

DISEASE MANAGEMENT 2005

Prepared by Frank L. Caruso

DISEASE/ TIMING	PESTICIDE/ FORMULATION	RATE (amt/A)	COMMENTS/RESTRICTIONS
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UPRIGHT DIEBACK

This disease can be reduced if heat or drought stress is minimized or eliminated through the proper use of irrigation during July and August. Vines may be made more susceptible to the disease if they have been subjected to winter injury or oxygen deficiency.

APRIL 25 THROUGH MAY 15	Champ Dry Prill	5.3 lb	Must be applied pre-bloom.
	Champ Formula 2 flowable	5.3 pt	
	Champion WP	8 lb	
	Bravo Weather Stik	4-6.5 pt	
	Bravo Ultrex	3.8 - 6 lb	

12-hour restricted entry interval. One pre-bloom application should be applied after the terminal bud has broken dormancy and begun to swell or has begun new growth. Exact timing will depend on whether the variety is early or late-season. Echo and Equus are not registered for upright dieback control.

For all above chlorothalonil formulations: When chlorothalonil formulations are to be used in a bed subject to Zone II regulations, growers will need permission to apply the fungicide. Please contact the Pesticide Bureau (617-626-1773) or the Cape Cod Cranberry Growers' Association (508-759-1041) for more information. The maximum allowable number of chlorothalonil applications is 3. If 1 Bravo application is used for upright dieback control, only 2 fruit rot applications are allowed. Do not mix with B.t. based products (Dipel, etc.).

PHYTOPHTHORA ROOT ROT

This disease can be controlled with a combination of drainage improvements (digging new lateral ditches and maintaining existing ditches, installing drain tile, adding crushed stones, etc.), sanding the low areas, fertilizing plants peripheral to dead areas to stimulate root growth and/or using a soil fumigant to renovate particular sections. Spread of the pathogen can be prevented through the judicious use of water when flooding several individual beds for water harvesting, by cleaning and sterilizing equipment and footwear with 10% Clorox solution or steam before going from infested to non-infested beds, and by using cranberry vines free from the pathogen when replanting renovated sections or new beds.

APRIL 25 THROUGH MAY 15 (1st application)	Ridomil Gold EC	1-1.75 pt	Apply by ground or chemigation equipment. Do not apply EC by air. Use a minimum of 20 gallons water/A when applied by ground.
	Ridomil Gold GR	20-35 lb	
	Aliette WDG Phostrol	5 lb 5-6 pt	

Do not exceed 4 applications per year. 30 day application interval

Three applications per season are recommended for newly diagnosed instances. As areas of dieback recover, consult with the Extension Plant Pathologist regarding the fungicide schedule. The second application should occur 60-90 days after the first but 45 days before harvest. The third application should be done after harvest, preferably prior to November 15. Ridomil must be watered in after application. Run the sprinklers for 3 hours after application to water the fungicide into the root zone. Too much water, however, may push the chemical past the root zone. Therefore, do not apply if more than 0.5 inches of rainfall is forecast or if the sprinklers will need to be run for more than 5 hours during the first few days after application. The drainage should be improved BEFORE applying any fungicide to the affected bed.

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FRUIT ROT			
EARLY BLOOM (10-20%), THEN AT 10-14 DAY INTERVALS	Bravo Weather Stik	4-6.5 pt	Use the maximum rate in beds with high rot incidence on a 10-day schedule. Zone II restricted, 3 applications/season. 12 REI, hold water for 3 days.
	Echo 720	4-7 pt	
	Echo 90DF	3.25-5.75 lb	
	Bravo Ultrex	3.8-6.0 lb	
	Equus DF	3.8-6.0 lb	
	Equus 720	4-6.67 pt	
<u>For all above chlorothalonil formulations:</u> When chlorothalonil formulations are to be used in a bed subject to Zone II regulations, growers need permission to apply the fungicide. Please contact the Pesticide Bureau (617-626-1773) or the Cape Cod Cranberry Growers' Association (508-759-1041) for more information. The maximum allowable number of chlorothalonil applications is 3. If 1 Bravo application was used for upright dieback control, only 2 fruit rot applications are allowed. Do not mix with Dipel. 12 hour restricted entry. Do not release irrigation water for at least 3 days following application. Existing product may be used according to the label.			
	Abound F	6.2-15.4 oz	Although six applications allowed, should not use more than two applications. Use this fungicide for the earlier applications spaced 7-10 days apart (see note #12).
	Ferbam Granuflo	6 lb	Do not apply more than 5 times. Apply at 14-day intervals. Using rates below the recommended rate will be ineffective.
MID-BLOOM, THEN AT 7-10 DAY INTERVALS	Dithane DF Rain Shield, Dithane M-45, Dithane DF, Penncozeb 80WP, Penncozeb 75DF, Manzate 75 DF, Manzate 80WP	3-6 lb	Addition of spray adjuvants will improve distribution and deposition for all of the maneb or mancozeb compounds.
	Top Cop	2 qt	Repeat at 7 to 10 day intervals.
	Dithane F-45, Manex, Manex II, Dithane F-45 Rain Shield, Manzate Flowable	2.4-4.8 qt	
	Maneb 75DF, Maneb 80 WP	4.8-6 lb	
	ManKocide	10.5 lb	
	Cuprofix MZ Disperss	7.5-14 lb	
LATE BLOOM, THEN ONE OR TWO APPLICATIONS AT 10-14 DAY INTERVALS	Kocide 2000	6 lb	Do not combine with any insecticide. <u>Note:</u> Kocide 4.5 LF is <u>highly corrosive</u> to all aluminum irrigation equipment.
	Kocide 4.5 LF	5.33 pt	
	Nu-Cop 50DF,	8 lb	
	Kocide DF, Kocide 101	8 lb	
	Champion WP	8 lb	
	Nu-Cop 3L, 3lb copper flowable	5.33-10.67 pt	
	Champ Formula 2 flowable	5.3 pt	
Champ Dry Prill	5.6 lb		
	Copper-Count-N	8 qt	

FRUIT ROTS - CULTURAL CONSIDERATIONS

Late Water: Holding late water (mid-April to mid-May) will improve berry quality by disrupting the life cycles of rot-inducing fungi. In late water years, fungicide rates and/or the number of total applications can be reduced with no sacrifice in fruit quality. The fungicide program should not be eliminated completely or vine diseases may be a problem the following growing season. Fungicide applications and rates can also be reduced during the first year after late water. Fungal inoculum will begin to build up during the second year after late water.

Lush Vines: Where fertilizer applications have been heavy, vines will tend to become very overgrown. This will lead to poor air circulation, retention of high humidity, and slow drying-out of heavy dew. These conditions encourage infection by the fungi that cause fruit rot and red leaf spot. When growth is excessive, pruning is recommended to promote air circulation in the vine canopy.

Trash Removal: Cranberry leaves, stems, and fruits left behind after harvest are colonized by several fungi that cause field and storage rot. This trash can serve as an inoculum source for fungal infections of the uprights, blossoms, or fruits in subsequent growing seasons. If the bed was dry-harvested, trash should be removed from the bed with a post-harvest flood in the fall or from the winter flood before it is withdrawn in February or March. Remove trash from water-harvested beds during harvest or as soon after as possible. Trash piles should not be left next to the bed. Trash should be deposited at least a quarter mile from the bed if possible. Self-pollinated seeds in berries left behind may germinate in the soil and possibly produce plants that are the typical "mongrels". These genotypes may produce much vegetation but few berries, and in worst case scenarios, may take over the productive vines in the bed.

Irrigation: When irrigation is necessary, sprinkler systems should be run for 4-5 hours in the early morning, and not in the early evening. Vines can get watered with minimal evaporation, and the surface of the vines can dry out in the sun's heat. When watering is done in the early evening, the vines are kept wet for an extended time period, thus creating favorable conditions for infection by the fruit rot fungi. On days with excessive temperatures (>100°F on the bed), particularly in newly planted or recently sanded beds, sprinklers should be run for 1-2 hours in the late morning or early afternoon to cool the vines and berries and to prevent injury. Sprinklers should be run to prevent scalding of the fruit when all of the following conditions persist: (1) dewpoints of 55°F or less during midday and afternoon hours, (2) high temperatures of 80°F or more, (3) clear or scattered sky conditions during the day, (4) bed soil moisture is low, (5) wind speeds average greater than 11 mph, and (6) no rainfall has occurred during the last 48 hours. This "forecast" is based on research performed in New Jersey. Scalded berries are typically browned on one side, with a clear demarcation between the brown area and the green (usually) area of the fruit. The rotted area in a berry affected with fruit rot typically has an area of anthocyanin production (reddish border) adjacent to the affected area. After seven days, a scalded berry will be hard to discern from a totally rotted berry, particularly since fungi will colonize the stressed scalded berry.

Resistant Varieties: When replanting bogs or planting new bogs, certain varieties with proven field rot resistance should be considered: Black Veil, Foxboro Howes, Matthews, Shaw's Success, and Wilcox. Research is still needed on the consistency of these cultivars to produce good crops. Small plantings are encouraged initially. Howes and Stevens also have good fruit rot resistance. Varieties can be identified at the Cranberry Station by bringing in uprights with attached full-size fruit.

One or two fungicide applications during the first two years after planting will help reduce fungal inoculum available.

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FAIRY RING

This disease is sporadic in occurrence and the severity of symptoms varies from year to year. It can be spread from one bed to another through uprooted vines during wet or dry harvest and their subsequent dislodgment in the next harvested bed. Picking machines should be freed of vines before moving to the next bed. Damage is usually worst during periods of drought; keep vines well-irrigated. Applications of lime during the growing season convey limited benefits to the vines and have no effect on the fungal pathogen(s).

