Integrated Cranberry Crop Management for Wisconsin

Cranberry

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Cranberry Virus Update

By Patty McManus

UW-Extension Fruit Crops Specialist & Plant Pathologist

My lab at UW-Madison is investigating two virus diseases of cranberry: tobacco streak virus (TSV) and blueberry shock virus (BlShV). Here I provide a quick overview of what we have learned so far and provide information for getting vines tested. For more details on our findings in 2012 and 2013, see previous issues of Cranberry Crop Management (especially August and September 2013) and the 2014 Cranberry School Proceedings. Also, we will provide an update on September 8 at 1:30 p.m. in the Wood County courthouse auditorium.

In 2012 and 2013 we found that berry scarring was associated with presence of TSV. In 2013, during the course of a survey to determine how widespread TSV was in Wisconsin, we encountered scarred berries that tested negative for TSV, despite having symptoms typical of TSV. Upon further testing, we identified a different virus, BlShV. Coincidently, TSV and BlShV are in the same virus family, which means that there may be similarities in how they affect cranberry. In fact, we have given up on predicting which virus is present based on symptoms (see photos). You will find in our presentations and writing about these viruses that we often borrow information about one virus to develop hypotheses about the other. I apologize if this gets confusing; do not hesitate to contact me if you want clarification.

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Symptoms caused by TSV and BlShV are very similar, and include puckering and deep crevices, irregular scorch marks, and superficial ring spots and swirl patterns. (More pictures on page 2.)

This Issue:

Cranberry Virus Update *(Continued from p. 1)*

By Patty McManus

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Continued from p. 1

My graduate student, Lindsay Wells, initiated research on TSV in 2013 and made the interesting observation that uprights seem to recover from TSV the year after symptoms are observed. That is, uprights with scarred berries in 2012 produced normal fruit in 2013. However, "recovered" plants continued to test positive for TSV and their pollen tested positive as well. This recovery phenomenon has been observed in blueberry bushes infected with BlShV. We do not know, yet, if cranberry plants infected with BlShV also recover the year after infection, but this year we found that BlShV is carried on cranberry pollen. In other crops, pollen-borne viruses are generally believed to be spread by insects. In the case of BlShV, honeybees can spread the virus, and infective pollen survives in hives for up to a week. In the case of TSV, thrips appear to have a role, but it's not clear whether they spread the virus among crops, provide a wound for TSV to enter plants, or both.

We are attempting to transmit TSV and BlShV by various methods to healthy plants in a greenhouse. Some plants were pollinated with infected pollen, some were wounded and then smeared with infected pollen, and others were wounded and smeared with sap from infected plants. So far, we have not been able to reproduce the scarring symptoms that are associated with TSV and BlShV in the field. However, in the case of BlShV on blueberry, symptoms actually show up the year after infection. We are continuing these experiments, but if TSV and BlShV in fact have multi-year disease cycles, then getting answers will also take multiple years.

In the absence of fast answers on how the viruses spread, I have recommended that to the extent possible, growers limit traffic in and out of beds during bloom to prevent the spread of potentially infected pollen. Unfortunately, this has been interpreted by some as meaning that crop scouts are spreading viruses. **Let me be clear: TSV and BlShV are showing up in beds not visited by crops scouts**. **Insects are the prime suspects for spreading TSV and BlShV in cranberry beds.** Viruses are another pest to be added to the long list of insects, diseases, and weeds that cranberry growers deal with every year. **In-the-bed inspections by crop consultants are absolutely necessary in crop management**. But if there are tasks that can wait until after bloom (e.g., wiping weeds), then wait. The risk of spread by carrying

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Publication for Cranberry Tissue Testing provided courtesy of

Suzanne Arendt, RedForest Crop Consulting, LLC

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Cranberry Tissue Testing

for producing beds in North America

J. Davenport, C. DeMoranville, J. Hart, K. Patten, L. Peterson, T. Planer, A. Poole, T. Roper, and J. Smith

Why use tissue testing?

