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Can We Use "Big Data" To Add Precision and Make Management Decisions in Cranberry?

By Jed Colquhoun and Paul Mitchell

Small-scale replicated field plot research is very useful to explore and identify potential new technologies and practices that can improve cranberry production. But there's also much to be learned from what growers are currently doing and tremendous power in the volumes of data already collected on marshes over the seasons. The goal of this article isn't to change how growers manage cranberries; it's to raise awareness of the potential to use a "big data" approach to optimize cranberry production and to get guidance on whether the questions that we ask here are important to the industry.

Many questions can be asked when diving into a robust data set. In this primer on the topic we report on a very preliminary look into data on 41 production variables from over 500 Wisconsin cranberry beds, and ask three questions:

1. What inherent bed characteristics and production decisions have the greatest impact on cranberry yield?
2. In general, what are the most common management decisions?
3. Is there a yield advantage to intense management and conversely a yield penalty to managing less intensely or using fewer inputs?

What inherent bed characteristics and production decisions have the greatest impact on cranberry yield?

To explore this question, we used some complex machine learning and regression analyses to determine which of the 41 variables contribute to or take away from cranberry yield. We've grouped these variables into three general categories: inherent characteristics related to the physical location or climate that are not easily managed (ie. water pH), variables that can be managed by the grower but are long-term investments that don't happen in a single season (ie. renovation/variety change), and variables that can be managed by the grower during a single season (ie. nitrogen application number and rate). A few variables certainly cross over categories, such as ice thickness that's determined by winter weather and grower flood-making decisions but are assigned to a category here for the simplicity of discussion.

Inherent characteristics not easily managed		Long-term management investments		In-season management decisions	
Influenced yield:	Did not influence yield:	Influenced yield:	Did not influence yield:	Influenced yield:	Did not influence yield:
Number of ice formation floods	Irrigation water pH	Cranberry variety	Tile drainage	Number of nitrogen fertilizer applications	Date beehives placed on marsh
Ice thickness	Ice off date		Planting year	Total nitrogen fertilizer rate	Monitoring dissolved oxygen
	Flood water pH			Trash flooding	Total irrigation amount
				Most recent sanding year	
				Average flood depth	
				Insecticide use	

The table to the left shows examples of the variables and their relative influence on cranberry yield from a data set of over 500 cranberry beds in a single season.

By far, the greatest influence on yield was the cranberry variety, where it's common knowledge that the newer introductions far outyield older varieties. As for variables that can be managed by the grower, insecticide use had a strong positive effect on yield, suggesting heavy insect pressure in this particular season. Increasing the number of fertilizer split applications was also related to increased yield, more so than season total nitrogen rate. Each split in nitrogen fertilizer application was related to a 6.8 barrel per acre increase in yield. Interestingly, sanding year was also highly related to cranberry yield, where each year out from the most recent sanding decreased yield by about 5 barrels per acre.

In general, what are the most common management decisions?

Growers are inherently curious about what they're neighbors are doing and often ask about the most common practices, like how much Callisto do most people apply per season, how much nitrogen do they apply or what frost set point temperature are they using? While all marshes differ in many ways, it's a useful exercise for growers to know how they're operating compared to the rest of the industry, and then, if they are managing differently, asking if it's for the better or not (that's the next question!). Here are a few examples of mean or average management, as well as the middle 50% of what the industry is doing. In this case, the data used is for bearing 'Stevens' beds only to reduce confounding factors given that variety is such a large yield driver.

Variable	Average	Middle 50% range
Total N rate (lb/A/season)	52	33 to 62
Number of N applications	4.5	3 to 6
Total P rate (lb/A/season)	43	28 to 48
Total K rate (lb/A/season)	120	84 to 180
Number of pesticide applications	3	2 to 5
Number of floods to make ice	4	2 to 8
Maximum ice depth	11.5	10 to 12
Years since last sanding	2.3	1 to 3

Is there a yield advantage to intense management and conversely a yield penalty to managing less intensely or using fewer inputs?

