Wisconsin Cranberry School proceedings. Volume 11 2000

Madison, Wisconsin: Wisconsin State Cranberry Growers Association, 2000

https://digital.library.wisc.edu/1711.dl/4CDTJQ2IN3R3Z8Z

FALL TO WINTER CRANBERRY PLANT HARDINESS

Beth Ann A. Workmaster and Jiwan P. Palta
Department of Horticulture,
University of Wisconsin-Madison

Protection of cranberry plants from frost and freezing temperatures is a concern throughout the year. With fall and the transition to winter, protection is necessary for two reasons. Fruit are increasingly vulnerable to frost damage in the period leading up to harvest. After harvest, the only means of protecting the vines is by reflooding, a process that involves the commitment of both labor and water. Learning more about the hardiness of different plant parts at this time of year will help growers to make better decisions on how and when to protect for frost and freezing temperatures. We have investigated several aspects of fall to winter hardiness, including: studying how the plant gets damaged by ice; the lowest survival temperatures for different plant parts; how the hardiness varies with environmental condtions; and the effect of duration of freezing temperatures. All of our recent experiments utilized 'Stevens' plant material collected in central Wisconsin, unless otherwise noted.

How Cranberry Fruit Freeze

The mechanism by which fruit are injured and the degree to which they are able to survive was studied by two methods: infrared thermography and controlled freezing tests. The use of infrared thermography operates on the principles that all objects give off heat (long wave or infrared radiation), and that the freezing of water releases heat (an exothermic reaction). Changes in the temperatures of objects are detected and visualized on a monitoring system. This way the location and spread of ice formation can be observed. Controlled freezing tests are a way to precisely define a plant tissue's hardiness level. In addition, observations about the patterns of damage can be made.

Symptoms of injury in a freeze-damaged cranberry fruit include: a watersoaked appearance (including the bleeding of color from the skin into the fruit's flesh); browning; and the collapse of the tissue. A consistent pattern of damage has been observed in fruit. **Watersoaking and browning are first seen at the the flower end of the fruit.** The injury starts right at the end of the fruit, and then advances like a wave or a front up the fruit until the entire fruit is watersoaked and the integrity of the flesh has collapsed. The same pattern was seen in infrared thermography experiments; the first signs of freezing in fruit consistently occurred at the flower end of the fruit. In general, the amount of watersoaking and damage corresponded to the amount of freezing that had been witnessed on the infrared monitor. However, in several instances where the fruit had just begun to freeze, those fruit showed no signs of freezing damage after thawing. The fact that these fruit appear to recover suggests that **fruit are able to at least tolerate the presence of small amounts of ice in their tissues.**

Stomata have been documented on a portion of the flower end of the fruit, called the nectary (a gland-like structure from which nectar is secreted) (Figure 2). Stomata are pores most found on leaves. Water vapor is lost and gases are exchanged through these pores. **Stomata are thought to be the primary point of entry for ice into both cranberry leaves and fruit** (Workmaster et al., 1999). However, it takes time for the ice to access the flower end of the fruit, since these pores are small.

At the other end of the fruit, it does not appear that ice is able to reach mature fruit by spreading down the pedicel (fruit stalk) from the stem. In infrared thermography pictures, **ice was never observed to spread along the pedicel from the stem to the fruit, after the rest of the upright had frozen.**

Since access is restricted at both ends of the fruit, it is most likely that **fruit survive freezing temperatures by the mechanism of supercooling.** Supercooling occurs when water is able to remain liquid at temperatures significantly below the normal freezing point of water (32F). Other factors also contribute to the ability of the fruit to supercool. The development of a thick cuticle creates a barrier to ice penetration on the fruit surface (Abdallah, 1989). Also, as fruit ripen and increase in sugars and other substances, the freezing point of the water in the tissue decreases. However, at least one study (Abdallah, 1989) has shown that the amount of solutes in the cells of mature, ripened fruit is not great enough to lower the freezing point to the temperatures at which these fruit can survive.

Hardiness Levels of Cranberry Fruit

Our program has evaluated the hardiness of cranberry fruit at different stages of ripeness. Controlled freezing tests have been performed using both fruit attached to the upright, as well as dettached fruit. The lowest survival temperature (LST) (temperature at which no damage is observed) has been determined for stages of fruit development and ripeness from just after fruit set to when fruit are greater than 75% red (Table 1). These hardiness levels are not as low as those listed for comparable fruit categories in the "Frost Protection Guide for Massachusetts Cranberry Production" (DeMoranville, 1998). This may be due to differences in evaluation method and/or growing conditions.

Full size green fruit have an LST of 26.6F (-3C), as do the later stages of riping. However, **at a given temperature, a much higher percentage of green and less red fruit are injured than are the most ripe fruits** (Figures 3). For example, in one set of experiments, at 21.2F (-6C) 25-50% red fruit had around 80 to 90% damage while fruit >75% red had only about 20 to 25% damage. There was no clear pattern in the differences in injury to attached and detached fruit (Figures 3), making it difficult to discern if attached fruit are injured by ice penetrating the fruit from the pedicel.

The duration of freezing temperatures to which fruit might be exposed is an important concern. A series of experiments investigating the effects of freezing temperature and time on the survival of 25-50% red and >75% red fruit showed that the **more ripe fruit were able to survive freezing temperatures for longer durations than were the less ripe fruit** (Figures 4). At 26.6F (-3C), slight damage (less than 5%) occurred in less ripe fruit after one hour, while the more ripe fruit did not show comparable damage. Similarly, less ripe fruit had damage levels of around 60% after two and three hours at 23F (-5C), although the more ripe fruit showed damage levels of only around 20%. The vast majority of fruit can survive slightly freezing temperatures for at least several hours.

Buds

Up to harvest fruit dictate the degree and timing of frost protection. Other plant parts, notably buds and leaves, are of concern after harvest. Cranberry plants, like other woody species, begin the preparation for winter conditions well before harvest, in late summer and early fall. Both the acclimation to cooler temperatures and the onset of dormancy contribute to lower plant hardiness levels in fall. These phenomena are in response to shorter days and colder temperatures. Previous testing of cranberry plant cold hardiness levels in fall (Abdallah, 1989) documented a transition to maximum hardiness levels of both buds and leaves from early September to mid-October, with maximum hardiness being reached by late October.

Our current studies (from 1996,1997, and 1999) confirm the length of this transitional period and the timing of the achievement of maximum hardiness. In 1996 and 1997, upright samples were submitted to a controlled freeze, and then grown in the greenhouse after addtitional chilling was given to the cuttings. The vigor and survival of the new growth was evaluated and a LST was determined. **In both years maximum hardiness was attained for both buds and leaves by the last week of October to the first week of November, with a transition from between 5 to 10F (-15 to –12C) in early September to at least –13F (-25C) by the time of maximum hardiness** (Figure 5). In 1996, a notable loss of hardiness was documented in uprights sampled the week following harvest. This result suggests that **vines may be stressed by either the flooded conditions (low oxygen levels, warmer temperatures relative to the air), or mechanical damage from harvesters.**

In 1999, upright samples of both 'Stevens' and 'Ben Lear' were evaluated for symptoms of damage one week after being subjected to controlled freezes. Buds were dissected longitudinally and evaluated. 'Ben Lear' buds appeared to increase in hardiness earlier than 'Stevens' buds, although the buds of both cultivars reached their maximum hardiness by the same time, in late November. There appeared to be no major differences in the transitional hardiness levels of 'Stevens' and 'Ben Lear' leaves. In late November, it is not known why 'Ben Lear' leaves were somewhat lower in hardiness than 'Stevens' leaves. 'Stevens' leaves reached a maximum hardiness of around –22F (-30C) by late November. Buds and leaves in 1999 appeared to reach maximum hardiness later in the calendar year than in either 1996 or 1997. This could be due to the fact that relatively warm temperatures persisted longer into the fall in 1999 (Figure 7). In 1996 and 1997 the daily average canopy temperature reached 32F (0C) or below consistently by early November, while in 1999, this did not occur until early December.

Conclusion

It is important to consider the hardiness level of different parts of the cranberry plant in order to make the best plant protection decisions. Full-size fruit have been found to survive temperatures down to 26.6F (-3C), although ripe fruit are noticeably hardier than unripe fruit. In addition, ripe fruit can survive 26.6F (-3C) for several hours. Buds and leaves experience a marked transition in their hardiness levels from early September (around 10F (-12C)) to late October/early November (maximum around –13F (-25C) for buds. Harvest activities may affect vine hardiness.

Stage of Fruit Development/Ripeness	Lowest Survival Temperature
Green (<0.5")	32 F (0 C)
Green (>0.5 up to full size)	30.2 F (-1 C)
Green (full size)	26.6 F (-3 C)
<25% red	26.6 F (-3 C)
25 – 50% red	26.6 F (-3 C)
>75% red	26.6 F (-3 C)

Table 1. Lowest survival temperatures of cranberry fruit at different stages of development and ripeness. 'Stevens' cultivar was used for all testing.

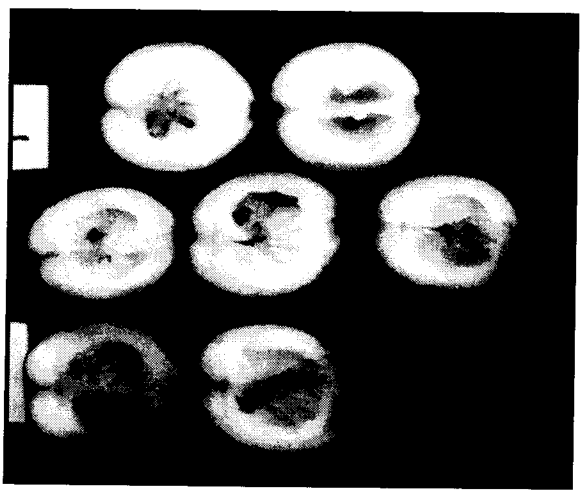


Figure 1. Pattern of freezing injury typically found in cranberry fruit. Top row: unijured control. Middle row: small areas of watersoaking and browning are visible only at the flower end of the fruit. Bottom row: "Wave" of freezing continues across fruit from the flower end, until fruit is completely watersoaked and soft.

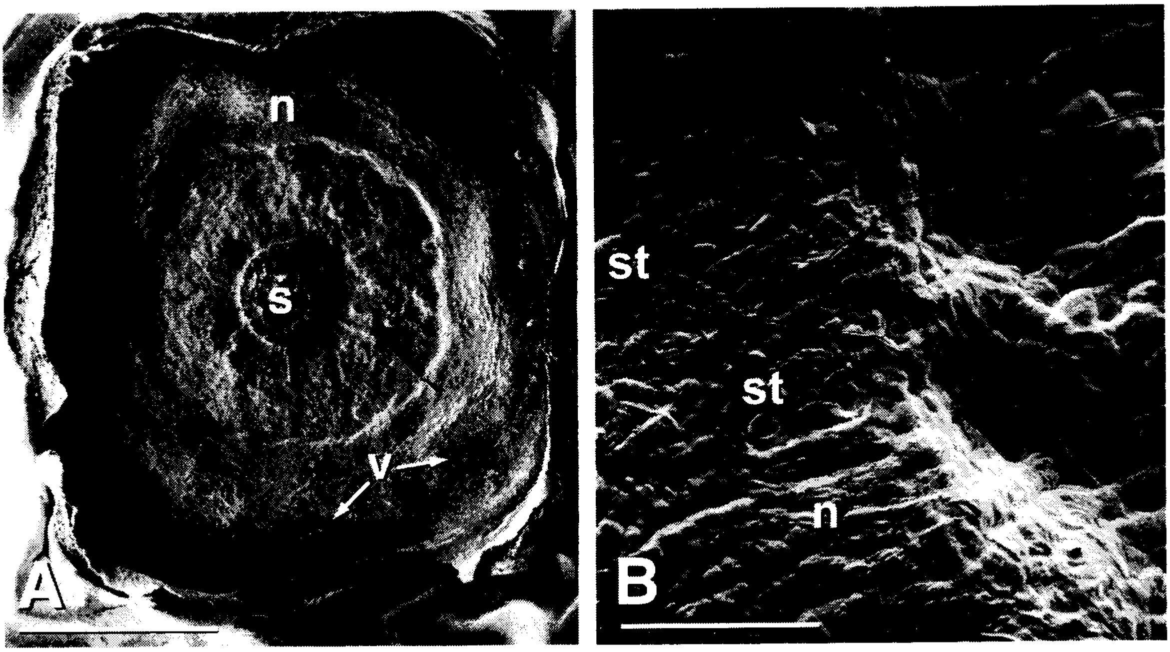
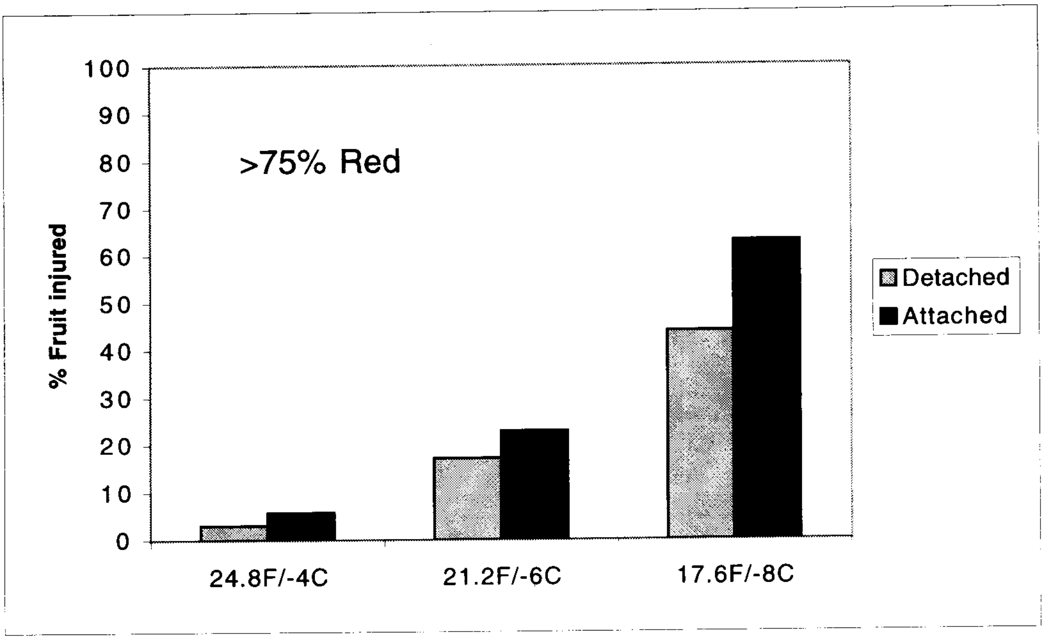


Figure 2. Scanning electron micrographs of the flower end of the cranberry fruit showing the location of stomata. (**A**) Overview of the area (remnant calyx tissue was removed to permit view of fruit end): area of stigma attachment (s), remnant of nectary (n), vascular bundles to stamens and petals (v). Bar represents 0.75 micrometers (ca. 0.03 inches). (**B**) Remnant area of the nectary (n) contains stomata (st), while the area between the nectary and the stigma attachment does not. Bar represents 60 micrometers (ca. 0.0024 inches).



