

WASHINGTON STATE UNIVERSITY  
EXTENSION

World Class. Face to Face.

# CRANBERRY VINE

WSU Long Beach Research and Extension Unit  
2907 Pioneer Road • Long Beach, WA 98631 • 360-642-2031 • pattenk@wsu.edu • longbeach.wsu.edu

December 2015

## MEETINGS

**Washington 2016 Cranberry Winter Workshop:** Saint Lawrence Catholic Church Hall, Raymond, 1 to 4 p.m., Tuesday, February 9, 2016. Three pesticide credits will be given. I promise another great program, full of priceless information.

**Oregon Cranberry 2016 Winter Workshop:** The 2016 Oregon Cranberry School will be held on Thursday, February 11, 2016, 9:00 a.m. to 3:00 p.m. at the Sprague Theater in Bandon, Oregon. For more information about the event, contact Cassie Bouska, Coos/Curry OSU Extension Service, [541-572-5263 ext. 25290](tel:541-572-5263).

**British Columbia Cranberry Congress:** This year's Congress is scheduled for Tuesday, February 2, 2016 at Mayfair Lakes Golf & Country Club. Call the BC Cranberry Marketing Commission at 604-307-1046 for details.

**Grayland Spring Workshop for pesticide credit:** North Cove Grange Hall, Wednesday, April 20<sup>th</sup>, 2016 from 6:00 to 8:00 p.m.

**Northwest AG Show:** Tuesday through Thursday, January 26 to 28, 2016, Portland Expo Building. Family Day is Wednesday,

January 27. Admission for the entire family is \$20.

## RESOURCES

**Research talks:** For those who like to stay informed: the PowerPoint presentations made at the 2015 BC Cranberry Congress are at: [www.bccranberries.com](http://www.bccranberries.com). The printout from the 2015 Wisconsin Cranberry School can be found at [http://fruit.wisc.edu/wp-content/uploads/2014/07/2014\\_Cranberry\\_School\\_Proceedings\\_WEB.pdf](http://fruit.wisc.edu/wp-content/uploads/2014/07/2014_Cranberry_School_Proceedings_WEB.pdf).

## PESTICIDES

**Lorsban:** This low-cost broad-spectrum insecticide is under review at EPA. It would be nice to retain this chemistry in the toolbox for resistance management against insects, like scale. However, I am not too optimistic in that regard. For 2016, I would be cautious about buying any more than what you will use this year. For fireworm control, Altacor and Intrepid are superior products with a much better environmental profile.

**Insecticides acutely toxic to bees:** With the exception of Altacor and Intrepid, all other cranberry insecticides are considered acutely toxic to honeybees. EPA is going to implement new pollinator protector policies

which will likely restrict the use of any of these products during bloom. This will include the use of Avaunt for weevil control in June and Entrust for fireworm control by organic growers. These have not been finalized, and the WSDA might allow some exceptions. Stay tuned.

**Curio herbicide:** The manufacture/registrant, Nufarm, is no longer going to support the Curio label. The WA SLN for use on cranberries expired this year, but had been extended for another 3 years. Supplies are limited and you are on our own finding product. Just make sure to use it all up in 3 years.

**Quinstar:** Thanks to the great work of the Cranberry Institute, the future looks bright for resolving the MRL issue in the EU. Growers should be able to use Quinstar in 2017 and be export-qualified.

**Unwanted and unused pesticides:** To keep unwanted pesticide storage to a minimum, growers should adopt the “three-year rule.” If a pesticide product was not used last year or this year and there are no current plans to use it in next year’s program, the odds are that it will never get used on the farm. If the product is still in good shape and legal, first check with another grower to see if he or she can use it. If no current uses are found, then it’s time to arrange for a pesticide disposal pickup. Also, if you recently obtained an ‘old farm’ it is very common to find obsolete pesticides “hiding” behind piles of junk. These pesticides are a big liability.