Advances in agricultural practices, variety genetics and technology have driven substantial increases in crop yield and quality. But does it pay to be leading the pack in making changes on the marsh, is the "sweet spot" to be in the middle of the pack and is there a penalty to being the last to alter production? When it comes to inputs like fertilizer and pesticides, is "more" always better or is the optimum not always the maximum? From the researchers' standpoint, the impact of our work is only

as good as the industry adoption of it, but what drives behavioral change? Here, we explored those questions and relationships with a few key variables that were identified in the first question analysis as influential to cranberry yield. Let's contrast nitrogen and potassium nutrient management as an example. We've long known that the maximum is not the optimum when it comes to nitrogen, and that's very nicely demonstrated in this data set where in figure 1 we see a very typical response curve and the yield penalty when excessive nitrogen pushes cranberry vines toward vegetative instead of reproductive growth. When it comes to the number of nitrogen applications during the season, there appears to be a yield penalty when too few passes over the bed are made, but not a benefit beyond the middle of the pack to be the most intense adopter of split applications (figure 2). In contrast, when the number of potassium applications are considered, there's quite a stark advantage to making more split applications (figure 3).

This is just a preliminary snapshot with much still to be developed and refined in the analyses to deal with confounding factors and endogeneity (where one variable changes in response to another, but not in a causal way). Again, the goal here is to stimulate discussion and gauge interest in whether complementing field research data with analyses of robust grower data is an area of industry interest. And keep in mind the work here is only from 41 variables and just over 500 cranberry beds. The variability in the work here can be greatly reduced, homing in on a finer point and more confident conclusions, with larger data sets over multiple growing seasons. If we assume an average bed size of 3 acres and 20,600 acres in Wisconsin, this data set could include over 6,800 beds per season.

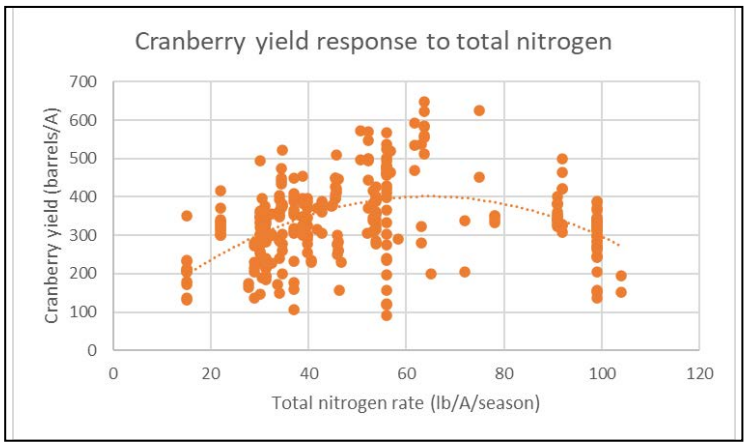


Figure 1. Cranberry yield response to total seasonal nitrogen rate. Data are from 317 bearing 'Stevens' beds.

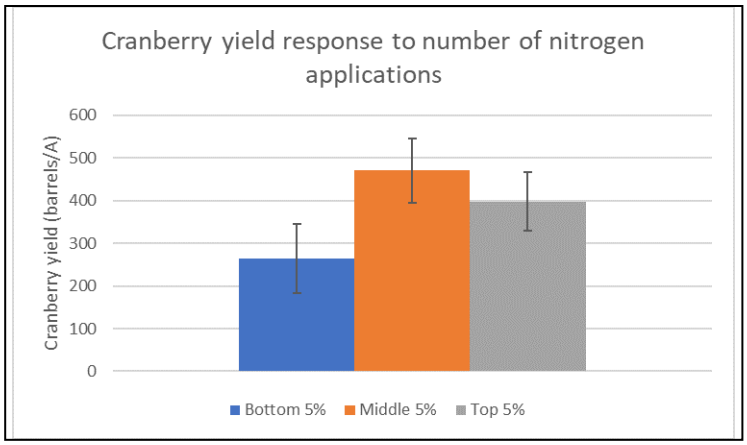


Figure 2. Cranberry yield response to number of nitrogen applications per season. Data are from bearing 'Stevens' beds and represent the bottom 5%, middle 5% and top 5% of split applications.

