Some Notes from the
Atlantic Cranberry Course 2008
Charlottetown, PEI - CANADA

March 27th – 29th at the Delta Prince Edward Hotel

"Charlottetown in the morning" (3/28/08)

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The course was organized by the PEI Cranberry Growers Association in cooperation with the PEI Department of Agriculture. I have tried to summarize and share key presentations that are relevant to our own cranberry industry. I have a binder from the conference with small printouts of many of the slides from the conference, so if anyone would like to get a copy of the slide printouts from a particular talk or two, just let me know. ~Charlie Armstrong

PEI has 112 acres of cranberries, but 38 of those are either new plantings as of this season or are in rough shape from having been neglected over the past several years when market conditions were depressed. There is now an interest among growers, however, to bring the abandoned bogs back into production.

Nova Scotia now has 258 cranberry acres, and New Brunswick has 525. Quebec is up to 4,636 acres.

List of Summarized Talks:

- ✓ **Cranberries – an update on health effects** (Marva Sweeney-Nixon) (page 1)
- ✓ **Automation, Quality and Optical Measurement of Antioxidants in Cranberries** (Jean-Francois Sylvain) (page 2)
- ✓ **Fruitworm Management in Cranberry** (Dr. Kenna MacKenzie) (pages 2-4)
- ✓ **Tipworm Management in Cranberries** (Dr. Kim Patten) (pages 4-7)
- ✓ **Optimizing the use of Callisto for weed control in cranberries** (Dr. Kim Patten) (pp 8-10)
- ✓ **Cranberry varieties for the 21st century** (Dr. Nicholi Vorsa) (pages 11-13)
- ✓ **Organic Cranberry Production** (Stan Lowell) (pages 13-14)

Be sure to see the "Other tidbits of information" section at the very end as well!

Cranberries – an update on health effects – by Marva Sweeney-Nixon, Dept. of Biology, Univ. of PEI & Atlantic Canada Network on Bioactive Compounds:

- Cranberries can be described as a "Functional Food" because health claims can be made about them. The term "Functional Food" was coined in 1991 by Dr. Stephen DeFelice, and public attention is really directed towards these kinds of foods in our ever-increasing health-conscious culture.
- Health claims about food basically fall into three categories: 1) structure/function, such as calcium helping to build strong bones, 2) risk reduction/prevention, such as stating that calcium helps reduce the risk and progression of osteoporosis, and 3) therapeutic, such as iron being indicated for the treatment of anemia.
- The Atlantic Canada Network on Bioactive Compounds (ACNBC) and the Bioactive Research Interdisciplinary group that Marva is a part of, have been conducting research trials, as well as berry chemical analyses, to test the hypothesis that blueberry and cranberry consumption reduce the severity of various diseases, namely cancer and cardiovascular disease.
- Cranberry chemistry: Polyphenols are plentiful in cranberries, such as Flavonols monoglycosides, Anthocyanin monoglycosides, and Proanthocyanidins)
- Cranberry urinary tract defense: 1) well-established that cranberries help prevent *E.coli* bacteria from adhering to the urinary tract lining (due to proanthocyanidins); 2) 108 mg of cranberry hard capsules

(powder form of cranberry) given to research subjects in a double-blind, randomized, crossover trial, found that cranberry lowered the virulence, *i.e.* the ability to do harm, of the *E.coli* bacteria (Lavigne *et al.* 2008); 3) cranberry juice reduced the number of urinary tract infections over a 12-month period, especially for women with recurrent UTIs (Jepson & Craig 2008).

- Cranberry's anti-cancer properties:
  1. cranberries lower the initiation of cancers (Neto 2007)
  2. cranberries promote cancer cell death (*i.e.* apoptosis) (Neto 2007)
  3. cranberries reduce tumor growth in cancer of the breast, prostate, stomach, and intestine (Boivin *et al.* 2007)
  4. cranberries reduced various markers and processes in breast, colon, and prostate cancer (Neto 2007), and cranberry proanthocyanidins did the same with regards to esophageal cancer (Kresty *et al.* 2008).
- Prevention of Cardiovascular Disease: In a study done on mice by Marva Sweeney-Nixon's crew, cranberries lowered cholesterol in both 'normal' mice as well as mice that were afflicted with atherosclerosis; 'bad' cholesterol adheres to the lining of blood vessels, causing inflammation as white blood cells latch on to the cholesterol molecules and become embedded there, building up over time and restricting blood flow. Marva believes the mechanism for the lowering of cholesterol may have to do with the anti-inflammatory nature of cranberries, possibly by preventing the cholesterol from attaching to the walls of the blood vessels in the first place. She hopes future work will reveal the "mechanism" whereby the cholesterol levels are reduced. Hypertension: cranberries lower blood pressure. Stroke: cranberry has been found to not be effective at reducing the occurrence of stroke in animal studies thus far, *but* cranberry does appear to reduce the level of *damage* (number of dead brain cells) caused by a stroke when one occurs, thereby increasing survival time after a stroke.