**Waste pesticide pick-up:** The WSDA is offering the same pesticide disposal offer for cranberry growers as in previous years. There is no customer charge for this WSDA-provided non-regulatory service! Growers do not have to dig through broken bags to

create an inventory or haul the pesticides to an event. WSDA will come out to farms to prepare the pesticides for disposal (inventory them and pack them into clear bags and/or drums, depending upon the volume, etc.). WSDA will return with our hazardous waste contractor and collect the prepared pesticides. They will provide a signed certificate to the grower verifying that they participated in the disposal program and that WSDA took legal possession of the pesticides for proper disposal.

This is good for both GAP programs and for any property transactions. WSDA is the owner of the pesticides before they are listed on a hazardous waste manifest for shipping to a disposal facility. No growers’ names appear on the disposal documents and WSDA takes on any future long-term liability in case of a shipping accident, disposal site incident or cleanup. To apply for this great program, email [WastePesticide@agr.wa.gov](mailto:WastePesticide@agr.wa.gov) or call 360-902-2056 or visit the website [http://agr.wa.gov/PestFert/Pesticides/WastePesticide\\_apply.aspx](http://agr.wa.gov/PestFert/Pesticides/WastePesticide_apply.aspx).

**Herbicide resistance:** If you’ve been paying attention to the global news about herbicides, you would be well versed on major issues concerning herbicide-resistant weeds in many of the field crops. This is not just a concern about Roundup-resistant weeds in corn and soybean. It will affect us. Read the last sections of the newsletter for more details on what we can do to minimize the hazard for the industry. We conducted several residue trials in 2015. The goals were to see what sort of carbaryl or mancozeb treatment program would get us into MRL issues for the export markets. Both of these pesticides have important residue implications (carbaryl with multiple sprays for tipworm, and mancozeb for

multiple late season sprays for twig blight control without Bravo).

For carbaryl: a) any spray during or after bloom could result in fruit with residue greater than the EU MRL; b) two August applications got fruit very close to the US MRL; c) five applications between July and August resulted in fruit with residue greater than the US MRL, and d) wet picking and running fruit through a cleaning line reduced residue levels by only 30% compared to hand-picking fruit. This latter result suggests multiple late summer sprays of carbaryl could be problematic even for wet harvest fruit.

For mancozeb: a) there were no MRL concerns for the US or EU with 3 late applications; b) any August application resulted in residue greater than the Canadian MRL, and c) wet picking and running fruit through a cleaning line reduced residues levels by only 30% compared to hand-picked fruit. Email me for the raw data.

**Cost sharing for pesticide sheds available:** Both NRCS and the Conservation District have options along these lines. Both have different requirements, so contact both of them to see if there is a fit for your needs.

## PEST MANAGEMENT

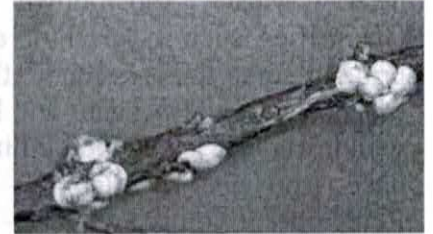
**Winter weed control:** For bad sheep sorrel infestation consider multiple winter Stinger applications, in combination with a good dose of Devrinol or Casoron. It is not perfect, but will slow it down. Winter grasses (annual bluegrass, sweet vernal, bentgrass) can be suppressed or controlled with repeated applications of Select, assuming the grass is showing with green tissue at the time of application. Spot treatment of winter Evital at high rates is good for sedge control. Cudweed is becoming a new major weed for young

plantings. Target the young plants with Quinstar for best control.