JUNE - JULY	Ferbam Granuflo	9 lb/100 gal	Apply 1 gal of this mixture to 1 sq. ft area. Treat the area 3 ft beyond the advancing line of dying vines and 2 ft within the line. Do not apply after July 31. Do not make more than one application.
MID-AUGUST THROUGH OCTOBER	Sul-Po-Mag or K-Mag 0-0-22	4000 lb/A or 1.5 oz/sq. ft	Use alone or after lime to help vines recover. Follow-up applications may be necessary. This may help the vines to out-compete the fungus.

MANAGEMENT NOTES

1. Read and follow label instructions. Always check label for variations in restricted entry interval and worker protection standards.
2. Make all pesticide applications in a manner to prevent contamination of streams, ponds and public ways. Impound water (as per label) for as long as possible after applying.
3. REFLOODING for black-headed fireworm control in June is likely to INCREASE FRUIT ROT and SERIOUSLY REDUCE THE CROP.
4. Holding late water will most likely reduce the incidence of fruit rot.
5. PRE-MIX fungicides with a small amount of water until a smooth suspension is obtained before final dilution. Use immediately. Blossom injury may occur with concentrate sprays especially when sprayed by air when the temperature in the bog is above 85°F. Do not combine any copper fungicide with an insecticide. Do not tank mix copper compounds with Aliette unless appropriate precautions have been taken to buffer the spray solution or severe phytotoxicity will result.
6. Consider delaying harvest to obtain acceptable color in thick vines or when Mancozeb or Maneb is used.
7. SANDING and FERTILIZING. Frequent resanding and fertilizing helps reclaim beds infected with false blossom disease. These are accepted IPM practices. Regular uniform sanding most likely helps to reduce inoculum of the fungi that cause fruit rot. Sanding should not be done during the same year late water is to be held.
8. SPREADER STICKERS are contained in most fungicides. The additions of wetting agents or spreader stickers to Bravo, Echo, or Equus may cause phytotoxicity damage. Please check the fungicide label.
9. STORED PESTICIDES may deteriorate. Avoid freezing liquid formulations. It is not advisable to use old materials in opened containers. Follow Pesticide Bureau regulations for disposing of pesticides and their containers.

10. Fungicide decisions should be based on the keeping quality forecast (KQF) published in the Station newsletter. If the forecast is good to excellent, consider fewer applications and/or lower rates of the fungicides. History of the cranberry bed is also important: if a bed is prone to fruit rot, one will need to be more conservative in the decision to reduce the total amount of active ingredient. Four fungicide applications are usually necessary for a bed prone to fruit rot. One or two fungicide applications may be adequate for a bed with very little fruit rot in previous growing seasons. Fungicide applications are more important when the berries will be harvested for fresh fruit, as this fruit will be held in storage for extended periods. Storage rot is not a concern for berries that are water harvested, as these berries will immediately be frozen in most cases. Normally, 3-5% fruit rot at delivery is considered acceptable. If in doubt, call the Extension Plant Pathologist.
11. If half-rates are used, the maximum number of applications (not material applied) must not be exceeded. It is not recommended that any fungicide application be lower than the lowest recommended rate.
12. Resistance development by the fruit rot fungi to Abound is a very real and serious threat. Applications of the fungicide should be made pre-infection rather than post-infection to minimize resistance development. One application is recommended per growing season unless the KQF predicts poor or worse keeping quality. Use very carefully and avoid drift if the bed is next to a McIntosh apple orchard, as the fungicide is highly phytotoxic to this cultivar.
13. Review the Disease Management BMP in the UMass Best Management Practices Guide.

<u>Fungicides</u>	<u>Pre-Harvest Interval</u>	<u>Maximum Number of Applications</u>	<u>Restricted Entry Interval</u>
Chlorothalonils (Restricted Use)			
Bravo, Echo, Equus	50 days	3	12 hrs
Coppers			
Champ, Kocide, Nu-Cop, Cuprofix	No time limitation	3 or 5	24 hrs
Copper-Count-N	No time limitation	3	12 hrs
Top Cop	No time limitation	3	24 hrs
Mancozebs, Manebs			
Dithane, Penncozeb, Maneb Manex, ManKocide	30 days	3	24 hrs
Other Products			
Aliette WDG	3 days	4	12 hrs
Ferbam Granuflo	50 days	5	24 hrs
Ridomil Gold	45 days	3	48 hrs
Abound F	3 days	6	4 hrs
Phostrol	3-days	4	4 hrs
** See Cautions at front of chart for more formulation specifics and maximum allowable formulation.			

INSECT MANAGEMENT 2005

Prepared by Anne L. Averill and Martha M. Sylvia

MANAGEMENT GUIDELINES PROVIDED HERE SERVE ONLY AS REMINDERS.
FOR COMPLETE GUIDELINES, REFER TO MATERIALS AVAILABLE AT THE CRANBERRY STATION.

MANAGEMENT GUIDELINES

Reducing inputs to cut costs of production. Within a cost-cutting framework, 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. If late water was not held, it is **not** advisable to skip the initial spray (the first spray in IPM-based programs) for cranberry fruitworm that occurs 7-9 (Howes/Blacks) or 3-7 days (Ben Lears/Stevens) after 50% out of bloom. This targets the largest portion of the population. When poorly managed, cranberry fruitworm pressure builds over time and is harder to manage. Sweep-netting of all acreage at mid May to detect cranberry weevil, cutworms, gypsy moth, and blackheaded fireworm outbreaks is important. It is likely that as most or all insecticide inputs are lowered, blackheaded fireworm and weevil levels will increase; Sparganothis fruitworm levels should drop. When infestation of weevil or fireworm establishes, management inputs must be intensified in subsequent years. Finally, walking the bog early and late in the season to inspect for soil insects, mites, and webbing of fireworms allows detection of pests that can affect the acreage in subsequent years or require renovation.

Start scouting bogs May 15. Always gauge pest levels of insect 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. At this point, some recommend night sweeping to gauge numbers. Small black-headed fireworm caterpillars may cling to the top of the net. Continue sweeping at least until the start of bloom. Be aware that some serious pests are active during and after bloom, for example, brown spanworm and cranberry weevil, and that you should continue to closely monitor your bog. Be aware that some pests, particularly cranberry weevil, gypsy moth, 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 root weevil adults, white grub adults, or some moth species.

Sweep netting. using a 12" net and 180° sweeps into the vine, 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 average number of each insect in your series of sweep sets exceeds these values, and after other external concerns have been brought to bear including cost of application, expected returns, weather, etc.

	AVERAGE #			AVERAGE #	
ADD UP: blossomworm, false armyworm, other cutworms, and gypsy moth	4.5			black-headed fireworm	1-2*
brown spanworm, green spanworm	18			<i>Sparganothis</i> fruitworm	1-2
				cranberry weevil	4.5

Adjustment of action thresholds to reflect current value of the crop. 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. In today's slump in returns, the thresholds for most spring caterpillars could be relaxed greatly because the value of the crop saved is too low to equal the cost of the spray. However, caution should be taken before ignoring high numbers of cranberry weevil, blackheaded fireworm, and Sparganothis fruitworm in the spring since established infestations are harder to manage in the summer and the following year.

*In past years, when black-headed fireworm infestations were very rare, we used the 1-2 larvae per sweep set to make a presence/absence determination on a bed. Now that black-headed fireworm infestations are well established on many beds, accurate assessment of infestation level will require not only the sweep net sample, but also visual assessment of the vines. See the black-headed fireworm section (page 8) for visual assessment methods.

Pheromone traps. Traps should be used for timing management of cranberry girdler, black-headed fireworm, and *Sparganothis* fruitworm. Monitor for moths with traps starting June 1. Check and clean traps weekly, recording number of moths captured. Change bait **every** 3 weeks. Use 1 trap/10 acres. Place on **upwind** side of bog. Check descriptions of adult moths because non-target species are sometimes caught. Confirm, Intrepid, and 3M Sprayable Pheromone follow a different schedule than conventional insecticide sprays (such as Diazinon). See labels.

For black-headed fireworm; if treating summer generation with conventional insecticide, apply insecticide 10 days after peak moth flight, usually during bloom. If fireworm pressure has been high and you are treating with Confirm or Intrepid, it may be advisable to treat 3 weeks after the moth flight begins. Begin searching vines for larvae 1 week after the first moths are caught to determine presence/absence of larvae.

For *Sparganothis* fruitworm; if treating with conventional insecticide, spray 10-14 days after peak moth captures, ca. mid-to-late July. If *Sparganothis* pressure has been high and you are treating with Confirm or Intrepid, it may be advisable to treat 3 weeks after the moth flight begins.

For girdler; treatments are usually in July. Refer to the section on cranberry girdler for timing of specific treatments. Be aware that a bad infestation can exist even with low trap catches.

Bacillus thuringiensis (B.t.) based products. Examples include Dipel, Agree, Mattech, Xentari and MVP2. These products may have varying activity - not all have been field tested. Check labels for directions and **consult Cranberry Station for specific guidance and efficacy information.** Consider treating before threshold is reached. Early attention to infestation is critical. Maximize effectiveness by treating young caterpillars, less than 1/4". Cutworms larger than 1/2" are difficult to control. Addition of 3-6 oz Pyrenone or Pyronyl to Dipel ES has improved performance. For larger caterpillars, low rates of synthetic insecticides added to Dipel - e.g. 3-6 oz Pyrenone or Pyronyl or very low rates of insecticides such as Diazinon or Sevin - improved performance.

Thorough coverage is essential and **repeat applications may be necessary.** Caterpillars stop feeding after eating compounds but may take several (3-10) **days** to die. New growth is not protected; rain, irrigation, or excessive water after application as a result of a poorly timed or large acreage chemigation system will remove active material. Use aerial application or low-volume ground applications when possible as it usually improves performance. Spot applications of low gallonages with backpack sprayers are a good option. Check the label for bee toxicity. Addition of a spreader/sticker (e.g. Bond, Stik) may be critical, check label.

