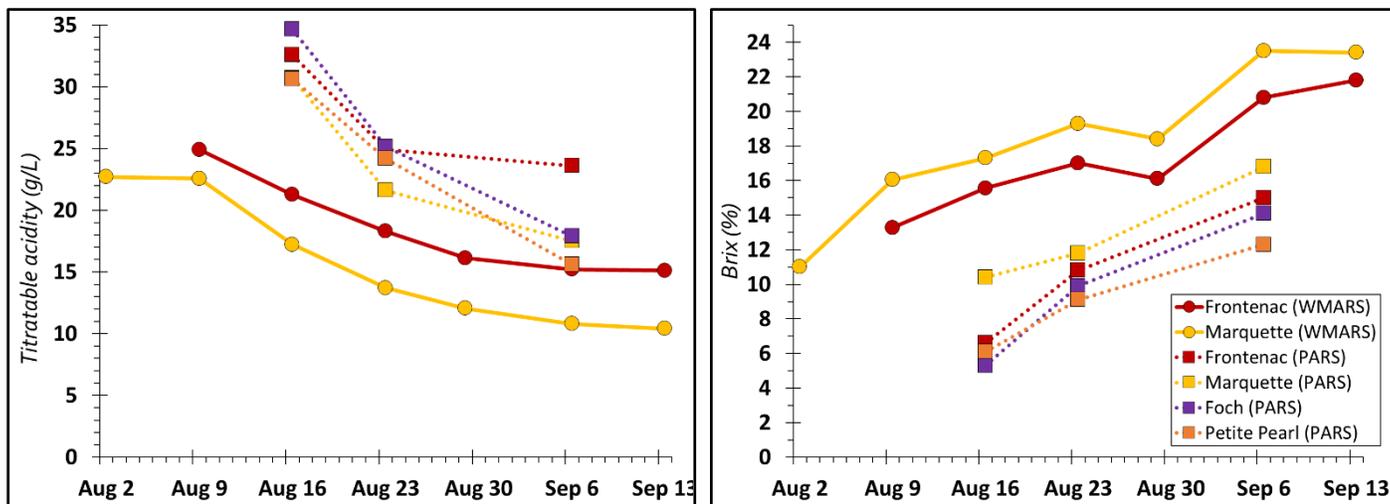
UW-Madison Soil and Forage Lab: <https://uwlabs.soils.wisc.edu/fees/>

Wine and Table Grape Developmental Stages

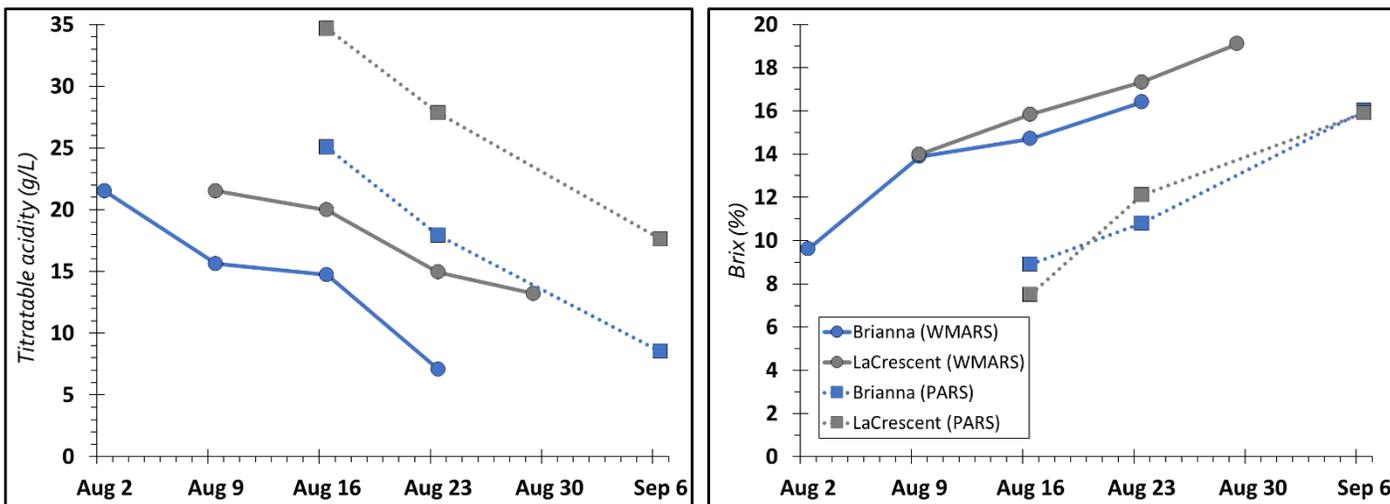
By: Janet van Zoeren, Annie Deutsch, Madeline Wimmer, and Amaya Atucha – UW-Extension