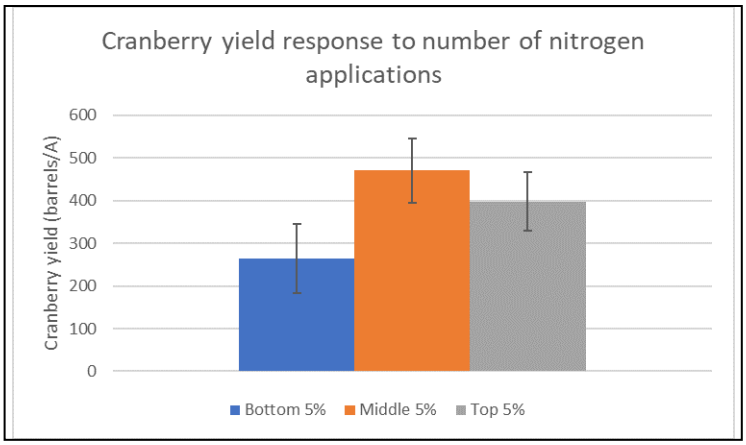
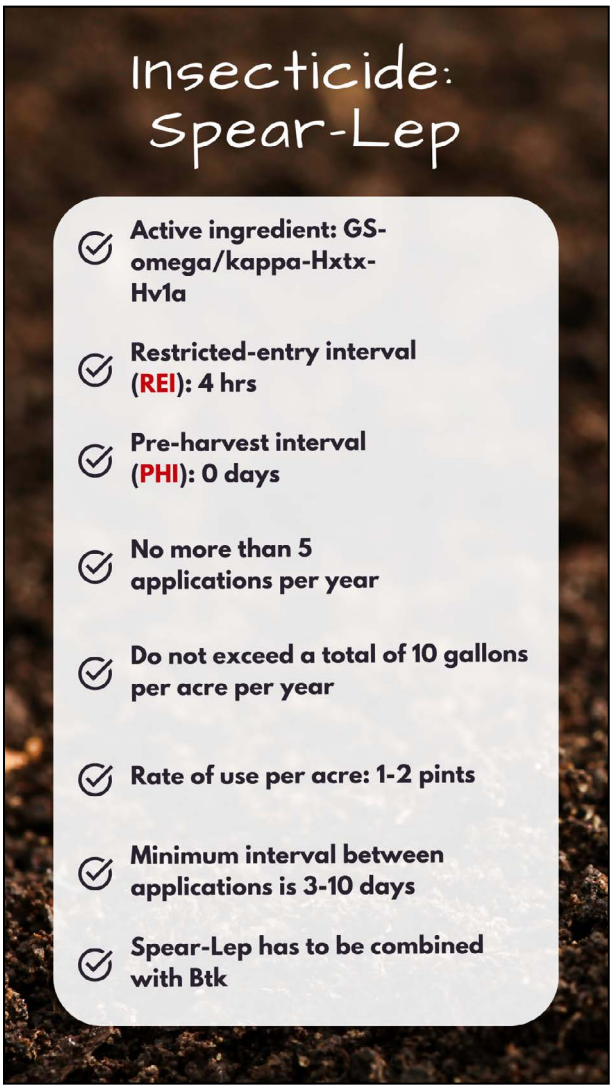


Figure 3. Cranberry yield response to number of potassium applications per season. Data are from bearing 'Stevens' beds and represent the bottom 5%, middle 5% and top 5% of split applications.

Biological Insecticide: Spear-Lep

By Christelle Guédot



Spear-Lep is a biological insecticide that is part of the first peptide-based insecticides that offer a new mode of action (IRAC 32). Spear-Lep is registered for use in Wisconsin on several fruit crops including small fruits and berries (Group 10) such as blackberry, blueberry, cranberry, currant, grape, raspberry, and strawberry; pome fruit (Group 11) such as apple, pear, and quince; and stone fruit (Group 12) such as apricot, cherry, nectarine, peach and plum. Spear Lep is marketed by Vestaron Corporation under a liquid formulation with 0.17 lbs of active ingredient per gallon.