Automation, Quality and Optical Measurement of Antioxidants in Cranberries – by Jean-Francois Sylvain of ATOKA Cranberries, Inc.:

- Since 2003, Mr. Sylvain and his research team at ATOKA have been working on the automation of the measurement of the antioxidant content of cranberries through the use of digital imaging techniques.
- The development of a simple and quick method of analysis through the use of digital still photography has been the object of research by the ATOKA staff. It has been shown that, rather than preparing and testing a cranberry purée, a mathematical algorithm would be able to transform an image of the fruit's anthocyanin level into a value of TAcy (Total Anthocyanin).
- The digital imaging process they are developing will provide ATOKA, and the cranberry industry, with a simple and easy method for the determination of the TAcy for a specific batch of fruit. Eventually, this new method will be able to be widely used by growers, agronomists and laboratory technicians across the industry.

Fruitworm Management in Cranberry – by Dr. Kenna MacKenzie, Atlantic Food and Horticulture Research Centre, Agriculture and Agri-Food Canada:

- Fruitworms are our most important pests in cranberry (according to Kenna), because they feed directly on the fruit, can cause a significant reduction in yield, are difficult to control, and will become increasingly important in eastern Canada as their cranberry industry matures and as acreage increases;
- Important to know if you have cranberry fruitworm and/or *Sparganothis* fruitworm, and to be able to distinguish between the two because they have different habits and timings, etc.
- Cranberry fruitworm
  - ✓ Most important cranberry insect pest
  - ✓ Found in most growing regions
  - ✓ Only one generation per year
  - ✓ Narrow host range (*Vaccinium* and *Gaylussacia*) [*Gaylussacia* = huckleberry]
  - ✓ Can cause 50%+ losses if not managed
  - ✓ Losses of 1-3% seem unavoidable

- Cranberry fruitworm – Wintering
  - ✓ Mature larva winters in hibernaculum (silken cocoon coated with sand grains and leaves)
  - ✓ Found just below the bog surface
  - ✓ Completes development late spring to early summer
- Adult Cranberry fruitworm
  - ✓ Adults emerge mid-June through late July
  - ✓ Nocturnal
  - ✓ Mating occurs
  - ✓ May move around in and out of beds
  - ✓ Females deposit eggs singly at the blossom end of developing berries (prefer larger berries, and lay about 50 eggs per female)
- Cranberry fruitworm Eggs
  - ✓ Eggs are small, oblong, and pale-green
  - ✓ Develop an oval orange-red line after 2 days
  - ✓ 3-9 days later, a small larva emerges
- Cranberry fruitworm Larvae
  - ✓ Newly emerged larvae crawl up fruit to stem end, chews into the berry leaving a small round hole, and makes a silken door on the entrance hole for protection
  - ✓ Larvae feed within the fruit, consuming all of its inside content, frass is left inside the berry; Once berry is hollowed out, the larva chews its way out and moves to a new berry (each larva consumes an average of 3 to 6 berries)
  - ✓ Up to 6 instars
  - ✓ Larvae are bright green when mature
  - ✓ Feeding causes berries to turn red prematurely
  - ✓ Later, berries dry up like raisins
  - ✓ Mature larva drops to ground and pupates
- Sparganothis ("Spag") fruitworm – *Sparganothis sulfureana* (Tortricidae)
  - ✓ Important cranberry insect pest (can be very destructive; occasional pest in Eastern Canada)
  - ✓ 2 generations per year
  - ✓ Induced pest (due to pesticides)
  - ✓ Related to fireworms (similar wriggling and webbing behavior)
  - ✓ Wide host range (*Vaccinium*, alfalfa, clover, willow, corn, etc.) and widely distributed
- Spag Eggs & Larvae
  - ✓ Eggs laid in masses of 20-50 eggs (on upper surface of leaves)
  - ✓ Color is variable, but generally yellow
  - ✓ Head capsule black in 1st instar to yellowish in later instars
  - ✓ Web leaves and/or fruit with silk
  - ✓ Wriggle when disturbed
  - ✓ Winter as 1st-instar larvae
- Spag Larval Feeding
  - ✓ Spring Generation: feed on foliage; 1st instars web leaves together; later instars web vine tips together; found on cranberry and various weeds (especially loosestrife)
  - ✓ Summer Generation: feed on leaves first, then move to fruit; silk berries together; may feed within fruit, usually irregular entrance holes, and fruit is entirely hollowed out (little to no frass inside)
- Spag Adults (moths)
  - ✓ Pupate within silken enclosure in leaves or within damaged fruit
  - ✓ Males and females are similar
  - ✓ Some color variation
- Timing Treatments for Fruitworms
  - ✓ Cranberry Fruitworm – based on: 1) past history, 2) crop stage (out-of-bloom counts) since onset of egg-laying is tied to plant phenology, 3) egg counts
  - ✓ Sparganothis Fruitworm – monitoring (sweeping for larvae in first generation; pheromone trapping of adults for second generation)
- Control Tactics for Fruitworms
  - ✓ Pheromones identified for both Spag and Cranberry fruitworm, but no thresholds developed;