**Scale:** Farms throughout Southern Oregon are showing significant damage from several species of scale insect. These insects have not been found in Washington and so far are not an issue. However, scale insects are attached to vines (see photo) and could be easily

transmitted

to Washington whenever a grower buys vines from



Oregon. If you are buying Oregon vines, get them from trusted sources that don't have scale, and have the beds and/or vines inspected. We do not need another major insect problem in Washington resulting from carelessness. Scale will get here soon enough without our help. For an overview of scale on cranberries and what to look for, see

<http://www.umass.edu/cranberry/downloads/Scale%20updated%20June%202014.pdf>

In general, if you have weak, red, or dead circles of vines this spring, you are likely to find scale insect as being the cause. The affected areas can enlarge rapidly over the years. You can only treat in the spring when the majority of crawlers (immatures) have emerged. These small specks can be seen moving on the stem with the aid of a hand lens. Diazinon is the preferred insecticide for control.

**Tipworm:** Based on our 2014 and 2015 data, two to three well-timed applications of Sevin to control first generation tipworm prior to bloom could provide reasonable suppression of subsequent generations of tipworm populations and their effects on cranberry apical meristems. The use of Sevin during bloom must be avoided due to

risk to pollinators. Because Sevin has residue issues, consult your handler for any uses after bloom.

If you have second generation tipworm problems, then your options are limited, based on whether you are export qualified or not, have implemented BMPs for surface contamination, and have bees still on your beds. Most knock-down insecticide chemistries, such as Diazinon and PyGanic, provide some suppression if they are well timed. Ditto with Altacor and Delegate, but with lower efficacy. Good timing is difficult once you get overlapping generations. Remember if you see damage – it is too late to kill the tipworm in that tip. It is best to open tips and treat when you see egg-laying and first instar larvae. You'll need a good magnifying lens to see either one of these.

**Fruit rot control:** All the results for the fruit rot trials across North America are not in yet, so it is difficult to conclude that there is a “best” fungicide protocol to use in the absence of Bravo. Data from our own trials are also still pending. For growers needing immediate recommendations for their 2016 fungicide order, our early efficacy data would suggest that you apply alternating fungicides every 5 to 7 days (Abound, then Proline, or vice versa) with the first application starting at early bloom. A total of four fungicide applications should be made over 4 weeks of bloom. For our long bloom season, this strategy might be better than our previous recommendation of a combination of these two products applied twice.

Regarding the Bravo export MRL for 2016: so far it looks good, but official word from your handler should be received before you consider its use for export. Several growers in Washington who did use Bravo during bloom this year reported a significant yield reduction, while the low yield in New Jersey

this year was attributed to not using Bravo. We have put out lots of trials with Bravo during bloom and have never seen a dramatic reduction in yield. If you want to err on the safe side, save your Bravo applications for after fruit set, and use alternative fungicides during bloom.

## PRODUCTION

**Bumble Bee Gardens:** Renee Prasad, of E.S. Cropconsult Ltd., conducted a research evaluating plants for Bumble Bee gardens at the cranberry research station in BC. She found several selections of plants to be useful to build up the populations of bumble bees adjacent to cranberry beds. For winter-early spring bloom she recommends rhododendron (var. PMJ Compacta and Red Eye) and heather (var. Kramer's Red and Phoebe). For mid-summer bloom she recommends catmints (var. Dropmore Blue and Walkers Low), lavender (var. Hidcote), summer heather (var. Flamingo) and sedum (var. Autumn Joy and Cherry Tart). NCRS has cost-share programs for pollinator enhancement. Give them a call if you want more information.

**Sprinkler uniformity and crop loss due to heat:** One of the biggest problems I saw this summer was heat stress. At least a quarter of the growers reported some level of damage. This occurred in parts of beds that were on the low side of irrigation uniformity (see adjacent photo for an example during frost protection). Based on the weather station data at WSU Long Beach PCCRF and Grayland, there were about a half dozen times in July and August when the evapotranspiration rates were double our normal use patterns. The consequences were that some areas just got too dry with our normal irrigation scheme.



To solve this, growers have a few options: over-irrigation on hot days to compensate for poor uniformity, adding supplemental sprinklers to cover the dry spots, or changing out heads for larger flow in these areas. Regardless of what you do, it would at least be prudent to test for coverage in these dry spots and determine how much less water they are getting than the rest of the bed. Run a few cup tests when you get the system running for frost in the spring.