Insect growth regulator products (Intrepid and Confirm). Growth regulators are caterpillar specific and conserve beneficial insects. Intrepid is restricted use and has Zone II restrictions.

Use aerial application or low-volume ground applications when possible to improve performance. Well timed chemigation systems may be critical for good efficacy. Consider treating before thresholds are reached. Efficacy may vary widely depending on conditions. Thorough coverage is essential and repeat applications are necessary. New growth is not protected; rain, irrigation, or chemigation washout will remove active material. A spray adjuvant should be used. 6 hours drying time following application is required. Death may not be observed until a week or more has passed. Pollinator safe! Check labels for directions and **consult Cranberry Station for specific guidance and efficacy information.**

Restricted Use Pesticide (Guthion, Lorsban, Diazinon, Intrepid, and Actara) A pesticide license (private applicator certification) is required to apply these compounds to your bog.

Guthion use on cranberries has been cancelled and will expire on August 31, 2005.

Existing stocks should be used up by December 31, 2005.

<p>BEES!! 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. IF APPLICATION IS NECESSARY, MAKE SPRINKLER APPLICATION AT NIGHT AND RUN SPRINKLERS EARLY FOLLOWING MORNING TO DELAY BEE FORAGING ACTIVITY. ADVISE BEEKEEPER.</p>

EARLY SEASON CATERPILLARS

BLACK-HEADED FIREWORM

3M Sprayable Pheromone	2-3 oz	Time-released microencapsulated pheromone concentrate used for mating disruption. Consult Cranberry Station on use. Do not exceed 25 oz per season. Most effective for low population pressure.
Confirm 2F	16 oz	Growth regulator product. Efficacy may vary widely depending on conditions. Thorough coverage is essential and repeat applications are necessary. New growth is not protected; rain, irrigation, or chemigation washout will remove active material. A spray adjuvant should be used. 6 hours drying time following application is required. Death may not be observed until a week or more has passed. Pollinator safe!
Intrepid 2F	10–16 oz	Similar to Confirm, but improved activity. Restricted use and Zone II restricted.
Diazinon 50 W	4 lb	It is advisable to hold water for at least 3 days. Limit 6 applications/season at rates listed at left, limit 4 applications/season if higher labeled rates for cutworms and fruitworm used. 7 day PHI, 14 day spray interval.
Diazinon AG 500	2 qt	
Diazinon AG 600	51 oz	
Guthion 50 WSP & Azinphos-M 50W	2 lb	Note limit of 2 applications/season and 7 day REI. Hold water for at least 5 days and release gradually. Make sure cranberry is on label. 14 days between sprays. Guthion registration expires at end of 2005: Use up existing stocks.
Imidan 70W	1.33–4 lbs	Little Imidan efficacy data available in MA.
Lorsban 4E, Nufos 4E & Chlorpyrifos 4E AG	3 pt	Rates as low as 1 1/2 pts (aerial) or 2 pts (chemigation) are reported to give satisfactory control. 2 applications/season. Do not mix with other insecticides. Observe 60 day PHI. Impound water for 5 days, then release gradually.
Orthene 97	1 lb	1 application/season. Observe 90 day PHI.
Orthene 75S & 75 WSP	1 1/3 lb	Do not apply from 10 days prior to bloom until all berries set.
Sevin XLR Plus	1.5-2 qt	Avoid applying Sevin within 10 days of start of bloom. Sevin XLR Plus is formulated to have minimal bee toxicity once the spray dries. Limit 5 applications/season, 7 day spray interval, 7 day PHI.
Sevin 4F & Carbaryl 4L	1.5-2 qt	
Sevin 80 WSP & Sevin 80S	1.88–2.5 lb	
SpinTor 2SC (Spinosad)	4-10 oz	Do not exceed 29 oz/season. 7 days between applications.
Entrust 80W (Spinosad)	1.25-3 oz	Do not exceed 9 oz/season. USDA organic approved.

For both formulations: use lower rates only with good chemigation systems (6 min or better).

Larvae hatch in mid-May; even earlier in odd warm springs. 2nd generation appears in July during bloom. Use pheromone traps (see page 7) 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. Be aware that the status of fireworm is on the rise: While sweeping in May look for the very small larvae on the rim of the sweep net. When larvae are small, using only the sweep net to monitor for infestation can be risky owing to the poor relationship between the actual infestation of young caterpillars on a bed and the number picked up in a sweep net. Further, the infestation most often is patchy, and larvae are often more numerous along edges, where vines are overgrown, where leaf trash has accumulated, or where winter flooding was truncated. Spot treatment is desirable here.

Visual sampling is recommended as the most effective means of early detection of spring infestation. Monitoring should begin as soon as larvae begin to hatch in May. The earliest activity will be detected in warmer bog edges by inspecting buds and leaves for mining, webbing, and brown pellets of excrement (frass). 1-2 weeks after the very first larvae are seen, more extensive monitoring can be done by 'visual sweeps.' This involves crouching down to closely examine areas of about 2 ft². Repetition of ten 'visual sweeps' is recommended per acre.

Infestations move rapidly! Spring generation is a much easier target than the second generation (occurs during bloom).

YELLOW-HEADED FIREWORM

Guthion, Lorsban, Orthene, Sevin, and Spintor can be used as specified for blackheaded fireworm. (see page 8).

Intrepid and Diazinon, FIFRA 2EE recommendations, use as specified for blackheaded fireworm (page 8).

Yellow-headed fireworm has been reported several times recently, typically on beds that are not completely flooded in the winter. Eggs hatch in May and caterpillars are all yellow and are impossible to distinguish from *Sparganothis*. It is often the case that totally wintered flooded beds have *Sparganothis* and partially, poorly winter flooded beds have yellow-headed fireworm. The yellow-headed fireworm pupa has a knob, which *Sparganothis* pupae do not have. The 3M Sprayable Pheromone for black-headed fireworm will NOT work for yellow-headed fireworm.

SPARGANTHIS FRUITWORM

3M Sprayable Pheromone	1.7–4.0 oz	Time released microencapsulated pheromone concentrate used for mating disruption. Do not exceed 24 oz./season.
Confirm 2F	16 oz	See insect growth regulator products on page 7 for details.
Intrepid 2F	10–16 oz	Similar to Confirm, but improved activity. Restricted use and Zone II restricted.
Lorsban 4E, Nufos 4E & Chlorpyrifos 4E AG	3 pt	Many populations are resistant, see note below. For susceptible populations, rates as low as 1 1/2 pt (aerial) or 2 pt (chemigation) have been reported to give satisfactory control. Limit 2 apps/season. Do not mix with other insecticides. Observe 60 day PHI. Impound water for 5 days, then release gradually.
Orthene 97	1 lb	Limit 1 application/season. Observe 90 day PHI.
Orthene 75S &	1 1/3 lb	Do not apply from 10 days prior to bloom until all berries set.
Orthene 75 WSP	1 1/3 lb	In some areas, <i>Sparganothis</i> has shown resistance to Orthene.
Guthion 50 WSP & Azinphos-M 50W	1-2 lb	In almost all areas, this insect has developed resistance. Note limit of 2 apps/season and 7 DAY REI. 14 day spray interval. Hold water for at least 5 days, release slowly. Guthion registration expires at end of 2005: Use up existing stocks.
SpinTor 2SC (Spinosad)	4-10 oz	Do not exceed 29 oz/season. 7 days between applications.
Entrust 80W (Spinosad)	1.25-3 oz	Do not exceed 9 oz/season. USDA Organic approved.
For both formulations: use lower rates only with good chemigation systems (6 min or better).		

Small *Sparganothis* caterpillars are already on the bog in mid-May and can be sampled by sweep-netting (see page 6). Check for *Sparganothis* caterpillars in loosestrife weeds that have folded, webbed leaves; this will give you an idea of the larva's appearance so that you can look for in your sweep net. The 2nd generation of *Sparganothis* appears in July and feeds on both fruit and foliage. With both generations, you should target the small caterpillars. Keep an eye on Ben Lears, which tend to be hardest hit, Howes the least.

Beginning in June, use pheromone traps to determine when newly emerged moths are laying eggs--you want to target caterpillars as they are hatching, not the adult moths (see pheromone trap details, page 7). Thus, conventional insecticide applications should be made about 2 weeks after peak moth flight (timing may coincide with second cranberry fruitworm application). Observe label instructions for spray timing of the growth regulators; here, it is recommended that Confirm or Intrepid be applied earlier in the moth flight.

Most populations in the Carver, Middleboro, Plympton, Marion, and Cape areas are resistant to Lorsban and Orthene. Intrepid, Confirm, and Spinosad products (SpinTor and Entrust) are alternatives. Late water has not been shown to be effective against this insect, but it may somewhat synchronize moth emergence.

CUTWORMS (BLOSSOMWORM, FALSE ARMYWORM) and HUMPED GREEN FRUITWORM

<i>Bacillus thuringiensis</i> (B.t.) based products		See information on page 7 for details.
Confirm 2F	16 oz	See insect growth regulator products on page 7 for details.
Intrepid 2F	10–16 oz	Similar to Confirm, but improved activity. Restricted use and Zone II restricted.
Diazinon 50 W	4-6 lb	FIFRA 2EE recommendation. Hold water for at least 3 days.
Diazinon AG 500	2-3 qt	Limit 4 applications/season at higher rates; 6 applications/season
Diazinon AG 600	51-76.5 oz	allowed at lower rates. 7 day PHI; 14 day spray interval.
Late Water		False armyworm and blossomworm may be managed with late water. See Late Water Section.
Lorsban 4E, Nufos 4E & Chlorpyrifos 4E AG	3 pt	Rates as low as 1 1/2 pts (aerial) or 2 pts (chemigation) have been reported to give satisfactory control. 2 applications/season. Impound water for 5 days, then release gradually. Do not mix with other insecticides.
Orthene 97	1 lb	1 application/season. Observe 90 day PHI.
Orthene 75S & 75 WSP	1 1/3 lb	Do not apply from 10 days prior to bloom until all berries set.
Sevin XLR Plus	2 qt	Avoid applying Sevin within 10 days of start of bloom. Sevin XLR Plus is formulated to have minimal bee toxicity once the spray dries. Note label changes - limit of 5 applications/season, 7 day spray interval, 7 day pre-harvest interval.
Sevin 4F & Carbaryl 4L	2 qt	
Sevin 80 WSP & Sevin 80S	2 1/2 lb	
SpinTor 2SC (Spinosad)	4-10 oz	Do not exceed 29 oz./season 7 days between applications.
Entrust 80W (Spinosad)	1.25-3 oz	Do not exceed 9 oz./season. USDA organic approved.
For both formulations: use lower rates only with good chemigation systems (6 min or better).		

