Integrated Cranberry Crop Management for Wisconsin

Cranberry

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Contents:

WHAT'S IN CRANBERRY BED SOILS?

Part 1: Roots and mycorrhizal fungi, or: One plant's trash is another's treasure—nutrient recovery from the litter layer.

Cranberries and related plants typically grow on very nutrient-poor, acidic soils. Nitrogen is the mineral nutrient most often limiting in these soils; cranberries and their plant relatives have evolved unique adaptations to allow them to thrive in these harsh conditions. Cranberries are native to peat bogs, where decomposition is very slow; what nitrogen is available there is primarily in the form of organic nitrogen, often bound to tannins. (Here the term "organic" is used in its chemical sense to refer to carbon-containing compounds). Organic nitrogen is typically not available to plants- they can only take up nitrate, ammonium, and a few of the smaller amino acids. Fungi, on the other hand, are specialists at breaking down recalcitrant organic compounds and using the components to supply their needs for nutrients and for energy. You can think of them as the ecosystem's recycling crew.

Cranberries have evolved a way to take advantage of these fungal abilities. Cranberry roots play host to fungi that grow within the outer cell layer of the roots. The scientific term for these roots is "mycorrhizal" roots, from the Greek for fungus (mycos) and root (rhizo)- hence, fungus-root. Cranberries, blueberries, rhododendrons, and other relatives in the plant family Ericaceae form associations with ericoid mycorrhizal fungi, where "ericoid" refers to the family name. These mycorrhizal fungi provide nitrogen to the plant, and in return obtain sugars from the plant. Since this is of benefit to both organisms, the association is symbiotic, rather than parasitic.

The managed cranberry bed has many traits in common with the native sphagnum bog habitat. In particular, decomposition is fairly slow in cranberry beds. Cranberry leaves are tough customers- full of lignin, tannins, and other organic compounds that are slow to break down. When we look at soil cores from cranberry beds, we find leaves that are still intact after being buried for up to 12 years. Does this mean that the nitrogen in these leaves is totally inaccessible? Probably not when the cranberry roots are colonized by mycorrhizal fungi. In a survey of Wisconsin cranberry beds, we found an average of 42% mycorrhizal colonization (on a root length basis), with the lowest colonization about 10%, and the highest about 80%. Neither bed age, soil pH, or substrate type (sand or peat) affected colonization substantially.

High nitrogen levels decrease mycorrhizal colonization. Trials with Stevens growing in nutrient solution indicate that mycorrhizal colonization reaches a maximum at fairly low solution nitrogen concentrations. We are not sure how much the range of variation in soil nitrogen levels typically found in Wisconsin cranberry beds might affect mycorrhizal colonization.

What does this mean for you? The duff layer of dead leaves, roots, and runners that accumulates on the top of the bed between sandings is sometimes called the "trash layer". Maybe we should refer to it as the "recycling layer"! With mycorrhizal fungi on the job, that leaf litter trash heap becomes a source of nutrients for the crop. On beds built on deep sand, the buildup of organic matter also provides a source of cation exchange sites and increased water holding capacity.

Kevin Kosola, UW-Madison, Dept. of Horticulture

MORE ABOUT SPRAY pH

Every year there are questions about the use of spray buffers and acidifiers to protect the performance of pesticides or increase their activity. Different magazine articles and product advertising have states that spray water with high pH or high mineral content can reduce pesticide performance by causing rapid breakdown in the spray tank or limiting uptake into the plant. Some of these comments apply to certain herbicides and others to insecticides, but they do not apply to all pesticides. With this article, I specifically want to comment on how herbicide performance is affected by the quality of the spray water. Understanding these factors will help you determine the situations where use of these additives seems reasonable.

Background information on water quality

Water pH and high mineral concentrations in water are two water quality factors that can cause problems with some pesticides. The water pH is a measure of whether the water is acidic, neutral, or alkaline. Pure water is neutral and has a pH of 7. If extra hydrogen ions (H+) are in water, the water becomes acidic and has pH values less than 7. Extra hydroxyl ions (OH-) make the water alkaline and pH values are greater than 7. In Wisconsin, most of our well water is slightly alkaline and has pH values around 7.5. Many wells in the counties that extend in a line from Barron County to Juneau County have a pH in the range of 6.5 to 7.

Water pH can affect a pesticides chemical breakdown (hydrolysis) in spray solution. It has been documented that certain insecticides degrade or undergo hydrolysis faster in water with a high pH. (see previous article) Although certain insecticides degrade rapidly at high pH, rapid degradation of insecticides in the spray tank is not a general problem in Wisconsin according to John Wedberg, UW Extension Entomologist.