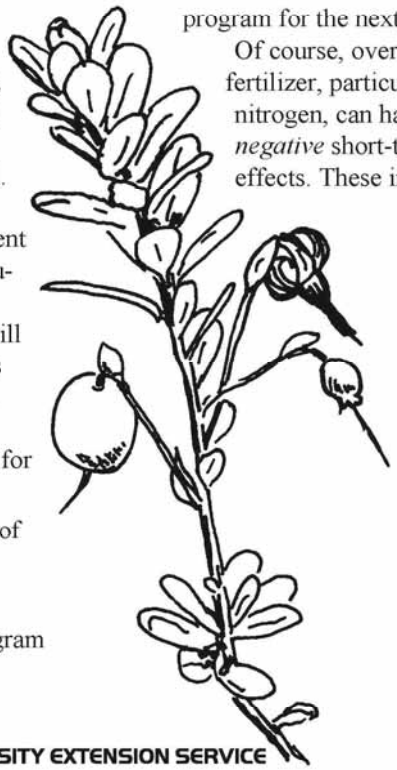
Cranberry plants require proper amounts of certain chemical elements from air, water, and soil to ensure adequate vegetative growth and fruit production. When levels of these nutrients in the plant are low, growth and yield may be affected.

Severely reduced nutrient supply can lead to visible nutrient deficiency symptoms. Routine collection and analysis of tissue samples can detect low nutrient concentration *before* visible symptoms or yield reduction occurs.

Mineral nutrients such as nitrogen (N), phosphorus (P), and potassium (K) are added through fertilizers to supplement the supply from the soil. By analyzing dried plant tissues for their nutrient content (tissue testing), you can evaluate the adequacy of mineral nutrients. This information will help you decide if fertilizer is needed, and if so, how much and what kind to use.

Tissue testing can be used for any of the following:

- Predicting fertilizer needs of annual crops
- Diagnosing problems
- Evaluating a fertilizer program for perennial crops



Tissue testing can be used to monitor and adjust fertilizer use during early growth stages of annual crops such as potatoes, sugar beets, or lettuce. By using a tissue test, growers can anticipate fertilizer needs for these annual crops.

In contrast, using tissue test results to anticipate *current* season fertilizer needs does not work well for perennial crops like cranberries. In part, this is due to the minimal short-term effect of fertilizer on yield in perennial crops. Therefore, tissue testing in producing cranberries is best used for end-of-season evaluation of a fertilizer program for the next year.

Of course, over-use of fertilizer, particularly of nitrogen, can have *negative* short-term effects. These include stimulation of excessive vine growth and fruit rot.

If problems such as poor growth or discoloration of vines appear during the growing season, you can use a comparative tissue test to check for possible nutrient deficiencies. You can collect samples to diagnose deficiencies at any time during the season. However, when outside the August–September time period (see "When to sample" on page 2), you also must collect a companion sample from an unaffected area for comparison.

Before using tissue testing to predict or evaluate fertilizer needs, you need the following information, which is provided in this publication:

- Sampling time (stage of development)
- Plant part to sample
- Normal or sufficient concentration range for each nutrient so you can interpret results

Joan Davenport, manager, agricultural research, Ocean Spray Cranberries, Inc.; Carolyn DeMoranville, cranberry plant nutritionist, University of Massachusetts Cranberry Experiment Station; John Hart, Extension soil scientist, Oregon State University; Kim Patten, associate horticulturist, Washington State University; Lloyd Peterson, professor of horticulture emeritus, University of Wisconsin-Madison; Tod Planer, Extension agent, University of Wisconsin; Arthur Poole, Extension agent, Coos County, Oregon State University; Teryl Roper, associate professor of horticulture, University of Wisconsin-Madison; Jonathan Smith, operations research, Northland Cranberries. (Authors listed in alphabetical order.)

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When to sample

Tissue samples should be collected when nutrient concentration is stable. Samples collected just a few days apart during periods of rapid change in nutrient concentration can give quite different results.

The change in nitrogen (N) and potassium (K) concentration in new shoots of Massachusetts "Early Black" cranberries during the 1988 growing season is illustrated in Figure 1. Tissue concentration changes rapidly early in the growing season. Compare the late August–early September sample results to samples collected between May 25 and June 24.

Tissue levels of both elements changed during the season but reached a constant level between August 23 and September 17. Samples collected between those dates should produce consistent analytical results.

Cranberry tissue research in Oregon produced similar results (Chaplin and Martin, 1979). See "For more information" on page 3.

Figure 1 also illustrates the danger in collecting late September samples. Nitrogen concentrations decrease as plants enter dormancy, so these samples may not give an accurate picture of the situation in a bed.

Collect cranberry tissue test samples during the stable period—late August to early September. Sampling cranberry tissue at any other time is not recommended except for samples collected for comparative tissue testing.