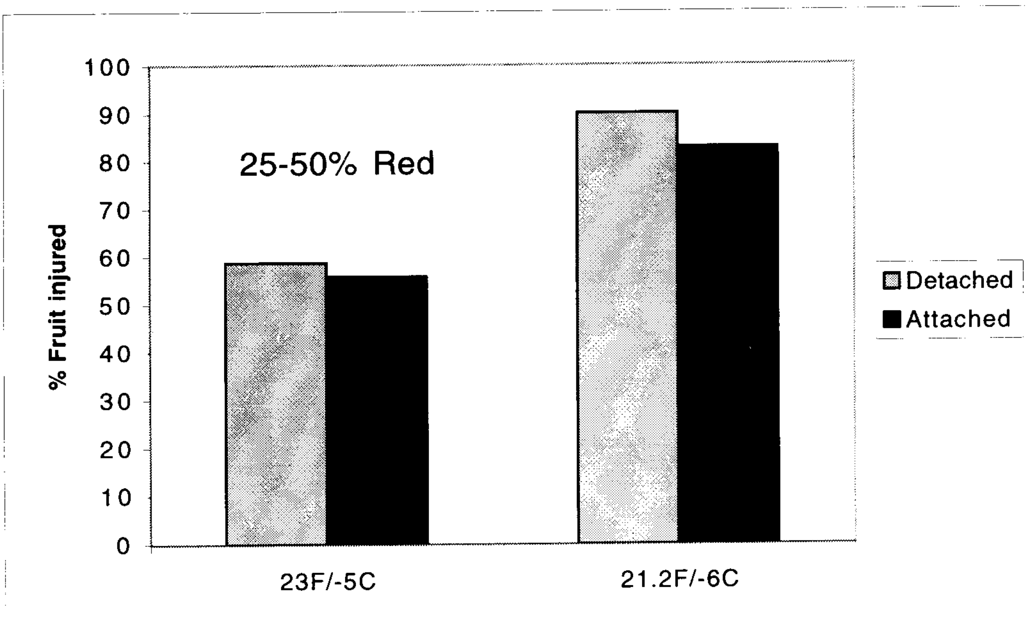


Figure 3. Percent of fruit injured in controlled freezing tests from 1998. Two stages of ripeness were tested (>75% Red and 25-50% Red) in September and October. Detached fruit were excised from upright, while attached fruit retained a portion of the upright stem. Percentages are averages of two experiments (three for 17.6F/-8C) (n=35 fruits for each type in each experiment).

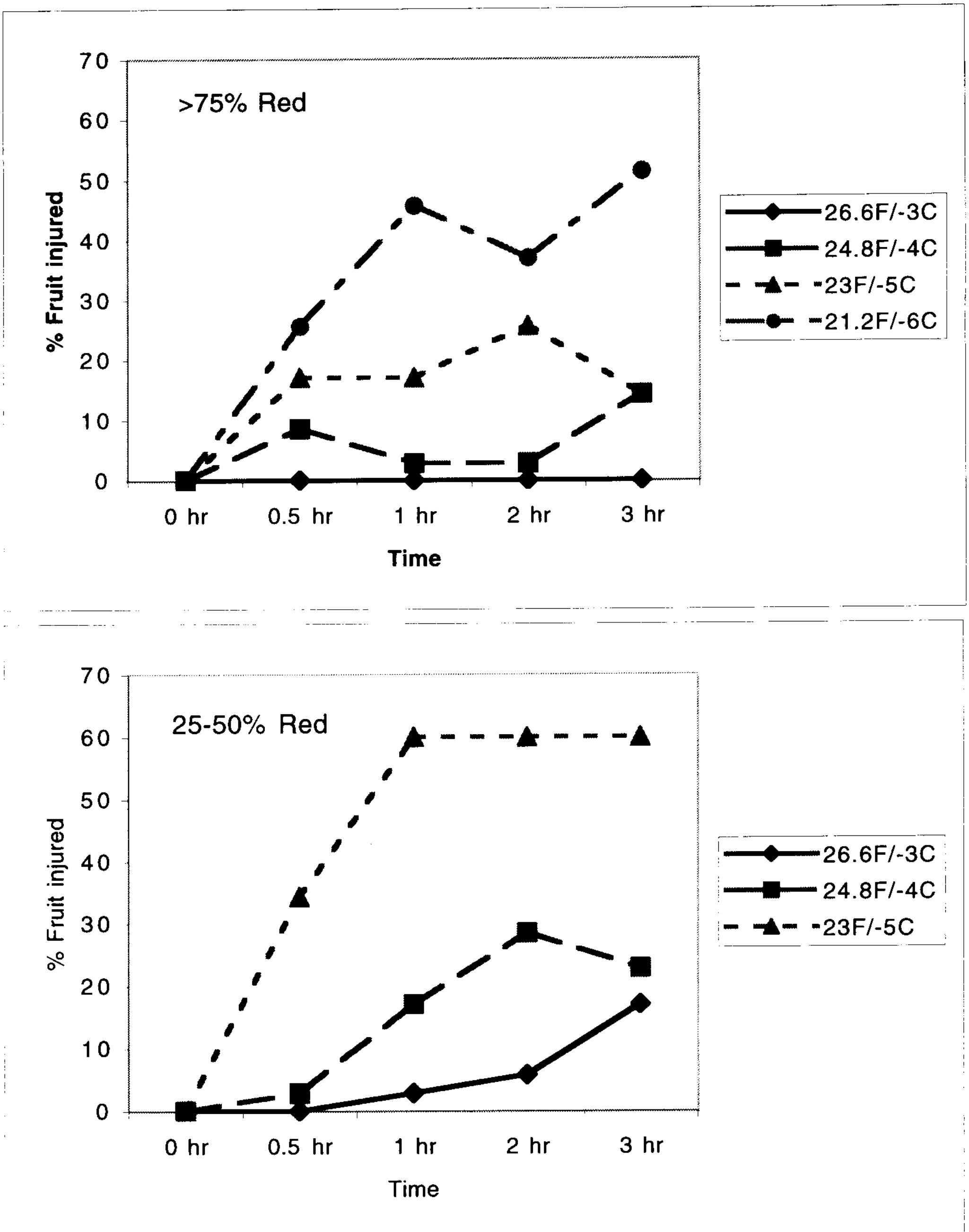


Figure 4. Effect of the duration of freezing temperatures on fruit injury. Individual fruits (n=35) for each duration were cut in half and evaluated for symptoms of watersoaking two days after thawing.

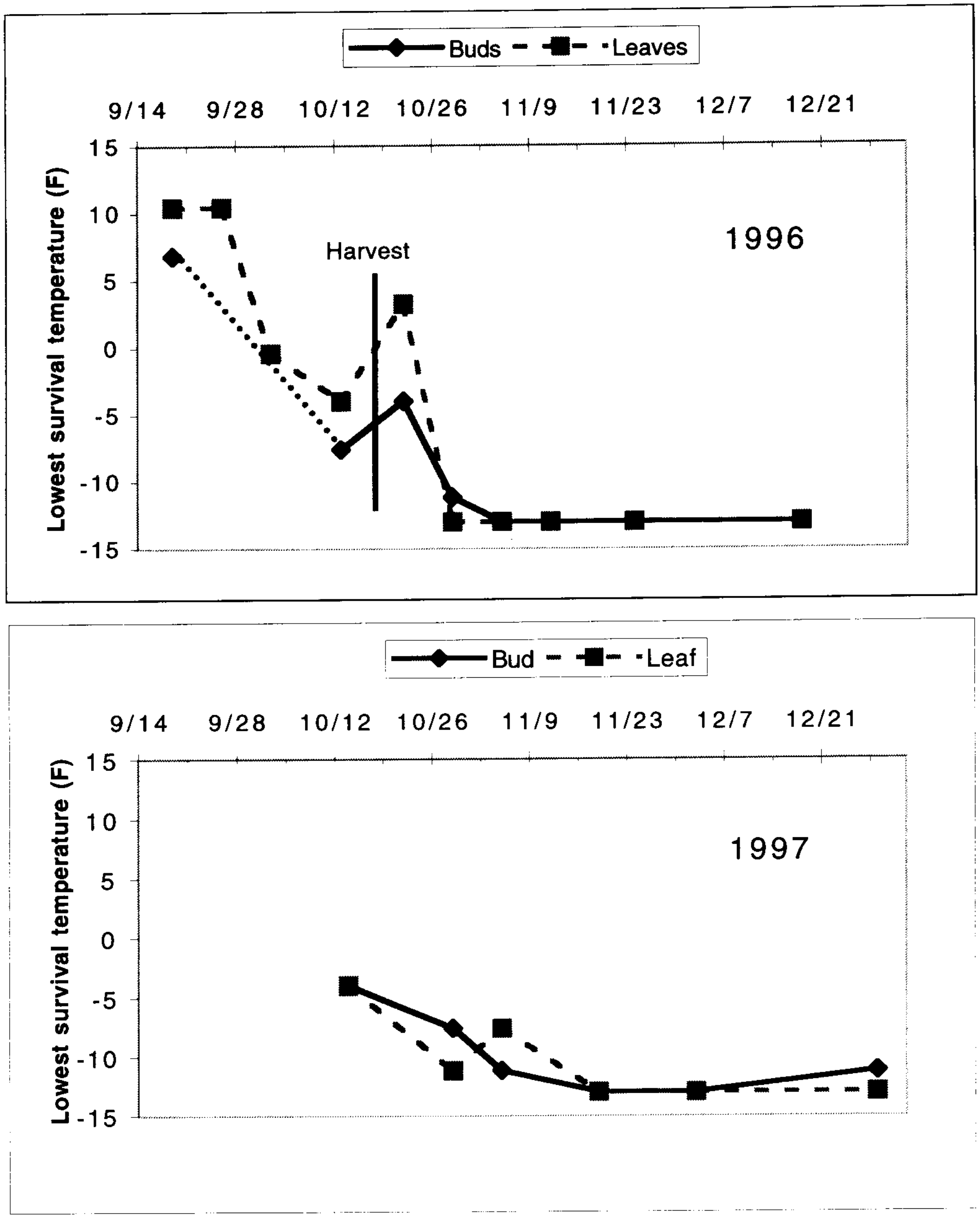


Figure 5. Lowest survival temperatures for buds and leaves of 'Stevens' cultivar in Falls 1996 and 1997. Buds and leaves were evaluated after controlled freeze, additional chilling, and then growth in greenhouse.

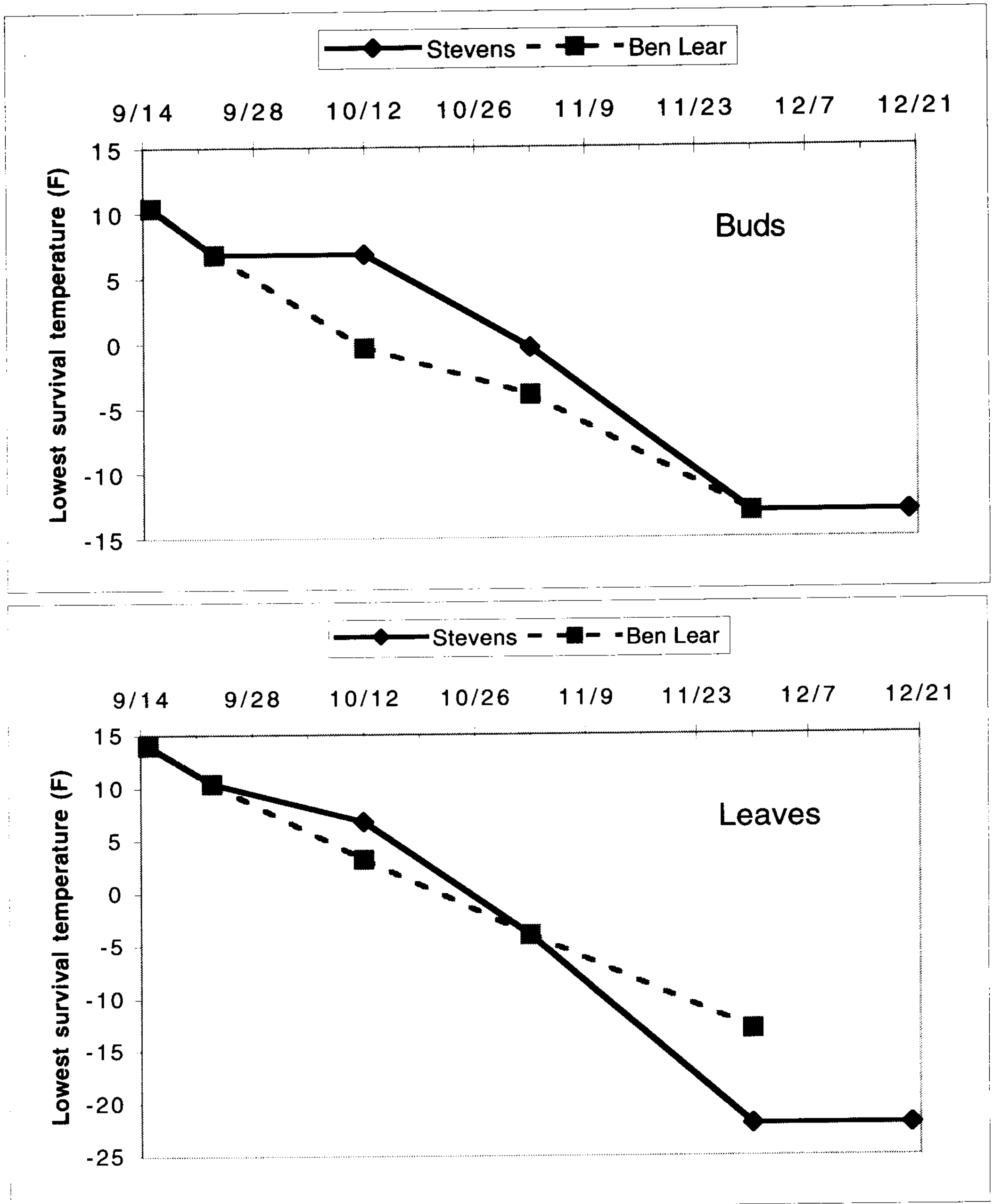


Figure 6. Lowest survival temperatures for buds and leaves of 'Stevens' and 'Ben Lear' cultivars in Fall 1999. Buds and leaves were evaluated one week after controlled freeze.