Mode of action and effect

The active ingredient in Spear-Lep is the biological peptide GS-Omega/Kappa-Hxtx-HV1a and constitutes an entirely new class of insecticides of the IRAC group 32. The mode of action for this peptide is by modulating the nicotinic acetylcholine receptor site II (differing from Spinosyns that modulate site I of these receptors and are in IRAC group 5). The peptide works only in combination with a low dose of the bacteria *Bacillus thuringiensis kurstaki* (Btk) which is highly specific to Lepidopteran pests (moths and butterflies). As the insect feeds on treated surfaces, the Btk crystals rupture the gut cells allowing the peptide to access the nervous system where it helps bind the neurotransmitter acetylcholine to the acetylcholine receptors, causing persistent depolarization of the neuron, leading to the hyperexcitation of the neuron, and resulting in paralysis and death. Spear-Lep (+Btk) is an insecticide with foliar activity that is fast acting by ingestion of treated plant surfaces. Affected insects will rapidly stop feeding, become paralyzed, and eventually die.

Spear-Lep in combination with Btk targets primarily Lepidopteran moth insects as the Btk offers high specificity to Lepidopterans. Of interest to cranberry on the label are fruitworms, spanworms, loopers, and cutworms. Although black-headed fireworm is not specifically mentioned as a target pest on the label, in Wisconsin, you are allowed to use products on pests not present on the label, as long as the product is labeled for the crop you are applying it to. In our trials, Spear-Lep + Btk was very effective at controlling sparganothis fruitworm and cranberry fruitworm, as well as black-headed fireworm and spanworms, using 3-4 applications per season. For more information on our results, refer to this factsheet from Vestaron.

Application restrictions

Spear-Lep may be applied by ground equipment, chemigation, and air, and specific recommendations are provided for the different application methods regarding direction for use, spray volumes, and spray drift requirements. For more information on mixing and spraying, and all other considerations,

please see the product label. For optimal performance, it is recommended to use a non-ionic spreader/sticker surfactant at 0.125% v/v.

Environmental impacts

Spear-Lep is considered to have very low to no risk to bees, fish, and mammals. Do not apply Spear-Lep directly to water or to areas where surface water is present.

Considerations

Please check with your handlers before using a new product as handlers may have restrictions on certain products for domestic and/or foreign markets. Handlers may extend PHIs beyond the number of days stated on the label to reduce residues, so please always check with your handlers. And as always, make sure to read the labels before using any pesticide.

Resources

You can find the label for Spear-Lep at the following link:

https://www.cdms.net/ldat/ldERT000.pdf

Happy growing season!

2023 Cranberry Mini-Clinic Recap

By Allison Jonjak, Jed Colquhoun, and Jyostna Mura

On April 19th, we had 56 cranberry growers join us at the Wisconsin Cranberry Research Station for the annual Spring Mini-Clinic. Livestream locations, hosted by Whittelsey Cranberry Co. and Bartling's Manitowish Cranberry Co. had 17 and 24 attendees each, allowing lively discussion without long drives. Five topics were covered: a bud dissection practicum, looking back while looking forward: a Casoron review and current weed management research, current dissolved oxygen work, grower polls/discussion, and Wisconsin State Cranberry Growers' Association Updates. Bud dissection, Casoron, dissolved oxygen, and selected polls are recapped here.

Bud Dissection Practicum

Growers who were able to access their vines brought 2-4 buds from their earliest variety for dissection practice. Microscopes on site gave growers the opportunity to strip the upright of leaves, make a longitudinal slice, and examine the state of the bud. Work pioneered by Dr. Amaya Atucha have provided growers with guidance for plant part identification and an easy index for cold damage evaluation.

An upright stripped of its leaves, and a bud cut open longitudinally. Photo credit Camilo Villouta.

Physically inspecting a bud is more instructive than looking at pictures, so make time this week to practice. If you are inspecting for cold damage, bring the buds inside and wait 24-36 hours at room temperature before dissecting and checking for brown, necrotic tissue. If you do not have a microscope, a magnifying glass or loupe are nearly as useful. (Apple growers can do these inspections with eyes alone, but to see cranberry flower primordia, especially in dormant or not yet swollen buds, magnification is very helpful.