The action threshold 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 spanworm 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 are required to gauge infestation.

GYPSY MOTH

<i>Bacillus thuringiensis</i> (B.t.) based products		See information on page 7 for details.
Confirm 2F	16 oz	See insect growth regulator products on page 7 for details.
Intrepid 2F	10–16 oz	Similar to Confirm, but improved activity. Restricted use and Zone II restricted.
Late Water		Holding late water kills eggs laid on the bog as well as prevents establishment of many tiny caterpillars that drift in from infested uplands. See Late Water section.
Orthene 97	1 lb	1 application/season. Observe 90 day PHI.
Orthene 75S & 75 WSP	1 1/3 lb	Do not apply from 10 days prior to bloom until all berries set.
Sevin XLR Plus	1.5-2 qt	Avoid applying Sevin within 10 days of start of bloom. Sevin XLR Plus is formulated to have minimal bee toxicity once the spray dries. Note label changes - limit 5 applications/season, 7 day spray interval, 7 day pre-harvest interval.
Sevin 4F & Carbaryl 4L	1.5-2 qt	
Sevin 80 WSP & Sevin 80S	1.88–2.5 lb	

Insecticides (Diazinon, Lorsban, SpinTor) applied for cutworms or spanworms may provide control for gypsy moth.

The action threshold for gypsy moths is an average of 4.5 larvae/25 sweeps. Check for patchy infestations that can be spot treated, i.e. along bog edges facing uplands with infested trees. Check previously infested areas -- eggs can overwinter on flooded bogs. Early detection is key: larvae consume terminal buds before new growth starts.

SPANWORMS (GREEN SPANWORM, BROWN SPANWORM, BIG CRANBERRY SPANWORM)

<i>Bacillus thuringiensis</i> (B.t.) based products		See information on page 7 for details.
Confirm 2F	16 oz	See insect growth regulator products on page 7 for details.
Intrepid 2F	10-16 oz	FIFRA 2EE. Similar to Confirm, but improved activity. Zone II restricted.
Lorsban 4E, Nufos 4E & Chlorpyrifos 4E AG	3 pt	Two applications/season. Do not mix with other insecticides. 60 day PHI. Impound water for 5 days, then release gradually.
Orthene 97	1 lb	Limit 1 application/season. Observe 90 day PHI.
Orthene 75S & 75 WSP	1 1/3 lb	Do not apply from 10 days prior to bloom until all berries set.
Pyreneone or Pyronyl	12 oz	Spot treating using low gallonage may be helpful for patchy infestations.
SpinTor 2SC (Spinosad)	4-10 oz	Do not exceed 29 oz/season. 7 days between applications.
Entrust 80W (Spinosad)	1.25-3 oz	Do not exceed 9 oz/season. USDA Organic approved.
For both formulations: use lower rates only with good chemigation systems (6 min or better).		

For green and brown spanworm, the action threshold is an average of 18 larvae in 25 sweeps. Threshold of 18 may be lowered if these spanworms are large. 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. Night sweeps are required to gauge infestation.

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! **Be aware of brown spanworm infestations during bloom** that may be quite clumped in bog areas. Newly hatched brown spanworms cling like thin threads to the inside of the sweep net.

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 is usually the best approach.

Other miscellaneous spanworms are increasingly common. They appear in patches and grow larger than the common green and brown spanworm, so it may be advisable to lower threshold by about half if infestation occurs.

CRANBERRY WEEVIL

Actara	2-4 oz	Works well against both spring and summer weevil populations. 8 oz max limit/season. 7 days between applications. 30 day PHI. No aerial apps. Restricted use and Zone II restricted. No flow through bogs.
Lorsban 4E, Nufos 4E & Chlorpyrifos 4E AG	3 pt	Many populations are resistant. For susceptible populations, rates as low as 1 1/2 pt (aerial) or 2 pt (chemigation) have been reported to work. Limit 2 applications/season. Impound water for 5 days, then release gradually.
Guthion 50 WSP & Azinphos-M 50W	2 lb	FIFRA 2EE recommendation. Most populations are resistant. 14 days spray interval. Hold water for at least 5 days and release gradually. Note limit of 2 apps/season and 7 DAY REI. Guthion registration expires at end of 2005.

Action threshold is an average of 4.5 weevils in 25 sweeps. Adult weevils are found throughout the growing season. See sweep-netting section page 6. Conduct sweep sets for weevil on warm, calm, and sunny days. Let net contents settle: weevils "play dead" when disturbed. Consult sweep records from previous years to determine if you have a history of extended weevil invasion. Even if threshold is exceeded, sometimes it is advisable to wait a week or two early in spring to treat. Weevil numbers may continue to rise, with additional weevils moving in, probably from upland sources. However, waiting becomes risky as blossom buds appear. Late water is not known to be effective against weevil. Look carefully: Do not count non-pest gray weevils.

Most populations are resistant to Lorsban and Guthion.

AVAUNT does NOT have a label for use in cranberry for 2005. DO NOT USE AVAUNT on your bogs.

CRANBERRY FRUITWORM

All research shows it is not necessary or desirable to mix compounds for effective control.

Diazinon 50 W	4-6 lb	It is advisable to hold water for at least 3 days. Limit 4 applications/season at higher rates, 6 applications/season at lower rates. Observe 7 day PHI, and allow 14 days between applications.
Diazinon AG 500	2-3 qt	
Diazinon AG 600	51-76.5 oz	
Guthion 50 WSP & Azinphos-M 50 W	1-2 lb	NOTE LABEL CHANGE: limit 2 applications /season. 7 DAY REI. 14 days between applications. Hold water for at least 5 days and release slowly. Guthion registration expires at end of 2005: use up existing stocks.
Imidan 70W	1.33-4 lbs	Efficacy results have been very variable.
Intrepid 2F	10-16 oz	FIFRA 2EE recommendation. Similar to Confirm, but improved activity. Low gallonage applications <u>only</u> are effective. Zone II restricted. Pollinator safe!
Late Water		Holding late water greatly reduces fruitworm; however, moths are very mobile and may move into late water-treated beds from areas of infestation. See Late Water Section.
Lorsban 4E, Nufos 4E & Chlorpyrifos 4E	3 pt	Rates as low as 1 1/2 pts (aerial) or 2 pts (chemigation) have been reported to give satisfactory control. Limit 2 applications/season. Do not mix with other insecticides. Observe 60 day PHI. Impound water for 5 days, then release gradually.
Sevin XLR Plus	1.5-2 qt	Avoid applying Sevin within 10 days of start of bloom. Sevin XLR Plus is formulated to have minimal bee toxicity once the spray dries. Note label changes - limit 5 applications/season, 7 day spray interval, 7 day pre-harvest interval.
Sevin 4F & Carbaryl 4L	1.5-2 qt	
Sevin 80 WSP & Sevin 80S	1.88-2.5 lb	

CRANBERRY FRUITWORM MANAGEMENT

FOR ALL PRACTICES

1. Every pump system should be scouted separately as 1 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.
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 high fruitworm pressure, it may be cost effective to apply Intrepid 2F in lowest gallonage at 50% out-of-bloom. There is no risk to pollinators with this compound.
6. Timing first spray using % out of bloom: In the event of unusual warm or cool weather during fruit set it may be advisable to shorten or lengthen accordingly the interval between 50% out-of-bloom and the first spray.

STANDARD PRACTICE

1st treatment - Calculate % out-of-bloom (1/2 OF BLOSSOMS HAVE LOST PETALS OR BECOME FRUITS)

To 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. For each acre of bog, randomly collect 10 uprights and record the number of pods, flowers, pinheads, and fruit. Calculate using the following:

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

Apply 1st treatment 7-9 days after 50% out-of-bloom for Howes and Early Blacks, 5-7 days for Ben Lears and 3-5 days for Stevens. Timing of this spray is critical.

2nd treatment

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

ADDITIONAL TREATMENTS - MONITOR EGGS TO TRIGGER SPRAYS

A 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 eggs. Follow guidelines in table below to determine necessity of spray. If egg numbers trigger spray, spray ASAP. If no egg is found, repeat berry inspection process every 3-4 days until Aug. 15.

SCOUTING PRACTICE

1st treatment - Calculate % out of bloom

Apply 1st treatment 7-9 days after 50% out-of-bloom (half the blossoms have lost all petals or become fruits) for Howes and Early Blacks, 5-7 days for Ben Lears and 3-5 days for Stevens. Timing of this spray is critical.

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 spray. If egg numbers trigger 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 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 SPRAY

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

SOIL INSECTS

BLACK VINE WEEVIL AND STRAWBERRY ROOT WEEVIL

Nematodes	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 immediately after application. Chlorpyrifos (e.g. Lorsban) has been reported to adversely affect nematodes.
Cryolite Bait	20-30 lb/A Target adults; they must ingest product. Limit 2 applications/season. Apply with ground equipment when adults are actively feeding, usually late June. A second application is possible 10-14 days after the first. Cryolite bait production has been discontinued, availability limited.
Fall Flood	Flood for 10-14 days as soon as possible after harvest. Warmer water temperatures enhance effectiveness.
Winter Flood	If you can winter flood, populations should be less abundant.

