

2017

2017 Chart Book: Insect Management

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INSECT MANAGEMENT 2017

Prepared by Anne L. Averill and Martha M. Sylvia

Reducing inputs to cut production costs. Some key insect management practices should be the last ones eliminated to save money. The following are listed in descending order of importance for most bogs. It is seldom advisable to skip the initial cranberry fruitworm spray (the first spray in IPM-based programs when most pinheads have set and berries have begun to size up) unless late water has been held. This first spray targets the largest portion of the population. Inspection for winter moth in early-May and sweep netting in mid-May to detect cranberry weevil, cutworms, gypsy moth, and black-headed fireworm outbreaks is important. It is likely that if insecticide inputs are lowered, black-headed fireworm and weevil levels will increase; *Sparganothis* fruitworm levels should drop. When infestations of weevil or fireworm establish, management inputs must be intensified in subsequent years. Finally, walk the bog both early and late in the season to inspect for damage from soil insects, scale and fireworms to detect pests that can affect the acreage in subsequent years or require renovation.

Start scouting bogs early May. Black-headed fireworm and winter moth larvae may be active early but larvae are difficult to see until mid-May. Always gauge levels of pest caterpillars in their early stages! As the caterpillars of many species grow larger, they cling more tightly to the vine or hide in daytime and are harder to pick up in daytime sweep netting. Small black-headed fireworm caterpillars may cling to the top of the net. Some serious pests are active during and after bloom, especially black-headed fireworm, brown spanworm and cranberry weevil, so it is important to continue scouting during and after bloom. Be aware that some pests, particularly cranberry weevil, gypsy moth, black-headed fireworm, and brown spanworm, may be very patchy or in coves or edges, so thorough assessment of total acreage is essential. Many stages of insects are active only at night and are concealed during the day, such as large cutworms, white grub adults, or some moth species.

Sweep netting. Using a 12" net and 180° sweeps into the vine, sweep netting should be conducted at least once a week. A sweep set consists of 25 sweeps across the bog. The insects in the net should be properly identified, counted, and recorded. Conduct 1 set of 25 sweeps for each acre. For larger pieces (more than 20 acres), at least 1 sweep set/2 acres is advisable. In multiple-acre pieces, calculate the average number of each insect in all of your sweep sets. Treat only after the average numbers of each insect in your series of sweep sets exceeds these values, and after other external concerns have been considered including cost of application, expected returns, weather, etc.

Action Thresholds for Common Cranberry Pests
Based on Average Numbers of Insects in Sets of 25 Sweeps

	AVERAGE #		AVERAGE #
ADD UP: blossomworm, false armyworm, other cutworms, and gypsy moth	4.5	black-headed fireworm	1 to 2
flea beetle	15	<i>Sparganothis</i> fruitworm	1 to 2
brown and green spanworm, winter moth	18	cranberry weevil	4.5 in spring 9 in summer

In sweep net sampling, the average numbers of a pest that we use to trigger a management measure is only a rule of thumb. It serves as an indication that an insect pest is being sampled at numbers that we consider high and worthy of attention. Significant pressure by cranberry weevil and particularly by black-headed fireworm and *Sparganothis* fruitworm should be attended to in the spring; infestations are harder to manage in the summer.

Pheromone traps. Traps can be used for timing management of cranberry girdler, black-headed fireworm, and *Sparganothis* fruitworm and should be up by June 1. Use 1 trap/10 acres. Place on upwind side of bog. Check and clean traps weekly, recording number of moths captured. Change bait every 3 weeks. Check descriptions of adult moths in extension materials because non-target species are sometimes caught.

Based on pheromone trap catches...

For black-headed fireworm: when treating summer generation with Altacor, Intrepid or Confirm, apply insecticide 2 weeks after **onset** of moth flight (~6/20), and again 10 days later. Conventional insecticides (Diazinon or Delegate) should only be used after bloom is over.

For *Sparganothis* fruitworm: if treating with Altacor, Intrepid or Confirm, apply insecticide 3 weeks after the moth flight **begins** (~late June), and again 10-14 days later. Timing for conventional insecticide (Delegate) is 10-14 days after **peak** moth captures, (~mid-to-late July).

For girdler: Refer to the section on cranberry girdler for timing of specific treatments.

CHEMISTRY FAMILIES OF CRANBERRY INSECTICIDES

Altacor (diamide-based compound). Altacor is the first insecticide registered in the diamide class of chemistry, and provides a new mode of action compared to all other classes of insecticides. This compound causes paralysis of the insect by sustained contraction of the muscles. It is an excellent fit in IPM programs in that it is a selective insecticide with low toxicity to beneficial arthropods, most importantly, pollinators. In addition to exhibiting excellent activity against our key lepidopteran pest (cranberry fruitworm), it also has long residual activity and is safe to key natural enemies. A good chemigation system, under 6 minutes, is likely necessary to get good efficacy. Ground applications using at least 30 gallons of water per acre, and preferably between 100-150 gallons per acre, may be the most effective applications. Must target eggs and tiny larvae only, this compound will not manage larger caterpillars effectively. This is the pollinator-safe compound we have been waiting for!

***Bacillus thuringiensis* (B.t.) based products.** Examples labeled in cranberry are Dipel, Xentari, Crymax and Biobit. These compounds are most effective when applied multiple times and in low gallonage against small caterpillars feeding on foliage. Well-timed chemigation systems are critical for good efficacy (6 minutes or less rinse time). Thorough coverage is essential and repeat applications may be necessary. *Early attention to infestation is critical.* Caterpillars stop feeding after eating compounds but may take several (3-10) days to die. Use aerial application or low-volume ground applications when possible to improve performance.

Intrepid and Confirm (Insect growth regulator products). Growth regulators are caterpillar-specific and conserve natural enemies and pollinators. These compounds need to be eaten to work. These compounds are most effective when applied multiple times and in low gallonage against small caterpillars feeding on foliage. The best choice is Intrepid, which has higher activity than Confirm, but Intrepid is restricted use and is Zone II restricted. Use aerial application or low-volume ground applications when possible to improve performance. Coverage and well-timed chemigation systems are critical for good efficacy (6 minutes or less rinse time); excessive chemigation washout will remove active material. A spray adjuvant should be used. 6 hours drying time following application is required. New vine growth is not protected. Larval death may not be observed until a week or more has passed. Pollinator safe!