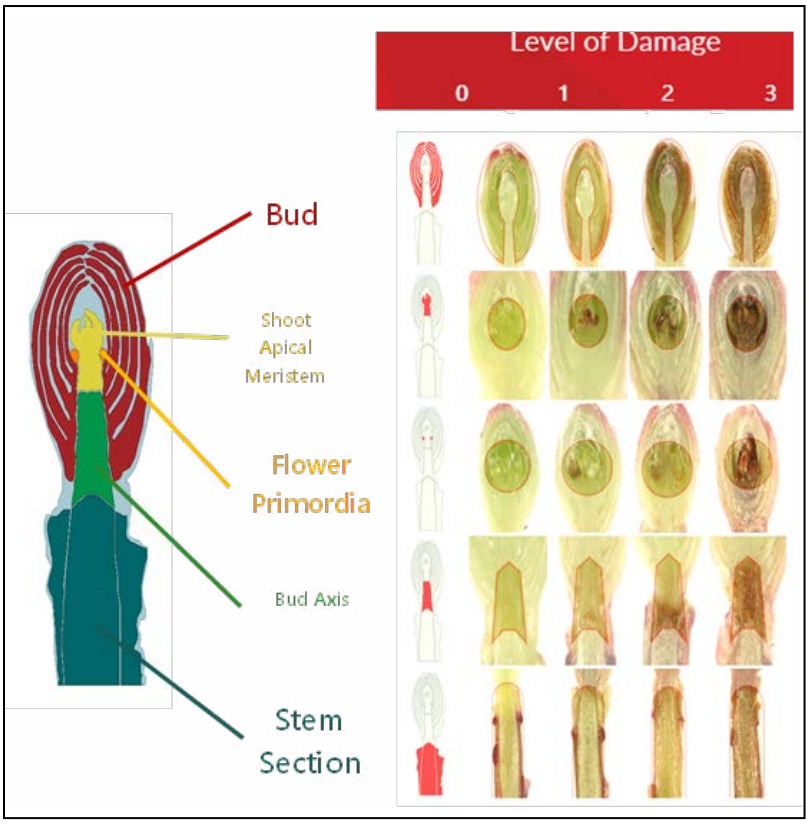


Figure 2

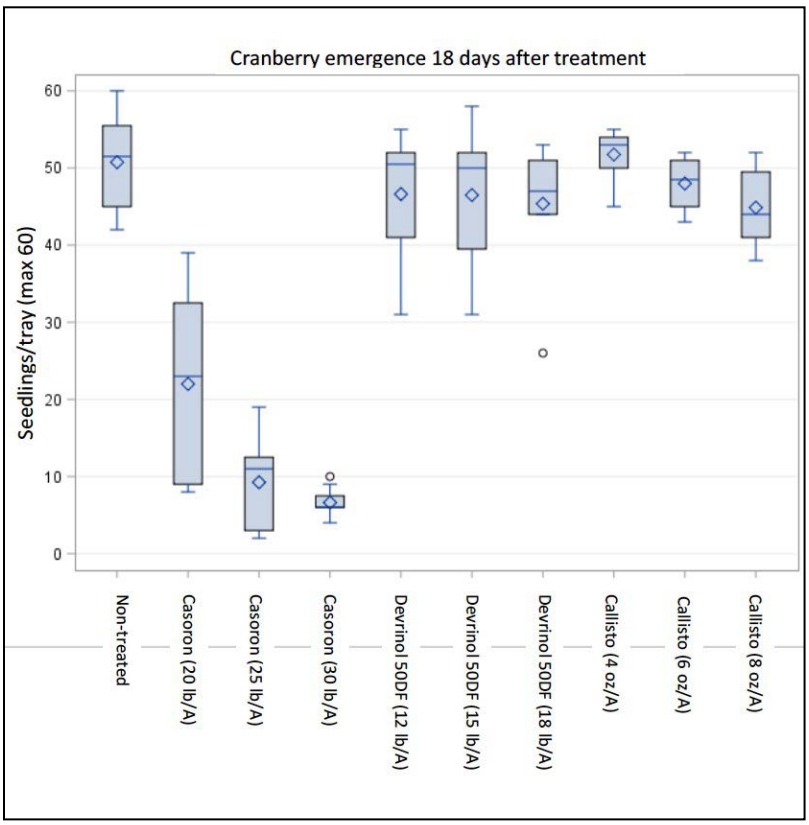


Figure 3

Looking back while looking forward: a Casoron review and current weed management research

Casoron has been the backbone of cranberry weed management programs for decades, so its mechanism of action and details around most effective use patterns deserve a thorough review. First discovered in the 1950's, Casoron has not had any reports of herbicide resistance. It exhibits pre-emerge activity only.