- ✓ Cranberry Fruitworm pheromone traps: used in highbush blueberry but not in cranberry because no apparent relationship with egg laying, but they *can* be helpful for moth detection in new plantings;
- ✓ Sparganothis Fruitworm pheromone traps: used for monitoring summer adults; apply pesticides 2 weeks after peak of adult populations; no product currently registered in Canada;
- ✓ Chemical spray timing is critical for successful control;
- ✓ Target eggs and/or young larvae before they can get into a protective location (*i.e.* inside the berries);
- ✓ Spag Management: Target 1st-generation larvae at bud break, and check for larvae in webbed leaves/tips; pheromone traps for peak adult populations; Spag larvae are attacked by many natural enemies, so they are rarely a problem on unmanaged (wild) sites; Larvae tend to develop pesticide resistance; Remove weeds that Spag larvae prefer, such as loosestrife, goldenrod and aster;
- ✓ Flooding:
    - o Cranberry Fruitworm: Late Water is effective (30-day spring reflood applied several weeks after winter flood is removed and before plants lose dormancy); if used, still monitor for eggs because re-infestation is possible from outside locations;
    - o Spag Fruitworm: Late Water doesn't work except to synchronize the emergence of the spring (1st-generation) larvae; Larvae are very resistant to flooding of any kind;

Tipworm Management in Cranberries – by Dr. Kim Patten, Washington State University Extension

- Impacts of Tipworm
    - o How important a pest is this? Fairly wide distribution in cranberry growing areas: MA, NJ, ME, WI, MI, PQ, Pacific NW; also known to attack Lowbush, Highbush, Southern Highbush & Rabbiteye blueberries;
    - o Tipworm is a known pest of cranberries since the 1900s
    - o What does it do? Kills growing tips
    - o What are the impacts on yield? Severe, to none, to positive
    - o Why should we be very concerned? Many reasons!
- Level of damage is highly dependent on latitude, climate, time of damage, and cultivar
    - o Northern Wisconsin, Maine and parts of Canada may experience significant loss;
    - o In Central Wisconsin, Massachusetts and Oregon, an infestation from 1st-generation tipworm may be beneficial to production;
    - o Tipworm kills the apical bud;
        - If damage is early enough, the upright produces new shoots that season
        - If damaged mid-season, re-growth to vegetative bud, but no fruit in the following year
        - If damaged late in the season, no re-growth in season of damage
        - If re-growth occurs early enough, the new tip(s) can form reproductive buds for the next year's production;
- Tipworms equally attack fruiting vs. vegetative uprights prior to bud set; fruit-budded uprights are not attacked late-season;
- Majority of tipworm activity & attack occurs during bloom/fruit set, with peak visible injury 2-3 weeks following initial attack.
- Why should you be concerned?
    - o Short season suggests it will cause yield loss;
    - o It is already a major pest in low-bush blueberries [Note from Charlie: it has not been described in Maine low-bush blueberries as a "major" pest—quite the opposite—but last season there was a major tipworm infestation in some low-bush (non-crop year) blueberries downeast, near Blueberry Hill Farm, so the tipworm pest status in Maine's blueberries might now be changing.]

- Known resistance to organophosphate insecticides!
- No new proven control method;
- Very difficult to monitor (too small to see with naked eye) [Note from Charlie: I think what he meant here is that they are "too small to see *very easily* with the naked eye."]
- Overlapping generations (so timing of sprays are problematic);