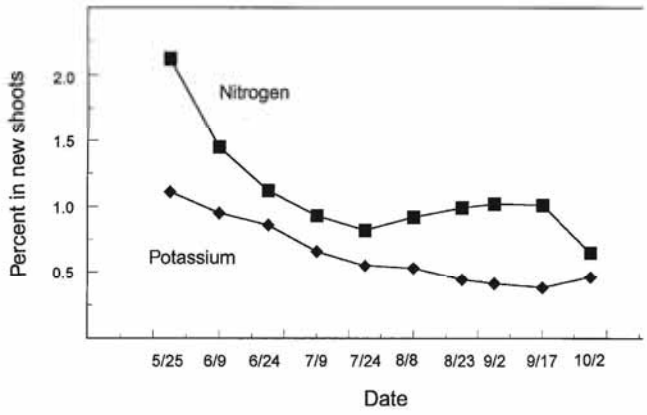

Figure 1.—Nitrogen and potassium percent in new shoot tips of "Early Black" cranberries in Massachusetts, 1988 (DeMoranville, 1992).

Part of cranberry to sample

A cranberry tissue sample should include current season growth from both fruit-bearing and non-fruiting uprights. To sustain uniform yields from year-to-year, fields should have a mixture of both types of uprights.

Figure 2 illustrates the tissue to collect. Clip just above the berries on fruit-bearing uprights. Clip above the bud break location on non-fruiting uprights to collect only current season tissue.

Collect 20 tips each from 10 locations representative of the bed. The total sample will consist of 200 upright tips per bed or 1 to 1½ cups of plant material.

Do not wash the sample or separate the leaves and stems.

Frequency of sampling

Sampling cranberry tissue from all fields annually is ideal for gathering nutrient status information. However, you may feel annual sampling is not necessary or financially feasible. Regardless of whether or not you sample every year, develop a plan for regular sampling.

Begin with fields that are not growing or yielding as desired. Annual sampling from these fields will be necessary until the problem is determined or corrected.

Divide the remainder of your acreage into two or three groups. Sample from a group of fields each year. In this way, you will sample one-half or one-third of the acreage each year.

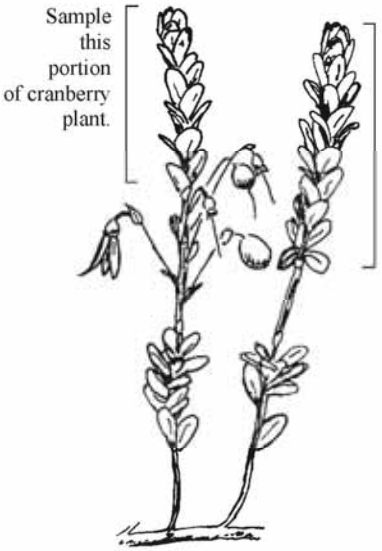

Figure 2.—Obtain tissue sample from area shown.

Cranberry Tissue Testing Bulletin continues on p. 7

Update from the Fruit Crop Entomology Laboratory

Christelle Guédot, Erin McMahan and Aidee Guzman

Department of Entomology, UW Madison and UW-Extension

Host plant resistance

The 2014 field season in the Guédot lab began with the second year of MS student Erin McMahan field study comparing population densities of the three most important moth pests in Wisconsin cranberry, blackheaded fireworm (BHFW), sparganothis fruitworm (SFW), and cranberry fruitworm (CFW), in different cranberry cultivars grown in Wisconsin. We trapped for these pests in beds of Stevens, Ben Lear, HyRed, GH1, and Mullica Queen at marshes in central Wisconsin to determine whether different varieties supported different populations of pests. The same study was carried out in the summer of 2013, and yielded no significant differences between pest populations in different varieties. However, problems with the commercial pheromone lures occurred last year and we decided to repeat the study this summer. Luckily, this second year went much more smoothly and the lures were effective at trapping insects! We also collected damaged berries in the study beds to determine whether differences among varieties in the numbers of berries damaged by these pests occur. The study has now been completed, and results are currently being analyzed.

Based on our trap counts, the 2014's peak flight for BHFW occurred at roughly the same time of year as the 2013's peak flight, and average trap counts at peak flight were similar. SGFW also had similar peak flight timing in 2014 and in 2013 and average trap counts were very close. CFW peak flight was about a week earlier and average trap counts at peak flight were somewhat higher in 2014 than in 2013.

A laboratory experiment is also currently underway to determine whether the cranberry variety that SGFW feed on affects their development rate. In the experiment, SGFW larvae are fed a strict diet of one of nine cranberry varieties and aspects of their development are measured. We are hoping to have results soon.