RODENT INJURY IN AND AROUND CRANBERRY BEDS

Teryl R. Roper
Dept. of Horticulture
University of Wisconsin-Madison

Cranberry growers are reporting increasing incidence of rodent trails through their beds and large emigration from beds when floods go on. Rodent trails are, just as the name implies, trails frequented by rodents such that they are visible in the beds. In some cases it is clear that rodents have gnawed off uprights. The damage resembles cranberry girdler injury in some cases.

It is not clear if rodents are causing economic loss or are just causing cosmetic damage to beds. Cranberries have an amazing ability to compensate for minor damage. Further research would be required to establish economic injury thresholds for vole populations in cranberry beds.

The likely culprit is the Meadow Vole (*Microtus pennsylvanicus*). Meadow voles are widely distributed throughout North America (Fig. 1). Its total length is 5 ½ to 7 ½ inches and its fur is gray to yellow-brown, obscured by black tipped hairs. Its underparts are gray. The preferred habitat is wet meadows and grasslands. This sounds an awful lot like cranberry production areas. Meadow voles eat a wide variety of foods, mostly grasses and herbaceous plants. In the late summer they store seeds, tubers, and rhizomes. They will eat crops when populations are high and occasionally they will eat insects, snails and animal remains.

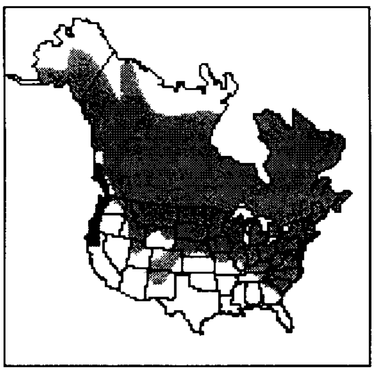


Fig.1. Distribution of the meadow vole in North America.

Voles are active both day and night, year round. They do not hibernate. They usually range over an area of about ¼ acre.

Large population fluctuations are normal with populations peaking about every 2-5 years, but the cycles are not predictable. High populations occur when adequate food, hospitable climate, good genetics, low predation and low physiological stress are present. Population densities are highly variable with studies placing populations of meadow voles from 32 to 160 per acre in an Ontario study to 2-6 per acre in an Illinois study.

Many voles are excellent swimmers and some are good climbers. Voles are prey for many predators including coyotes, snakes, hawks, owls and weasels. Predators do not normally control vole populations. Voles are non-game mammals and can be controlled when causing damage.

Managing Vole Populations

Exclusion. Exclusion works well for small areas such as hardware cloth cylinders around individual trees. Obviously, in a cranberry marsh exclusion is not a viable option.

Frightening. Frightening agents such as sounds are not effective in reducing vole damage.

Repellants. Some repellants such as capsaicin (the "hot" in chili peppers) can provide short term protection but will not provide long term control.

Cultural methods and habitat reduction. This is the primary means of managing vole populations. In order to thrive voles need food, shelter, and protection from predators. Removing any one of these will serve to reduce populations.

Reducing the food supply in a cranberry marsh will be difficult. However, mowing dikes and ditch banks and keeping herbaceous weeds out of the beds will reduce the immediate availability of food. Berries left on dike edges or bed floors after harvest may be food for voles, but it would not be practical to collect or destroy these.

Mowing dikes and ditch banks will also destroy vole habitat. However, this may also serve to drive voles into the beds. Certainly cranberry beds offer ideal habitat for voles. The cranberry canopy is sufficiently tall and dense to provide protection from predators, yet the canopy is sufficiently open to allow runways or trails. Small burrows in dikes or beds can be well hidden and would offer excellent protection from the elements. Sprinkler pipe placed on the dikes before harvest would provide excellent rodent habitat through the fall and winter. Further, after the winter flood has been drained when cracks may form along bed edges rodents have access to beds and under the ice would be excellent habitat with food, protection from the elements and predators. Eliminating habitat is likely not a complete answer for vole management in cranberries.

Again, mowing dikes and ditch banks will remove protection from predators. Avian predators can be encouraged to live or hunt in the area by providing stands or nest boxes. A tall pole with a flat board on top is an excellent hawk stand where they can survey the area looking for movement. However, this action will probably not increase predator populations since the same factors drive predator and rodent populations with adequate food supply at the top of the list.

Toxicants. Baiting for rodents can be an effective means of reducing high populations. However, remember that compounds that are toxic to rodents are also toxic to people and to other mammals and perhaps birds. **To my knowledge none of these materials are labeled for placement within cranberry beds, so all baiting would need to be done outside of the planted beds.** Handle and place baits with care. Rodenticides can be grouped into three categories: anticoagulants, zinc phosphide and calcium remobilizers.

Anticoagulants are materials like Warfarin and diphacinone. These work by preventing the blood from clotting so that if rodents are injured or as they squeeze through tight spots they bleed internally. These materials are relatively slow acting and may take several feedings to be effective. Because of this bait shyness may develop where after initial feedings rodents will avoid the bait. Anticoagulants may be used indoors or outdoors.

Zinc phosphide is an acute poison. It may be effective with a single feeding. When zinc phosphide contacts stomach acids phosphine gas is released which kills the rodent in a matter of hours. Zinc phosphide is not stored in muscle tissue so secondary poisoning does not usually occur. Zinc phosphide may be used indoors or outdoors.

A chemistry that has recently become available is cholecalciferol or vitamin D_3. This acts by mobilizing calcium from the bones into the blood stream resulting in hypercalcemia, leading to heart failure. This material does not lead to bait shyness and there is no secondary poisoning.

Toxic baits come in a variety of forms from pariffinized bars to pelleted baits to treated meal or cracked grain. The pelleted or pariffinized baits will stand up to weather better. Choose a bait that best suits your situation.

Bait stations. It is critical to place poisons so they are readily available and attractive to rodents while not being available to non-target species. Bait stations are one approach to accomplish this. A variety of commercial bait stations are available and are effective. One inexpensive and effective bait station is made of 1½ or 2 inch PVC pipe. Six inch lengths of pipe are inserted into the openings of a "T" and the T is laid on its side along a dike or other suitable spot outside of beds. The bait station should be placed without bait for a week or two before adding the bait to allow rodents to habituate to the station. To add bait, lift up the side arm of the T and pour in the bait and then set it back on its side. This sort of bait station excludes larger mammals and birds and it provides protection for rodents while they feed. Because the station is open on both ends rodents can see that they won't have to "back out" blindly but can exit head first. Slanting a shingle over a rock and placing the bait underneath makes an even more simple bait station.

Don't forget to bait in pump houses, machine sheds and other structures that may offer food and protection for rodents if populations are excessive.

No single approach to rodent management will solve the problem. You'll achieve the best results by taking multiple actions. Given the cyclical nature of rodent populations patience may be the best approach.

***Note**: Much of the material for this article was adapted from O'Brien, J.M. 1994. Voles. pp. B-177-182 in Prevention and control of wildlife damage. University of Nebraska, Lincoln.*

Night Sweeping to Enhance Cranberry Pest Monitoring

Donald C. Weber
Agricultural Science Group
Ocean Spray Cranberries

Sweep-net sampling is the basis for most thresholds and decisions in cranberry insect management. Sweep-netting and related action thresholds are used by around ¾ of cranberry growers commodity-wide, and over 85% of Wisconsin growers, according to our 1997 grower survey. However, the same survey showed that few growers sweep at night, especially in Wisconsin, since root weevils, which are the only specific target of night sweeping in other regions, are not a cranberry pest in Wisconsin.

Growers and scouts have felt for several years that several species were likely to be captured in different numbers by sweep-netting, based on the time of day or night. Root weevil and cranberry weevil adults seem to be strongly nocturnal and diurnal (day-active), respectively. Neither of these cranberry pests is important in Wisconsin. However, fragmentary information on cutworms, which can be very destructive in Wisconsin, suggested nocturnal captures were higher, especially for later instars.

The Study

With these clues, our objectives were to examine the diel (24-hour cyclical) pattern of sweep-net captures systematically, for several pest species at different times during the growing season. We also wanted to gain insight into variability amongst individual sweepers, and how much a sweeper's different sweep-sets differed on the same cranberry bed. The experimental design reflects a balanced approach to address these objectives. For each of the three months of May, June and July, we located three beds with significant infestations of pests of interest. Three sweepers then swept each of the three beds, each with three sweep-sets every three hours for a total of two daily cycles (48 hours). For each sample, we counted all cranberry pests, and also noted other insects.

What we found

For ten cranberry pests, we had sufficient sweep-net captures to be able to look at patterns including 24-hour (diel) cycles. These species were: blossomworm, false armyworm and green spanworm (May and June); brown spanworm, tarnished plant bug, and grasshoppers (June and July); Sparganothis (June only); flea beetle and black vine weevil (July only); and cranberry weevil (all three months). In general, time of day had by far the greatest influence on sweep-net captures of most important pests. Variation amongst individual sweepers was surprisingly small, although we could have underestimated this, since we had similar training and swept on the same beds together. Variation among sweeps by the same person showed the least variability. Sweep-netting procedures differ slightly from region to region: Wisconsin uses a 15-inch-diameter net and 20 sweeps per set, whereas Massachusetts uses 12-inch-diamter nets with 25 sweeps per set, as in this study. However, the trends for the same insect species, and probably for related cutworms and spanworms, are likely to be similar from region to region.

Our results for blossomworm are typical of those for other cutworms and also for the spanworms. Early larval instars showed some daytime activity, but sweep counts peaked between dusk and midnight, exceeding thresholds more often than day sweeps. As larvae grew with age, the pattern was even more strikingly nocturnal. Figure 1 shows the results of May sweeping for blossomworm, plotted on a linear scale over the two days of sampling. To see the diel (24-hour) trends in this same data, it can be combined by site and day, then displayed on a circular plot (Figure 2). The top is midnight, and the bottom of the circle or clock is noon. Bars correspond to when we sampled at 0200, 0500, 0800, 1100, 1400, 1700, 2000, and 2300 hours, with the bar length (out from the center) proportional to the number of insects caught. From our captures of 1940 blossomworms in May, the best time to sample was about 11pm. This was also true with later instar blossomworms (fish-bait size) in June (Figure 3), but the trend was even stronger. That is, very few blossomworm were swept outside the optimal time, which was near 11pm.

This nocturnal trend held true for the middle- to late-instar cutworms and spanworms, and as with blossomworm, the trend strengthened over the course of the season as the caterpillars grew. A few other species were exceptions. As expected, cranberry weevil, not considered a pest in Wisconsin, was strongly diurnal (day-active). Cranberry flea beetle adults were among the few pests active around the clock, with slightly more captures in the afternoon than at other times of the day or night (Figure 4), possibly a behavioral response to temperature.

Why?

It's interesting to speculate why caterpillars, especially larger caterpillars, tend to be nocturnal. First, in this study, that means they tended to be high enough in the cranberry canopy to be captured by sweep netting, only after dark. The threat of bird predation may be important. Birds are foraging actively during the daytime of their prime nesting season. Growers often notice bird activity corresponding to cutworm and other lepidopteran infestations. Humidity and water balance may also be more favorable to caterpillars being up in the canopy at night. Finally, the insects which are day-active, are either cryptic feeders (leafrollers such as blackheaded fireworm and *Sparganothis*, or cranberry fruitworm), not particularly choice morsels for birds (such as tiny lep instars and cranberry weevil), or capable of effective escape (flea beetle).

So what?

Our findings emphasize the importance of weekly sweeping during the day so as not to miss early-instar foliar-feeding lepidoptera larvae before they "go nocturnal." Night sweeping may be desirable at least once before bloom on each monitored bed, to make sure that lepidopteran worm infestations have not escaped notice. Sometimes, cutworm or spanworm numbers will be at or near threshold, then dip unexpectedly. Following such a trend, it would be a good idea to sweep after dusk, since the decrease may be caused by a change in behavior of the larvae rather than a population decrease. Night sweeping may be most convenient on potential frost protection nights, after dusk but before the dew or frost forms.

Lastly, our current thresholds were adopted some years ago when cultural practices were different and before night sweeping was contemplated. Therefore, these thresholds may need revision in the future. For now, however, they should be retained as the best basis for cranberry IPM decision-making in Wisconsin and elsewhere.