- Monitoring for Adult Tipworm (Flies)
  - Routine sweep net sampling primarily (small and hard to ID from other midges)
  - Colored sticky cards/traps (doesn't always correspond to population flux, so not too effective)
  - Emergent traps (don't know if any of these work with cranberries)
  - Pheromone traps (Ag Canada and others working in this area but probably many years away from any breakthroughs)
- Monitoring for Tipworm Eggs/Larvae
  - Hand lens and/or microscopic dissections – at least weekly!
  - 30 to 50 tips collected randomly from both bed perimeter and interior section; record life stages and % infestation levels;
  - 10X hand lens in field for more mature larval stages (hard to see eggs or 1st-instar larvae);
  - Salt water extraction of larvae
    - 5% NaCl solution in a ziplock bag with samples – agitate slightly, wait 5 minutes, then snip bottom corner and let the larvae drain out with the salt solution (90% of the larvae/eggs will wash out from the tips); But not tried on cranberries yet.
- Damaged tips - Monitoring
  - End-of-year bud counts to determine injury levels/plant recovery (tag uprights)
  - Two ¼ to ½ ft^2 samples per section; count & record (make year to year comparisons)
  - Return bloom studies indicate differences in variety, growing area; also dependent upon growing season & plant vigor (Roper *et al* 1989)
- Biological Controls
  - Predatory Syrphid fly (Hover fly) named *Toxomerus marginata*, a very important natural enemy found frequently during bloom in Wisconsin;
  - At least 4 types of parasitic wasps found to attack tipworm larvae in WI; [Note from Charlie: wasps also found in Mississippi recently]
  - Reducing broad-spectrum insecticides will conserve predators and parasites resulting in better biological control;
- Cultural Controls
  - Vine Selection
    - Do not bring this insect into new areas, and avoid vines from sites with tipworm;
    - Pre-treatment
      - heavy spraying of nursery vines
      - treatment of affected vines (maybe by using hot water?)
  - Tipworm found to have variety preferences:
    - Howes (most preferred) > Ben Lear > Pilgrim > Macs > Searles > Stevens
    - Varietal rebudding characteristics (% return bloom is important);
  - Sanding
    - ¾ to 1" every 3-5 years if possible;
    - Effects are not long-lasting and re-infestation can be expected;
  - Flooding
    - Mixed results from British Columbia;
    - Not too realistic;

- Nitrogen Management
  - Do not over-fertilize!
  - Carefully monitor and treat beds which require high N input (nursery beds and first years of growth);
  - Tipworm prefer new plantings, lush overgrown vines (high N use) & mowed beds;

- Chemical Control Options
  - Old Chemistries
    - resistant population in Massachusetts to Guthion
    - resistant population in BC to Diazinon (no OPs in Canada after 2012)
    - populations could increase (at least short-term) in the absence of broad-spectrum insecticides
  - New Chemistries
    - No suitable chemistries yet to surface
    - Research in BC, WA, WI, NJ, MA ongoing

New insecticides with potential activity on midges

Active Ingredient	Contact	Systemic Trans-laminar	Systemic root uptake	Ingestion	Ovicide	Soil Activity
Acetamiprid		X		X	X	
Chlorantraniliprole		?		X	X	X
Clothianidin	X			X		X
Flonicamid		X				
Dinotefuran		X	X			?
Flubendiamide	X			X		
Imidacloprid	X	X		X		X
Lepimectin				?		?
Novaluron	X				X	
Pyriproxyfen	X				X	
Spinetoram		X		X		
Spiromesifen	X			X		
Spirotetramat		X				
Thiacloprid		X				
Thiamethoxam	X	X				

Efficacy summary of new insecticides on Tipworm

Active Ingredient	WA	BC	WI	NJ	MA	Blueberries
Acetamiprid			Good	No		
Chlorantraniliprole	so-so	No	Good		Mixed	
Clothianidin			Good		Good	Good
Flonicamid						
Dinotefuran				No	Good	
Flubendiamide	No				Poor	
Imidacloprid			Good			Good
indoxacarb			No	so-so		

Table continues on the next page

Tipworm Efficacy Table continued from previous page						
Active Ingredient	WA	BC	WI	NJ	MA	Blueberries
Lepimectin						
metaflumizone	so-so				Poor	
Novaluron						
Pyriproxyfen			No			
Pyridalyl			Good			
Spinetoram						
Spinosad		No	so-so			
Spiromesifen						
Spirotetramat	Good					
Thiacloprid						
Thiamethoxam		No	Fair			

- Research on these new chemistries does not suggest a silver bullet
  - Example: Chlorantraniliprole
    - WI broadcast application good control in 2006, but no yield in 2007
    - MA dipping method only minor control
    - WA broadcast application very minor control
    - BC broadcast application gave no control
  - Example: one neonicotinoid works and provided consistent efficacy in MA and WI, but may not get registered as it is likely to cause damage to pollinators.
- Organophosphates may be the current best available options for 2008
  - Efficacy varies by product and location
- Most all new chemistries performed poorly
- For the new chemistries that worked, we have inadequate and/or inconsistent data
  - too early for any recommendations
- Several chemistries with potential still need to be tested
- In almost all cases, newer reduced-risk insecticides don't work well with chemigation
- No economic thresholds developed; however, infestation levels approaching 40% or greater = "*Action* Threshold"
- Chemical timing is important: target younger stages (eggs, and 1st-instar larvae)
- Timing to control first and second generations important to prevent subsequent problems
- Timing to control early generations of adults might work if there were synchronous hatches and we could monitor for them.
- Suppression sprays at "key times" during the growing season.