Harvest is nearly finishing up at the West Madison Agricultural Research Station (WMARS), with Somerset and Einset table grapes and Brianna and La Crescent wine grapes already harvested, and the others to be harvested in the coming weeks. At the Peninsular Agricultural Research Station (PARS), grapes are still several weeks away from harvest, but are beginning to color and soften up. Sugar (Brix) and TA (titratable acidity) concentrations from both WMARS and PARS are shown in the chart and graphs below.

Sept 12, 2016				
Grape Brix and Titratable Acidity (TA)				
WMARS			PARS	
Grape Variety (Reds)	Brix (%)	TA (g/L)	Brix (%)	TA (g/L)
Frontenac	21.8	15.1	15.0	23.6
Marquette	23.4	10.4	16.8	17.5
Foch	n/a	n/a	14.1	17.9
Petite Pearl	n/a	n/a	12.3	15.6
Grape Variety (Whites)				
Grape Variety (Whites)	Brix (%)	TA (g/L)	Brix (%)	TA (g/L)
Brianna	HARVESTED	HARVESTED	16.0	8.5
La Crescent	13.2	16.4	15.9	17.6



Titratable acidity (above left) and Brix (above right) of red wine grape varieties as WMARS (solid lines) and PARS (dotted lines).



Titratable acidity (above left) and Brix (above right) of white wine grape varieties as WMARS (solid lines) and PARS (dotted lines).

Wisconsin's 2016 growing season experienced high incidence and amounts of rain. We commonly observe higher amounts of disease and rot during years like this, but high precipitation can also affect fruit quality. This season we saw sugar levels stall or even drop slightly during some weeks, which contrasts our expectations that sugar levels will steadily rise as the fruit ripens. Although we did not measure them, we can assume that other flavor compounds were also temporarily diluted throughout these events. What we can learn from this is that it is best to harvest before large rain events or wait a few days to harvest afterwards if allowed.

Following photos taken on September 13th at West Madison Agricultural Research Station.



La Crosse at WMARS



Marquette at WMARS



St. Croix at WMARS



Frontenac at WMARS

Following photos taken on September 15th at the Peninsular Agricultural Research Station.