Spinosyn-based products. These include Delegate and Entrust (an organic formulation). Delegate is the more active and provides longer residual control than Entrust; Delegate is the compound of choice. Spinosad-based products are fast-acting nerve poisons but are still reduced-risk compounds. Allow 7 days between applications. These compounds are the better choice (compared to Intrepid or Confirm) once the caterpillars have reached a larger size. For Delegate, only use lower rates if rinse time is 4 minutes or less. Keep in mind that spinosyn products can be toxic to natural enemies and are **highly** toxic to bees. Sprays made over bees when they are actively foraging must be avoided (this includes Entrust, even though it is an organic formulation!). However, dried residues are essentially non-toxic. If treating during bloom, be sure that overnight conditions are such that evening chemigation applications will dry by morning.

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Neonicotinoid products. Neonicotinoids are a relatively new class of chemicals that act on the neurotransmitters of the insect. They bind the nicotinic acetylcholine receptors leading to hyperexcitation of the nervous system resulting in death. Neonicotinoids have low human toxicity and have been heavily adopted in other crops. Research has shown that the neonicotinoids have long-term detrimental effects on bee populations. They are the most toxic insecticides to bees. There are a number of neonicotinoid compounds registered in cranberry including Actara (thiamethoxam), Assail (acetamiprid), Belay (clothianidin), Scorpion (dinotefuran) and Admire (imidacloprid). While these compounds could help manage our insect complex, the risks to bees have made them undesirable. If you choose to use them, do so after bloom and be aware of bee toxicity and long-term residues for export qualified fruit.

Organophosphate and carbamate products. Organophosphate and carbamate products are an older class of chemicals that are nerve agents acting on the enzyme acetylcholinesterase. These compounds are generally acutely toxic to bees, wildlife and humans. Parathion and Guthion have been banned for use in cranberry. Lorsban, Diazinon, Imidan, Orthene and Sevin remain in use although much reduced. Sparganthis fruitworm, Cranberry weevil, tipworm and leafminers are resistant to this chemistry.

NOTE: Restricted Use Pesticides (Actara, Diazinon, Intrepid, Lorsban, and Scorpion)

A private applicator certification is required to purchase, handle and apply these compounds to your bog.

BEES!! MOST INSECTICIDES ARE HIGHLY TOXIC TO BEES, ESPECIALLY DIRECT APPLICATIONS AND RESIDUES. DO NOT APPLY OR ALLOW TO DRIFT TO CRANBERRIES IN BLOOM OR NEARBY BLOOMING PLANTS/WEEDS IF BEES ARE FORAGING. REMOVE HONEY BEE HIVES OR ADVISE BEEKEEPER IF SPRAYS ARE APPLIED. REMEMBER THAT NATIVE WILD BEES, SUCH AS BUMBLE BEES, ARE ALSO VULNERABLE TO SPRAYS APPLIED AT BLOOM AND THAT POPULATIONS WILL DWINDLE OVER TIME IF THEY ARE NOT PROTECTED.

CRANBERRY WEEVIL

Bolded selections are the best choices for management. All rates are per acre.

Actara <i>thiamethoxam</i>	2-4 oz	Effective against both spring and summer adult populations. Do not apply in spring if possible, neonicotinoid gets into pollen and nectar. Lower rates effective. Restricted Use and Zone II restricted. Do not apply by air or to flow-through bogs. Highly toxic to bees – do not apply within 5 days of bee arrival. Hold water 5 days.
*Belay <i>clothianidin</i>	4 fl oz	Use only for summer adult populations after bees are gone. Highly toxic to bees and for more than 5 days after treatment! 12-hr REI, 21-day PHI. If you use Belay for weevil, you cannot use it for soil application. Label being pulled from cranberry, use existing stocks. *Beware, handler restrictions.
Avaunt <i>indoxacarb</i>	6 oz	<u>Effective against spring weevil populations only.</u> Do not use after bloom against weevil in summer. Only 2 apps allowed targeting weevil in spring, prior to bloom. 7 days between applications. No flow-through bogs, hold water 1 day. Toxic to bees.

Action threshold is an average of 4.5 weevils in 25 sweeps for spring population, and 9 weevils in summer. Summer feeding is not as damaging as spring feeding and egg-laying. Adult weevils are found throughout the growing season. Sweep-net for weevil when warm, sunny, and calm. Let net contents settle: weevils "play dead" when disturbed. Do not count non-pest gray weevils. Spring weevils move in from the woods and blueberry outside the bog; consult sweep records from previous years to determine invasion pattern. Even if threshold is exceeded, sometimes it is advisable to wait 1-2 weeks in spring to treat. Weevil numbers may continue to rise as more weevils move in. However, waiting too long becomes risky if blossom buds have appeared and eggs are being laid. Late water is not effective against weevil.

EARLY SEASON CATERPILLARS

CUTWORMS (BLOSSOMWORM, FALSE ARMYWORM), HUMPED GREEN FRUITWORM AND GYPSY MOTH

Bolded selections are the best choices for management. All rates are per acre.

Assail 30 SG	4.0-6.9 oz	7 days between apps, 2 apps maximum.
Avaunt	6 oz	FIFRA 2EE recommendation. 7 days between applications, do not use on flow-through bogs, hold water 1 day.
Dipel ES Biobit, Xentari, Dipel DF, Crymax	1-4 pt 0.5-2 lb	<i>Bacillus thuringiensis (B.t.)</i> products. Multiple applications, addition of an adjuvant, and good coverage in low gallonage are essential. See product discussion page 19.
Delegate WG (spinetoram)	3-6 oz	Do not exceed 19.5 oz/season. 7 days between apps. Only use lower rates if rinse time is 4 minutes or less.
Diazinon 50 W Diazinon AG 500 Diazinon AG 600	4-6 lb 2-3 qt 51-76.5 fl oz	FIFRA 2EE recommendation. Hold water for at least 3 days. 5-day REI!! 3 apps/season, 7-day PHI, and 14-day spray interval, except AG500 which has a 7-day minimum spray interval.
Intrepid 2F Confirm 2F	10-16 fl oz 16 fl oz	Insect growth regulator products, these compounds need to be eaten. Intrepid is more active and has greater residual than Confirm. Note Intrepid is restricted use and Zone II restricted. See product discussion on page 19. Safe for pollinators and natural enemies.
Lorsban 4E, Nufos 4E Chlorpyrifos 4E AG Lorsban Advanced, Hatchet Lorsban 75 WG	3 pt 2 lb	2 apps/season. Do not mix with other insecticides. Observe 60-day PHI. Impound water for 5 days, then release gradually. Note: 75 WG formulation is not restricted use. Use up existing stores; EPA may cancel.
Orthene 97, Acephate 97, Acephate 97 UP, 97 WDG Acephate 90 WSP, 90 WDG Acephate 90 Prill	1 lb 1.1 lb	Do not apply within 10 days of start of bloom due to bee concerns. 1 app/season. Observe 90-day PHI, except 75-day PHI with some Acephate 90, 97, 97UP only – check label.
Sevin XLR Plus, Sevin 4F, Carbaryl 4L	1.5-2 qt	5 applications/season, 7-day spray interval, 7-day PHI.
Late Water	Starting April 15-20, hold water for 30 days to manage cutworms. For Gypsy Moth, holding late water kills eggs laid on the bog as well as prevents establishment of tiny caterpillars that drift in from infested uplands. See Late Water section, page 77.	
Spring Flood	Flood in mid-late May, 24 hour reflow to manage cutworms, 48 hour to impact fireworm. Care must be observed as these floods must be completed before roughneck stage or likely to increase fruit rot and seriously reduce the crop.	