- Cranberry Tipworm - Summary
  - Tipworm likely to be problematic in areas with short growing season
  - Monitoring for activity is essential
    - No easy way to monitor
    - New methods are being developed
    - It is too damn small
  - Well-timed insecticide sprays during "peak larval activity" may improve bud set.
    - No real good chemical control option available at this time
    - Lots of people working in this area
  - Work hard to employ all viable control options available to suppress populations

Optimizing the use of Callisto for weed control in cranberries – by Dr. Kim Patten, Washington State University Extension

- What is Callisto? (mesotrione)
    - Manufactured by Syngenta, and it is derived from a family of plants in the *Callistemon* (bottlebrush) genus that produce this chemical naturally [Note from Charlie: This genus is comprised of 34 species of shrubs in the family Myrtaceae, and most of its members are native to Australia.]
    - Mesotrione inhibits an important enzyme involved in photosynthesis; specifically, the synthesis of a yellow pigment that functions as a sunscreen to protect chlorophyll.
    - Susceptible plants are bleached, followed by necrosis in 3-5 days.
    - Some plants are tolerant of mesotrione and can readily metabolize it (*cranberry is one such plant and is highly tolerant of it*).
    - Absorbed by roots, stems and leaves, and is quickly translocated throughout the plant
    - 88% of the applied herbicide is absorbed within 3 hours (little 'dry time' needed)
        - Has pre and post-emergent activity on a wide range of species
        - Half-life in soil is 5 to 15 days
        - Little runoff or soil mobility (so no leaching)
        - No hazard to wildlife
        - "Caution" label to workers
        - Labeled on cranberries as a Section 18 in Washington and Oregon since 2005 [Note from Charlie: WA and OR argued successfully that they needed it primarily for silverleaf (a species of *Potentilla*) for which they had no other good control option].
- Crop Safety on Cranberries
    - At label rates there are usually no symptoms
    - Application above label rates may result in bleaching symptoms on the cranberry vines
        - During early growth, cranberries always grow out of it
        - During bloom, some growers have noted blossom damage and reduced fruit set (this effect is likely from the surfactant being used)
        - After fruit set, bleaching may last longer
            - cranberries may or may not grow out of it
            - no permanent effect noted and next season's growth is unaffected
        - No long-term effect has yet been noted (after 3 years so far in WA and OR)
        - No damage to new plantings has been noted (other than temporary bleaching)
        - Growers who have made "whoops" applications at 4x higher than the label rate on new plantings have noted bleaching, but have seen complete recovery in 1 month
        - Damage from Callisto to cranberries is typically surfactant-related, and Silicon hybrid appeared to be the worst in that regard
- Callisto: other observations
    - Permanent control of perennial weeds will take several years of treatment
    - Yellowing or whitening of vines will occur with mid or late-season applications, or if excessive product is used.
    - "Callisto is truly a 'Silver Bullet' herbicide for cranberries!" (stated on one of Kim's slides)
    - Weed spectrum controlled (Post-emergence weeds on the label): amaranth, atriplex, buffalobur, carpetweed, carrot, chickweed, cocklebur, crabgrass, horse nettle, jimsonweed, lambsquarters, mustard, nightshade, pigweed, ragweed, smartweed, some annual grass (when applied early), some perennial grass (when applied early), most annual broadleaves (when applied early), many herbaceous perennial broadleaves (when applied early) (silverleaf, aster, rushes, Lotus, St. John's Wort, sedges), and some woody perennials such as blackberries.
    - Annual grasses: Callisto gives poor control by itself, so better to tank mix it with a grass herbicide
    - Perennial grasses: Varies by species, but poor season-long control unless very early timing, so tank mix with grass herbicide

- Annual broadleaves: Most all species controlled, but requires early timing, against weeds that are less than 5 inches tall
- Perennial broadleaves: Several species controlled; timing is important; several seasons are required; less effective on well-established stands
- Lotus: Very sensitive to Callisto, but only effective if treated before the canopy completely covers vines
- Buttercup: If plants are already established, expect suppression only, so use against seedlings for best results
- Willows: Control is possible if timed at early emergence
- Vetch: Sensitive, but late-germination mandates mid-season timings (one or two applications)
- Morning glory: Early post-emergence for timing
- Violet species: Sensitive, but may take several seasons to remove/kill it
- Aster: Control in one season with two applications, and don't apply too early