Brianna at PARS



La Crescent at PARS



La Crosse at PARS



Marquette at PARS



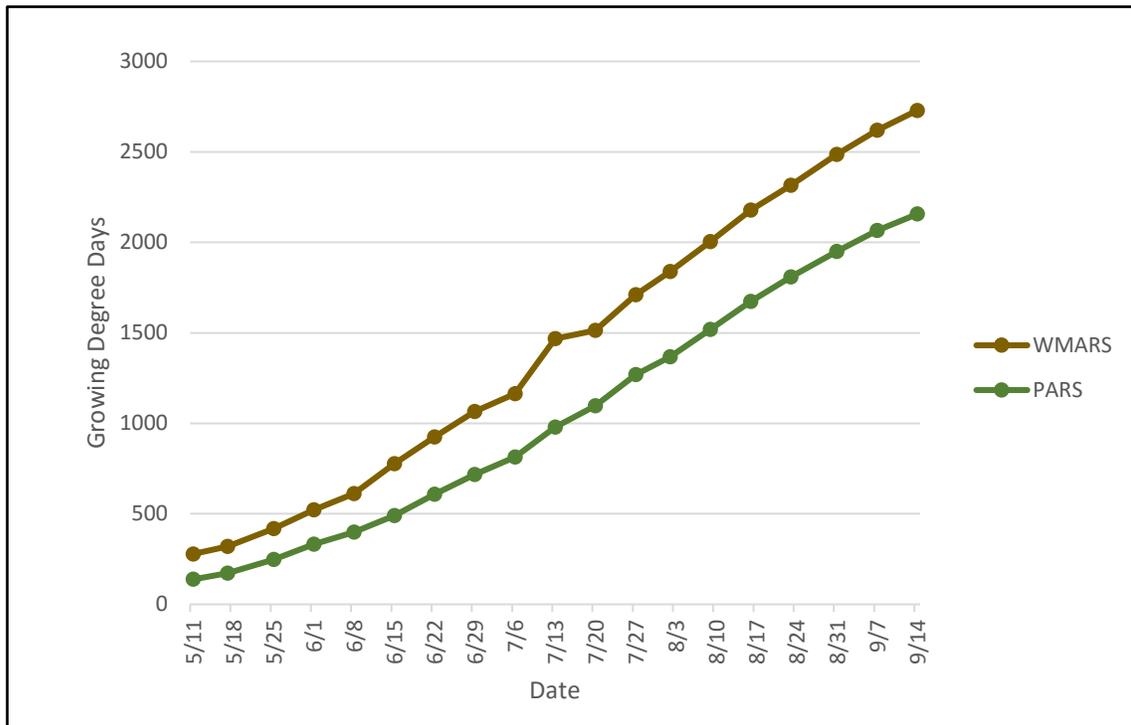
Frontenac at PARS

The growing degree day accumulations as of September 14th for this year are: 2,729 GDD at WMARS and 2,156 GDD at PARS. All growing degree days are calculated using a base of 50°F.

Grape Growing Degree Days

April 1 - Sept 14, 2016

	2016	2015
WMARS	2729	2619
PARS	2156	1960



Hazelnut Harvest and Processing

By: Jason Fischbach, UW-Extension Food and Energy Woody Crop Specialist

Since 2007, I have been working with early-adopter hazelnut growers in the Upper Midwest to help build their industry. Our research focus has been primarily on developing improved germplasm, but we have also been working to develop appropriately-scaled processing capacity. The plants come into production around year 5, and at that point growers quickly realize that hand-cracking and sorting isn't an option. There is hazelnut processing equipment available, but it is scaled for the larger Oregon, Turkish, and E.U. production areas.

Like any new industry, there is a chicken-and-egg process of matching production with processing capacity with market development. In the Upper Midwest, there are two efforts afoot, the first is to develop small-scale low-cost equipment tailored to hobby growers. The second is to pool production volumes and build processing lines with sufficient throughput to accommodate and encourage an anticipated increase in production. The purpose of this article is to outline the steps in hazelnut processing so new and aspiring hazelnut growers know what is involved with the harvest and sale of hazelnuts.



A hybrid hazelnut shrub in Bayfield, WI ready for harvest on September 9, 2016.



Hazelnut clusters picked from hybrid hazelnut shrubs.

At this point, hazelnuts in the Upper Midwest come from shrubs of crosses between our native American Hazelnut (*Corylus americana*) and the imported European Hazelnut (*Corylus avellana*). When ripe, the nuts fall free from the husk of European hazelnuts and are harvested from the orchard floor, but the ripe nuts from American hazelnut and hybrids stay in the husk and the entire cluster (nuts and husk) are harvested directly from the shrub (Photo 1). Most growers harvest by hand, but the larger growers are now using blueberry harvesters with good success.

To remove the nuts from the husks, the husks first have to be dried (Photo 2). Once crispy dry, the clusters are run through some form of a hammer mill that pulverizes the husks and frees up the in-shell nuts. A blower or vacuum aspirator is then used to separate the husk material from the in-shell nuts. This process is considered part of the harvest process and does not require a food processing plant license. Drying the in-husk nuts is not ideal and work is underway to develop the capacity for removing the husks while still green, possibly in the field as part of the harvest process.

It's possible that improved genotypes will be grown as trees with nuts harvested from the orchard floor as is done with European hazelnuts. However, in the Upper Midwest, growers are motivated by the conservation benefits of hazelnuts, and shrubs combined with over-the-top harvesting reduce the inputs and impact of orchard floor management.



In-husk hazelnuts in mesh onion bags air drying in a greenhouse.

In-shell nuts have a long shelf life and are best stored in cool conditions. Though some growers sell in-shell nuts, the nuts from current genetics in the Upper Midwest are relatively small compared to the jumbo Oregon-grown nuts. Likewise, the market for in-shell nuts is shrinking and seasonal. As such, Upper Midwest growers are interested in selling whole kernels or adding value to the kernels by making salad oils, cosmetic oils, nut butters, confections, or other food products.