The action threshold for cutworms is an average of 4.5 larvae per 25 sweeps. Count all cutworms and gypsy moths together. Very young false armyworm caterpillars are whitish with black spots, each with a black spine. These caterpillars tend to loop like spanworms but gradually drop this movement. Early detection is important because they consume the terminal buds before new growth starts. As cutworms get older, they will not be picked up in day sweeps. Night sweeps may be required to gauge infestation at that point.

For Gypsy Moth, check for patchy infestations and spot treat, i.e., along edges facing uplands with infested trees. Populations may reoccur as larvae balloon in. Check previously infested areas - eggs can overwinter on flooded bogs.

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SPANWORMS

(GREEN SPANWORM, BROWN SPANWORM, BIG CRANBERRY SPANWORM, WINTER MOTH)

Bolded selections are the best choices for management. All rates are per acre.

Avaunt	6 oz	7 days between apps, no flow-through bogs, hold water 1 day.
Dipel ES Biobit, Xentari, Dipel DF, Crymax	1-4 pt 0.5-2 lb	<u><i>Bacillus thuringiensis (B.t.)</i></u> products. Multiple applications, addition of an adjuvant, and good coverage in low gallonage are essential.
Delegate WG (spinetoram)	3-6 oz	Do not exceed 19.5 oz/season. 7 days between applications. Only use lower rates if rinse time is 4 minutes or less. If infestation appears during bloom, remember this compound is highly toxic to bees, but dried residues are non-toxic; thus, sprays must go on at night and dry by morning.
Imidan 70W	1.33-4 lb	Efficacy may be reduced at pHs found in bog water (pH 6-7). REI of 3 days, 10-day spray interval, 14-day PHI. Beware bee toxicity.
Intrepid 2F Confirm 2F	10-16 fl oz 16 fl oz	Insect growth regulator products, these compounds need to be eaten. Intrepid is more active and has greater residual than Confirm. Note Intrepid is restricted use and Zone II restricted. See product discussion on page 19. Safe for pollinators and natural enemies.
Lorsban 4E, Nufos 4E Chlorpyrifos 4E AG Lorsban Advanced, Hatchet Lorsban 75 WG	3 pt 2 lb	<u>Poor choice for most bogs</u> , nearly all populations are resistant. Limit 2 apps/season. Observe 60-day PHI. Impound water for 5 days, then release gradually. Note: 75 WG formulation is not restricted use. Use up existing stores; EPA may cancel.
Orthene 97, Acephate 97, Acephate 97 UP, 97 WDG Acephate 90 WSP, 90 WDG Acephate 90 Prill	1 lb 1.1 lb	Do not apply within 10 days of start of bloom due to bee concerns. 1 app/season. Observe 90-day PHI, except 75-day PHI with some Acephate 90, 97, 97UP only – check label.
Pyganic EC 1.4 Pyganic EC 5.0	16-64 fl oz 4.5-18 fl oz	Spot treating using low gallonage may be helpful for patchy infestations. Beware bee toxicity – do not apply when bees are present.
Sevin XLR Plus, Sevin 4F, Carbaryl 4L	1.5-2 qt	FIFRA 2ee recommendation for winter moth. Limit 5 apps/season, 7-day spray interval, 7-day PHI.
Late Water		Holding late water kills eggs laid on the bog as well as prevents establishment of tiny caterpillars that drift in from infested uplands. See Late Water section.

Scout for winter moth much earlier than other spanworms. Winter moth is a spanworm species and is likely present as early as **May 1**. If you have a history of winter moth infestation, you may need to apply a prophylactic spray early in the season. Populations may reoccur as larvae balloon in. Injury may be done to the developing tips before populations can be detected, resulting in no crop!

The action threshold for spanworm is an average of 18 small larvae in 25 sweeps. Threshold may be lowered for large larvae. **Be aware of brown spanworm infestations during bloom** that may be patchy. Newly hatched brown spanworms cling like thin threads to the inside of the net. For big cranberry spanworm, the action threshold is 4.5 in 25 sweeps. As spanworms get older, they will not be picked up in day sweeps.

Green spanworm caterpillars start to appear in early season sweeps; brown spanworm caterpillars appear later. A flight of brown moths in June may be an indication of a brown spanworm problem but only target caterpillars with sprays! Big cranberry spanworms appear in mid-June. They can be very destructive, occurring in patches. Caterpillars are dark brown with bumps across their back and grow to 2.5" in size. Spot treating may work. Other miscellaneous spanworms appear in patches and grow larger than the common green and brown spanworm, so it may be advisable to lower the action threshold by half if these infestations occur.

BLACK-HEADED FIREWORM

Bolded selections are the best choices for management. All rates are per acre.