In the spring, look for grubs in soil associated with areas of dying vines (often near bog edge) that may have an orange halo of vines around edges. Grubs feed on the bark of the vine. Adults 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 in 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

Diazinon 14G	21 lb	Limit 2 applications/season. Target immatures in soil. Do NOT apply aerially. Where one treatment is needed, apply 2 weeks after end of moth flight. For sites that are badly infested, apply 2 weeks after peak flight and again 10 days later. Applications made by the end of July give the best results. Water in thoroughly to increase efficacy and <u>reduce bird hazard</u> . Avoid puddling. Do not apply to bare ground or ditch water. Do not discharge water from treated area for at least 7 days. Spot treat isolated infestations.
Nematodes		Apply Nematodes 2 weeks after end of moth flight. Target immatures in soil. Apply in early evening under low wind conditions. Irrigate before and immediately after application. Excessive leaf trash may reduce effectiveness. Chlorpyrifos (e.g. Lorsban) has been reported to adversely affect nematodes.
Fall Flood		Flood for a week as soon as Early Blacks are harvested starting not later than Sept. 25. Vines must be completely covered. It may be necessary to flood late varieties with berries on the vine.
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, but be sure to target immatures in soil with control treatment. If there is a history of girdler on your bog, use pheromone traps to time treatments (details on page 7). 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.

SCARAB GRUBS

Admire 2F 16-32 oz Target oriental beetle immatures in soil with a soil drench treatment. In turf and blueberry, oriental beetle grubs are suppressed; we have no efficacy data in MA cranberry. Limit 2 applications/season; limit 32 oz./season. No aerial application. 30 day PHI. Newly-hatched grubs are most vulnerable and the best results are achieved when the compound is present just prior to egg hatch—this can be determined by monitoring beetle flight with pheromone traps. Irrigate before and after application. Kills bees: Apply post-bloom when bees are not present at the end of July through early August. Admire has a long residual.

Summer flood Drain bog thoroughly from early April to May 12. Reflow May 12 and keep well flooded until July 20. This will eliminate cranberry root grub and cranberry white grub larvae, as well as the crop for that year. Oriental beetle and *Hoplia* are probably also impacted by the summer flood. Check for true cutworm infestations after flood removal.

Cranberry root grub - grubs turn into beetle adults that are low-flying bumblebee mimics; 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 the Cranberry Station.

STRIPED COLASPIS

Admire 2F	16-32 oz	Soil drench treatment applied to immatures in soil. Preliminary data in MA cranberry appears favorable. No aerial application. Limit 2 applications/season. Limit 32 oz./season. Irrigate before and after application. Kills bees: applications should be made in July post bloom after the bees have been removed. Admire has a long residual.
Diazinon 50 W	4-6 lb	FIFRA 2EE recommendation targeting adults. It is advisable to hold water for at least 3 days. 4 applications/season at higher rates, 6 applications/season allowed at lower rates. 7 day PHI and 14 day interval between applications.
Diazinon AG 500	2-3 qt	
Diazinon AG 600 & 5 WP	51-76.5 oz	
Sevin XLR Plus	1-2 qt	FIFRA 2EE recommendation targeting adults. Do not spray within 10 days of bloom. Limit 5 applications/season, 7 day spray interval, 7 day PHI. Sevin XLR Plus is formulated to have minimal bee toxicity once the spray dries.
Sevin 4F & Carbaryl 4L	1-2 qt	
Sevin 80 WSP & Sevin 80S	1.25-2.5 lb	

Diazinon and carbaryl (Sevin) efficacy levels may vary greatly. Sprays should target adults when they are active at bloom and are being picked up while sweep netting. They are ca. 1/6" long; oblong-oval. Head area metallic greenish-black and wings blackish, striped with yellow. Legs and antennae 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 FLEA BEETLE

Actara	2-4 oz	8 oz max limit/season. Zone II restricted, no flow through bogs and no aerial apps.
Sevin XLR Plus	1-2 qt	Avoid applying Sevin within 10 days of start of bloom.
Sevin 4F & Carbaryl 4L	1-2 qt	Limit 5 applications/season, 7 day spray interval, and 7 day PHI.
Sevin 80 WSP & Sevin 80S	1.25-2.5 lb	Sevin XLR Plus is formulated to have minimal bee toxicity once the spray dries.
Diazinon 50 W, 50 WSB	4-6 lb	FIFRA 2EE recommendation. Hold water for at least 3 days.
Diazinon AG 500	2-3 qt	Limit 4 applications/season at higher rates, 6 applications/season
Diazinon AG 600	51-76.5 oz	allowed at lower rates. Observe 7 day pre-harvest interval.

Adult flea beetles are active in late July through September. Beetles and their feeding damage are very patchy, often in areas of lush vine. 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 current rule of thumb.

SOUTHERN RED MITE

Pyramite 4.4-8.8 oz Low-end rates provide control in most chemigation systems. Limit 2 applications/season. Apply by ground and chemigation only – no aerial application. Required water holding for 3 days after application. No flow through bogs. 5 hours of drying time required.

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.

Trilogy 70 EC This is a neem oil product. Use 1% rate for ground application or 1 qt/A for aerial application in 10 gallons of water. Do not chemigate. Do not use older formulation, 90 EC. Useful as a dormant application for suppression of egg hatch. Be aware that it accelerates plant growth stage and adjust frost protection accordingly. Also suppresses eggs and motile mites post bloom. We have no evidence to support claims that this product controls cranberry diseases.

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.

CRANBERRY TIPWORM

Extensive spray trials in MA have shown that available insecticides do not control tipworm, probably because this insect has developed resistance. Early-season tipworm damage often is high, but good vine health enhances rebudding. Appearance of damage does not mean that insects are still present. Only very late-season damage, which is rare, appears to consistently impact yield. Stressful vine conditions in the year of damage may also result in yield reduction. Diazinon and Guthion are labeled for tipworm. However, research shows ONLY ca 20% mortality. Sprays are not encouraged for this insect.

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. Late water research shows that the flood severely reduces mites, cranberry fruitworm, false armyworm, and gypsy moth.

REFLOODING –

- a) About May 18th for 10 hours controls false armyworm and blossomworm.
- b) About June 1-12th for 10 hours controls green spanworm, small black-headed fireworm, spotted and black cutworms and armyworms, but is likely to **increase fruit rot** and **seriously reduce the crop**.
- c) About May 12th and holding up to July 15-20th kills all insects, but with the loss of crop.
- d) Sept. 20-30th. Flooding within this time for a 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.

3. **SANDING** -- Regular uniform sanding helps check girdler and green spanworm and may temporarily suppress early season tipworm populations.

4. **LEAFMINERS** -- There is no evidence that available registered insecticides control this insect.

5. For complete guidelines -- Refer to materials available at the Cranberry Station. Management guidelines provided here serve only as reminders. Review the Insect Management BMP in the UMass Best Management Practices Guide.

6. BEES!! 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. IF APPLICATION IS NECESSARY, MAKE SPRINKLER APPLICATION AT NIGHT AND RUN SPRINKLERS EARLY FOLLOWING MORNING TO DELAY BEE FORAGING ACTIVITY. ADVISE BEEKEEPER.

CAUTIONS

<u>Insecticides</u>	<u>Maximum actual toxicant/A</u>	<u>Pre-harvest interval (PHI)</u>	<u>Restricted entry interval (REI)</u>	<u>Maximum number of applications</u>
Actara (Thiamethoxam)*	0.125 lb	30 day	12 hrs	- (8 oz.)
Admire (Imidacloprid)	0.5 lb	30 day	12 hrs	2
<i>B.t.</i> based products	NA	No PHI	4 hrs	-
Confirm (Tebufenozide)	1 lb	30 days	4 hrs	4
Cryolite bait	NA	30 days	12 hrs	2
Diazinon *	12 lb	7 days	24 hrs	4 or 6
Diazinon granular *	0.5 lb/1,000sq ft	7 days	12 hrs	2
Entrust (Spinosad)	0.45 lb	21 days	4 hrs	6
Guthion (Azinphos Methyl) *	1 lb	21 days	7 days	2
Imidan (Phosmet)	15.6 lbs	14 days	24 hrs	-
Intrepid (Methoxyfenozide)*	1 lb	14 days	4 hrs	4
Lorsban (Chlorpyrifos)*	1 1/2 lbs	60 days	24 hrs	2
Nematodes	NA	No PHI	0 hrs	-
Orthene (Acephate)	1 lb	90 days	24 hrs	1
Pyramite (Pyridaben)	1 lb	21 days	12 hrs	2
Pyrenone or Pyronyl	60% PBO + 6% Pyrethrins	No PHI	12 hrs	-
Sevin (Carbaryl)	4 lb	7 days	12 hrs	5
SpinTor (Spinosad)	0.55 lb	3 days	4 hrs	6
Sprayable Pheromones	24/25 oz	No PHI	4 hrs	read label
Trilogy (Neem Oil)	NA	No PHI	4 hrs	read label

* = restricted use pesticide, requires a pesticide license to buy and apply.

WEED MANAGEMENT 2005

Prepared by Hilary A. Sandler

WEED LIFE CYCLES. *ANNUAL PLANTS* complete their life cycle in one year and must reproduce by seed. *PERENNIAL PLANTS* can live for many years and may reproduce by seed, runners, rhizomes, etc. Most of the weeds in cranberry production are perennials. With the exception of dodder, annual weeds are much less common and easier to control than perennials. However, infestations of annual weeds should not be taken lightly, especially on new plantings. Annual plants are designated with an (A). Unless otherwise noted, all other weeds are perennials.