**Umbrella bloom:** The cause of high rate of umbrella bloom in Oregon in 2015 has yet to be resolved. Fortunately, it did not seem to hurt the overall state yield. Some of the newer selections from Rutgers seem more prone to umbrella bloom. Oregon growers should note if they see any trends in that regard and let Cassie Bouska in OSU Extension (541-572-5263 ext. 25290) know.

**Cranberry Varieties:** I've included a summary from four west coast trials. There are several interesting observations. A full report will be available at a later date.

*The 2003 Washington trials:* Our data indicate that Pilgrim is the most productive variety, with reasonably low rot, and good fruit size. Unfortunately, these Pilgrims may not be the same ones you can obtain from other growers. As I have previously discussed, there are a lot of off-type Pilgrim beds. Getting true to type Pilgrims is not easy. Crimson Queen production has been inconsistent over the long term.

With the new emphasis on having a larger, lower color "SDC" berry, two old selections, AR2 and Bain Favorite #1, have piqued my interest. AR2 in particular has always had good vigor, high yield, low rot, decent size, and the ideal TACY for an SDC berry. I would encourage growers to look at it for both fresh and processed fruit. Vines are available from our plots to take cuttings and

make plugs. They are not patent protected, so no planting fee is required. Let me know if you are interested.

*The 2009 Oregon trials:* This is the best performing trial. Pilgrim, Welker and Haines are the highest yielding selections. Welker is prone to high field and storage rot. Stevens, Yellow River and Grygleski 1 have all had unremarkable yields, but are low in field rot. These Yellow Rivers may not be the same Yellow Rivers that many growers in Oregon like. Up to 2015, Demoranville looked really good, but it appears to have an issue with needing more chilling units than the other selections. This year it had a lot of umbrella bloom and the bulk of its yield is from secondary bloom on new growth. Even though it has incredible fruit quality, I would be nervous planting this selection in Oregon. That is not the case for Washington or British Columbia.

*The Washington 2009/2010 trials:* We have had some production issues due to frost damage in 2013 and extensive deer predation in 2014, so I am only presenting the 2015 data. These plots have never been treated with fungicides and therefore have very high levels of field rot. Pilgrim and Welker have been the best producing varieties. Welker has been prone to high field rot. Demoranville has also shown consistently high production, with good fruit quality. BG's have had the largest fruit size and always start off looking great, but in the end the yield hasn't been there

*The B.C. 2013 trials:* This is a very young planting with new data just coming off. The planting was on virgin peat and has been very precocious. The 2nd year yields (bbl/ac) for Crimson Queen, Mullica Queen, Demoranville, Welker and Haines were 335, 153, 172, 611 and 508. Rots were 2.60, .78, 1.02, 4.41 and 1.68%. For two year old plantings those are impressive numbers.

Variety	Mean yield over 7 years of full production (bbl/ac)	Accumulative return @ \$46/bbl (\$)	Mean 5 yr percent field rot	Mean 5 yr percent storage rot	Mean fruit size (g)
Crimson Queen	252	100,942	11	10	1.5
Mullica Queen	290	107,597	10	7	1.4
Willapa Red	297	119,227	4	6	1.1
AR2	354	140,554	8	5	1.3
Bain Favorite #1	307	121,084	13	7	1.5
Pilgrim	405	158,171	8	5	1.4
Stevens	240	90,476	5	5	1.1

Variety	Mean yield over 4 years of full production (bbl/ac)	Accumulative return @ \$46/bbl (\$)	Mean % field rot	Mean % storage rot	Mean fruit size (g)
Crimson Queen	423	78,888	15	43	1.7
Mullica Queen	472	87,768	6.5	14.5	1.5
Demoranville	378	71,186	7.5	12.5	1.3
Welker	531	110,593	17	43	1.4
Haines	507	103,615	8	25	1.4
Willapa Red	401	76,322	7	11	1.0
Yellow River	233	44,519	2	8.5	0.7
Stevens	360	66,965	7.5	24	1.0
Pilgrim	547	102,053	7.5	13.5	1.5
Grygleski 1	313	58,396	2.5	8.5	0.9