Altacor	3-4.5 oz	Low rinse time required for efficacy. Must target eggs or tiny larvae only. See product discussion on page 19.
Avaunt	6 oz	7 days between applications. 30-day PHI. Do not use on flow-through bogs, hold water 1 day.
Delegate WG (spinetoram)	3-6 oz	Do not exceed 19.5 oz/season. 7 days between apps. Only use lower rates if rinse time is 4 minutes or less. If infestation appears during bloom, remember this compound is highly toxic to bees, but dried residues are non-toxic; thus, sprays must go on at night and dry by morning.
Diazinon 50 W	4 lb	It is advisable to hold water for at least 3 days. 5-day REI!! 3 applications/season, 7-day PHI, and 14-day spray interval, except AG500 which has a 7-day spray interval. Do not apply during bloom.
Diazinon AG 500	2 qt	
Diazinon AG 600 WBC	51 fl oz	
Imidan 70W	1.33-4 lb	Efficacy may be reduced at pHs found in bog water (pH 6-7). REI 3 days, 10-day spray interval, 14-day PHI.
Intrepid 2F	10-16 fl oz	Insect growth regulator products; these compounds need to be eaten to work. Intrepid is more active and has greater residual than Confirm. Note Intrepid is restricted use and Zone II restricted. See product discussion on page 19. Safe for pollinators and natural enemies.
Confirm 2F	16 fl oz	
Lorsban 4E, Nufos 4E Chlorpyrifos 4E AG	3 pt	2 apps/season. Observe 60-day PHI. Impound water for 5 days, then release gradually. Note: 75 WG formulation is not restricted use. Use up existing stores; EPA may cancel.
Lorsban Advanced, Hatchet Lorsban 75 WG	2 lb	
Orthene 97, Acephate 97, Acephate 97 UP, 97 WDG	1 lb	Do not apply within 10 days of start of bloom due to bee concerns. 1 app/season. Observe 90-day PHI, except 75-day PHI with some Acephate formulations – check label.
Acephate 90 WSP, 90 WDG Acephate 90 Prill	1.1 lb	
Sevin XLR Plus Sevin 4F, Carbaryl 4L	1.5-2 qt	5 applications/season, 7-day spray interval, 7-day PHI.
Spring Flood		Flood in May for 48 hours, see page 31.

Watch out: Fireworm can be a very serious problem! *Best approach is to start inspecting in early spring.* This pest is easy to manage if infestation is detected early. Larvae hatch in mid-May; even earlier in warm springs. While sweeping in May, look for very small, hard-to-see larvae on the net rim. Small larvae are less likely to be picked up in the net than larger larvae. Infestations are often patchy and more numerous along edges, where vines are overgrown, where leaf trash has accumulated, or where winter flooding was withdrawn early. Spot treatment is desirable here.

2nd generation is active during bloom. Use pheromone traps to time management of 2nd generation. Black-headed fireworm moths are only 1/4" long and are black and gray; be aware that the pheromone trap often picks up a much larger, non-pest moth. When treating summer generation with growth regulators (Intrepid or Confirm) or Altacor, timing is 2 weeks after **onset** of moth flight (~6/20), and again 10 days later. Do not use conventional insecticides (Diazinon, Lorsban, Orthene or Sevin) during bloom, it is illegal and will interfere with pollination. **Infestations move rapidly!** **Spring generation is a much easier target than the second generation (occurs during bloom).**

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YELLOW-HEADED FIREWORM

Lorsban, Orthene, Sevin, and spinosyn products (**Delegate** and Entrust) can be used as specified for black-headed fireworm (see previous page). **Intrepid** and **Diazinon**, FIFRA 2EE recommendations, can be used as specified for black-headed fireworm (previous page).

Yellow-headed fireworm may appear on beds that are not completely flooded in the winter. Eggs hatch in May. Caterpillars are all yellow and are impossible to distinguish from Sparganothis. It is often the case that totally winter-flooded beds have Sparganothis and partially, poorly winter-flooded beds, have yellow-headed fireworm. The yellow-headed fireworm pupa has a knob at its top, which Sparganothis pupae do not.

SPARGANOTHIS FRUITWORM

Bolded selections are the best choices for management. All rates are per acre.
*** indicates restrictions from handlers. Please check with handler before using.**

Altacor	3-4.5 oz	Low rinse time required for efficacy. Must target eggs and small larvae. See page 19 for product discussion.
Assail 30 SG	4.0-6.9 oz	7 days between apps, 2 apps.
Delegate WG (spinetoram)	3-6 oz	Do not exceed 19.5 oz/season. 7 days between applications. Only use lower rates if rinse time is 4 minutes or less.
Intrepid 2F	10-16 fl oz	Insect growth regulator products; these compounds need to be eaten to work. Intrepid is more active and has greater residual than Confirm. Note Intrepid is restricted use and Zone II restricted. See product discussion on page 19. Safe for pollinators and natural enemies.
Confirm 2F	16 fl oz	
*Lorsban 4E, Nufos 4E Chlorpyrifos 4E AG Lorsban Advanced, Hatchet	3 pt	<u>Poor choice for most bogs</u> , nearly all populations are resistant. Limit 2 apps/season. Do not mix with other insecticides. Observe 60-day PHI. Impound water for 5 days, then release gradually. Note: 75 WG formulation is not restricted use.
*Lorsban 75 WG	2 lb	Use up existing stores; EPA may cancel.
*Orthene 97, Acephate 97, Acephate 97 UP, 97 WDG	1 lb	<u>Poor choice for most bogs</u> , nearly all populations are resistant. Do not apply within 10 days of start of bloom due to bee concerns. 1 app/season. Observe 90-day PHI, except 75-day PHI with some Acephate formulations – check label.
*Acephate 90 WSP, 90 WDG Acephate 90 Prill	1.1 lb	

Small Sparganothis caterpillars are picked up in the sweep net in mid-May. Check for caterpillars in yellow loosestrife tips that have rolled leaves; this will give you an idea of the larva's appearance so you can ID them in the net. The 2nd generation in July feeds on both fruit and foliage. With both generations, always target the small caterpillars. Keep an eye on large-fruited cultivars, which tend to be hardest hit; Howes the least. The 2nd generation feeding on larger fruited cultivars develop faster and may feed inside the fruit.

Beginning in June, use pheromone traps to determine moth flight. When managing 2nd generation population, you want to target caterpillars as they are hatching, not the adult moths. If treating with growth regulators (Confirm or Intrepid) or Altacor, apply insecticide 3 weeks after the moth flight begins, (~late June), and make at least one more application 10-14 days later. When treating with Delegate, apply 10-14 days after peak moth captures (~mid-to-late July).

Nearly all Sparganothis populations are resistant to the organophosphates, including Lorsban and Orthene. Intrepid and Delegate are excellent alternatives and good choices. Late water has not been shown to be effective against this insect, but it does synchronize moth emergence.