Acknowledgment:

I would like to thank my partners in this study, Scott Roskelley of Ocean Spray, and Monika Weldon and Peter Belanger of Clean Sweep Cranberry Consulting. Additional sweepers were Karen Ahola, Karen Asmussen, David Regan, Alan Rink, and Bonnie Soule. Without the cooperation of several Ocean Spray growers, this work would not have been possible. And special thanks to Slocum-Gibbs Cranberry Company for our 48-hour project headquarters.

Figure 1. 48-Hour Sweep Sampling - Blossomworm (May 1999)

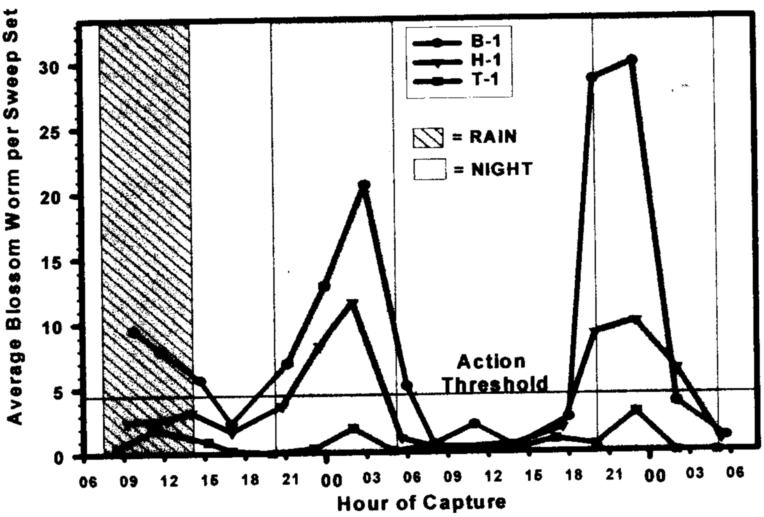


Figure 2. Same data as Figure 1, combined over 3 sites and 2 days to show frequency of all sweep captures in May 1999 for BLOSSOMWORM versus TIME of DAY

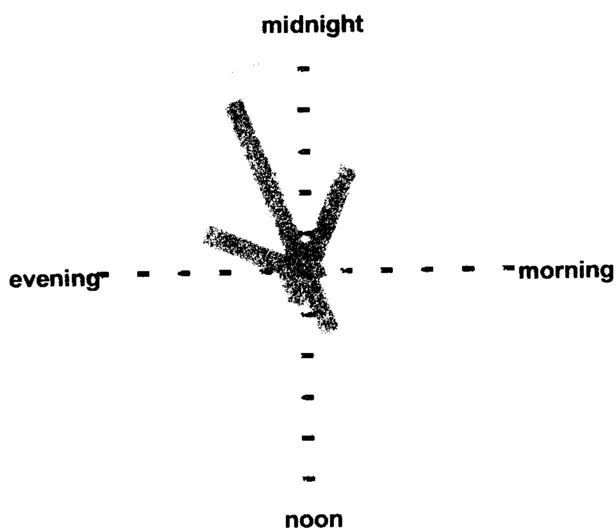


Figure 3. Frequency of all sweep captures in June 1999 for BLOSSOMWORM versus TIME of DAY

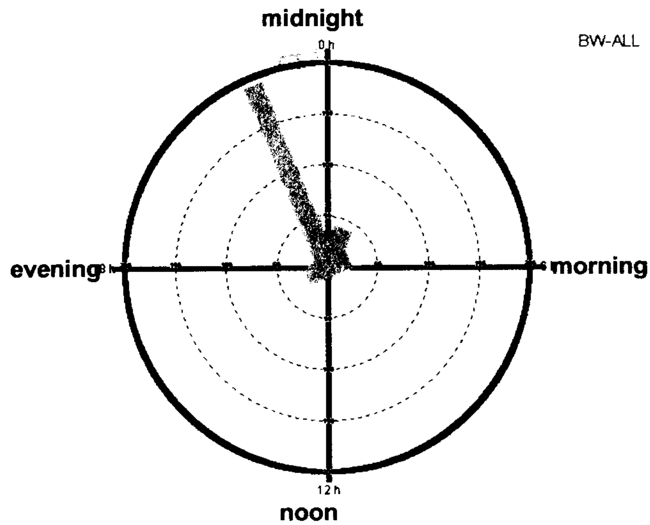
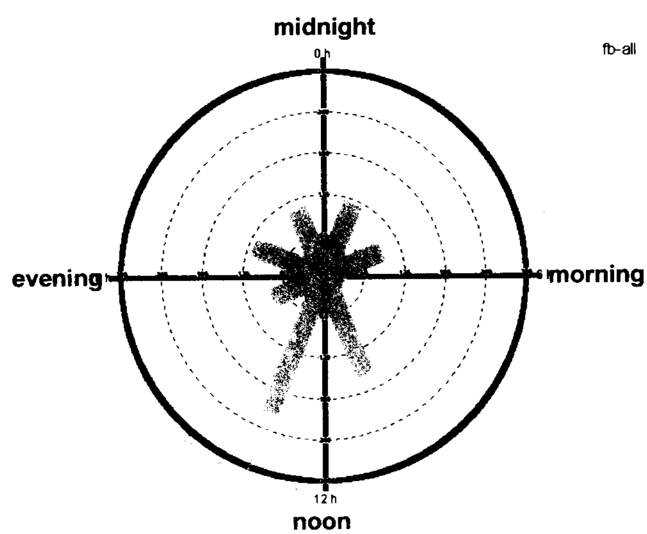


Figure 4. Frequency of all sweep captures in July 1999 for CRANBERRY FLEA BEETLE versus TIME of DAY



WHAT CAN YOU DO TO IMPROVE CRANBERRY POLLINATION?

Marla Spivak
University of Minnesota

When your cranberries are in bloom, do you observe bees gathering nectar and pollen from the blossoms? If you don't see an average of 3-4 honey bees or 1-2 bumblebees per 100 sq.ft of cranberries, you may need to rent some bee colonies to enhance pollination.

Cranberries require insect (primarily bee) pollination to set fruit. Bees transfer pollen from the anthers of one flower to the stigmas of another flower. Multiple bee visits to many flowers ensure cross-pollination, which increase the size of the fruit, the number of seeds, and the consistency in the shape of the fruit.

Honey Bees and Bumblebees as Pollinators of Cranberry

Honey bees are the most effective pollinators of cranberries, but bumblebees are the most efficient. The difference is that honey bee colonies have 40,000 – 50,000 female workers while bumblebees have 200 - 300 female workers, so there are considerably more honey bees available for pollination per colony (from 25-50% of the workers in each kind of colony may actually be foraging on a nice day). In addition, honey bees have a effective communication system to recruit their nestmates to foraging sites. Bumblebees do not have a means to recruit other foraging nestmates. However, bumblebees are more efficient foragers than honey bees on cranberry flowers because they are capable of buzz-pollination. Bumblebees hang on to the flower and buzz it by vibrating their muscles that control flight. The pollen in the flower is actively shaken loose and released onto the bee, and the bee then grooms the pollen grains onto her hind legs. After visiting many flowers to collect pollen, she will have accumulated a large ball of pollen on each hind leg, and will have cross-pollinated the flowers along the way. Honey bees are not able to buzz pollinate. They gather pollen passively by rubbing up against the anthers as they visit the flowers. They also collect large balls of pollen on each hind leg as they cross-pollinate, but they are not nearly as efficient in collecting the pollen from each flower as are bumblebees.

Both honey bees and bumblebees must visit flowers to obtain significant quantities of pollen to sustain the nutritional needs of the colony. Pollen is the sole source of protein for bees, and their bodies are covered with fine hairs that help catch and hold the pollen. In addition, bees require carbohydrates which they obtain from nectar. Nectar is a sugary solution that some flowering plants secrete to attract pollinators. Nectar is produced in nectaries located deep within the plant so the pollinator is forced to brush up against the pollen-bearing anthers to reach the carbohydrate reward. Some bees forage exclusively for nectar, others for pollen, and some bees forage for both. Even if bees are foraging for nectar, they transfer some pollen from flower to flower as they go. Honey bees gather huge quantities of nectar and convert it to honey within the colony. They require large amounts of honey (75-100 lbs in northern climates) to survive the winter months. Bumblebees collect nectar and store it as honey, but because the colony does not survive the winter, they do not need to store surplus quantities. They store the honey in small wax pots and usually only have enough to survive through short periods of dearth.

A honey bee colony is perennial; it survives the winter as a colony and may produce a new queen and colony in early summer through the process of swarming. A bumblebee colony is annual; only newly mated queens that are produced in late summer survive the winter hibernating alone in the ground. In late spring, the surviving queens emerge and initiate a new nest.

There is only one species of honey bee in the United States, *Apis mellifera*, and it is not native. All honey bees originated from Europe and Asia, and were introduced into the US in the 1600's. There are at least 19 species of bumblebees in Minnesota and Wisconsin, all within the genus *Bombus*. Bumblebees are native to the US, as are cranberries, so they were the original pollinator of this plant.

Our dependence on honey bee pollination has increased because the number of native bees (bumblebees, orchard mason bees, sweat bees, etc.) has been reduced due to the use of pesticides and the destruction of nesting sites by modern agricultural technology. There are still a number of bumblebees in areas that are wooded (e.g., surrounding some cranberry properties), but in areas that have been cleared for development or for crop production, their presence may be scarce. In the past, introduced honey bees established wild populations in trees and were prevalent for pollination. However, in the last decade, the number of honey bee colonies has diminished due to the introduction of two, highly destructive parasitic mites specific to honey bees. Many home gardeners and growers of large commercial crops have noticed the lack of bee pollinators and have taken an interest in renting or purchasing bee colonies to increase pollination.

Pollination Requirement – Honey Bees

Cranberries require 2-3 honey bee colonies per acre for adequate pollination. Colonies can be rented from a reputable commercial beekeeper who will truck the bees in and out of the property. It is strongly recommended that the grower and beekeeper draw up a pollination contract before the bees are brought into the property. The contract will ensure that the beekeeper will bring in strong, healthy colonies at the desired time and to the desired location, and that the grower will pay the beekeeper a specified amount and will either not spray toxic pesticides while bees are on the property. A sample pollination contract is supplied below.

With recent funding from the WI Cranberry Board, Dr. Gordon Waller, graduate student Elaine Evans, and I are investigating if there is an optimal time during cranberry bloom to bring in and take out honey bee colonies from a cranberry property. However, the following are some common sense rules of thumb. Honey bees prefer to forage on clover, alfalfa, and some other wildflowers because they produce more nectar than cranberries. If the cranberry property is in a wooded area where clover and other flowers are not abundant, the honey bee colonies will forage predominantly on cranberries and can be introduced before 10% bloom. If the property is located where bees have access to large amounts of other flowers, it may be best to wait to introduce the bees until there is at least 10% bloom. That way, the honey bees will not learn the location of and recruit other bees to flowers off the property before the cranberries bloom.

Honey bees may gather small crop of cranberry honey in some locations and in some years, which the beekeeper can harvest. Cranberry honey is very delicious and unique.

However, by bringing honey bee colonies in for cranberry pollination, the beekeeper sacrifices the larger crop and potential income he/she could obtain by moving bees into clover and alfalfa fields. It is important to come up with a pollination fee that is equitable for the beekeeper and the grower. Without bee pollination, the cranberry grower may have very low yield, so the grower must consider the value of the bees relative to the value of the entire cranberry crop.

Pollination Requirement – Bumblebees

Some estimates indicate that 4 bumblebee colonies per acre are needed to pollinate cranberries. The number of colonies needed will vary depending on the number of feral bumblebees present and whether or not honey bees colonies are also being used for pollination. Honey bees and bumblebees seem to be compatible for use together. Bumblebee colonies can be placed in the bogs at or before the first flowering. Since bumblebees do not communicate with each other about foraging, most of them will not leave the cranberries in search of better rewards.

Bumblebee colonies can be rented for a minimum of $75 each. The reason bumblebee colonies are so expensive is that there are only a few companies with the knowledge of how to rear them on a large scale. The species of bumblebee that is reared commercially in the Midwest is *Bombus impatiens.* Other bumblebee species are more difficult (if not impossible) to rear. We are investigating methods of rearing this species of bumblebee and hope to publish a small how-to manual in the near future.

Setting out nest boxes around a cranberry property in the hope of attracting bumblebee queens in the spring is not a reliable way to obtain bee pollinators. The success rate of this method is very low. The best way to encourage native pollinators is to conserve native prairies and woodlands.

For further information on pollination requirements or on how to keep bees, contact:

Dr. Marla Spivak
Department of Entomology
1980 Folwell Ave; 219 Hodson Hall
University of Minnesota
St. Paul, MN 55108

(612) 624-4798 phone
(612) 625-5299 FAX
spiva001@tc.umn.edu
http://www.entomology.umn.edu

Table 3. POLLINATION AGREEMENT

Date ______________________________ For Season 19 __________

The Beekeeper

Name ______________________________

Address ______________________________

Phone Number ______________________________

The Grower

Name ______________________________

Address ______________________________

Phone Number ______________________________

No. of Colonies Ordered ______________________________

Rental Fee for Grade A Colonies ______________________________

Rental Fee for Grade B Colonies ______________________________

Compensation for Additional Movement
of Bees or Other Extras ______________________________

Total Rental Fee ______________________________

Name of Crop ______________________________

Location of Crop ______________________________

____

Distribution Pattern of Colonies shall be ______________________________

____

The Grower Agrees:

1. To give ________ days notice to bring colonies into the crop.
2. To give ________ days notice to take colonies out of the crop.
3. To pay one-half the agreed total fee when the bees are delivered.
4. To pay in full within ________ days after the delivery date.
5. To pay one percent a month interest on amounts unpaid after the due date.
6. To use no toxic pesticides in the crop during the rental period except with the understanding and consent of the beekeeper, and to warn the beekeeper if neighbors use toxic sprays.
7. To provide an uncontaminated water supply.
8. To assume liability for livestock damage or vandalism.
9. To assume public liability for stinging while the bees are on location in the crop.