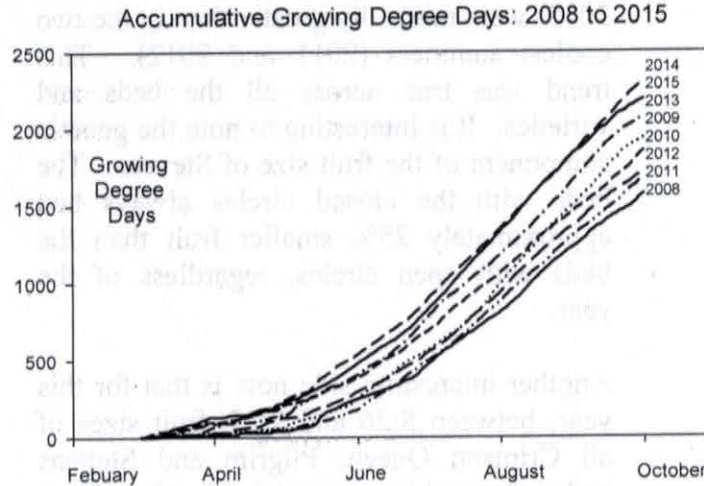
Variety	2015 production (bbl/ac)	2015 percent field rot	fruit size (g)
Crimson Queen	301	58	1.4
Mullica Queen	329	32	1.1
Demoranville	447	20	1.3
Welker	549	41	1.4
Haines	317	19	1.6
Willapa Red	289	25	0.9
Yellow River	234	24	1.2
Stevens	381	36	1.3
Pilgrim	491	32	1.5
Grygleski 1	285	31	1.4
BG's	277	30	1.8

## WEATHER

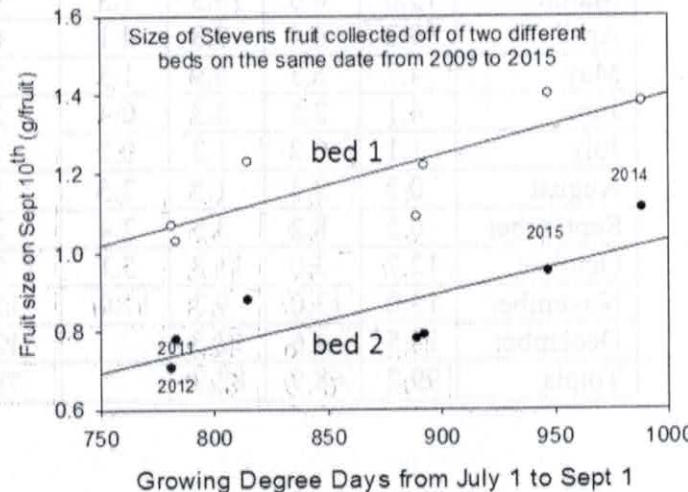
**Weather Stations in Grayland, Long Beach and Tokeland:** WSU Agweathernet stations have been in use at these locations for a while. The ones in Grayland and Long Beach have bed temperature sensors that are useful for low temperature alerts this coming frost season. Everyone with a smart phone or computer should have them programmed to give you a text or email alert whenever the temperature is below or above the level you set the alert for. While the temperature won't be exactly the same as your beds, it will match closely enough and get you out of bed on a frost night to check that your system is working.

**Weather for 2016 and beyond:** El Niño conditions are expected to persist through the winter of 2015-16. The 3-month seasonal forecasts from the [Climate Prediction Center](#) are representing the tendency for El Niño winters to be warmer and drier than usual in the Pacific Northwest. Hopefully that will continue into the summer. See below for effects on production.