Casoron, an HRAC 29, inhibits root and shoot meristem division and growth, as well as inhibiting seed germination. It can be absorbed by roots and leaves—but while it can move from roots to leaves, it will not move from leaves to roots. Casoron doesn't display "symptoms" on treated weeds, as the treated weeds simply don't emerge, or simply stop growth. No coloration or growth patterns are visible.

Cranberry plants tolerate Casoron because applications are made when cranberries aren't actively growing. Plants are capable of processing Casoron into a less-toxic form, though at high rates this natural protection mechanism can be overwhelmed. Casoron applications are safest for cranberries when cranberries are still dormant and temperatures have not risen appreciably. Casoron's average half-life Is 60 days, which means an application provides between 2 and 6 months of weed control depending on soil characteristics. (Casoron will last longer in heavy soils.) Casoron has low mobility in the soil, but high volatility losses can happen in hot and wet conditions. To avoid volatile losses, apply granular Casoron, incorporate it via irrigation or rainfall, and make applications when temperatures are low.

To incorporate Casoron, ½ to ¾ inch of water should be applied after a Casoron application to incorporate the active ingredient into the weed zone. Watering-in prevents losses from volatility, and ensures the active ingredient will come into contact with weeds. Many growers apply Casoron on a day when they expect to frost protect at night, counting on water from frost protection to incorporate the application. This is a good practice—volatility will be low on a cool day preceding a frost protection night.

A grower perception is that beds should kept "wet, so that Casoron keeps working." Best practice is to keep beds at the proper moisture for cranberry growth, regardless of whether Casoron has been applied. Too little water would result in weeds not taking up Casoron, but too much water results in dilution, or driving the Casoron deeper than the germination and growth zone. Another risk of excess moisture is puddling—puddling can concentrate Casoron in areas which then results in vine injury.

Casoron is the only known herbicide which controls "volunteer" or "sport" cranberry plants. Colquhoun et al evaluated rates of Casoron, Danitol, and Callisto on cranberry emergence, and found the results in Figure 3. Casoron at 30 lb/a produced good control in this greenhouse study, which implies including Casoron at least every 2 to 3 years in your rotation will protect cranberry vine variety purity.

Dissolved Oxygen work in Wisconsin

When under flood, cranberry plants are subjected to a number of stressors, including reduced photosynthesis, no transpiration, no nutrient uptake, and the potential to shift from aerobic to anaerobic carbohydrate consumption. Various anatomical changes can take place as an adaptation mechanism—but some of these are not yet well understood in cranberry (for example, the results of ACC synthase and ethylene production). Negative impacts of flooding are influenced by the dissolved oxygen content in the flood water, the flood duration, the flood water temperature, and clarity. Plant age and cultivar may also play roles. Under anaerobic conditions, the plant consumes more carbohydrates per unit of energy produced, resulting in early depletion of carbohydrate stores. Low carbohydrates result in low fruit set later in the season.