WEED MAPPING. Weed maps can help you organize the management of your weed problems, especially with perennial weeds. Weed maps should be done every few years, depending on weed pressure and management objectives. Several steps are involved: 1) Correctly identify the weeds, 2) Document the location of the weeds (by drawings or photographs), and 3) Designate a priority number to the weed. Weeds are grouped into priorities (1=no tolerance; 2=serious concern; 3=less concern; and 4=lowest concern) based on their likelihood to cause yield loss, ability to spread, and the difficulty of control. Deal with the most yield-threatening weeds first. Recommended priority groupings are noted in the right-hand margin for each weed. Growers may change and adapt weeds into priority groups to best fit their own management program.

CLIPPER APPLICATORS. Roundup products are the only products currently labeled for use in clipper application (Section 2ee-'Cut Stump'). No other glyphosate products may be used in clipper applicators. Using the correct technique is critical for maximizing the performance of this herbicide application. Roundup must be applied to the stem as it is cut! Good stem coverage and adequate flow without dripping on the vines is essential. Concentrated solutions (50-100% Roundup) work best. Notations are made within each weed management description below if field studies have demonstrated clippers to be effective in giving partial or good weed control.

TIMING OF PREEMERGENCE HERBICIDES. Spring applications are typically done from March through mid-April. Fall applications are typically done 1-2 weeks after harvest, but at least 2-3 weeks prior to the winter flood. Applications for dodder control are put out as close as possible to the time of seedling emergence (usually mid-April through mid-May).

DODDER (A) *Cuscuta gronovii*

PRIORITY 1

Prevention. The best management strategy for dodder control is prevention of infestation. This is best accomplished through good sanitation. Dodder seed is easily moved in harvest water and on equipment. When possible, dodder-infested beds should be harvested after clean beds. Floats used to corral berries should be inspected for the presence of dodder seed or fruit before they are placed in beds that are dodder-free. This is especially important for custom harvest operations. A good trash flow after harvest is also helpful in removing seed capsules from the bed, but is not a replacement for prevention since subsequent infestation occurs.

Dodder may also be spread vegetatively: pieces of stem can be moved on equipment, such as granule spreaders, and become attached to healthy plants. Care should be taken when moving any piece of equipment from a bed infested with dodder to one that is not.

Dodder is an obligate parasite and must have a host plant to survive. Early in the growing season, cranberry stems are somewhat resistant to dodder infection, so control of weeds that can act as hosts, such as goldenrod, loosestrife and asters, is important for early season control. Dodder emergence may continue for 2 to 3 months, which is far longer than the residual activity of most preemergence herbicides. Therefore, control of other hosts early in the season is especially important. Where dodder infestations are just beginning, careful scouting and hand removal of dodder seedlings prior to infection is a good practice. Weed plants that are infected with dodder should be completely removed from the bed, since dodder stems will re-grow from the portion that is embedded in the plant.

Scouting. Scout in areas where infestation has occurred in the past and in bare areas in beds infested previously with dodder. Often, dodder seed will accumulate in the areas where berries are removed from the beds at harvest.

Begin scouting for dodder in early-mid April (unless your bog history or unusual weather conditions indicates otherwise). Mild winter temperatures promote earlier emergence of dodder. Recent research indicates that dodder populations in MA emerge slowly at first, that is, less than 3% emerge within 7-10 days of first emergence. In these studies, most seedlings emerged from about Day 10 through Day 60 after first emergence. It is not known how variable dodder populations are from bog to bog. Growers should consider previous successful experiences, along with scouting, and plan applications of preemergence herbicides accordingly.

CHEMICAL RECOMMENDATIONS FOR DODDER CONTROL

Casoron 4G 30-60 lb/A Apply within 10-14 days of first seedling emergence.

Follow with 0.2" water to incorporate herbicide. Split applications can be used

(up to a total of 100 lb/A in a 12-month period). Allow at least 3 weeks between applications. See Notes on Casoron.

Other Herbicide Considerations. In order to maximize effectiveness of Casoron, monitor the soil temperature with a standard soil temperature probe. The soil should be at least 60°F to allow Casoron to volatilize and work effectively. If frequent frost events and/or spring rains occur after application and prior to the volatilization of the herbicide, the water may move some herbicide below the dodder seed zone and reduce effectiveness of the herbicide. To avoid injury, do not apply as vines approach bud break.

Spring floods. Recent research and grower experience has shown that short (24-48 hr) floods in early to mid-May can be effective for reducing dodder infestations. Timing of the flood may affect efficacy. Research is on-going to refine recommendations. Floods should cover vine tips adequately. No adverse vine or yield impact has been reported. Sometimes, dodder floods may coincide with floods used to control black-headed fireworm.

Postemergence Control. For light to moderate dodder infestations, raking is not recommended. Yield and quality are reduced and dodder growth is unaffected. For heavy infestations, raking can prevent the onset of upright dieback caused by dodder infection. It can also prevent leaf-drop due to shading of the cranberry by the dodder canopy. Raking prior to seed set is not as effective in reducing dodder seed production as raking after seed set. Raking should be done before the seed capsules begin to dry. No benefit is provided from raking earlier as the dodder stems re-grow from the portions embedded within the cranberry. No benefit is gained from raking more than once.

Spray applications of certain household cleaning products (20% solution) may desiccate dodder growing on cranberry. Treatments made in mid-July have given good results; repeat applications may be needed. Research is on-going to refine recommendations for postemergence control; check with the weed specialist for information. A good trash flow after harvest is also helpful in removing seed pods from the bog.

BRISTLY & PRICKLY DEWBERRY *Rubus hispidus, R. flagellaris* (Running brambles)

PRIORITY 1

Dewberries spread rapidly on bogs by rooting at the tips of canes. Both types will kill vines if allowed to spread. The most effective way to manage dewberries is to eliminate them as they invade the bog. Remove young plants by pulling or digging out by the roots. Chemical control of established plants is difficult because the weed grows close to vine level. Sparse or moderately colonized spots can be hand-wiped with glyphosate products. Clipping stems with Roundup-dispensing applicators may offer an additional method of partial control.

Late water floods reduce numbers of dewberry crowns and offspring plants in that year. Summer refloods (May 10-12 through July 15-20) may be used in desperate circumstances. This will eliminate the crop for that year! It is particularly helpful to hand-pull or hand-wipe remaining dewberry plants after the flood has been withdrawn. Fall floods may suppress populations of *R. hispidus*; results have varied from no impact to reduced crown density. Start the flood as early as possible (mid-September) and hold for 4 weeks for best dewberry management. Consider starting a fall flood in early-mid September, if possible. It is important to remove the flood by early November to allow the vines time to become dormant prior to winter.

Knife-raking or pruning in the fall may help uproot offspring plants. Significant dewberry patches should be scraped and replanted with new vines.

CHEMICAL RECOMMENDATIONS

Roundup WeatherMAX	Mix 1 part glyphosate with 4-9 parts water (10-20% solutions). No additional additives, buffers, or surfactants are needed. However, the addition of ammonium sulfate may sometimes improve performance.
+ A marker dye (i.e., Blazon Blue)	Add according to manufacturer's recommendations.
Glyphosate products	Mix 1 part glyphosate with 4-9 parts water (10-20% solutions).
+ Surfactant	1 oz (2 tablespoons) per gallon of glyphosate mixture.
+ Ammonium sulfate	3 oz (6 tablespoons) per gallon of glyphosate mixture.
+ A marker dye (i.e., Blazon Blue)	Add according to manufacturer's recommendations.
Weedar 64	Mix 1 part Weedar to 2 parts water for hockey-stick application. Best results are obtained when used in late June and July. Do not drip or touch vines.

GLAUCOUS GREENBRIER *Smilax glauca* (Silverleaf sawbrier) PRIORITY 1

Greenbriers are very difficult to control because they have extensive underground storage organs. Glaucous greenbrier (silverleaf) is more difficult to control than common greenbrier (greenleaf). Glaucous grows in dense patches, spreads rapidly, and usually reaches just above vine level. It significantly impacts fruit production. Digging up the root system is not practical and will cause significant vine and bog damage. Infestations of sawbrier are more likely to occur on high edges or in locations where the bed is out of grade.

S. glauca may be managed by hand-wiping if sufficient coverage is obtained. Summertime wipes of Roundup may offer partial control. Clipping stems with Roundup-dispensing applicators in August may offer an additional partial control. Severe infestations of *S. glauca* may necessitate bog renovation. Weedar 64 may be used on sawbrier as per dewberry recommendations. Flooding is not effective against sawbrier.

WILD BEAN *Apios americana* (Ground Nut) PRIORITY 1

Wild bean can be partially controlled with both pre- and postemergence control techniques. Nuts may be dug out and removed from the bog. When using wipes, stake the wild bean vines to make wiping easier.

WILD BEAN - CHEMICAL RECOMMENDATIONS		
Stinger	<i>Spray:</i> 0.07-0.11 oz/gal	0.4-0.7 tsp (1.8-3.0 ml) per gallon. Wild bean is very sensitive to Stinger.
	<i>Wipe:</i> 2.5 oz/gal	wipe: 5 Tbl per gallon. See Notes on Stinger.
Casoron 4G	75 lb/A	Apply as two separate applications. Time applications before rain or irrigate within one day. Apply late March to early April. For best results, allow 10 days between applications.
FOLLOWED BY Devrinol 10G	75 lb/A	
Salt	1 lb/gal water	Apply during the summer months after berry set. Never spray more than 200 gal/A. This practice keeps bean tops burned off. Repeat as necessary. Wash equipment with soap and water immediately after use.
Glyphosate products/ Roundup WeatherMAX		Apply anytime weeds are present except 30 days before harvest. For rates, see below and Notes on Roundup.