- Pre-emergent Timing
  - Seedlings
    - Callisto has a short half-life in the soil, so wait until the seedlings are just starting to emerge
    - Callisto is a good choice for new plantings
    - Callisto provides short-term control (<1/2 to 1 month)
    - No surfactant required
  - Perennials
    - Some growers report great results even when used on susceptible perennials that are hidden below the crop canopy
    - Requires high spray volumes, or use during or before a rain event
- Post-emergent Timing
  - Annual broadleaves: maximum height of 5"
  - Perennial broadleaves (varies by species)
    - Against susceptible species (those with rapid desiccations with large root reserves capable of fast re-growth such as Cinquefoil):
      - If too early, then reduced effectiveness
      - Wait until the first flush of growth is done
      - Followed by 2nd application whenever weed canopy warrants treatment
    - Against moderately-susceptible species (those with moderate bleaching, no dessication, such as Yellow Loosestrife):
      - Early emergence while new growth is succulent (2-5" tall)
      - Repeat application in 2 to 3 weeks
- Rate
  - The maximum application rate for Callisto is 8 oz/acre/application
  - No more than two applications per season
  - Split applications need to be at least 14 days apart
- Spray volume rule of thumb for general efficacy
  - For a given herbicide rate, efficacy is improved at lower spray volumes, such that 10 gpa is better than 100 gpa (more concentrated amount of herbicide in contact with the leaves)
  - Most growers report 10 to 20 gpa works best
  - Research results vary by weed species
    - For most susceptible species, spray volume doesn't make much difference
    - For moderately susceptible species, efficacy is improved with low gpa
    - For species hidden under the crop canopy at application time, efficacy is improved with a *high* volume application of >200 gpa

- Calibration – How many ounces of Callisto do I put in a backpack sprayer?
    - It depends on your application volume (some people spray to wet at about 100 gpa, while others spray 400 gpa)
        - For backpack spraying to wet (about 100 gpa), use 1.5 teaspoons (~7 ml) of Callisto + 1 oz. (28 ml) of surfactant in 3 gallons
        - Note that 100 gallons per acre is just enough product to barely cover the leaf surface
- Surfactant recommendations for general use for Callisto
    - Low volume broadcast (less than 20 gpa) – 1 qt/ac. crop oil concentrate (COC) or 0.25% Non-ionic surfactant (NIS)
    - Higher volume sprays (spray to wet) – 0.5% COC or 0.25 to 0.5% NIS
    - Use very low rate of COC or NIS when conditions for phytotoxicity to crop oil are ideal (high temperatures and lush tender growth)
        - Some growers have reported good results without using any surfactant at all under such conditions (*i.e.* high temps and lush tender growth)
    - Not all COC are created equal with respect to problems with phytotoxicity.
    - When in doubt use 0.25% NIS
    - Consider specific surfactants for troublesome weeds
- Grass herbicides + Callisto? This is a useful mixture, *but*!!
    - Callisto label states "Do not tank mix with emulsifiable concentrate grass herbicides."
    - The xylene in the grass-selective formulation probably acts as a spraying oil and increases the uptake of the herbicides.
    - Univ. of Washington's research and grower experiences there have not indicated any problems when these two are combined.
    - Caution should be used, however, especially when conditions are right for damage by any surfactant being used.
- Replacing Casoron with Callisto?
    - Prolonged annual use of Casoron leads to gradual but steady decline of vine health, and production. Is Callisto an answer to this problem?
    - Photo slides were then shown, depicting side-by-side plots that had been applied for 3 years with either Casoron, or with Callisto, and in both cases, the cranberry vines in the Callisto plots were filled-in more (denser coverage), and just generally healthier in appearance (greener and more robust)
- Grower Experiences in Washington, Oregon and British Columbia
    - *"Several problematic species have ceased being a problem (asters and goldenrod)"*
    - *"Stopping the use of Casoron has allowed damaged beds to recover and increased yield by 20 to 50%"*
    - Some growers have gone to using Casoron every third year
    - Some growers are using weed mapping to spot-treat with Casoron
    - Some beds have seen a weed shift to more Callisto-tolerant species.
    - Many growers are reporting that a wide array of species are controlled even when those species are much taller than the ideal size is supposed to be.
    - Some growers report damage to bloom and yield decline, but 95% do *not*!
    - No grower has reported any permanent or serious damage.
    - Wide array of application methods is being used, and most very successfully.
    - In general, low-volume broadcast has been the most successful application method.
    - Cranberries may turn whitish, but always grow out of (recover from) those symptoms.

Cranberry varieties for the 21st century – by Dr. Nicholi Vorsa, PE Marucci Center for Blueberry & Cranberry Research & Extension at Rutgers University