CRANBERRY FRUITWORM

This is the number one insect pest on cranberry and is present on all bogs. Moths are flying in June just waiting for any pinheads to start sizing up. For most bogs, a properly timed first cranberry fruitworm spray is the most important one of the season. Large-fruited varieties will be hardest hit with egg-laying. Management of Howes should be later than all other varieties as berries are later to size up.

Bolded selections are the best choices for management. All rates are per acre.

Late Water Holding late water is an excellent cultural practice that severely reduces fruitworm. However, moths may move into late water-treated beds from other areas of infestation, so it is advisable to spot check for eggs. Refer to Late Water Practice for fruitworm on next page.

Early fruitworm spray options, when bloom is present (~6/20-7/10):

Altacor <i>chlorantraniliprole</i>	3-4.5 oz	<p><u>Highly recommended</u> for first fruitworm at 50% out of bloom for all varieties, except on Howes wait 7 days. This compound is superior to all others and targets the eggs as they hatch. Timing is end of June, early July. This compound should NOT be used as a “clean-up” spray after mid-July, it does not work well on larger larvae.</p> <p>2 applications are allowed but they should be spaced at least 7 days apart while spacing at 10-14 days is better as it has very long residual. Low rinse time required for efficacy. Do not exceed 9 oz/season. Bee safe!</p>
Intrepid 2F <i>methoxyfenozide</i>	10-16 fl oz	<p>This compound will work OK on fruitworm eggs as they hatch. It allows some larvae to get into fruit before dying.</p> <p>Zone II restricted. Ground applications only are highly effective. Chemigation gives moderate to good level of control in well-timed systems. It gets watered down in chemigation systems. 4 applications allowed at the 16 oz rate. Medium-lived residual. Safe for bees and natural enemies!</p>
Delegate WG <i>spinetoram</i>	3-6 oz	<p>Excellent compound but doesn't last as long as Altacor. Effective for both egg and larvae management. Better choice for later applications after Altacor is used. Medium-lived residual.</p> <p>3 applications allowed at the 6 oz rate. Do not exceed 19.5 oz/season. Highly toxic to bees, but thoroughly dried residues are safe. Thus, sprays must go on at night and dry by morning if sprayed during bloom.</p>

Later fruitworm spray options, once bloom is gone (after 7/10):

Assail 30 SG <i>acetamiprid</i>	4.0-6.9 oz	Toxic to bees. 7 days between applications, 2 apps maximum, 1-day PHI. Only short-lived residual.
Delegate WG <i>spinetoram</i>	3-6 oz	Highly toxic to bees. Effective for both egg and larvae management. Best choice for later applications after Altacor is used. Medium-lived residual.
Diazinon 50 W Diazinon AG 500 Diazinon AG 600 WBC <i>diazinon</i>	4-6 lb 2-3 qt 51-76.5 oz	Highly toxic to bees. It is advisable to hold water for at least 3 days. 5-day REI!! 3 applications/season, 7-day PHI, and 14 days between sprays, except AG500 which has a 7-day minimum. Only short-lived residual. Do NOT apply during bloom.
Imidan 70W <i>phosmet</i>	1.33-4 lb	Highly toxic to bees, label disallows spray during bloom. Efficacy results have been variable. If chosen, use higher rate. Efficacy may be reduced at pHs found in bog water (pH 6-7). REI of 3 days, 10-day spray interval, 14-day PHI.

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Later fruitworm spray options, once bloom is gone (after 7/10) continued:

Lorsban 4E, Nufos 4E Lorsban Advanced, Hatched Chlorpyrifos 4E AG	3 pt	Highly toxic to bees. 2 apps/ season. Observe 60-day PHI. Impound water for 5 days, then release slowly. Note: 75 WG formulation is not restricted use. Handler restrictions, beware. Only short-lived residual.
Lorsban 75 WG <i>chlorpyrifos</i>	2 lb	
Sevin XLR Plus Sevin 4F, Carbaryl 4L <i>carbaryl</i>	1.5-2 qt	Highly toxic to bees. Limit of 5 applications/season. 7-day spray interval, 7-day PHI. Most handlers restrict use after August 1. Only short-lived residual.

CRANBERRY FRUITWORM MANAGEMENT

FOR ALL PRACTICES

1. Every pump system should be scouted separately as one piece.
2. To be valid, sampling of berries by size and bog area must be random because moths select larger berries particularly along bog margins and inner ditches.
3. Use a magnifier to look for eggs. Look at eggs carefully to be sure they are alive. As you move into the season, many eggs are dead or parasitized. Do not count these.
4. Target only eggs. Do not treat in attempt to control caterpillars in the fruit. Research shows that sprays made after caterpillars have entered fruit are minimally effective.
5. For beds with very high fruitworm pressure and large fruited varieties, it is advised to apply Altacor or Intrepid even before or at 50% out-of-bloom. There is no risk to pollinators with these compounds.
6. Timing first spray using % out of bloom: In the event of unusually warm or cool weather during fruit set it is advisable to shorten or lengthen accordingly the interval between 50% out-of-bloom and the first spray.
7. It is not necessary or advised to mix compounds for effective control.

STANDARD PRACTICE

Timing of this first spray is critical. If fruitworm pressure has been high in previous years and berries are sizing up, spray should occur very soon after 50% OOB in early cultivars. Altacor is the compound of choice for during-bloom sprays. Intrepid is not as effective but can be used. Delegate, sprayed only at night when residues can be dried by morning, is another choice but is better saved for the 2nd or 3rd fruitworm spray. Keep in mind that all other insecticides are highly toxic to bees, and labels do not allow application during bloom.

1st TREATMENT - CALCULATE % OUT-OF-BLOOM

(# of blossoms that have lost petals or become fruits)

To properly time your first spray, you must calculate the % out-of-bloom every couple of days as pinheads start to form, usually around the end of June. You are trying to accurately assess when 50% OOB occurs. For each acre of bog, randomly collect 10 uprights and record the number of pods, flowers, pinheads, and fruit.

Calculate using the following:

$$\% \text{ out-of-bloom} = \frac{\text{total number of pinheads and fruit}}{\text{total number pods, flowers, pinheads, and fruit}} \times 100$$

For Early Blacks, Ben Lears, Stevens and large-fruited hybrids -- Apply 1st treatment 0-7 days after 50% out-of-bloom. For Howes -- Apply 1st treatment 7-9 days after 50% out-of-bloom.