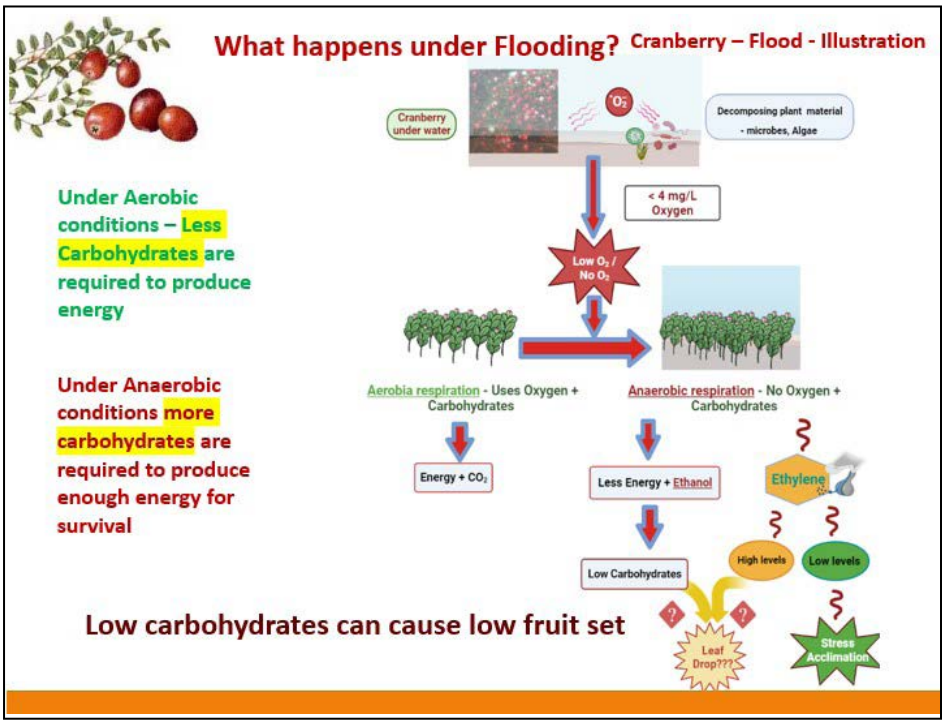


Figure 4. Energy consumption under aerobic and anaerobic conditions.

Dr. Mura's lab is currently researching dissolved oxygen outcomes of flood parameters, including, for both winter & spring floods: time of application, depth, duration, water and air temperature, ice layer thickness, and light penetration. Work is also being done to characterize carbohydrate levels available in the plant across growing periods. (Figure 5)

Work was done at the Wisconsin Cranberry Research Station to characterize dissolved oxygen during a winter flood. Dissolved oxygen reduced from 13mg/L (on day 1 of the flood) to 5.16mg/L on day 8 of the flood, on which the Marsh Manager elected to drain the flood. The critical dissolved oxygen level for cranberry plants before damaged is observed has been shown to be 4mg/L of dissolved oxygen.

Dissolved oxygen has also been measured in spring floods and found to be highly temperature dependent. It was noted that small puddles tend to read low in dissolved oxygen, corroborating poor vine health in areas prone to ponding.

Dr. Mura's current work focuses on the questions of:

1. What critical Dissolved Oxygen levels reduce carbohydrates in plants in winter and spring floods?
2. What levels of carbohydrates are critical for cranberry production?
3. Is excess ethylene production under anaerobic respiration protecting plants, or is it causing leaf drop?