- He began by citing the origin of the traditional cranberry varieties that are grown today, and showed that there is an expected decline in future planting of all of those varieties except for possibly Stevens and Pilgrim. He mentioned that a weak spot for Pilgrim may be that it seems prone to fruit rot, or at least in New Jersey they have seen problems with rot in Pilgrim plantings.
- Recent New Variety Releases
    - Univ. Wisconsin
        - HyRed in 2003 (US patent, Canada PBR application)
    - Private (Grygleski) (during the 1990s)
        - Grygleski #1
        - Grygleski #2
        - Grygleski #3
        - Grygleski BG
    - Rutgers University
        - NJS98-23 (Crimson Queen in 2006) (US patent, Canada PBR application)
        - NJS98-35 (Demoranville in 2007) (US patent appl., Canada PBR appl.)
        - CNJ97-105-4 (Mulica Queen in 2007) (US patent appl., Canada PBR appl.)
    - Traits of Interest in new variety development
        - Yield
        - Color content (TAcy – total anthocyanin)
        - Early ripening
        - Establishment vigor ('vine-ing in')
        - Fruit rot resistance
        - Additional but lower priority traits: Fresh fruit (storage life), Brix (soluble solids), TA (titratable toxicity), and Fruit shape (ease of cleaning)
- Some Varietal Issues in Cranberry
    - Identification of varieties is problematic / difficult
        - Few qualitative morphological traits to discriminate varieties
        - Vegetative morphology of cranberry varieties is similar
        - Thus, mostly fruit characteristics used, but it is important to keep in mind that fruit *shape* within a variety can be variable
        - The cranberry's natural propensity to produce stolons (runners) that root along their entire length makes it very hard to recognize one plant from another within a given bed
    - Bed purity (contaminating varieties)
        - Contaminants will struggle to compete and so will grow mostly vegetatively (propensity for asexual propagation) and therefore can quickly spread
        - Beds with varietal mixtures can have varieties which compete with one another vegetatively
        - Non-productive (poor-fruiting) genotypes with a propensity for runnering can out-muscle a productive variety
            - 'Non-flowering' Early Blacks in NJ beds
            - 'bad Mcfarlin' in WA – low flower production, sterility
        - Nature of cranberries: Fruit set is a stress on the plant! There is a competition for resources between fruit production and runnering (if runnering is high, fruit production will be low, and vice versa)
        - DNA Fingerprinting aids in varietal identification and bed evaluation
        - Sources of Contamination?

- Vegetatively aggressive contaminants may be mixed in with one's initial propagation materials
- Self-seeding (offspring won't be genetically identical to what you start with, so prevent self-seeding in young plantings)
- Fairy ring disease (in Ben Lear), or other such dieoffs, followed by colonization from more vegetatively aggressive genotypes

- Performance of new varieties
  - Grygleski #1 (planted in 1996 in one Massachusetts bed)
    - nice round berry
    - still learning how to manage this variety (yields have varied from year to year in one test bed in MA) – Slide with a graph was shown, with yield data → ~265 bbls/ac. in 2000, ~210 bbls/ac. in 2001, ~340 bbls/ac. in 2002, ~190 bbls/ac. in 2003 and 2004, ~250 bbls/ac. in 2005 and 2006, and ~185 bbls/ac. in 2007
    - Another slide showed much better yield results (doesn't say where this location was, or if it's an average of more than one location perhaps?): ~110 bbs/ac. in 2004, all the way up to ~380 bbls/ac. in 2005, ~410 bbls/ac. in 2006 and 2007
    - TAcy performance has varied some over the years as well, but about 10 pts higher than Stevens in general
  - HyRed
    - Early ripening
    - High TAcy
    - Yield comparable to Stevens yields
  - Crimson Queen – NJS98-23
    - Is a cross between Stevens and Ben Lear that was made in 1988 *(Stevens came from a cross between McFarlin and Potters)*
    - Outperforming Stevens and Ben Lear both in yield and in berry weight
    - Regional Trial Yield Results *(Estimated Maximum Yields)*:
      - Massachusetts site (planted in 2000): In 2005, Crimson Queen plots had a maximum yield of ~450 bbls/ac. compared to a maximum of ~290 bbls/ac. for Stevens plots, and in 2006, Crimson Queen had a maximum of ~400 bbls/ac. compared to ~230 bbls/ac. for the Stevens. Fertilizer used was 73.2N-64P-64K
      - Wisconsin site (planted in 2001 and harvested for fresh fruit): differences were milder here, and reversed in '06; In 2005, Crimson Queen plots saw a maximum of ~290 bbls/ac. compared to ~250 bbls/ac. for Stevens plots, and in 2006, Stevens won with ~295 bbls/ac. maximum compared to ~230 bbls/ac. maximum for Crimson Queen. Fertilizer was only about 25N, though.
      - British Columbia site (planted in 2000): In 2004, Crimson Queen yielded slightly over 500 bbls/ac. maximum compared to ~385 bbls/ac. maximum for Stevens, and in 2005, Crimson Queen yielded ~370 bbls/ac. maximum compared to ~320 bbls/ac. maximum for the Stevens plots. Fertilizer used in 2004 was 30N-36P-80K and in 2005 it was 42N-42P-75K
  - NJS98-35 Demoranville
    - Is a cross between Franklin and Ben Lear (*Franklin is a cross between Early Black and Howes*)
    - He showed some graph slides, indicating that Demoranville outperformed (and at worst equaled) Stevens in their Chatsworth, NJ site in all three traits of Yield, Berry Weight, and especially Color (TAcy readings). In City Point, WI, the results followed the same general pattern, with yields reaching into the 400-410 bbls/ac. mark for Demoranville each year from 2003-2005 (the Stevens came close to that range in 2004 and 2006, but was only about half of that—down in the 200 bbls/ac. range—for 2003 and 2005)