**Yield and Growing Degrees Days (GDD):** Historically (the past 25 years), the mean average yield for WA growers is highest when we have high GDD for February through April. This year confirmed that trend. The GDD for February through the end of April for 2008, 2009, 2010, 2011, 2012, 2013, 2014 and 2015 were 141, 76, 265, 73, 156, 153, 214, and 329, respectively. In 2015, the state average for Washington yield was 120 bbl/ac. This is the highest in the past two decades. This would suggest that early GDD is indeed very important for yield. Interesting enough, the following graph shows seasonal GDD across the entire growing season. Total GDD was higher in 2014 than 2015, yet yield in 2014 was average at best.



**Fruit size and weather:** The extreme differences in summer temperatures over the last seven years have provided a good data set to examine the effect of weather on fruit size. We have collected and measured size and BRIX on the same Crimson Queen, Stevens and Pilgrim beds on the same dates during that time period. I am still processing all the data, but there are several interesting trends. The figure below shows mean fruit size as a function of the total number of growing degree days from July 1 to September 1 for two Stevens beds.



Sizes in the two warm summers (2014 and 2015) were markedly greater than in the two coolest summers (2011 and 2012). This trend was true across all the beds and varieties. It is interesting to note the genetic component of the fruit size of Stevens. The beds with the closed circles always had approximately 25% smaller fruit than the beds with open circles, regardless of the year.

Another interesting side note is that for this year, between 8/26 and 9/25, fruit sizes of all Crimson Queen, Pilgrim and Stevens beds increased by approximately 6%. There were two exceptions, one Pilgrim bed and one Stevens bed, which obtained 16% of their final weight (~ 0.2 grams/fruit during that time period. It will be worthwhile to examine what the management components

to these beds are that could account for these differences in growth rates.

**Water for irrigation and harvest in the future:** The total rainfall from May to September was half our 20 year average (see below). If 2015 was a foreboding of long-term potential problems with the quantity of water for late summer irrigation and flood harvesting, then growers should consider developing additional water sources. This could be as easy as expanding the depth and/or size of your irrigation pond, or may require something as onerous as getting a water right permit for a shallow well. Since these permits can take decade to obtain, now might be the time to make inquiries. For more information on these requirements see <http://www.ecy.wa.gov/programs/wr/rights/water-right-home.html>.

<b>WEATHER HISTORY – WSU Long Beach Research and Extension Unit</b>										
Month	Precipitation (inches per month)					Monthly growing degree days (based 45°)				
	2012	2013	2014	2015	20 yr ave.	2012	2013	2014	2015	20 yr ave.
January	12.4	10.2	5.9	9.5	11.8	21	3	16	65	40
February	7.1	6.5	7.5	6.6	7.4	43	9	24	139	37
March	15.6	6.6	13.3	7.3	9.5	29	57	86	121	59
April	9.2	6.4	7.3	4.1	6.2	103	90	141	114	105
May	4.7	5.3	5.9	1.3	3.9	182	249	382	248	236
June	4.1	2.5	3.3	0.4	2.8	290	326	356	367	332
July	1.1	0.2	1.2	0.2	1.2	397	408	462	533	438
August	0.3	2.4	1.5	2.5	1.7	468	235	474	532	446
September	0.5	8.2	3.5	2.4	2.8	350	429	478	367	371
October	12.7	3.0	11.8	5.1	7.5	179	177	354	350	225
November	13.0	13.0	9.3	17.0	12.2	103	64	120	77	85
December	18.5	4.6	12.5		12.1	26	8	97		36
Totals	99.2	68.9	82.9		79.1	2191	2055	2990		2374



# Avoiding Herbicide-Resistant Weeds in Cranberries



Herbicide resistant weeds have not been as high on the radar for cranberry growers as they have been for row crop producers in recent years, but resistant weeds still can pose a significant risk. While most cranberry production regions are isolated from grain crops — such as field corn and soybean where resistant weeds are all too common — the lack of crop rotation, a limited arsenal of control tools and weeds (including perennials) that produce abundant seed increase the risk of selecting for herbicide resistance in the cranberry system.