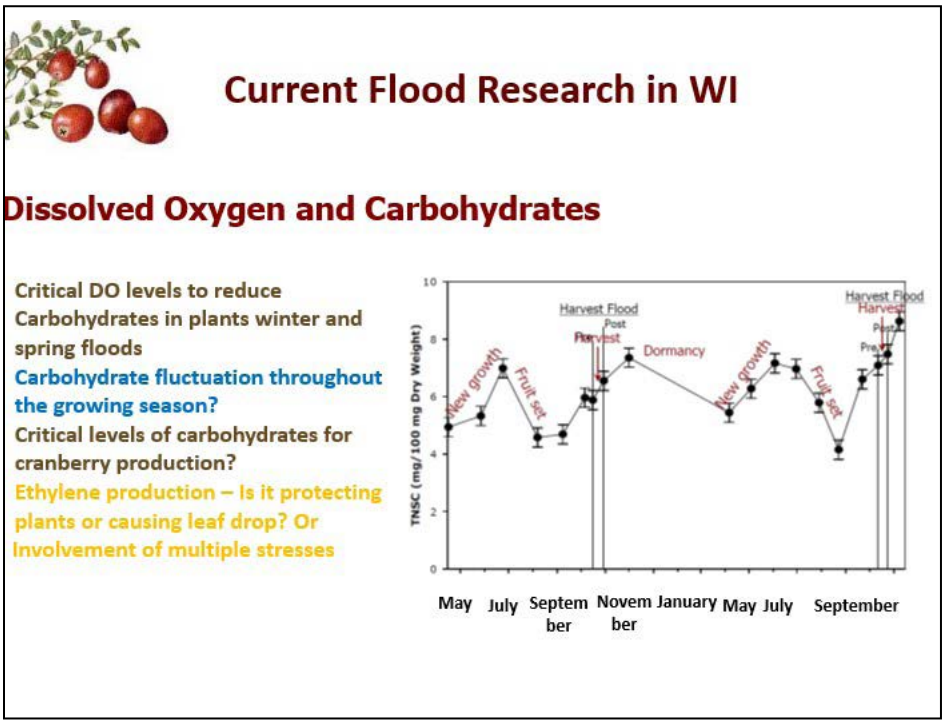


Figure 5. Total Non Structural Carbohydrates (TNSC) available throughout the cranberry plant's life cycle.

Selected Grower Poll Results

Diazanon 600, produced by Loveland, has been discontinued and to the best of our knowledge, prior inventory is sold. Diazanon 500 and Diazanon 50W still currently have inventory available, but Adama does not intend to produce more to resupply inventory. If growers have an expected need for Diazanon products, plans should be made to purchase sooner rather than later.

Growers faced with controlling red-headed flea beetle without Diazanon available plan to use (most popular) Venom, (second most popular) nematodes/ biological, and (all tied) not sure, Imidan, Sevin, Confirm, Altacor.

Department of Agriculture, Trade, and Consumer Protection has released a Special Pesticide Registration for Stinger in cranberry. If you are making a Stinger application, you need to have a physical printed copy of the Special Registration on hand as an extension of the label. That label can be found here: https://datcp.wi.gov/Documents/SPRStingerCranberryLabel.pdf

Growers' planned pre-bloom insect control, from most popular to least popular, were: Fanfare, Orthene, Delegate, a pest flood, Intrepid, with various combinations of Orthene, Fanfare, and Delegate comprising the least popular tier.

Thank you to those who made time to attend the Mini-Clinic in person, and please reach out if you have any questions or suggestions for next year!

Update from the Wisconsin Cranberry Research Station

By Wade Brockman

April started with temps in the low 90s and forest fires way too close, but Mother Nature made sure we knew spring wasn't here yet. 5 days after seeing record high temps, we received around 18"-20" of snow with 2" of rain a few days later. Now we are flooded, waiting for these nights in the teens to disappear and start frost protection on the hybrid varieties.

Grower Updates

Flying Dollar Cranberry

By Seth Rice

Hello everybody! Like every year it has been a whirlwind and mother nature has never disappointed us so far so why start now. Most growers had used that opportunity to put their irrigation pipe in or at least took a big chunk out the spring work. Some growers flooded because the thought is giving the vines the opportunity to soak up more heat than they want and have them come out of dormancy is not always the best thing you want. Especially if you have cold weather right around the corner. It's always tricky to decide what to do. You have to rely on some wisdom from other growers or just go with your gut feeling. I wish all of you a happy growing season and the best of luck this year!

Vilas 51

By Jeremiah Mabie

Hello everyone, hope you all had a wonderful winter!

I have been eagerly awaiting our first issue of the CCMJ as it is a sure sign of spring, and this spring we could use any and all signs! It's been another "Cabin Fever" spring up this way as well as across most of the state, as I write this its currently 36 and snowing. Seems that everyone up north faired the winter well with getting sanding and renovations projects done as needed. All growers are holding water with most of us still having a pretty solid layer of ice on beds that we did not sand.

Two weeks ago, when it was 80+ degrees the snow finally melted off the roads so we were able to carry some pipe out onto the ice. Bets are being placed on when Ice Out will happen on the lakes and we will officially be off to the races.

The forecast looks like we are on a gradual warming trend so hopefully in the next week or two we will get to see the vines finally and start putting irrigation in. Keep thinking warm thoughts everyone and I hope you all have a smooth and uneventful start to the growing season!