POISON IVY *Toxicodendron radicans* PRIORITY 1

Poison ivy is much easier to control when the patch is small. Control is very difficult because the plant grows close to the vines. Glyphosate wipes will control this weed, but the potential for vine damage is high. Use of specialized applicators that minimize drip is recommended. Recent research has shown that clipping the stems with Roundup-dispensing applicators in August may offer an additional method of partial control. In addition, studies in 2001 indicated that early-mid September applications may give better control than August applications. Again, this technique can be used on bogs that will not be harvested due to crop-destruct floods (or very late harvested bogs).

Rates as low as 5-10% solutions gave decent control. Control for significant infestations of poison ivy is post-harvest spot treatments with Roundup sprays or mechanical spot renovation followed by replanting.

Some people may be highly allergic to poison ivy. Protective lotions and soaps are available that minimize skin irritation caused by the poison ivy oils. Lotions are usually applied prior to exposure and soaps are used to remove oils after exposure to the plant. Rinse with liberal amounts of water; small amounts of water may only spread the oils.

COMMON GREENBRIER *Smilax rotundifolia* (Greenleaf sawbrier, bullbrier) PRIORITY 2

Common greenbrier is bushier and spreads more slowly than glaucous greenbrier and grows well above the cranberry vines. It is easier to control with glyphosate wipes than glaucous greenbrier. Thorough coverage is important. Repeat applications in successive years may be needed for total control. See Notes on Roundup. Digging up the root system is not practical and will cause significant vine and bog damage.

YELLOW LOOSESTRIFE *Lysimachia terrestris* PRIORITY 2

Yellow loosestrife can cause moderate yield reductions. It may also serve as an early-season host for dodder and tips may harbor *Sparganothis* larvae. Preemergence herbicide application should be made in the spring. Loosestrife may be wiped with glyphosate during the season. Fall applications of Casoron may also offer some control of loosestrife. Since loosestrife is difficult to control, efforts should begin while patches are still small and before they have a chance to spread.

<u>CHEMICAL RECOMMENDATIONS</u>		
Casoron 4G	up to 100 lb/A	Spring or fall application. Offers partial control. See Notes on Casoron.
Roundup WeatherMAX / Glyphosate products		Apply anytime weeds are present except 30 days before harvest. See Notes on Roundup.
Weedar 64		Mix 1 part Weedar to two parts water for hockey-stick application. Best results are obtained when used in late June and July. Do not drip or touch vines.

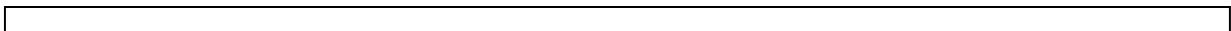
NARROW-LEAVED GOLDENROD *Euthamia tenuifolia* PRIORITY 2

Narrow-leaved goldenrod causes little direct yield loss, but is extremely difficult to control and spreads rapidly. For this reason, every effort should be made to control patches before they spread. Preemergence and postemergence herbicides can provide partial control of this weed. Clipping the stems with Roundup-dispensing applicators in August may offer an additional method of partial control.

<u>CHEMICAL RECOMMENDATIONS</u>		
Roundup WeatherMAX / Glyphosate products		Apply anytime weeds are present except 30 days before harvest. See Notes on Roundup.
Weedar 64		Mix 1 part Weedar to two parts water for hockey-stick application. Best results are obtained when used in late June and July. Do not drip or touch vines.
Stinger	Spray: 0.33-0.5 oz/gal Wipe: 2.5 oz/gal	0.75-1.2 tsp (3.6-5.4 ml) per gallon. See Notes on Stinger. wipe: 5 Tbl per gallon.

ASTERS *Aster sp.* PRIORITY 2

The impact of asters on cranberries is variable. Asters are usually found in bare patches on the bog. Once the patch becomes established, asters are much harder to control. Applications of Casoron in March-April or November offer some suppression but will probably not eradicate this weed. Glyphosate wipes in the summer may be helpful. Thorough coverage and repeat applications are necessary.



CHEMICAL RECOMMENDATIONS FOR ASTERS		
Casoron 4G	up to 100 lb/A	Apply Spring or Fall. See Notes on Casoron.
Iron sulfate	3 oz/sq. ft	Apply during Summer. See Notes on Iron Sulfate.
Weedar 64		Mix 1 part Weedar to two parts water for hockey-stick application. Best results are obtained when used in late June and July. Do not drip or touch vines.
Stinger	<i>Spray:</i> 0.33-0.5 oz/gal <i>Wipe:</i> 2.5 oz/gal	0.75-1.2 tsp (3.6-5.4 ml) per gallon. See Notes on Stinger. wipe: 5 Tbl per gallon.

UPRIGHT BRAMBLE *Rubus allegheniensis* (Blackberry) **PRIORITY 2**
 Upright bramble is not as common as the dewberries. It does not trail on the ground. Control may be obtained with glyphosate wipes. Young plants can be pulled or dug out by the roots. Weedar 64 may be used as described for other *Rubus* (dewberries) species.

CHOKEBERRY *Pyrus melanocarpa* **PRIORITY 3**
 Infestations of chokeberry can reduce yields and will spread in the beds. The best management strategy is to treat patches before they get too large. Chokeberry plants do not grow tall on the bog. Take extra care when using postemergence wipes of glyphosate products to minimize vine injury. When chokeberry plants are short, it may be more effective to hand-wipe them rather than wiping with a hockey stick wiper.

SEDGES **PRIORITY 3**
 Management of sedges combines cultural and chemical controls. Hand dig, pull small patches or spot-treat with one of the preemergence herbicides listed below. Encourage vine growth in the bare areas so the sedges will not re-colonize. Refer to the table below to locate the target weed and recommended control options and related information. TIMING: Spring applications are typically done from March through mid-April; Fall applications are typically done 1-2 weeks after harvest but at least 2-3 weeks prior to the winter flood. (S) or (F) following the weed name indicates 'Spring only' or 'Fall only' applications are preferred.

SEDGES - CHEMICAL RECOMMENDATIONS			
HERBICIDE	RATE	WEEDS CONTROLLED	NOTES
Devrinol 10G	60-90 lb/A 40-60 lb/A	Nut sedge (nutgrass)	Rate for peat-based bogs. Rate for mineral soils. Works best when applied to a weed-free surface.
Casoron 4G	up to 100 lb/A	Cottongrass, Dulichium(S), Fresh meadowgrass (F), Needlegrass, Nut sedge, Spike rush, Woolgrass	
Evital 5G	80-120 lb/A 120-160 lb/A	Needlegrass (S), Nut sedge Broomsedge, Needlegrass (F), Spike rush, Woolgrass	Needlegrass is difficult to hand-pull. Broomsedge may be controlled with glyphosate wipes. Dig up clumps.
Weedar 64		Three-square	Mix 1 part Weedar to two parts water for hockey-stick application. Best results when used in late June and July. Do not drip or touch vines.

SHEEP LAUREL *Kalmia angustifolia* **PRIORITY 3**
 Sheep laurel can spread on the bog and reduce yields. Saplings should be pulled by hand. Larger plants can be wiped with glyphosate products (see Notes on Roundup).

LEATHERLEAF *Chamaedaphne calyculata* **PRIORITY 3**

Leatherleaf is a perennial, woody plant that can spread on the bog and reduce yield. It can be controlled by hand-wiping during the summer with a solution of glyphosate products. Weedar 64 can also be used as a wipe as per dewberry recommendations.

RUSHES *Juncus sp.*

PRIORITY 3

Rushes grow in clumps and can become quite large when well established. Control of large plants with preemergence herbicides may be difficult except at very high rates. Control may also be possible with hand-digging or repeated hand-wiping with glyphosate solutions. TIMING: Spring applications are typically done from March through mid-April. (S) following the weed name indicates if 'Spring only' applications are preferred. Use glyphosate wipes in summer.

<u>RUSHES - CHEMICAL RECOMMENDATIONS</u>			
<u>HERBICIDE</u>	<u>RATE</u>	<u>WEEDS CONTROLLED</u>	<u>NOTES</u>
Devrinol 10G	60-90 lb/A 40-60 lb/A	Soft rush (<i>J. effusus</i>)	Rate for peat-based bogs. Rate for mineral bogs. Works best when applied to a weed-free surface.
Casoron 4G	up to 100 lb/A	Canada (S), Mud, Soft (S)	Offers partial control for Canada rush.
Evital 5G	120-160 lb/A	Canada rush	
Salt	1-3 teaspoons		Apply sodium salt to the base of each rush clump in the spring, prior to bud break.

PERENNIAL GRASSES

PRIORITY 3

These grasses often colonize bare areas. Encouraging vine growth may reduce potential for problems. Some species may be difficult to eradicate once established. Postemergence herbicides are now available for grass control on bearing and non-bearing beds. TIMING: Spring applications are typically done from March through mid-April; Fall applications are typically done 1-2 weeks after harvest, but at least 2-3 weeks prior to the winter flood. (S) or (F) following the weed name indicates if 'Spring only' or 'Fall only' applications are preferred. Apply Devrinol early in spring (usually prior to April 10) for cutgrass control; it comes up earlier than other grasses.

CHEMICAL RECOMMENDATIONS – PREEMERGENCE OPTIONS FOR PERENNIAL GRASSES

<u>HERBICIDE</u>	<u>RATE</u>	<u>WEEDS CONTROLLED</u>	<u>NOTES</u>
<i>Devrinol 10G</i>	60-90 lb/A 40-60 lb/A	Rate for peat-based bogs.	Rate for mineral soils.
Poverty grass	Repeated mowing is helpful.	Rice cutgrass Summergrass (S)	Early application is desirable (before April 10) for best control. Improve drainage for cutgrass problems. Hard to mow.
Casoron 4G	up to 100 lb/A	Mannagrass (S) Rattlesnakegrass (S)	Clean ditches in infested areas. Minimal control by pulling.
Evital 5G	80-120 lb/A 120-160 lb/A	Rice cutgrass (S), Smokegrass (S) Broad-leaved panicgrass (S) Summergrass	Gives partial control. Hard to mow.
	Switchgrass (F)	Difficult to control. Repeated mowing	

helps. Best to dig out plants prior to seed

formation.