As with all nut crops, the in-shell nuts are highly variable in size and shape, even within a single plant. Thus, the cracking process must manage this diversity either by size-sorting prior to cracking or using a size independent cracking technology. Most growers in the Midwest are sorting the in-shell nuts into size classes with a roller-sizer and using the Drill Cracker™ to crack each size class. However, there is considerable ongoing work by growers and researchers to develop a better cracking system that maximizes whole kernel recovery. Impact cracking, for example, involves striking the nuts against a surface at high speeds. Such cracking is size independent and can minimize or eliminate the size-sorting step.

After cracking, the kernels must be separated from the shell fragments (Photo 3). This is being done with a combination of roller-sizing, aspiration, and mechanical sorting. The process is imperfect and even in the well-established nut industries there is still a final hand-sort step at the end of the processing line. Laser color-sorting can also be used for shell-kernel separation, but is expensive and requires considerable volume to justify the expense. Once out of the shell and exposed, the kernels will quickly oxidize and go rancid. Thus, most growers are storing the kernels frozen or doing the cracking on a just-in-time basis.



Separating the kernel from shell fragments is typically the most expensive part of nut processing and even with great machines requires a final hand sort.

Cracking and separation is considered food processing in Wisconsin and a food processing plant license from the WI Department of Agriculture Trade and Consumer Protection (DATCP) is required. Obtaining this license requires a facility that meets food codes, a HACCP plan, and food grade processing equipment. To meet these requirements, a group of growers launched the American Hazelnut Company (AHC) in 2014. The AHC is located in Gays Mills, WI and is utilizing the Kickapoo Culinary Center. More information about the AHC can be found at www.americanhazelnut.co.



Hazelnut kernels from promising selections of hybrid hazelnuts grown in Bayfield, WI.

Apple fruit Maturity: how to determine the optimal harvest date

By: Amaya Atucha, UW-Extension State Specialist

Whether you are planning on selling your apples at a farmers' market, wholesale, for processing, or considering regular or controlled atmosphere storage, harvesting at optimal maturity for the targeted consumer will be key to ensure a high quality product. There are several maturity indices that can be used to establish harvesting windows for apples, and identifying when and where the fruit will be marketed is a starting point to select the most relevant indicators. For example,

if you are planning on marketing your apples at a farmers' market, color and flavor might be the most relevant maturity indicators for harvesting, as the fruit will probably be consumed immediately. However, if you are planning on storing the fruit for an extended period of time, starch conversion and fruit firmness might be better indicators of fruit maturity. Here is a review of the maturity indices that can be used for apples:

Fruit firmness

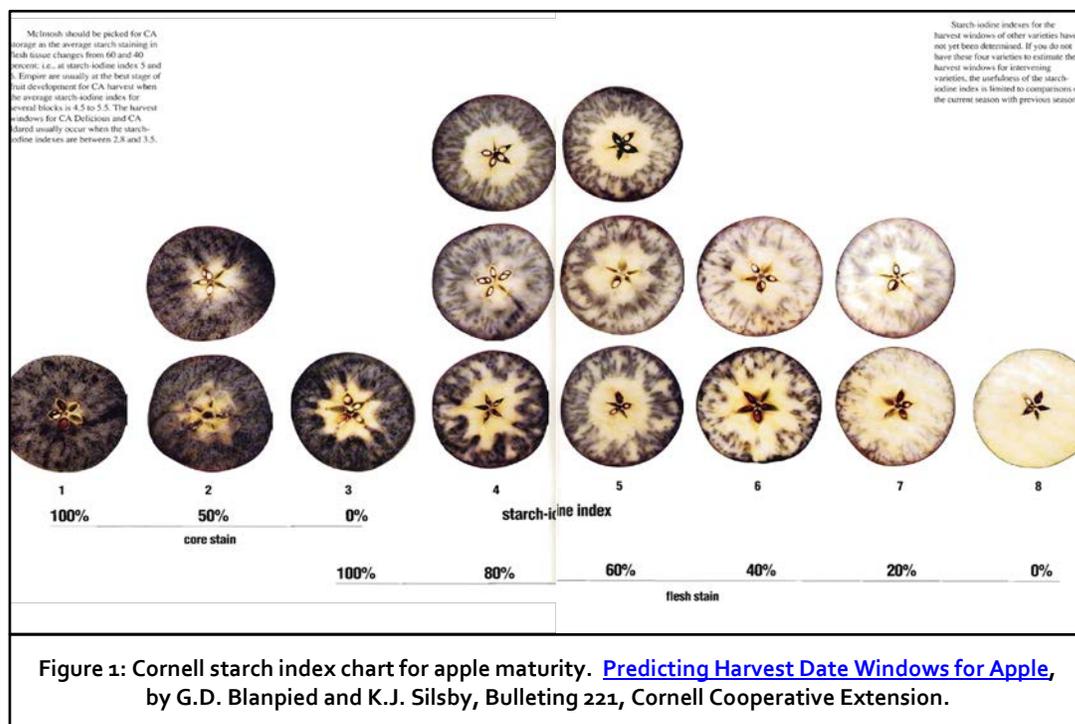
As apples mature, the flesh becomes softer and this can be measured using a penetrometer. Penetrometers with a 7/16" diameter plunger tip can be purchased at farm supply stores; some of the common brands are Wagner Fruit Test FTX, Magness-Taylor, and McCormick. To get accurate readings it is critical to adjust the speed with which the plunger tip is inserted in the flesh. Here's a link to [Measuring Fruit Firmness with a Penetrometer](#) from Washington State University.