The Beekeeper Agrees:

1. To open and demonstrate the strength of colonies randomly as selected by the grower.
2. To leave the bees in the crop for a period necessary for effective pollination estimated to be approximately ________ days and with a maximum period of ________ days, after which time the bees will be removed or a new contract negotiated.
3. To ensure that colonies are properly located and will remain in good condition while pollinating the crop.

Signed: Date ______________________________

______________________________ ______________________________

Grower Beekeeper

Cranberry Marketing Order
Volume Regulation

David Farrimond
Cranberry Marketing Committee

Why is there a marketing order for cranberries?

During the 1950's, production of cranberries increased as growers improved their cultivation and harvesting practices. Cranberry sales centered primarily on the Thanksgiving fresh fruit market. On November 9, 1959, Arthur S. Flemming, Secretary of the U.S. Department of Health, Education and Welfare, announced that a herbicide, aminotriazole, had been used on cranberries in Oregon and Washington. Aminotriazole had been found to cause cancer in mice. Cranberries treated with the herbicide had already been distributed into the marketplace before they could be recalled. These cranberries could not readily be identified so the public viewed all cranberries as suspect. The demand for cranberries plummeted and the marketplace was glutted with unsold and unwanted cranberries.

Independent testing was conducted, at the behest of the industry, where it was found that less than 0.3% of cranberries tested showed any traces of aminotriazole residue. On May 1, 1960, President Eisenhower issued an executive order indemnifying cranberry growers.

While the industry worked to reestablish consumer confidence, sales remained well below pre-November 1959 levels. Meanwhile production continued to increase resulting in oversupply and disorderly markets. Leaders of the cranberry industry determined there was a need to establish a mechanism to administer the surplus fruit.

Operating under the provisions of the Agricultural Marketing Agreement Act of 1937, as amended, public hearings were held throughout the cranberry growing areas. Based on testimony given at the hearings the United States Department of Agriculture conducted growers' referendum, wherein eighty-five percent of the growers voting approved establishment of a federal marketing order. On August 15, 1962, the Federal Cranberry Marketing Order, Title 7, Part 929, Code of Federal Regulations, became effective.

One of the Committee's duties, under the order, is to annually develop a marketing policy. The marketing policy provides for an economic analysis of the cranberry industry. The Committee gathers production, acreage, and sales data from growers, while handlers and processors supply the Committee with data on cranberry acquisitions, utilization, and inventories.

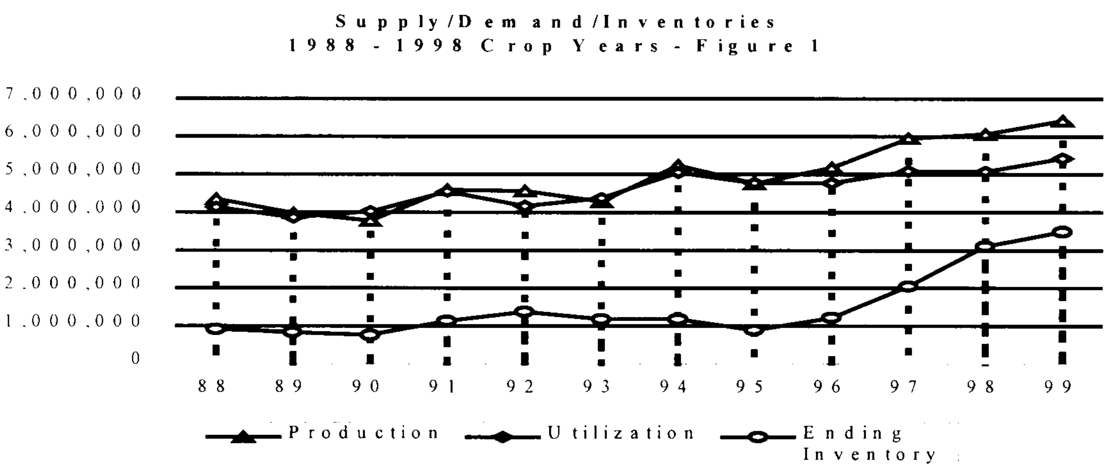
Using industry data and the Committee's projections, a forecast of cranberry production, utilization, and inventory for the ensuing crop year is developed. If, on the basis of its analysis conditions existed that would lead to disorderly markets the Committee can recommend the Secretary, USDA, establish a volume regulation program.

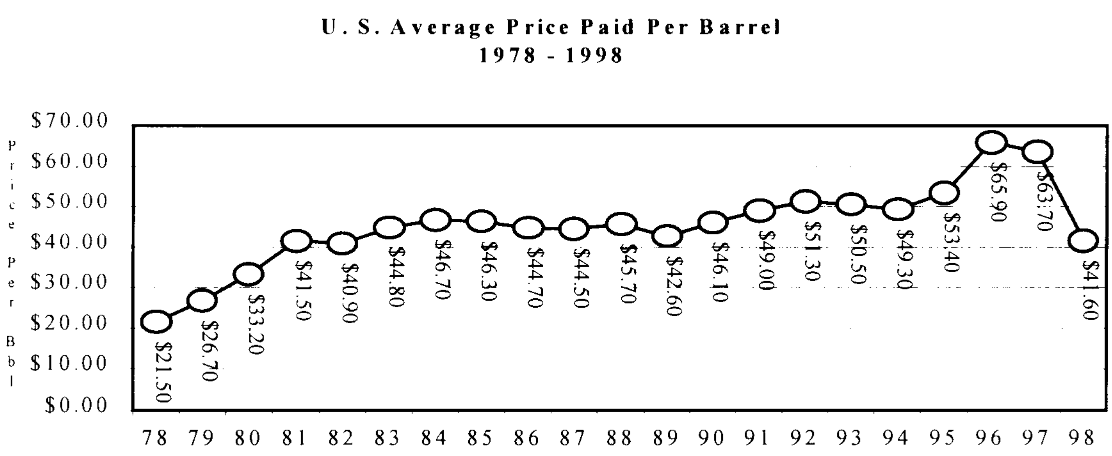
The establishment of a volume regulation program limits the quantity of cranberries, fresh and processed, that can enter commercial markets to that amount equal to the total marketable quantity of cranberries necessary to meet projected demand and provide for an adequate carryover.

When are marketing orders effective?

Marketing orders are effective when:

- Markets fail, causing disorderly markets.
- When the outlook for reaching equilibrium between supply/demand is long-term in nature. (Figure 1: Source CMC)
- When grower returns fall below the cost of production. (Figure 2: Source NASS)





The Committee has used its volume regulation authority sporadically since its inception. Starting with the 1962 crop year, the Committee has recommended the establishment of a withholding program, often referred to as set aside, on four occasions. (Table 1)

Table 1: Withholding Programs Established

Crop Year	Free Percentage	Withholding Percentage
1962	Eighty-eight Percent	Twelve Percent
1963	Ninety-five Percent	Five Percent – Rescinded before implementation
1970	Ninety Percent	Ten Percent
1971	Eighty-eight Percent	Twelve Percent

Volume Regulation Programs

Withholding Program

Under a withholding program the Secretary sets the "free" and "restricted" percentage of cranberries that can be handled. The free and restricted percentages are applied to each handler's cranberry acquisitions. Each handler would have the same percentage restriction applied. Under withholding growers have to deliver 100% of their harvested crop as the withholding provisions only apply to fruit delivered. All withheld, restricted, cranberries must be inspected by the Federal-State Inspection Service and certified as meeting established quality requirements.

Free cranberries can be marketed through any outlet, while restricted berries have to be withheld from handling and diverted to noncompetitive markets. Currently, noncompetitive outlets for restricted cranberries include exports to countries other than Canada; donations to charitable organizations; disposition to any nonhuman food use; research, and development projects, approved by the USDA, for the development of foreign markets.

The Committee becomes a clearinghouse for restricted cranberries. Handlers can apply to the Committee for a release of their restricted cranberries. However, before restricted fruit is released the handler must deposit an amount equal to the fair market value of the cranberries. The Committee determines the fair market value. The Committee uses deposited funds to purchase an equal amount of free cranberries from other handlers to replace the amount of restricted cranberries released.

The marketing order was amended in 1968 to add another form of volume regulation called the producer allotment program. In 1992, the Committee amended the producer allotment program provisions to simplify procedures.

Producer Allotment Program

Under a producer allotment program the Committee makes a recommendation to the Secretary, USDA, as to the marketable quantity of cranberries needed to meet total market demand and to provide for an adequate carryover.

The Committee then calculates an average sales history for each grower. Currently, the Committee uses a growers' best four, out of six years, of sales in its calculation.

The marketable quantity is then divided by the total average sales histories to derive at an allotment percentage. This percentage is applied to each individual grower's average sales history, and the result is the producer allotment, i.e., amount of fruit that handlers can handle on behalf of that grower. If a grower sells to more than one handler the grower must declare, on a form provided by the Committee, the distribution of their producer allotment among those handlers.

Cranberries received by handlers in excess of their total producer allotments are referred to as "excess" cranberries. Handlers cannot place excess cranberries into commercial markets. However, excess cranberries can be used in noncommercial or noncompetitive outlets. Noncommercial outlets are defined as charitable institutions and research and development projects. Noncompetitive outlets are defined as nonhuman uses and foreign markets (except Canada).

Under a producer allotment program growers can make adjustments in their cultural practices during the growing season in order to adjust their production to meet their producer allotment.

Application

Volume regulation programs only apply to domestically produced cranberries and do not apply to cranberries produced outside of the United States.

Compliance Issues

To ensure compliance with a volume regulation program the Committee conducts audits and onsite inspections of handlers and producer-handlers to verify restricted or excess cranberries are being maintained. The marketing order requires handlers to provide the Committee with written documentation on any disposition of restricted or excess cranberries through noncommercial and noncompetitive markets.

Handlers and producer-handlers are subject to further enforcement action by the USDA if they are found to be out of compliance with the regulations. Penalties associated with enforcement range from fines to legal action.

Conclusion

The cranberry industry finds itself in an economic downturn, the duration of which is difficult to foresee. Options available to the industry include increasing demand or limiting supply. Everyone would agree to ensure industry stability in the long-term requires growing the market by increasing the demand for cranberries and cranberry products. However, to accomplish these objectives will take time and an aggressive effort on the part of the industry. While in the short-term the most pressing issues are growing inventories and decreasing grower returns.

The industry must weigh all options available to it in addressing the short-term and long-term issues facing it. Increased health related research and aggressive marketing programs consisting of branded and generic promotions, domestically and internationally, will be beneficial in achieving those long-term objectives.

However, in the short-term the marketing order's volume regulation provisions provide the industry with a means to address the immediate problem of disorderly markets caused by increases in supply and falling grower returns. Whether the industry wishes to proceed with establishing a regulatory program is yet to be decided.

The CMC subcommittee continues its review and discussion the possibility of utilizing a regulatory program as part of an overall industry strategy to address these issues. This process will include an industry meeting in January 2000 and will culminate with a report on its findings to the full Committee in February 2000.

Strategies for Insect Control in a Weak Market

Daniel L. Mahr
Department of Entomology
University of Wisconsin - Madison

There are many advantages to growing a crop that has strong market potential. In the area of pest control, it allows a bit of flexibility in making management decisions. The grower can use practices that may be a bit more expensive, but that have other beneficial attributes, such as ease of use, worker safety, good environmental compatibility, and safety to beneficial organisms such as pollinators and biological control organisms (such as predators). It has been gratifying working with the cranberry industry because many growers have been making these sorts of decisions, and therefore Integrated Pest Management has become broadly adopted by the industry. However, in a weak market, growers must find ways of cutting production costs. If possible, this should be done without substantially upsetting a production system that has been operating successfully for many years. Here I address the subject of insect pest management as it relates to the declining market. Each grower has their own ideas in this area and so I am going to offer little in the way of specific recommendations. My objective is to provide sufficient background information to allow you to consider the various issues involved.

Pest Management Costs.

First, let's briefly review the actual costs associated with pest management. Foremost is the cost of the damage itself, if left untreated. Insects are significant pests of cranberry; if left unchecked they can result in significant economic damage -- damage that far exceeds the costs of even the most rigorous pest management programs. But this varies from location to location within the state; insect pressures are certainly greater in central Wisconsin than in the northern counties. One benefit of pest monitoring (IPM scouting) is that it allows us to reduce our pest management inputs when pest populations are low, but to respond to increasing populations accordingly. A second set of costs is associated with pest scouting. Whether contracted or done with farm personnel, there are labor and equipment (traps, nets, etc.) costs associated with pest scouting. However, because this is such an important aspect of pest management decision making, it is not a practice that can easily be set aside. Finally are the costs of actually killing the pests themselves. These costs include materials (chemicals or biological controls), personnel, and equipment, and, for some farms, the costs associated with custom application (such as aerial sprays) where there is an associated profit margin for the applicator. All of the above costs must be considered when developing or implementing a pest management program.

Action Levels.

Pest management must be economical; that is, there have to be greater economic benefits to doing pest management than there are associated with doing nothing. Somewhere along the continuum is a "break even point" where the costs of controls exactly equal the amount lost if no controls were implemented. This break even point is usually measured by the numbers of pests present, because the more pests, the more the economic damage. If we know what population level causes economic damage, we can use that population level to decide when to take action.

Therefore, in insect management, we talk about "action levels." Generally, there are two action levels that we consider. The Economic Injury Level (EIL) is the pest population level at which the amount of damage done by the pest population exactly equals the costs associated with controlling that insect; in essence, this is the break even point. However, because there may be time lags associated with controlling a pest population, we actually base our actions on a more conservative population level, known as the Economic Threshold (ET), which is a bit below the EIL. Figure 1 is a hypothetical example of a population of cranberry fruitworm through time (the fluctuating line) and both the Economic Injury Level and the Economic Threshold. Note that in some years the insect population is naturally so low that the application of any controls would cost more than would be recouped from increased yield or quality.