**Table 1.** Herbicide sites of action number<sup>1</sup> and name, active ingredients, example trade names, susceptibility and number of resistant weed species observed globally in crops other than cranberry as of 2015 (source: [weedsociety.com](http://weedsociety.com)).

*Herbicide labels change often and vary regionally — always read and follow the label prior to use.*

CHART KEY	
Site of action number	Site of action name
Active ingredient (example)	Susceptibility; # of resistant species
<b>Group 1</b>	ACCase inhibitors
sethoxydim (Poast)	High; 17
clethodim (Select, Select Max)	High; 15
<b>Group 2</b>	ALS inhibitors
chlorimuron (Curio <sup>2</sup> )	High; 16
<b>Group 4</b>	Synthetic auxins
clopyralid (Stinger <sup>3</sup> )	Low; 1
quinclorac (QuinStar 4L)	Moderate; 5
2,4-D	High; 16
<b>Group 9</b>	EPSP synthase inhibitors
glyphosate (Roundup)	High; 31
<b>Group 12</b>	Carotenoid biosynthesis inhibitors
norflurazon (Evital 5G)	Low; 0
<b>Group 15</b>	Long chain fatty acid inhibitors
napropamide (Devrinol)	Low; 0
<b>Group 20</b>	Cellulose inhibitors
dichlobenil (Casoron 4G)	Low; 0
<b>Group 27</b>	HPPD inhibitors
mesotrione (Callisto)	Moderate; 2

## Why are resistant weeds a concern in cranberry production?

- ☑ Cranberry production relies on just a few herbicide sites of action for the vast majority of weed control. An herbicide's site of action describes where it works in the plant, such as by blocking a particular enzyme. While agronomic row crop producers may be able to choose from a suite of herbicides with up to 18 different sites of action, commonly used cranberry herbicides represent only 8 different sites of action (Table 1).
- ☑ Herbicides are often applied individually in cranberries because of application timing restrictions (for example, dormant pre-bud break applications vs. in-season post-emergent applications), crop safety issues when tank-mixing (surfactant incompatibility between herbicides) and herbicide label restrictions. This increases the selection pressure during individual herbicide applications on a single-site herbicide to maintain its ability to prevent weed seed production.
- ☑ The allowable rate range is fairly broad for several of the cranberry herbicides. The use of a sub-lethal herbicide dose can increase the resistance selection pressure as these weeds often recover to produce viable seed.
- ☑ Annual crop producers can use crop rotation to not only diversify herbicide sites of action across years but also to expand non-herbicide weed control options, such as cultivation. Cranberry producers do not enjoy these cultural options.
- ☑ While perennial weeds often reproduce vegetatively (for example, through below-ground runners), many of them are also prolific seed producers (gold-enrods). Annual and biennial weeds in cranberries also produce abundant seeds. The selection for herbicide resistance and the spread of resistant weeds commonly occurs through seed production. Additionally, several weeds in cranberries have special adaptations that allow seed to travel long distances: the "pontoons" that float curly dock seed in water, the wind-blown seed of Canada thistle and prolific small dodder seeds that spread among beds when flooding.
- ☑ Weed resistance to several of the herbicide sites of action used in cranberry production has already been observed in other crops and production regions (Table 1). It can happen, even in a diversified crop rotation! In some cases, individual weeds are resistant to several sites of action, greatly limiting control options. Resistant weeds are a one-way trip — when they become resistant to an herbicide, they will not return to herbicide sensitivity.
- ☑ New herbicide options in specialty crops like cranberries are few and far between, so we need to maximize and extend the effectiveness of our current tools so that they remain useful.

<sup>1</sup> Weed Science Society of America (WSSA) herbicide mode of action group numbers. <sup>2</sup> Available through a special time-limited label in Oregon and Washington only. <sup>3</sup> Available through a special time-limited label in several states and with various trade names.