2nd TREATMENT - Apply 2nd treatment about 10 days after 1st treatment.

ADDITIONAL TREATMENTS - MONITOR EGGS TO TRIGGER SPRAYS

One week after your 2nd treatment, inspect 50 randomly picked berries/A (with a minimum of 200 berries per piece, no matter how small piece is) for viable eggs. Follow guidelines in table below to determine necessity of additional sprays. If egg numbers trigger a spray, spray ASAP. If no egg is found, repeat berry inspection process every 3-4 days until Aug. 15 or longer if eggs are still being detected.

SCOUTING PRACTICE

1st TREATMENT - CALCULATE % OUT-OF-BLOOM (# of blossoms that have lost petals or become fruits)

Apply 1st treatment 0-7 days after 50% out-of-bloom for Early Blacks, Ben Lears, Stevens and large-fruited hybrids, apply 7-9 days after 50% out-of-bloom (half the blossoms have lost all petals or become fruits) for Howes. *If fruitworm pressure has been high in previous years and berries are sizing up, spray timing is critical and should not be delayed long after 50% OOB has been reached.*

ADDITIONAL TREATMENTS USING SCOUTING PRACTICE

Five days after treatment, inspect 50 randomly picked berries/A (with a minimum of 200 berries per piece) for eggs. Follow guidelines in table below to determine necessity of additional sprays. If egg numbers trigger a spray, spray ASAP. If no egg is found, repeat berry inspection process every 3-4 days until Aug. 15.

LATE WATER PRACTICE

Late water may effectively reduce fruitworm pressure. It is possible that sprays can be eliminated for cranberry fruitworm but berries must be monitored for eggs throughout the fruitworm season as the moths are very mobile and may move into your bog from external sources.

TREATMENTS - MONITOR EGGS TO TRIGGER SPRAYS

As fruits set, begin inspecting 50 randomly picked berries/A (with a minimum of 200 berries per piece) for eggs. Follow guidelines in table below to determine necessity of spray. If egg numbers trigger a spray, spray ASAP. If no egg is found, repeat berry inspection process every 3-4 days until Aug. 15. If fruitworm pressure is low through fruit set, it may be safe to extend intervals between berry sampling dates.

TABLE USED (for all practices) TO DETERMINE NECESSITY OF MAKING A SPRAY

Number of acres	Number of berries checked	Number of viable eggs needed to trigger spray
0-5	200-250	1
5-7	251-350	2
7-9	351-450	3
9-11	451-550	4
11-13	551-650	5
13-15	651-750	6
for each additional 2 acres	add 100 berries	add 1 egg

SOIL INSECTS

SCARAB GRUBS

Admire Pro Alias 4F, Nuprid 4F, Wrangler	7-14 fl oz 8-16 fl oz	<i>Imidacloprid</i> products, rate per acre. Use soil drench treatment for oriental beetle. May suppress cranberry root grub and cranberry white grub, but data are lacking and multiple years likely required to see effect. Limit 2 apps/season but 1 app at higher rate is recommended. No aerial app, 30-day PHI. <i>Best results are achieved when the compound is present just prior to egg hatch—timing is post bloom immediately after bees are removed. Oriental beetle flight can be monitored with pheromone traps starting in late June-early July. Application should be made 3 weeks after peak flight of the beetles (or slightly earlier).</i> Irrigate before and after application, but do not apply to saturated soil. Compound has very long soil residual. Highly toxic to bees; do not apply when pollinators are on bog.
Admire 2F, Alias 2F, Nuprid 2SC, Widow	16-32 fl oz	
*Belay <i>clothianidin</i>	12 fl oz	Highly toxic to bees. Apply as a soil drench after bees are removed or all bloom gone. 12-hr REI, 21-day PHI. If you use Belay as a soil drench, you cannot use it as a foliar application on weevil, flea beetle or fruitworm. Total amount allowed is 12 oz. Label being pulled from cranberry, use existing stocks. *Beware, handler restrictions.
Summer flood		Remove winter flood, allow bog to dry out. Reflow mid-May and keep well flooded until mid-July. This will eliminate cranberry root grub and cranberry white grub larvae, as well as the crop for that year. Oriental beetle and <i>Hoplia</i> are also likely impacted.

Cranberry root grub - grubs turn into low-flying beetle adults that look like bumblebees; they emerge from the soil during cranberry bloom and set. Males fly after dawn through mid-morning.

Cranberry white grub - grubs turn into large-bodied "June bugs" as adult beetles and are active in the evening in May and June.

Oriental beetle - small beetle (5/8 inch), vary greatly in color and pattern from light brown to black. Grubs develop over two years and are similar in appearance to small white grubs. An adult sex pheromone trap is available.

Hoplia equina - adult beetles emerge synchronously from the soil during bloom in late afternoon. The small brown beetles are about 5/16 inch in size. The grubs develop over two years and are similar in appearance to small white grubs.

In the spring, look for grubs in both root layer and lower soil associated with areas of weak or dying vines. Because it is unknown if Oriental Beetle and *Hoplia* respond to summer flooding, let us know if you summer flood for these species. In grub-infested areas, try to avoid stress to vines such as high doses of Casoron and drought. For *Hoplia* only, there is some evidence of nematode efficacy. Call Marty (508-295-2212 x20) at the Cranberry Station for additional advice.

BLACK VINE WEEVIL AND STRAWBERRY ROOT WEEVIL

Nematodes	Availability limited—need to plan ahead and order well in advance of application. Target immatures in soil. Apply in early evening in May and/or September. Best results occur when soil temperatures are higher than 56°F. Irrigate before and after application.
Fall Flood	Flood for 10-14 days as soon as possible after harvest. May also negatively impact vines. Warmer water enhances effectiveness.
Winter Flood	If you can winter flood, populations should be less abundant.

In the spring, look for grubs in soils of areas with dying vines (often near bog edge) that may have an orange halo of vines around edges. Grubs feed on the bark of the vine. Adult beetles emerge in June; they must feed for about 4 weeks before egg-laying starts. Night sweep for weevils at edge of weevil-damaged areas, starting after dusk but before dew forms mid-June through July. Notched new foliage indicates adult feeding. Sweep when vines are dry. These pests are more abundant in bogs with no winter flooding or high spots.