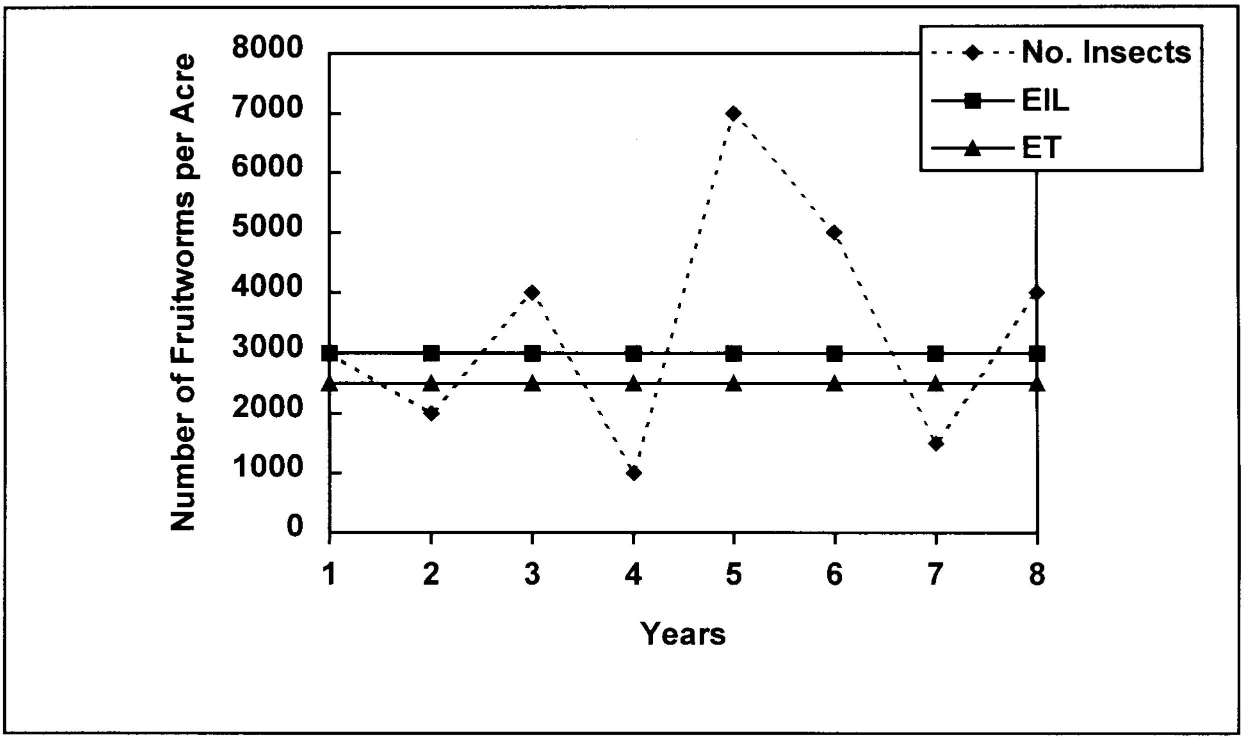


Figure 1. A hypothetical example of a fluctuating insect population through time (years) and the action levels known as Economic Injury Level (EIL) and Economic Threshold (ET).

There are several things that are taken into consideration when calculating action levels. Important factors include (1) the amount of injury caused by a single insect, (2) the total number of insects, (3) the cost of control, and (4) the value of the crop. Generally, action levels are graphically depicted as flat lines as in Figure 1 above. However, if any of the above four factors change significantly, then the action levels must also be changed. For example, if a new cranberry variety were developed that was 90% resistant to cranberry fruitworms, the population numbers would have to be significantly higher to cause the same amount of injury; therefore, the action levels would be much higher. Similarly, if the cost of controls were substantially reduced, the action levels could also be reduced and still be economical.

To give a sense of the development, usage, and change of action levels, let's continue our example with cranberry fruitworm.

First, we need to know how much damage can be done by a single fruitworm. From our knowledge of the biology of the insect, we know that a single fruitworm during the course of its life can destroy 5-7 berries (let's take an average of 6).

My good friend and colleague, Dr. Teryl Roper, who has weighed thousands of cranberries, has told me that an individual berry weighs about 1.5 grams (on average). There are 454 grams per pound, so there are about 300 berries in a pound.

At 300 berries per pound, it takes 50 fruitworms, each eating six berries, to eat a pound of cranberries, or 5000 fruitworms to eat a barrel (100 lbs.).

Now let's consider control costs. First, we will choose Orthene as an insecticide (others are effective as well, but we need to choose one). Orthene costs about $10 per pound. The rate of Orthene is 1.33 lbs/acre. So, enough Orthene to treat one acre costs about $13. Let's say that application costs (labor, fuel, equipment) are $12 per acre (this might be a bit high, but it makes for easy arithmetic!). Therefore, our calculated cost to control fruitworm is about $25 per acre, *irrespective of the number of fruitworms present.*

The next factor to consider is the value of the crop. First, let's consider a market that returns $60 per barrel to the grower. At a $25 treatment cost, it requires 0.42 barrels (42 pounds) (calculated as $25 treatment cost ÷ $60/barrel = 0.42 barrel) to cover the cost of treatment. If 50 fruitworms eat 1 pound of berries (see above), the Economic Injury level can be calculated to be 2100 fruitworms per acre (50 fruitworms/pound of berries x 42 pounds of berries = 2100 fruitworms).

If instead we consider $40 berries, the calculations for the EIL are as follows:

$25 treatment cost ÷ $40/barrel = 0.62 barrel = 62 pounds of fruit, and
50 fruitworms/pound of berries x 62 pounds of berries = 3100 fruitworms/acre.

Finally, if we consider $20 berries:

$25 treatment cost ÷ $20/barrel = 1.25 barrels = 125 pounds of fruit, and
50 fruitworms/pound of berries x 125 pounds of berries = 6250 fruitworms/acre.

These values are represented graphically in Figure 2. But note that the EIL increases substantially between $40 berries and $20 berries. Also note with this hypothetical example, for $60 berries treatment would be economical six of the eight years, whereas for $20 berries, treatment would be economical in only one of the eight years of the example.

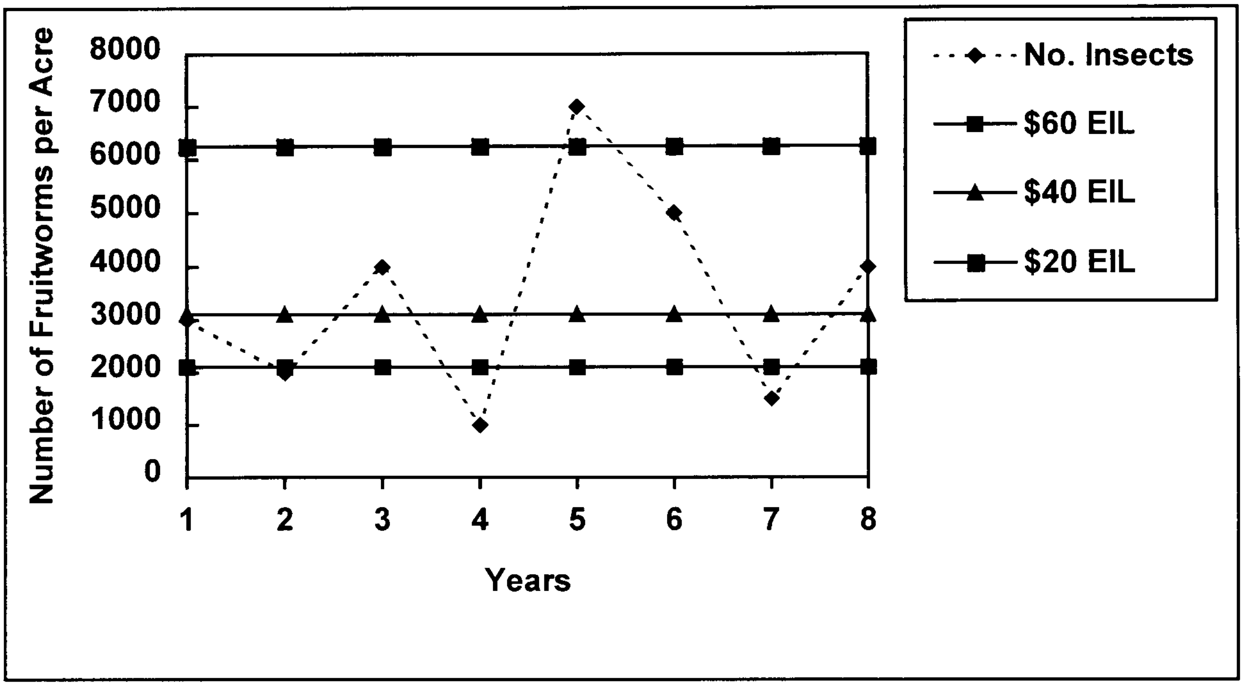


Figure 2. Hypothetical Economic Injury Levels calculated for cranberry fruitworm, based on crop values of $60, $40, and $20 per barrel.

There are always "intangibles" to be considered when dealing with action levels. The example given assumes just a single application for control. If two applications are necessary, the action levels must be adjusted accordingly. The example does not factor in how much damaged fruit a handler will tolerate, or penalties based upon the amount of bad berries. Further, the presence of multiple types of insect pests adds to the complexity. But none of these factors should obscure the important point, which is simply that, as prices fall, you must consider adjusting the amount that can economically be justified for pest management.

Scouting.

Pest monitoring, or "scouting", has been one of the most important advances in cranberry pest management in the past 20 years. Only through scouting can you determine what pests are active, and at what levels. This information is vital to making pest management decisions. However, in this period of depressed prices, scouting must be done in a cost-effective manner. Further, don't expect scouting to answer all questions. To illustrate this, let's once again take up the example of cranberry fruitworm. Although we can establish economic thresholds for cranberry fruitworm, it's not economically feasible to scout to determine if fruitworms are at threshold. In order to be effective, we need to scout the egg stage and eggs are laid singly under the calyx lobes at the bottom of the fruit. Another key factor in making this analysis is the size of the crop, and for this example we will assume an average yield of 300 barrels/acre. Let's again consider the situation for $60/barrel berries. The treshold that we calculated earlier is 2100 larvae per acre which averages about 1 per 20 sq. ft., or about one per 4000 berries. So, we wouldn't be able to tell if we were at threshold unless we inspected 4000 berries for eggs. And usually we recommend taking at least four sets of samples! Even at $20 berries, we would need to examine about 570 berries per sample in order to determine if the population was at threshold. Obviously, the economics aren't there to justify sampling berries to see if we are at threshold for cranberry fruitworm. What scouting for cranberry fruitworm can do is to determine the best timing for spray applications, and to track population levels (in qualitative terms) from year to year. And of course there are pests that are easier to sample, such as with sweep nets, where sampling to determine thresholds is a valid and economical practice.

Pesticide Costs.

Insecticides do vary in cost. Variation can depend on the specific product (active ingredient), the manufacturer, the distributor, and the quantity purchased. It's also important to consider the pest complex that needs controlling, as well as your specific pest management philosophy. For example, one insecticide may be more expensive on a per-pound basis, but it may require fewer applications for your particular complex of pests. If you are particularly interested in conserving beneficial organisms that will aid in the control of pests, you may choose to use a more selective material rather than a broad spectrum product. These are things to discuss with your pest management consultant.

Some Concluding Thoughts.

⇒ Consider all of your pest management options. Don't rely just on pesticides. Flooding, sanding, and biological controls may all play a role. If using pesticides, learn about the products that might be best for your conditions.

⇒ Know your pests and the most effective times to apply controls. I still see growers putting tipworm treatments on in August, long after the insects are mostly gone.

⇒ Carefully consider whether "second applications" are necessary. While there are certainly instances where pest populations are sufficiently big and spread out to warrant followup treatments, in many cases, a properly timed application will provide adequate control. Depending on the value of the crop, a second application may not be justified on the basis of economics.

⇒ In deciding how to cut production costs, it's likely you will think about reducing or eliminating pest scouting. Weigh this option very carefully. You may find that pest scouting pays for itself in reduced pesticide costs, more accurate (and efficient) timing of applications, and reduction in crop losses.

⇒ Finally, "doing nothing" relative to pest problems is not an option. Insects can rapidly build up if left unchecked and have a devastating impact on the yield as well as the health of the vines. Even if you decide that you won't harvest some low-producing beds, consider at least a minimal insect management program on those beds to keep large pest populations from developing and overwhelming adjacent beds.

Agriculture, Child labor and Wage and Hour Laws

by M. Elizabeth Winters
DeWitt, Ross & Stevens
Madison, WI

I. FAIR LABOR STANDARDS ACT ("FLSA")

A. General Overview

Generally, the FLSA regulates the wages and hours of work of public and private sector employees who fall within its scope. In particular, the FLSA does the following:

a) establishes a minimum wage to be paid all covered employees;
b) generally requires the payment of extra wages for hours worked in excess of 40 per workweek;
c) proscribes the use of **oppressive** child labor in interstate commerce activities;
d) prohibits wage discrimination on the basis of sex; and
e) requires employers to retain certain records and reports.

B. Who is covered?

To be covered by the FLSA, an individual must be:

a) an employee;
b) engaged personally in commerce or in the production of goods for commerce or employed by an employer in an enterprise engaged in commerce or in the production of goods for commerce; and
c) within the geographical area covered by the FLSA.

1. "Employee"

The FLSA defines "employee" as "any individual employed by an employer."

2. "Employer"

The FLSA defines "employer" to include "any person acting directly or indirectly in the interest of an employer" in relation to an employee. In determining whether an individual or business entity is an employer, a good test is whether that individual or entity has:

a) the right to hire and fire;
b) the right to direct/control employees in their work;
c) the right to set hours of work; and
d) the obligation to pay wages.