Several weeds in cranberries have special adaptations that allow seed to travel long distances.



Prolific small dodder seeds spread among beds when flooding.



Canada thistle seeds are easily blown by wind.



Curly dock seeds have 'pontoons' that float in water.

## How does resistance happen?

Herbicides themselves are not likely to cause resistance within a plant. The repeated exposure of plants to an herbicide site of action selects for individuals within the population that differ genetically so that they survive the herbicide application and reproduce. The selected survivor plants produce seed and the proportion of resistant plants increases among the overall population over time. Repeated exposure to the same site of action further selects for higher levels of resistance among the survivor population and the cycle continues. The result is a resistant plant population with the inherited ability to survive an herbicide application to which previous or other populations of the same species had been susceptible.

## Steps to avoid herbicide-resistant weeds in cranberries

**1. Monitor for weeds that escape control.** Keep records of new, problematic and expanding weed populations. The key to successful management is to identify new resistant populations early when they can still be eradicated, but oftentimes, they go unnoticed until the problem is out of control. Keep in mind that a resistant weed will not become susceptible again. Ask yourself a few key questions:

- Is the weed of concern normally controlled by the herbicide in question?*
- Are there any application factors — a sprayer skip or miscalculated herbicide rate — that could account for the lack of control?*
- Are there dead or symptomatic weeds of a different species nearby the weed of concern?*
- Have you had to increase the rate of the suspect herbicide over time in order to get control?*

**2. Rotate herbicide sites of action, not only within a growing season but also across years.** This requires careful record keeping and an awareness of the site of action numbers included in Table 1 and on most herbicide labels. Pay particular attention to the herbicide sites of action where resistance has been more commonly observed: the ACCase inhibitors (sethoxydim and clethodim), EPSP synthase inhibitors (glyphosate) and ALS inhibitors (chlormuron).

**3. Guard against contaminated crop inputs that can spread resistant weeds.** Consider all sources — seed planted along roadways and dikes; new cranberry vines when renovating, equipment brought on the farm; and sand/water sources. Unfortunately, people are historically one of the greatest weed dispersal mechanisms!

**4. Eliminate survivors.** Resistant weed populations spread through seed production, so efforts like hand-pulling and wick-wiping that prevent viable weed seed production can greatly reduce risk. These efforts may be time-consuming, but the alternative will be much more troublesome and long-term. For example, in some areas where weeds are resistant to multiple herbicide sites of action, growers have had to rely heavily on hand-pulling and removing problematic weeds from fields. Also, be sure to use herbicide rates within the labeled range and timing that will kill weeds and prevent seed production.

**5. Ask for help.** If you suspect herbicide resistance on your farm, contact your extension agent and other specialists to help verify resistance. Also notify neighboring growers so they can take preventative action.



**Authors:** Jed Colquhoun and Jack Perry, University of Wisconsin; Hilary Sandler, University of Massachusetts; Kim Patten, Washington State University

WSU Cooperative Extension provides educational opportunities in agriculture and natural resources, family living, youth and community development, in cooperation with the USDA. Extension helps you put knowledge to work.

Cooperative Extension programs and policies are consistent with federal and state laws and regulations on nondiscrimination regarding race, color, gender, national origin, religion, age, disability, and sexual orientation. Evidence of noncompliance may be reported through your local cooperative extension office. We welcome your suggestions to improve educational programs offered through this division of WSU.

WSU - Long Beach Research & Extension Unit  
2907 Pioneer Road  
Long Beach, WA 98631

COOPERATIVE EXTENSION



Washington State University

Long Beach Research and Extension Unit

Dr. Kim Patten, Extension Professor  
Email: [pattenk@wsu.edu](mailto:pattenk@wsu.edu)  
Phone and fax; 360-642-2031  
Mobile phone; 360-355-7864

NON-PROFIT ORG.  
U.S. POSTAGE PAID  
LONG BEACH, WA  
PERMIT NO. 24