Several commercial products are marketed to adjust the pH of spray solution, in part to protect pesticides from rapid hydrolysis. They are generally referred to as buffers or acidifiers. These additives lower the pH of the water into the acidic range. The term buffer is more specific and refers to additives that lower the pH of the spray solution and keep it close to that pH even other products are added to the spray tank. Other materials have been used to acidify spray solutions such as vinegar or citric acid.

Minerals like calcium, magnesium, sodium, potassium and iron at high concentrations in spray water are antagonistic or interfere with the activity of certain herbicides. In western North Dakota (where sodium concentrations up to 1600 ppm have been measured), water with 300 ppm of sodium causes noticeable antagonism when 2,4-D and MCPA amines, Poast and Roundup are applied. Water with greater than 150 ppm calcium also causes noticeable antagonism with these same herbicides, except Poast. Fortunately, most Wisconsin ground water has low or moderate concentrations of these minerals and concentrations of sodium, potassium, and iron are generally minor. As an example, the average and highest mineral concentrations for sample wells are listed for 12 cranberry producing counties (Table 1). Potassium and iron concentrations averaged less than 3 ppm across the state and were not included in the table. Although these minerals are generally at concentrations below levels reported to cause antagonism, some wells have mineral concentrations that may antagonize herbicide activity. Also, the antagonistic effect of minerals on herbicides is additive so water with 150 ppm calcium and 100 ppm sodium will cause more antagonism than water with only 150 ppm calcium. Unfortunately, it is difficult to predict the exact concentration of mineral that will cause a noticeable reduction in control because of many factors (weather, stage of growth, etc.) that affect herbicide performance.

Water Quality and Herbicide Activity

The activity of granular herbicides, of course, is not affected by the pH of spray water. Because of the large buffering capacity of soils, these herbicides are active at the soil pH regardless of the water pH in the area.

The activity of some postemergence herbicides is definitely reduced with poor quality water. The herbicides affects are called weak acids such as 2,4-D amine, Banvel, Basagran and Roundup. These herbicides disassociate into an herbicide component and the "salt" in water.

Is lowering the pH of the spray mixture the solution to antagonism from high mineral concentrations? The results from studies on Poast suggest that it is beneficial (Table 2). When sodium or calcium were added to the spray solution with Poast, grass control was reduced at the higher pH levels. When the sodium or calcium source made the spray mixture acidic, no antagonism occurred.

Table 1. Mineral concentrations for ground water in 12 cranberry producing counties.

County	Calcium *(mg/l)*		Magnesium *(mg/l)*		Sodium *(mg/l)*	
	Mean	High	Mean	High	Mean	High
Jackson	12	15	4	6	4	6
Juneau	14	17	7	16	1.5	2.2
Monroe	36	48	18	28	4	6
Oneida	16	29	6	14	2	9
Portage	30	73	13	58	3	31
Price	27	37	9	16	5	8
Sawyer	32	49	9	16	5	8
Vilas	14	38	4	10	3	9
Washburn	32	42	9	11	11	20
Wood	17	68	6	19	12	26

Adapted from UWEX Geological and Natural History Survey. 1981. Ground water quality atlas of Wisconsin. Information Circular 39.

Table 2. Activity of Poast plus oil concentrate on oat with either 345 ppm sodium or 600 ppm calcium added to the spray solution.

Mineral	pH	Oat control
None	3.5	51 %
Sodium Bicarbonate	7.6	15 %
Sodium sulfate	4.6	51 %
Calcium Hydroxide	11.2	17 %
Calcium Chloride	4.2	52 %

A low pH is not the only treatment that will overcome mineral antagonism. Ammonium additives are also effective at overcoming mineral antagonism with many herbicides. Ammonium sources actually increased the activity of Poast regardless of pH (Table 3). At a high pH ammonium ions may form salts with Poast. The ammonium salts of Poast must be more active than salts formed with calcium or sodium at higher pH levels. The performance of several herbicides can also be increased with nitrogen additives even where antagonism is not a problem.

Table 3. Activity of Poast plus oil concentrate on oat with different ammonium sources.

Ammonium source	pH	Oat control
None	3.4	54 %
Ammonium nitrate	4.7	68%
Ammonium sulfate	5.3	67%
Ammonium orthophosphate dibasic	8.3	68%
Ammonium hydroxide	10.5	79%

Conclusions

1. Label recommendations for nitrogen additives should be followed for maximum effectiveness.
2. The quality of most Wisconsin groundwater should not reduce the activity of postemergent herbicides.
3. Spray water does not need to be acidified to protect **HERBICIDES** from rapid breakdown in the spray tank.
4. Low pH spray water will overcome the antagonism of high mineral concentrations, but ammonium ions also overcome mineral antagonism and enhance the performance of several herbicides.

This article was excerpted and adapted from "Effect of spray solution pH, mineral concentration, and ammonium additives on herbicide activity" by Chris Boerboom and originally appeared in Wisconsin crop manager June 1, 1995.