- Mullica Queen – CNJ97-105-4
  - Is a cross between No. 35 and Lemunyon [No. 35 comes from a cross between Howes (from MA) and Searles (from WI)]
  - A graph was shown with Mullica Queen out-performing Stevens impressively and consistently between 2001 and 2005 for both yield and TAcy (though TAcy levels were about the same in 2003). For Berry Weight, Stevens was a little better than Mullica Queen in 2001 and 2002, about the same as Mullica Queen in 2003, and then dropped well below Mullica Queen in 2004 and 2005.

Organic Cranberry Production – by Stan Lowell:

[This is Stan's page that was in the binder]

I am Stan Lowell, and together with my wife Marie, we grow 10 acres of certified organic cranberries in Kent County, New Brunswick. When we took over these bogs in 2001, they had trees 6 feet high in places and fruitworm, brown spanworm and cranberry girdler were major problems. Today, the insects are a minor problem.

Why do we grow organic?

First, when the price paid for cranberries dropped below the cost of production, we looked at it as an opportunity to transition to organic. Second, to experiment in "pushing the limits" of late water while reducing our input costs. Third, to remove fruit from the marketplace to drive prices up. Fourth, and most important "because we believe in the organic method," having tried many of the practices over the last 35 years.

What methods do we use?

Before we had our own bogs, I worked for Aili and Leonard Heikkila, a Finnish family, from Carver, Massachusetts, who were masters of a practice called "holding late water." Late water is the practice of leaving the winter flood on or reflooding the bog before the cranberry vines break dormancy and holding the flood until late in May. Late water is the most important practice we use.

What are the advantages of Late Water?

1. It controls most insects, fruitworm by almost 100% most years.
2. It suppresses some weeds and kills some woody weeds.
3. It improves fruit quality.
4. It provides frost protection in the spring.
5. It gives a fertility response to the vines.

What are the disadvantages of Late Water?

1. Green scum may form. This may be prevented by placing burlap bags of barley straw in the ditches. Also, try to pull the flood just before a hot sunny say and most of the scum will quickly dry up.
2. Vine and buds may be damaged if you have dark water or high water temperature.
3. Sudden emergence of insects can occur, especially cutworms. Control options are limited: Dipel, Spinosad, or short reflows.
4. The buds have no tolerance for frost. Set your sprinkler system up immediately for frost protection and take no chances.

How do we control the weeds?

1. Right after flood is pulled, while the bog soil is good & moist, pull as many woody weeds as possible.
2. When bog dries out more, inject vinegar into root zone of weeds.
3. Hand-weed Tussocks, because even if you kill them [chemically], you still have to pull them out.
4. Remove all seed tops by cutting or pulling off. Most pull easily when green, but must be cut when dried out.
5. Keep banks mowed and trees and brush cut as far back from the bog as is possible.

Picking

Late water on our Stevens variety bog seems to ripen the same time as conventionally grown bogs. Let bog temperatures go as low as possible (keeping above the tolerance) to color fruit and to get any fruitworm to leave the berries. Be sure to check temperatures at different locations as the cold spots can change from spring to fall.

Some other tidbits of information that came from the course:

- Consider alternative materials to Bravo for fruit rot control! (Indar and/or Abound, for example – results are very good when these two are used together) *Why not Bravo?* Answer:
  - Work done by Peter Oudemans out of Rutgers has found an apparent moderate level of phytotoxicity by Bravo to cranberries (lowering yields when Bravo was used).
- Vinegar for Weeds: Kim Patten reported on some trials looking at the use of vinegar as an herbicide (at 1, 2, 3 & 4% concentrations of acetic acid, and spraying just to wet)
  - Found that a 3% to 4% acetic acid solution is best (lower than that gives poor control, and higher than that results in cranberry damage)
  - 200 gpa better than lower volumes
  - A lot of weed species will grow right back, so it works best on young annuals (and appears to be useful for controlling moss)
- pH of Spray Water Used with Callisto may alter its Efficacy: Kim Patten reported that Callisto appears to be less soluble in water at lower pH values (solubility of 2,200 at pH of 5, but much higher—15,000 solubility—at pH of 7)
  - This finding suggests that efficacy of weak acid herbicides (such as Callisto) could be enhanced by adjusting pH of your water to 7 or greater. However, there is no data to support this yet.
  - So, growers with problems achieving efficacy with Callisto should test their spray water pH and adjust it if needed, using an appropriate pH buffered Surfactant

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