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Pheromone trap with lure

Update from the Fruit Crop Entomology Laboratory

Continued from p. 5

Cranberry pollination

The second project on cranberry in the Guédot Laboratory during this summer is conducted by B.S. students Aidee Guzman and Tressa Franzmeier, who are looking at the impact of honeybee hive placement on cranberry pollination.

Currently, 70% of cranberry growers rely on honeybees for pollination services. Although, cranberry is able to produce fruit without pollination, fruit set, berry size, as well as ripening is maximized by successful pollination. We are investigating whether hive placement on the marsh might have an impact on the foraging efficiency of honeybees in cranberry. We are assessing whether cranberry contribution to the pollen collected by honeybee foragers varies with hive placement on the marsh between (1) the center of the marsh, (2) the edge of the marsh near a reservoir, or (3) the edge of the marsh near natural habitat. We hypothesize that bees from hives surrounded by cranberry beds (center) or at the edge near a reservoir have less opportunity to forage on resources off-farm in comparison to hives located near natural habitat.

Observers collecting pollen foragers returning to the hive

This summer, we collected over 500 pollen foragers, bees coming back to the hive with full pollen baskets (see picture), at three locations (center of the marsh, near a reservoir, and near natural habitat) at 5 cranberry marshes in central Wisconsin. In the upcoming months, we will be processing our samples. We will be determining the percentage of cranberry versus non-cranberry pollen grains brought back to the hive by looking at pollen morphology and we will identify which other plants honeybees are foraging on while cranberry is in bloom.

We also surveyed the abundance and density of non-cranberry plants flowering at each marsh. Cranberry marshes are quite diverse, with 46 species of plants sampled in our survey (Shannon index for diversity H=3.0). Most commonly found on the marsh, were: annual knawel black medic; broadleaf plantain, common cinquefoil, mouseear chickweed, pepperweed, rough cinquefoil, sheep sorrel, white campion, white clover, and yellow woodsorrel.

Honeybee with full pollen baskets (yellow bundle)

Honeybees foraging on milkweed

This study is part of a larger project in collaboration with Juan Zalapa, Shawn Steffan, and Johanne Brunet, assessing the fidelity of honeybees to cranberry. Understanding the best placement of hives on the cranberry marsh could provide a simple practical approach to improving cranberry pollination efficiency by honeybees.

Thanks to all participating growers, Jayne Sojka, and field day volunteers from the Guédot, Zalapa, and Steffan labs for their assistance and enthusiasm!

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Interpreting laboratory results

Compare the results from a laboratory analysis to the values in Table 1 on page 4 to determine if sufficient nutrients were supplied by the soil and your fertilizer program.

Lower than normal tissue nutrient concentrations are common with vine overgrowth. In this case, low tissue nutrient concentration is caused by the nutrient content of the tissue being diluted by the intensive growth.

This situation should correct itself when growth returns to normal. Therefore, do not apply extra fertilizer to correct low tissue concentrations in a situation of vine overgrowth.

Review the vine growth and crop load from current and last season. Choose the combination of tissue analyses and crop growth listed below that corresponds to your situation. Follow the instructions given for the appropriate category.

- **Low tissue analyses and abundant vine growth.** If vine growth is luxurious, don't apply additional fertilizer.
- **Low tissue analyses and weak vine growth.** If vines are weak, discolored, or stunted, apply fertilizer at rates recommended by your local Extension Service.
- **Normal tissue analyses and vine growth.** If your tissue analyses are within the normal range, continue with your current fertilizer program.
- **Above normal tissue analyses and weak vine growth.** If the vines are weak, discolored, or stunted, and the tissue analyses are above normal, look for stress from pests, drainage, drought, frost, or other factors limiting growth.
- **Above normal tissue analyses and vine growth.** If your tissue analyses are above normal and vine growth is adequate or above normal, reduce the amount of fertilizer you have been applying.

Other considerations

Tissue analysis results outside the normal range cannot always be attributed to your fertilizer program. Insufficient mineral nutrient concentration can be caused by saturated or dry soils; high temperatures; frost; shade; weed, insect, or disease pressure; or herbicide injury.

Several fungicides contain plant nutrients. Because tissue samples are not washed before analysis, high copper (Cu), manganese (Mn), or zinc (Zn) may be the result of fungicide residue. High boron (B) and Zn also may occur if liquid fertilizer was used.

High levels of manganese are common in cranberry tissue. If Mn-containing fungicides have not been used and the tissue concentration of Mn exceeds 300 ppm, soil drainage may be inadequate.