Soluble solids

Sugar concentration increases as the fruit ripens. A refractometer can be used to measure sugar concentration in degrees Brix in apples. To measure sugar concentration, a small amount of juice from the fruit needs to be squeezed and placed onto the prism of a digital or optical handheld refractometer.

Acidity

Unripe apples have a high concentration of acids, mainly malic acid; however, as the fruit ripens, the acid concentration decreases. Measuring acidity can be more complicated than other maturity indicators, as it requires a higher level of training and more sophisticated laboratory equipment, such as a titrator. There are a couple new tools that can be used in the field to measure acidity, Accuvin titratable acidity test kit and the Atago Pal-BX/ACID5, however the precision of the readings is not as high as with a titrator.



Starch Content

During the ripening process of apples, starch in the flesh is converted into sugar. This process can be measured using the starch-iodine test, which allows us to visually evaluate the conversion of starch into sugars. The iodine binds to the starch molecules in the apple flesh and turns into a very dark purple/black color. As the fruit matures, there is less concentration of starch and thus less dark color of the flesh (see Figure 1 above). Each variety has a different pattern of starch disappearance, and variety specific visual charts can be found online ([Honeycrisp](#), [McIntosh](#)).

To determine the stage of maturity of apple fruits, cut an apple horizontally and apply the iodine solution to the cut surface, draining any excess, and rate the fruit after 2 minutes. The reaction of the iodine with the starch is temperature dependent, and it will take longer under cold conditions. A rating scale system from 1 to 6 is commonly used to evaluate the results, as follows:

- 1= full starch (all dark purple-black)
- 2= clear of stain in seed cavity and halfway to vascular area
- 3= clear to the area including vascular bundles
- 4= half of flesh clear
- 5= starch just under skin
- 6= free of starch (no stain)

The iodine solution to perform the test can be purchase online ([iodine solution](#)) or it can be prepared following either of these two recipes:

- 1) Mix equal parts of 2% alcoholic solution of medicinal iodine (you can purchase it at a local drug store) and water. Using medicinal iodine can be expensive if you are testing a high number of samples.
- 2) Dissolve 9 grams of potassium iodide and 2.2 grams of iodine crystals in 1 liter of warm distilled water. This may take several hours to fully dissolve. You can purchase the reagents from a chemical supplier as Fischer Scientific or Sigma-Aldrich.

Store the iodine solution in an amber bottle, or a clear container wrap in aluminum foil to avoid light exposure (iodine color will degrade if exposed to the light). Old iodine solution will deteriorate, so make sure to test it before using it on an immature apple that should turn black within seconds if the solution is still good.

Useful Links:

You can purchase (\$10) the 2016 Midwest Fruit Pest Management Guide from the UW Learning Store:

<http://learningstore.uwex.edu/Midwest-Fruit-Pest-Management-Guide-2016-P1785.aspx>

Wisconsin Fruit Website: <https://fruit.wisc.edu/>

Insect Diagnostics Lab: <http://labs.russell.wisc.edu/insectlab/>

Plant Disease Clinic: <http://labs.russell.wisc.edu/pddc/>

Soil and Forage Analysis Lab: <https://uwlabs.soils.wisc.edu/>

Weed Identification Tool: <http://weedid.wisc.edu/weedid.php>

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