CRANBERRY GIRDLER

Nematodes	Availability limited—need to plan ahead and order well in advance of application. Apply Nematodes 2 weeks after end of moth flight. Target immatures in soil.
Fall Flood	Flood for 1 week, at end of September. Vines must be completely covered. These floods are best done when fruits have been removed. Research shows that this flood timing may negatively impact vine health.
Regular Sanding	Sanding with 1-3 inches every 3rd year will reduce favorable girdler habitat.

In June through July, appearance of silvery-white moths with a "snout" on front of head that make short, jerky flights as you walk through the vines may signal a problem. If there is a history of girdler on your bog, use pheromone traps to time treatments. Be aware of girdler's true appearance; a very similar non-pest moth is also picked up in traps. A bad girdler infestation can exist even with low pheromone trap catches. Just below the trash line, look for old feeding damage that may be quite deep in the wood of the vine. Thorough trash flows are beneficial.

STRIPED COLASPIS

Admire Pro	7-14 fl oz	<i>Imidacloprid</i> products. Soil drench targets immatures in soil. When adult beetles are picked up in net, application should be made to target larvae as eggs hatch. Compound has very long soil residual. No aerial application. Limit 2 apps/season, but 1 app at higher rate is recommended. Irrigate before and after application. Highly toxic to bees; apply after bloom in mid-late July. 30-day PHI.
Alias 4F, Nuprid 4F Wrangler	8-16 fl oz	
Admire 2F, Alias 2F, Nuprid 2SC, Widow	16-32 fl oz	
Diazinon 50 W	4-6 lb	FIFRA 2EE recommendation targets adults. It is advisable to hold water for at least 3 days. Check labels; most 3 apps/season, 5-day REI, 7-day PHI, 14-day spray interval, except AG500 which has 7-day minimum spray interval.
Diazinon AG 500	2-3 qt	
Diazinon AG 600 WBC	51-76.5 fl oz	
*Sevin XLR Plus Sevin 4F & Carbaryl 4L	1.5-2 qt	FIFRA 2EE recommendation targets adults. Do not apply when bed is in bloom. 5 apps/season, 7-day spray interval, 7-day PHI. *Beware, handler restriction.

Imidacloprid (Admire/Alias) should target hatching eggs in the soil. Diazinon and carbaryl (Sevin) sprays should target adults being picked up while sweep netting. Highly toxic to bees; advise beekeepers to remove or cover hives before application; these daytime applications will kill native bees foraging during bloom. The striped colaspis beetles are ca. 1/6" long and oblong-oval. Head area is metallic greenish-black and wings blackish, striped with yellow. Legs and antennae are yellow.

Grubs in soil feed in root area, killing vines. Adult feeding results in distinct notching in top leaves of uprights, particularly in infested area.

MISCELLANEOUS PESTS

CRANBERRY TIPWORM

Early season tipworm injury often is high, but good vine health enhances rebudding. Appearance of injury does not mean that insects are still present. Only very late-season injury, which is rare, appears to consistently reduce yield. Stressful vine conditions in the year of injury may also result in yield reduction. Diazinon is labeled for tipworm, but control is very poor. Sprays are strongly discouraged for this insect.

CRANBERRY FLEA BEETLE

Bolded selections are the best choices for management. All rates are per acre.
*** indicates restrictions from handlers. Please check with handler before using.**

Actara	2-4 oz	May only provide suppression of flea beetle. Restricted Use and Zone II Do not apply by air or to flow-through bogs. Hold water 5 days!
Delegate WG	3-6 oz	FIFRA 2EE recommendation. Delegate may only provide suppression of flea beetle. Do not exceed 19.5 oz/season. 7 days between applications.
Imidan 70W	1.33-4 lb	FIFRA 2EE recommendation. Efficacy may be reduced at pHs found in bog water (pH 6-7). REI of 3 days, 10-day spray interval, 14-day PHI.
*Sevin XLR Plus Sevin 4F, Carbaryl 4L	1.5-2 qt	5 applications/season, 7-day spray interval, 7-day PHI. Beware, most handlers restrict use after August 1.
Diazinon 50 W	4-6 lb	FIFRA 2EE recommendation. Hold water for at least 3 days.
Diazinon AG 500	2-3 qt	Check labels; most are 3 apps/season, 5-day REI, 7-day PHI, and
Diazinon AG 600 WBC	51-76.5 fl oz	14-day spray interval, except AG500 which has a 7-day minimum.

Adult flea beetles are active in late July through September. Beetles and their feeding injury are very patchy, often in areas of lush vine. High levels of beetle feeding can impact bud development for the following year. Firm thresholds have not been quantified, but sweep net counts of 15 per 25 sweeps on average over all acreage is the trigger to consider management.

SOUTHERN RED MITE (SRM)

Nexter	3.5-7.0 oz	2 apps/season. Ground and chemigation only – no aerial application. Hold water for 3 days after application. No flow-through bogs. 5 hours of drying time required.
*Oberon	12-16 fl oz	FIFRA 2EE recommendation, but efficacy data are needed for SRM. Apply by ground and chemigation only – no aerial application. Hold water 1 day after app, 12-hr REI. *Handler restrictions.
Late Water	Research shows that late water can eliminate mites in the year that the flood is held. In the second year following late water, mite pressure may still be low. See Late Water Section.	

Look for tiny red mites in sweep net and for red/orange streaks on rim of net or white card. Use a 10X magnifier to examine leaves to determine that mites are present; misidentifications frequently occur. Areas of discolored vines late in the season are often an indicator of mite infestation.

MANAGEMENT NOTES FOR ALL INSECT RECOMMENDATIONS

1. **READ AND FOLLOW LABEL INSTRUCTIONS.** Do not use a pesticide for control of a pest not on the label unless a specific recommendation is made by a person authorized to do so (FIFRA 2EE). Pesticide-treated bogs may need to be posted. Check labels. Workers and scouts should be notified prior to treatments and informed about re-entry times. See label for variation in restricted entry times and worker protection standards (WPS). **ONLY APPLY INSECTICIDES IF DAMAGING NUMBERS ARE PRESENT – DETERMINE THIS BY SCOUTING EACH BED.**

2. **LATE WATER** -- See Late Water section for more details. Late water research shows that the flood severely reduces mites, cranberry fruitworm, false armyworm, blossomworm, gypsy moth and winter moth.