In this case, check the drainage conditions of your bed. If the soil is poorly drained during the growing season or if there are numerous wet spots or poorly drained areas, consider improving the soil drainage with ditching and perforated flexible drain pipe (or lines).

For more information

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How to collect cranberry tissue samples

Sample collection

- Collect tissue samples between August 15 and September 15.
- Do not collect samples from weak, weedy, or diseased areas unless the entire bed has a problem.
- Do not mix varieties in a sample.
- Collect tissue randomly across the bed.
- Clip current season growth from above the berries on fruit-bearing uprights or from approximately the upper 2 inches of growth on non-fruitful uprights.
- Do not collect berries, growth below berries, or growth below the point of bud break.
- Collect 20 upright pieces each from 10 locations representative of the bed.
- The total sample will consist of 200 upright pieces per bed or 1 to 1½ cups of plant material.
- One composite sample per bed is adequate if field condition and yield are uniform.
- Multiple samples may be needed if field size is more than 10 acres.

Sample handling

- Do not wash or rinse the sample.
- Allow the sample to air dry at room temperature before mailing to the laboratory. This should take a few days, depending on temperature and humidity.
- Put samples in paper bags or paper envelopes for mailing. Vented plastic bags such as Ziploc™ brand vegetable bags also may be used.
- Label each bag with the bed number or another identification code.
- Do not put samples in unvented plastic bags as the samples may mold in transit.
- Avoid mailing after midweek as the samples may sit in the post office or laboratory over the weekend.

Laboratory analyses

Request determination of: (N) nitrogen (B) boron (S) sulfur (if available at no additional cost) (Ca) calcium
(Mn) manganese (K) potassium (Cu) copper (Mg) magnesium (P) phosphorus (Zn) zinc

Table 1.—Cranberry tissue nutrient content guidelines for producing beds.

Nutrient	Normal concentration[1]
	Percent
Nitrogen (N)	0.90–1.10
Phosphorus (P)	0.10–0.20
Potassium (K)	0.40–0.75
Calcium (Ca)	0.30–0.80
Magnesium (Mg)	0.15–0.25
Sulfur (S)	0.08–0.25
	ppm
Boron (B)	15–60
Iron (Fe)[2]	>20
Manganese (Mn)[2]	>10
Zinc (Zn)	15–30
Copper (Cu)	4–10

[1]Normal levels are based on samples taken between August 15 and September 15.
[2]Cranberry researchers have not found a normal range for Fe and Mn.

Illustrations by Meredith Albright, freelance scientific illustrator, Bellingham, MA.

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Cranberry Virus Update

(*Continued from p. 2*)

infected sap on feet or tools is probably very small. But because "very small" is not the same as "zero", I am suggesting to UW workers that they spray their shoes with 95% ethanol when moving from one bed to another. I am concerned that this practice may be raising suspicion among growers, but in fact, it is just our attempt to exercise the utmost caution.

One way that people *are* likely to spread TSV and BlShV is if they establish a new bed with cuttings from an infected bed. This is a good reason to submit samples (even random samples of healthy cuttings) for virus testing. Another reason to test vines is to determine if symptoms are actually associated with a virus. For example, I got excited earlier this summer when I noticed that vines testing positive for BlShV in 2013 had all sorts of problems in 2014: aborted terminals, side shooting, and umbrella bloom. However, when I actually tested a larger sample of vines with these abnormalities, some were positive for BlShV and some were negative. Thus, it's likely that something else was responsible for the unusual growth.

If you do wish to have vines sampled for viruses, I recommend the commercial lab Agdia (agdia.com or 800-622-4342). You can request that they test for TSV, BlShV, both TSV and BlShV, or run the blueberry/cranberry panel, which includes TSV, BlShV, eight other viruses, and the sometimes-root-rotter, *Phytophthora*. The cost is generally greater for the panel than individual viruses, but the web site suggests calling for details on prices. In our experience, scarred berries test positive for TSV or BlShV greater than 99% of the time, whereas leaves are hit or miss. Therefore, if you have suspicious fruit, I suggest you ask Agdia to test fruit. If your fruit appear healthy but you want to test for viruses, I suggest testing some fruit and some leaves. Remember, recovered plants look healthy but their leaves and fruit test positive for virus, and these plants are capable of introducing virus into new sites.

Join us September 8, 1:30 p.m. in the Wood County courthouse auditorium for more information and to ask questions.

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Thank you!

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