3. FLSA v. Wisconsin Child Labor Law

Most employers, regardless of size of their organization, are subject to state child labor laws. The FLSA requires employer compliance with state laws that establish a higher standard if those laws do not contravene the FLSA's requirements. If state law contradicts the FLSA, such laws continue to apply to the employment of children who are outside the FLSA's general coverage or who are specifically exempted or excepted from the FLSA's requirements.

For purposes of this presentation, these materials will address the child labor laws within the context of the requirements under the FLSA and will note exceptions under Wisconsin law.

II Exemptions for Agricultural Workers

1. General Overview

There are two types of agricultural exemptions to the FLSA that may apply to the cranberry industry:

a) an exemption from the minimum wage, equal pay and overtime provisions; and
b) an exemption from the overtime pay requirements.

2. Complete overtime pay exemption

The FLSA grants complete exemption from its overtime pay provisions to:

a) an employee employed in agriculture or in connection with the operation or maintenance of ditches canals, reservoirs, or waterways, not owned or operated on a sharecrop basis, and used exclusively for supply and storage of water for agricultural purposes; and
b) an employee engaged (1) in the transportation and preparation for transportation of fruits or vegetables, whether or not performed by the farmer, from the farm to a place of firs processing or first marketing within the same state, or (2) in transportation, whether or not performed by the farmer, between the farm and any point within the same state, of persons employed or to be employed in the harvesting of fruits or vegetables.

3. Minimum wage, equal pay, and overtime pay exemptions

Exemptions from the minimum wage, equal pay, and overtime pay requirements of the FLSA are granted to five types of agricultural workers:

a) An employee whose employer did not, during any calendar quarter in the preceding calendar year, use more than 500 man-days of agricultural labor;
b) an employee who is the parent, spouse, child, or other member of the employer's immediate family;
c) a hand-harvest laborer who commutes daily from his residence to the farm, who has been employed in agriculture less than 13 weeks during the prior calendar, and who is paid on a piece-rate basis in an operation that is customarily and generally recognized in the region of employment as paying on a piece-rate basis;
d) a hand-harvest laborer who is 16 years of age or under, (a) who is employed on the same farm as his parent or as a person standing in his parent's place, (b) who is paid on a piece-rate basis in an operation that is customarily and generally recognized in the region of employment as paying on a piece-rate basis, and (c) who is paid at the same piece-rate as employees on the same farm who are over 16;
e) an employee who is principally engaged in the range of production of livestock.

4. FLSA Child Labor Provisions

The FLSA further does not apply to any employee employed in agriculture outside of school hours for the school district where the employee is living while so employed, **if** the Secretary of Labor has not declared an occupation to be particularly hazardous for children under 16 **and** the employee is:

a) age 14 or 15;
b) age 12 or 13 and either (1) the employment is with the consent of the parent or the person standing in the place of the parent or (2) the parent of such person is employed on the same farm as the child;

c) age 10 or 11 and the employer has been granted a waiver by the Department of Labor for the child's employment as a hand harvest laborer during no more than eight weeks in any calendar year; or

d) age 11 or under and is employed either (1) by a parent, or by a person standing in the place of the parent, on a farm owned and operated by the parent or person or (2) with the consent of the parent or person standing in place of the parent on a farm that qualifies for the man-days exemption from the FLSA's minimum wage, equal pay, and overtime pay rules.

1. **Parental exemption.**

As an exemption to the FLSA's child labor coverage, the statute permits parents or persons "standing in place of the parent" to employ their own children, or children in their custody, who are under age 16 in an occupation that is not found to be particularly hazardous for, or detrimental to the health or well-being of children between ages 16 and 18. Persons "standing in the place of the parent" are those who take children into their own homes and treat them as members of their own families, educating and supporting them as if they were their own.

The parental exemption applies only where the child is exclusively employed by the parent or a stand-in, not when the child is dually employed by the parent and another person. Thus, the exemption is not available where the child works for a corporation, even if the parent owns substantially all its stock and is an active manager.

A parent or stand-in who operates a farm may employ a child under 16 on the farm even in an occupation which has been declared particularly hazardous for a child under 16.

2. **Examples of particularly hazardous occupations for children under 16.**

The following are a few of the occupations that the Department of Labor has identified as particularly hazardous occupations in agriculture for children under age 16:

a) operating a tractor that has more than 20 PTO horsepower, or connecting or disconnecting an implement or any of its parts to or from such a tractor;

b) working from a ladder or scaffold, painting repairing, or building structures, pruning trees picking fruit, etc., at a height of more than 20 feet;

c) working inside (1) a fruit, forage, or grin storage designed to retain an oxygen deficient or toxic atmosphere, (2) an upright silo within 2 weeks after silage has been added or when a top loading device is in operation position, (3) a manure pit, or (4) a horizontal silo while operating a tractor for packing purposes;

d) handling or applying agricultural chemicals classified as toxic by the Federal Insecticide, Fungicide and Rodentile Act;

e) transporting, transferring, or applying anhydrous ammonia; and

f) operation of forage harvester, forage blower, auger conveyor, or the unloading mechanism of a non-gravity type self-unloading wagon or trailer, non-walking-type rotary tiller.

3. Examples of non-hazardous agricultural activities for children under 16.

The following activities in agriculture have not been found by the Department of Labor to be hazardous for the employment of children under age 16:

c) age 10 or 11 and the employer has been granted a waiver by the Department of Labor for the child's employment as a hand harvest laborer during no more than eight weeks in any calendar year; or

d) age 11 or under and is employed either (1) by a parent, or by a person standing in the place of the parent, on a farm owned and operated by the parent or person or (2) with the consent of the parent or person standing in place of the parent on a farm that qualifies for the man-days exemption from the FLSA's minimum wage, equal pay, and overtime pay rules.

1. **Parental exemption.**

As an exemption to the FLSA's child labor coverage, the statute permits parents or persons "standing in place of the parent" to employ their own children, or children in their custody, who are under age 16 in an occupation that is not found to be particularly hazardous for, or detrimental to the health or well-being of children between ages 16 and 18. Persons "standing in the place of the parent" are those who take children into their own homes and treat them as members of their own families, educating and supporting them as if they were their own.

The parental exemption applies only where the child is exclusively employed by the parent or a stand-in, not when the child is dually employed by the parent and another person. Thus, the exemption is not available where the child works for a corporation, even if the parent owns substantially all its stock and is an active manager.

A parent or stand-in who operates a farm may employ a child under 16 on the farm even in an occupation which has been declared particularly hazardous for a child under 16.

2. **Examples of particularly hazardous occupations for children under 16.**

The following are a few of the occupations that the Department of Labor has identified as particularly hazardous occupations in agriculture for children under age 16:

a) operating a tractor that has more than 20 PTO horsepower, or connecting or disconnecting an implement or any of its parts to or from such a tractor;

b) working from a ladder or scaffold, painting repairing, or building structures, pruning trees picking fruit, etc., at a height of more than 20 feet;

c) working inside (1) a fruit, forage, or grin storage designed to retain an oxygen deficient or toxic atmosphere, (2) an upright silo within 2 weeks after silage has been added or when a top loading device is in operation position, (3) a manure pit, or (4) a horizontal silo while operating a tractor for packing purposes;

d) handling or applying agricultural chemicals classified as toxic by the Federal Insecticide, Fungicide and Rodentile Act;

e) transporting, transferring, or applying anhydrous ammonia; and

f) operation of forage harvester, forage blower, auger conveyor, or the unloading mechanism of a non-gravity type self-unloading wagon or trailer, non-walking-type rotary tiller.

3. Examples of non-hazardous agricultural activities for children under 16.

The following activities in agriculture have not been found by the Department of Labor to be hazardous for the employment of children under age 16:

This exemption applies to the specific relationship mentioned, even though they are employed by an employer who otherwise used more than 500 man-days of agricultural labor in a calendar year.

According to the Department of labor, only the following will be considered as other members of the employer's immediate family: stepchildren, foster children, stepparents, and foster parents. Other relatives, even when living permanently in the same household as the employer, are not considered to be immediate family members.

III Minimum Wage

1. Federal

All employers covered under the federal law must pay their employees $5.15 an hour **unless** the employee is under the age of 20 and within the first 90 days of employment, and in that case, the employer must pay the employee $4.25 an hour. However, an employer who employees persons under the age of 20 and pays such persons $4.25 an hour, should take care not to displace other workers who are over the age of 20.

2. Wisconsin

All Wisconsin employers must pay their agricultural workers covered under Wisconsin minimum wage at least $4.55 an hour for adults and $4.20 an hour for minors.

IV Record Keeping and Retention Requirements

There is no requirement that an employer maintain personnel files, *per se*. However, several state and federal laws require employers to keep certain records. Outlined below are the *minimum* requirements. An employer may choose to retain records beyond the minimum time frame required.

Notwithstanding the minimum requirement, any records relating to an ongoing legal claim must never be destroyed even if the minimum retention time frame has expired. This includes other records related to the ongoing lawsuit. For example, if a job applicant files a charge alleging discriminatory hiring practices, the company may not throw out all applications in excess of one year old.

Medical records must always be kept separate from other personnel files and only accessible on a need to know basis.

1. Records Related to Hiring
2. Job Evaluations
3. Occupational Injury and Illness
4. Affirmative Action Plans
5. Wage and Hour Records
6. Handicapped Workers Paid at a Subminimum Wage
7. Federal Contractors
8. Pensions, Profit Sharing and Other Employee Benefit Plans
1. Polygraph Testing

A. Apprenticeship Programs

B. Employment of Minors and Student Learners

V. Posting Requirements

A copy of required Wisconsin and Federal Posters are included in the Appendix attached to these materials.

DOs and DON'Ts of Fungicide Use on Cranberry in Wisconsin

Patricia McManus
Department of Plant Pathology
University of Wisconsin-Madison

Most processing market cranberry growers in Wisconsin do not use fungicides on a regular basis, unless spraying for cottonball control. However, many growers spray from time to time to control upright dieback, Phytophthora root and runner rot, fruit rot, and problems for which the cause is not known. When the price received for cranberries is high, the cost of spraying fungicides on a sporadic basis is negligible compared to profits. In the current economic environment, however, every expense counts. Fortunately, in Wisconsin, cranberries can be produced without fungicides. Growers should use this period of low profitability to minimize fungicide use, and test just what is and isn't needed to manage diseases.

Fungicides don't always work! A great problem in trying to control cranberry diseases is the limited efficacy of fungicides. Research in Wisconsin has shown that Orbit, the fungicide that has been available by Section 18 registration for cottonball, has provided good (but not excellent) control. Control of other diseases with fungicides has been poor to fair. The following sections will review cranberry diseases and summarize basic DOs and DON'Ts to help you reduce fungicide inputs. Note that most of these diseases were discussed in the 1999 Wisconsin Cranberry School Proceedings (1999 WCSP). Please refer to the cited articles for further details.

Cottonball. See pages 5-11 in 1999 WCSP. Data from several years' research in Wisconsin indicate that bloom sprays are more important for cottonball control than are sprays during budbreak and shoot elongation. In fact, under low to moderate disease pressure, spraying only during bloom controls cottonball as well as spraying during budbreak *and* during bloom. There are no clear-cut, research-based definitions of low, moderate and high disease pressure, but Table 1 provides some working guidelines for determining how to spray for cottonball control. In all cases, it is important to monitor and record cottonball levels at harvest to plan for the following year.

Fruit rot. See pages 25-28 in 1999 WCSP. Fruit rot is usually classified as either field rot or storage rot. There is significant overlap among the many fungi that cause field rot and those that cause storage rot. With both field and storage rots, the environment is a major factor in disease development. Also critical is time—how long are the berries in the field? How long are the berries stored? In 1998 many growers in Wisconsin experienced field rot problems. This was probably in part due to the warm, early spring which made for a long growing season (plants were in bloom 2-3 weeks ahead of normal, but harvest took place at the usual time).

Table 1. Guidelines for determining how to spray for cottonball control

Disease Pressure	***Working definition***	***Recommended DOs and DON'Ts***
Low	• Cottonball never or only rarely detected in the bed; OR • During early bloom, primary cottonball (tip blight) not found after 10-15 minute search.	1. Don't spray. 2. Do monitor cottonball berries at harvest.
Moderate	• Bed has a history of cottonball (1-10%); OR • During early bloom, primary cottonball (tip blight) found after 5-10 minute search.	1. Do spray 1-2 times during bloom; if only 1 spray, make it at 10-20% bloom. 2. Do monitor cottonball berries at harvest.
High	• Bed has a history of severe cottonball (greater than 10%); OR • During early bloom, you can easily find primary cottonball (tip blight) within the first few minutes.	1. Do spray 2 times during bloom and 2 times during budbreak the following year at the higher rate. 2. Do monitor cottonball berries at harvest.

Field rot in Wisconsin is typically 4-7% (by number of berries, not weight) in the field before any sorting. During harvest, some of the rot is sorted out, so that by the time fruit is at the receiving station, rot is less than 4-7%. Research in all major cranberry growing areas shows that even with fungicides (Bravo, Ferbam, or Dithane), rot incidence is typically around 3-5%. Trials in Wisconsin in the late 1980s and in 1999 showed no difference in fruit rot control between sprayed plots and unsprayed plots (Table 2). Bravo applied during early and mid bloom reduced fruit set. This sometimes, but not always, resulted in reduced yield. Dithane reduced fruit color slightly. The bottom line is, *fungicides probably do not reduce fruit rot in Wisconsin, and they can actually harm the crop.*

Table 2. 1999 Fruit rot fungicide trial, Wisconsin Rapids, WI

Treatment (rate/acre)	***Schedule***	***% Rot***	***% Fruit set***
Dithane (6 lb)	early, mid, late bloom	5.9	55
Dithane (6 lb)	late bloom, 10 days later, 10 days later	4.9	54
Bravo (5.5 pt)	early, mid, late bloom	5.6	35*
Bravo (5.5 pt)	late bloom, 10 days later, 10 days later	5.2	60
Unsprayed	---	5.3	52

*Value is statistically significantly different from the unsprayed control and from other fungicide treatments.