3. **REFLOODING OPTIONS** –

a.) Late Water Flood – Starting April 15-20, hold water for 30 days to manage cranberry fruitworm, southern red mite, gypsy moth, and cutworms. See Late Water section.

b.) Spring Flood – mid-late May, 24-hour reflow manages false armyworm and blossomworm, 48 hours necessary to impact black-headed fireworm and yellow-headed fireworm. Care must be observed as these floods must be completed before roughneck stage or likely to increase fruit rot and seriously reduce the crop.

c.) Summer Flood – Mid-May to mid-July kills all insects, especially cranberry root grub and white grub, but with the loss of crop and impact on following years as well.

d.) Fall Flood – Sept. 20-30. Flooding within this time for 1 week every third year discourages girdler and blossomworm. A 3 or 4-week flood at this point will manage cranberry fruitworm. These floods are best done when fruits have been removed. Research shows that this flood timing may negatively impact vine health.

4. **SANDING** -- Regular uniform sanding helps check girdler and green spanworm.

5. **LEAFMINERS** -- There is no evidence that available registered insecticides control these insects.

6. **FOR COMPLETE GUIDELINES** – Management guidelines provided here serve only as reminders. Review the Insect Management BMP in the UMass Best Management Practices Guide: www.ag.umass.edu/cranberry/publications-resources/best-management-practices .

7. BEES!! MOST INSECTICIDES ARE HIGHLY TOXIC TO BEES, ESPECIALLY DIRECT APPLICATIONS AND RESIDUES. DO NOT APPLY OR ALLOW TO DRIFT TO CRANBERRIES IN BLOOM OR NEARBY BLOOMING PLANTS/WEEDS IF BEES ARE FORAGING. REMOVE HONEY BEE HIVES OR ADVISE BEEKEEPER IF SPRAYS ARE APPLIED. REMEMBER THAT WILD BEES, SUCH AS BUMBLE BEES, ARE ALSO VULNERABLE TO SPRAYS APPLIED AT BLOOM AND THAT POPULATIONS WILL DWINDLE OVER TIME IF THEY ARE NOT PROTECTED.

INSECTICIDE TOXICITY TO HONEYBEES

Admire/Alias	imidacloprid	
Actara	thiamethoxam	
Belay	clothianidin	super toxic
Nexter	pyridaben	
Delegate, Entrust	spinetoram, spinosad	
Scorpion	dinotefuran	
Lorsban	chlorpyrifos	
Avaunt	indoxacarb	highly toxic
Diazinon	diazinon	
Imidan	phosmet	
Orthene	acephate	
Sevin	carbaryl	
Altacor	chlorantraniliprole	
Assail	acetamiprid	practically non-toxic
Intrepid	methoxyfenozide	
Confirm	tebufenozide	

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ORGANIC OPTIONS FOR INSECT MANAGEMENT

Organic production may not be a profitable option unless there is low-moderate insect pressure and a good water supply. Cranberry fruitworm, black-headed fireworm and cranberry weevil pose the greatest threats to viability.

Growers who wish to be certified by an organic certification organization need to go through *Bay State Organic Certifiers* (www.baystateorganic.org). Every certifier must work under standardized USDA rules and all inputs must be listed with OMRI (Organic Materials Review Institute, www.omri.org). This list can be found on the web www.omri.org and a hard copy is supplied with certification. Some products are listed as A (allowed) others as R (restricted). The restricted products have certain conditions attached to them that have to do with the generic materials in the product (amounts or frequency of application, etc.). OMRI also has a Generic Materials List. Three years of no synthetic chemical applications are necessary before a crop can be certified organic (transition period).

Use of cultural practices (sanding and water floods) is the most effective strategy in organic management.

Late Water	Holding late water is an excellent choice to greatly reduce cranberry fruitworm pressure; however, moths may move into late water-treated beds from other areas of infestation. False armyworm, blossomworm, gypsy moth, and southern red mite may be managed with late water. See Late Water Section.
Fall Flood	May be used to reduce cranberry girdler populations. Flood for 10-14 days as soon as possible after harvest. May also impact vines to some degree. Warmer water temperatures enhance effectiveness.
Sanding	If you can sand, populations of most insects should be less abundant.
Winter Flood	If you can maintain a good winter flood, populations of most insects should be less abundant.

These are options cleared for organic management on cranberry, but efficacy has not been quantitatively assessed.

<u>Azadirachtin products</u>		
Aza-Direct	1-3.5 pt	Target small caterpillars with this biological insecticide – it serves as a repellent, antifeedant, and interferes with the molting process. Restricted.
Neemix 4.5	4-16 fl oz	
<u>Bacillus thuringiensis (B.t) products</u>		
Dipel DF (<i>kurstaki</i> strain)	0.5-1 lb	These compounds are most effective when applied multiple times in low gallonage against small caterpillars feeding on foliage. Treating early infestations is critical. Well-timed chemigation systems are critical for good efficacy (6 minutes or less rinse time). Beware, not all B.t.'s are certified organic or have cranberry on the label.
Biobit HP (<i>kurstaki</i> strain)	0.5-1 lb	
Xentari (<i>aizawai</i> strain)	0.5-1.5 lb	
Entrust 80W	1.25-3 oz	This compound is an effective, fast-acting, but short-lived spinosyn insecticide. More effective than Bt once caterpillars have reached a larger size. When chemigating, a short rinse time (6 minutes or less) is necessary for good efficacy. Spinosyn compounds are highly toxic to bees, but thoroughly dried residues are safe. Thus sprays must go on at night and dry by morning. Apply when drying conditions are optimal overnight.
Entrust SC	4-10 fl oz	
Grandevo	2-3 lb	No chemigation allowed. <i>Chromobacterium subtsugae</i> strain.
M-pede Insecticidal Soap	1-2% solution	No chemigation allowed.
<u>Neem Oil Products</u>		
Trilogy	Useful as a dormant application for suppression of southern red mite egg hatch. Do not chemigate. Use 1% rate for ground application or 1 qt/A for aerial application in 10 gallons of water. Be aware that it accelerates plant growth stage and adjust frost protection accordingly. Also suppresses eggs and motile mites post bloom.	
Nematodes	Availability limited. Expensive but available organic option for grub and girdler management.	
Pyganic EC 1.4	16-64 fl oz	Restricted. Spot treating using low gallonage may be helpful for patchy infestations. Note: other Pyrethins with added piperonyl butoxide are not allowed.
Pyganic EC 5.0	4.5-18 fl oz	
Venerate XC	1-8 qts	Heat-killed <i>Burkholderia</i> spp. strain A396. Ground or Aerial, no chemigation. 4 hr REI, 0 day PHI.