Storage rot is caused by fungi that infect in two ways: through wounds during harvest; or during the growing season but then remain dormant internally until after berries have been stored. It seems that internal, dormant fungi may be triggered into action when a fruit is wounded during harvest. Wounding breaks open fruit cells, making it easier for fungi to obtain sugars and other nutrients they need to grow. Fungicides are fair (Bravo) to poor (Dithane, copper) at controlling storage rot.

Upright dieback. See pages 29-31 of 1999 WCSP. The fungus *Phomopsis vaccinii* is believed to be a factor in the disease upright dieback. However, the term "upright dieback" is sometimes used as a catch-all phrase for any case of upright shoot death. This confusion of terms has resulted in misapplication of fungicides.

In recent years a fungicide has been available by special "24c" registration to control upright dieback. Watch industry newsletters for information on fungicide registration in 2000. Grower experience, our knowledge of *Phomopsis*, and limited research indicate that the time to apply the fungicide is in the spring when most shoots have about ½ inch of new growth. Waiting until bloom is too late. Spraying later in the season is useless, because *Phomopsis* is already safe inside the plant, out of reach of the protectant fungicide. Spraying fungicides during the summer also will not reduce *Phomopsis* inoculum the following year.

Phytophthora root and runner rot. See pages 1-4 in 1999 WCSP. The species of *Phytophthora* (*P. cinnamomi*) that causes root and runner rot on cranberry in Massachusetts and New Jersey is not found in Wisconsin. The most common species found on cranberry in Wisconsin are *P. cryptogea* and *P. megasperma* (Table 3). However, these species cause disease only if the soil is flooded. *P. megasperma* is not controlled by Ridomil; the effect of Ridomil on *P. cryptogea* is not known. Good soil drainage is the only way to control putative *Phytophthora* problems in Wisconsin.

Table 3. *Phytophthora* species on cranberry in Wisconsin

Species of Phytophthora	*Pathogen?*	*Controlled by Ridomil?*
P. cryptogea	Maybe, if flooded	?
P. megasperma	Yes, if below 60°F and flooded	No
P. dreschleri	?	?
Misc. *Phytophthora* species	?	?

Miscellaneous problems. In general, fungicides are not the answer to cranberry problems for which the cause is unknown. This would include large areas of dead or dying vines, stem canker (more accurately called stem gall; see pages 22-24 in 1999 WCSP), and uniform reddening at leaf margins. Likewise, fungicides are not recommended after hail, sun scald, or similar environmental or physical stresses.

Summary

DOs

- Do scout for cottonball tip blight (see Table 1).
- Do the math before spraying any fungicide to determine whether it will be economically beneficial. Fungicides typically do not reduce fruit rot to less than 3-4% of berries.
- Do scout for diseases and other problems by getting into the bed. It requires a close look to diagnose most problems.
- Do "drive-by" scouting to monitor patterns of disease development or other disorders.
- Do keep accurate notes of what you see for future reference.
- Do submit samples to your Extension service for a diagnosis rather than spraying fungicides to fix a problem for which the cause is not known.
- Do read past cranberry school proceedings. The 1999 school focused on cranberry diseases.

DON'Ts

- Don't expect miracles from fungicides. Orbit for control of cottonball has generally been good, but fungicide performance against other diseases has ranged from fair to poor.
- Don't overdo it with nitrogen. Succulent tissue is generally more susceptible to disease. Dense, lush vines retain moisture that favors fungal growth.
- Don't go below the 4 oz. rate when using Orbit. Lower rates won't control disease and may ultimately lead to fungicide-resistant pathogen populations.
- Don't let a cottonball-infested bed go unharvested. It may not be profitable to harvest such a bed when the price of cranberries is low. But if cottonball mummies are allowed to accumulate, the bed will have severe problems in the future (when price of cranberries is high again).
- Don't mix Bravo with compounds designed to enhance uptake. Bravo can be phytotoxic (reduces fruit set, burns fruit) and uptake-enhancing compounds will make this worse.
- Don't use Bravo before late bloom as this may lead to reduced fruit set.
- Don't apply Bravo if bed temperatures are expected to reach 90°F on the day of application. This increases risk of phytotoxicity.
- Don't apply fungicides following hail, sun scald, or similar environmental and physical stresses.
- Don't apply fungicides to control stem canker (stem gall).

What Can I Do Without and Still Produce a Good Crop?

Jonathan D. Smith, Ph.D.

Have we really been wasteful?

- Have we:
  - Applied too much fertilizer?
  - Applied the wrong type of fertilizer?
  - Sprayed too many fungicides?
  - Sanded too many beds?
  - Wasted fuel by watching too much frost?!!

THE REAL QUESTION

What can I (as a field manager) do to maximize profitability?

MAXIMUM PROFITABILITY

Equals

HIGHEST YIELDS + MINIMUM COSTS

Costs controlled by a field manager

- **Fertilizers**
- **Insecticides**
- **Spring Herbicides**
- **Fungicides**
- **Roundup**
- **Pollination**

How can we minimize costs on our property?

1. Set up a Budget for the Season
2. Scrutinize every input

- How much does it cost?
- How much benefit do I get from the use of this product?

The Profitability of a Cultural Practice is based on Yield Response

Gather Information

Test the Product

Gather as much information as possible

Talk with other Growers
University personnel
Text Books and Technical Manuals
Chemical / Fertilizer suppliers
Private Research Organizations
Read books and magazines

Test the Product Yourself

NEVER ASSUME

QUESTION AUTHORITY

Find out how the product works on your property in your particular situation.

Example: We want reduce fertilizer costs by switching from manufactured to blended fertilizers

- What do we know about the products?
- What are the benefits?
- What are the drawbacks?
- What are the risks?
- Is there any hidden expense?
- If used successfully, where is the proof?

Results from the field tests

- Saved $5.00 per acre throughout the season
- Poor distribution from the boom
- Highly variable particle size
- Product separated, causing streaks in field
- Yields dropped 9.8 % due to over and under fertilization within the bed
- Yield loss cost us $920 / acre.

Frequently Asked Question

How do I set up a useful experiment in my field?

Not difficult, but proper setup is crucial.

Setting up a field experiment

Initial Question:

Will my cranberry beds benefit from a spring gypsum application?

From our initial investigation

- Advantages
  - Excellent source for calcium additions
  - Will not influence soil pH levels
  - soluble in water, so readily available
- Disadvantages
  - Displaces Mg and K in the soil system
- Cranberry Myth
  - Greatly improves water penetration in poorly drained beds

Additional questions to consider

- Do I need additional Calcium?
  - Determine needs with a soil test
- Will the additional calcium increase my need for additional potassium and magnesium?
  - Implement a soil testing program
- Will a gypsum application influence my yield?
  - Develop a field test to find the answer

Lay out Experiment Properly

- Conduct the test using your own production equipment.
- Make the plots big enough to view results
- Perform test on only one side of a uniformly producing bed
- Replicate the rates

Gypsum Field Test

- Rates to Test:
  - 0, 100, 200, 400 lb. / acre
- Location:
  - East side of bed 1
- Plot size:
  - Entire boom width, change rate every 2-3 sprinklers
- Replication
  - 0, 100, 200, 400, 0, 100, 200, 400

Quantify Your Results

- In each plot, answer these questions…
  - Differences in current season yield?
  - Differences in berry size?
  - Differences in number of berries per upright?
  - Differences in plant color, vigor?
  - Differences in yield the next season?
  - Any other responses to the application?

Potential Studies for your consideration

Assess the need for Additional Potassium Applications at fruitset

How does an application of Potassium Chloride (0-0-62) influence:

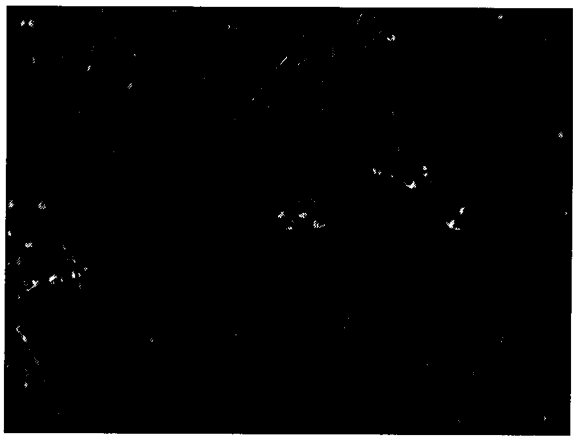
- Berry Size?
- Re-bloom?
- Bud Set?
- Yields?
- Vine Hardening?

Potassium Chloride on Producing Beds

- Stevens bed averaged 199 bbl / acre
- Applied a single application on July 14, 1998
  - 0 lb / acre
  - 300 lb / acre
  - 450 lb / acre
  - 600 lb / acre
- Replicated 4 times
- Put on with a boom

Potassium Chloride on Producing Beds

- Checked for Re-Bloom on August 21st
- No difference in the average number of flowers
  - Re-bloom averaged 1 flower / 4 sq. ft.
  - 11,000 flowers per acre
  - (300 lb. of berries per acre)



% Re-bloom from 0-0-62 Applications

Lb. per acre 0-0-62	Avg. # flowers
0	48.3
300	44.3
450	45.8
600	35.3
Significance	NS

Potassium Chloride on Producing Beds

- Tissue Samples showed high nitrogen levels for mid-July when numbers should be 1.4%.
- Very high nitrogen levels usually give high potassium concentration in the tissue at this time (0.7-0.8%)

Mid-July Tissue Concentrations

	Concentration in %						Concentration in parts per million					
Bed	N	P	K	Mg	Ca	S	Fe	Mn	B	Cu	Zn	Al
44-7	2.02	0.20	0.84	0.22	0.88	0.18	211	443	40	16	101	70
44-8	1.60	0.15	0.70	0.22	0.94	0.17	213	570	43	10	34	50
44-9	1.70	0.15	0.69	0.20	0.87	0.15	180	571	36	12	36	41
44-10	1.57	0.16	0.71	0.21	0.79	0.16	191	475	40	18	49	63

Potassium Chloride on Producing Beds

- How did the 0-0-62 affect Yield?
- This product was put on after fruitset and berries were beginning to size.
- We saw a reduction in yield as 0-0-62 rates increased.

Effect of 0-0-62 on Yield

Pounds per acre 0-0-62	Average Wt. per Berry (grams)	% Yield Reduction
0	1.44	0.00%
300	1.38	4.17%
450	1.30	9.72%
600	1.18	18.06%
Significance	**	**

Potassium Chloride on Producing Beds

- Where does this lead us?
  - No effect on re-bloom
  - yield loss as rates increase
- Avoid the desire to apply high rates of 0-0-62 to influence crop culture

% Re-bloom from 0-0-62 Applications

Lb. per acre 0-0-62	Avg. # flowers
0	48.3
300	44.3
450	45.8
600	35.3
Significance	NS

Potassium Chloride on Producing Beds

- Tissue Samples showed high nitrogen levels for mid-July when numbers should be 1.4%.
- Very high nitrogen levels usually give high potassium concentration in the tissue at this time (0.7-0.8%)

Mid-July Tissue Concentrations

	|------------Concentration in %------------|						|-Concentration in parts per million-|					
Bed	N	P	K	Mg	Ca	S	Fe	Mn	B	Cu	Zn	Al
44-7	2.02	0.20	0.84	0.22	0.88	0.18	211	443	40	16	101	70
44-8	1.60	0.15	0.70	0.22	0.94	0.17	213	570	43	10	34	50
44-9	1.70	0.15	0.69	0.20	0.87	0.15	180	571	36	12	36	41
44-10	1.57	0.16	0.71	0.21	0.79	0.16	191	475	40	18	49	63

Potassium Chloride on Producing Beds

- How did the 0-0-62 affect Yield?
- This product was put on after fruitset and berries were beginning to size.
- We saw a reduction in yield as 0-0-62 rates increased.

Effect of 0-0-62 on Yield

Pounds per acre 0-0-62	Average Wt. per Berry (grams)	% Yield Reduction
0	1.44	0.00%
300	1.38	4.17%
450	1.30	9.72%
600	1.18	18.06%
Significance	**	**

Potassium Chloride on Producing Beds

- Where does this lead us?
  - No effect on re-bloom
  - yield loss as rates increase
- Avoid the desire to apply high rates of 0-0-62 to influence crop culture

Using 0-0-62 on Non-Productive Cranberry Beds

- Did the potassium stay in the soil?
- Three weeks after the application, potassium levels in the soil were the same as when we started.
  - 150 lb 0-0-62 added 77 lb. K
  - 1200 lb. 0-0-62 added 617 lb. K

Using 0-0-62 on Cranberry Beds

- Was hardening off different in September?
- On Sept. 18th
  - No "red" remaining in the runners
  - All appeared to harden off at same rate
  - No upright color differences in plots
  - Tissue concentrations same for plots

Using 0-0-62 on Cranberry Beds

What do we do with these results?

- 0-0-62 didn't slow down vine growth
- Potassium wasn't in soil for a long time
- Hardening off not affected.
- Similar bud development % but size was smaller.

Where should we Look to Maximize our Yields?

(Or, alternatively, determine what is currently limiting our yields)

"My" Yield Limiting Factors in Cranberry Production

- Soil Moisture Levels
- Rates and timing of fertilizers
- Unnecessary use of herbicides
- Poor boom uniformity
- Irrigation Uniformity

What is the effect of irrigation uniformity on yields?

- Selected one bed of Stevens
  - Average yield 239 bbl / acre
- Poor Irrigation Uniformity Coefficient
- Took berry weight and yield
  - System applied too much water
  - System applied optimal moisture

Results: Effect of moisture on yields

- **Berry Weight** (mid-August)
  - Excess irrigation 1.05 grams / berry
  - Good irrigation 1.21 grams / berry
- **Yields** (October)
  - Excess irrigation 182 bbl / acre
  - Good irrigation 297 bbl / acre