PERENNIAL GRASSES - CHEMICAL RECOMMENDATIONS - POSTEMERGENCE OPTIONS

Poast 1-1.5% solution **True grasses only. Apply at 6-8 leaf stage**

+ Dash HC (0.5%) OR crop oil concentrate (1%) for best results.

Mix 2 oz Poast + 0.6 oz Dash HC **or** 1.3 oz crop oil concentrate per gallon. Repeat applications may be needed for these grasses. Addition of other adjuvants is not recommended. May be applied by broadcast applicator or by air. Chemigation is **not** permitted! See Notes on Poast.

Select	6- 8 oz/A per application + 1% v/v COC in the finished spray volume unless label indicates otherwise.	True grasses only. Chemigation not permitted. Repeat applications may be needed. Use 10-30 gal water per acre. For each gallon, mix 0.4 oz Select + 1.3 oz COC.
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RED MAPLE and other trees

PRIORITY 3

The best management strategy is to pull young saplings before the root system becomes established. Larger trees must be dug out. Glyphosate wipes may be used to control small maples and to weaken large trees to facilitate removal. Clipping stems with Roundup-dispensing applicators in August may offer partial control.

CHEMICAL RECOMMENDATIONS

**Roundup WeatherMAX /
Glyphosate products
Weedar 64**

Apply anytime weeds are present except 30 days before harvest.
See Notes on Roundup.
Mix 1 part Weedar to two parts water for hockey-stick application.
Best results are obtained when used in late June and July. Do not drip or touch vines. Labeled for red maple only.

MOSSES [*Haircap moss (Polytrichum sp.)*, *Sphagnum moss (Sphagnum sp.)*]

PRIORITY 4

The presence of these plants on the bog may indicate a drainage problem. Evaluate the drainage in the area and improve prior to starting a chemical control plan.

HAIRCAP MOSS - CHEMICAL RECOMMENDATIONS

Casoron 4G	up to 100 lb/A	See Notes on Casoron. Be judicious in applying high rates for moss control, especially on vines showing signs of stress.
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Ammonium Sulfate	15 oz/100 sq. ft	21-0-0. Apply in the spring.
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SPHAGNUM MOSS - CHEMICAL RECOMMENDATIONS

Iron sulfate	3 oz/sq. ft	Apply in March to mid-April. See Notes on Iron Sulfate.
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Casoron 4G	up to 100 lb/A	Apply in the fall only. See Notes on Casoron.
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JOE-PYE WEED *Eupatorium dubium*

PRIORITY 4

This perennial plant generally grows along the ditch areas. Due to its tough stem, it may be difficult to hand-weed. Some growers use pliers to uproot large plants. Glyphosate wipes during the summer offer good control.

CINQUEFOIL *Potentilla canadensis*, *P. simplex* (*Five-finger*)

PRIORITY 4

The impact of cinquefoil is variable. Colonization of cinquefoil may indicate a problem with vine growth. Improvement of fertilizer program may help control this weed. Hand-wiping or hand-pulling can also be used to eliminate small patches. If the soil is considered alkaline, the use of sulfur may help improve the soil condition such that the vines become more competitive. See Notes on Sulfur.

CHEMICAL RECOMMENDATIONS FOR CINQUEFOIL

Iron sulfate 20%	3 oz/sq. ft	Apply during the summer months. Several formulations and percent active ingredient of iron sulfate are available. Granular forms are easier to apply (drop-spreader), but take longer to act than finely powdered formulations. See Notes on Iron sulfate.
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MEADOWSWEET *Spiraea latifolia*

PRIORITY 4

Meadowsweet is a slow spreader on cranberry bogs. This weed should be pulled out by hand or wiped during the summer.

CHEMICAL RECOMMENDATIONS

**Roundup WeatherMAX /
Glyphosate products**

Apply anytime weeds are present except 30 days before harvest. See Notes on Roundup.

WHITE VIOLET *Viola lanceolata*

PRIORITY 4

Found most often in bare patches on beds, white violet is thought to compete poorly with established vines. Thus, the best management approach is the fill in bare spots on the bog by encouraging runner growth. Otherwise, hand-pulling is the next best recommendation, especially on new bogs. No chemical controls are recommended.

PITCHFORK, RAGWEED, AND FIREWEED (A) PRIORITY 4

Bidens frondosa, Ambrosia artemisiifolia, and Erechtites hieracifolia (Beggarstick, stick-tights, Spanish needles/Common ragweed, hogweed, bitterweed, Roman wormwood/Cottonweed, pilewort.)

PITCHFORK, RAGWEED, & FIREWEED - CHEMICAL RECOMMENDATIONS

Casoron 4G	up to 100 lb/A	Apply in spring. May also be applied in the fall for control of ragweed. Moderate rates are suggested.
Caliber 90	up to 3.3 lb/A	Apply in spring. See Notes on Princep.
Princep 4L	up to 3 qt/A	
Princep 80W	3.75 lb/A	
Weedar 64	for ragweed only	Mix 1 part Weedar to two parts water for hockey-stick application. Best results are obtained when used in late June and July. Do not drip or touch vines.
Stinger	<i>Spray:</i> 0.07-0.11 oz/gal <i>Wipe:</i> 2.5 oz/gal	0.4-0.7 tsp (1.8-3.0 ml) per gallon. Pitchfork and ragweed are sensitive to Stinger. wipe: 5 Tbl per gallon. See Notes on Stinger.

ANNUAL GRASSES

PRIORITY 4

Generally, annual grasses are most likely to appear in bare patches or on new bogs. Hand-pulling and/or treatment with postemergence grass herbicides may be used on new and established bogs. Encourage vine growth to reduce ability of weeds to colonize the bog surface. Preventing seed production may also be important in managing these weeds. **TIMING:** Spring applications are typically done from March through mid-April. (S) following the weed name indicates if 'Spring only' applications are preferred.

ANNUAL GRASSES - POSTEMERGENCE OPTIONS

Poast	1-1.5% solution +Dash HC (0.5%) OR crop oil concentrate (1%)	True grasses only!	For each gallon, mix 2 oz Poast plus 0.6 oz. Dash HC or 1.3 oz crop oil concentrate. See Notes on Poast.
Select	6-8 oz/A per application +1% v/v COC in the finished spray volume unless label indicates otherwise.		True grasses only. Chemigation not permitted. Repeat applications may be needed. Use 10-30 gal water per acre. For each gallon, mix 0.4 oz Select + 1.3 oz COC.

CHEMICAL RECOMMENDATIONS FOR ANNUAL GRASSES - PREEMERGENCE OPTIONS

HERBICIDE	RATE	WEEDS CONTROLLED	NOTES
Devrinol 10G	60-90 lb/A		Rate for peat-based bogs.
	40-60 lb/A		Rate for mineral soils.
		Barnyardgrass, Corn grass,	Take action to promote vine growth.
		Warty panicgrass (S)	
Casoron 4G	up to 100 lb/A	Crabgrass (S)	Take action to promote vine growth.
Evital 5G	120-160 lb/A	Barnyardgrass, Corn grass	Take action to promote vine growth. Lower rates have been shown to be effective on established bogs. Use the minimum effective dose. Very low rates (<25 lb/A) have caused injury on newly planted vines.

HARDHACK *Spiraea tomentosa* (Steeplebush)

PRIORITY 4

Hardhack is a solitary plant that does not spread except through seed. Pulling or wiping this weed is very effective. The roots of hardhack can be woody and larger plants may cause damage to the bog when pulled.

CHEMICAL RECOMMENDATIONS

**Roundup WeatherMAX/
Glyphosate products** Apply anytime weeds are present except 30 days before harvest. See Notes on Roundup.

CLOVER AND VETCH *Trifolium repens and Vicia sp.*

PRIORITY 4

Clover and vetch tend to occur in areas of very high pH (alkaline soils). If soil pH is 5.0 or above, spot treat with two applications of sulfur at the rate of 0.2 oz/sq. ft. Apply in the late spring when soil is drained and frost protecting is over. For more details, refer to Notes on Sulfur. Lower rates of herbicides may be effective when sulfur has been added and the pH is lowered. **Stinger** offers good postemergence control of these weeds (use rates similar to asters and narrow-leaved goldenrod). See ‘Stinger notes’ at the end of the weed section. Control clover early in spring prior to cranberry budbreak.

FEATHER, ROYAL, CINNAMON, AND SENSITIVE FERNS

PRIORITY 4

Dryopteris thelypteris, Osmunda regalis, Osmunda cinnamomea, Onoclea sensibilis

(S) or (Smr) following the weed name indicates if “Spring” or “Summer” applications are preferred. When using iron sulfate treatments, apply a small amount to each plant. See Notes on Casoron and Iron Sulfate.

FERNS - CHEMICAL RECOMMENDATIONS

HERBICIDE	RATE	WEEDS CONTROLLED	NOTES
Casoron 4G	up to 100 lb/A	Bracken fern(S)	Appears on bogs showing signs of stress. Spot-treat and use moderate rates.
		Royal fern (S)	Spot-treat and use moderate rates.
Iron sulfate	2 oz/sq. ft [20% a.i.] See Iron Sulfate notes	Feather fern (Smr)	Sensitive fern is difficult to hand weed due to perennial rhizomes breaking. Use caution on bogs that have been sanded within 18 months.
		Sensitive Fern (Smr)	
Iron Sulfate & Salt	9:1 ratio (iron:salt)	Cinnamon fern, Feather fern, Sensitive fern	Treat during the summer months. Place a small amount at the base of each plant.

MINOR WEEDS

PRIORITY 4

[Blue joint (*Calamagrostis canadensis*), Hawkweed (*Hieracium sp.*), Horsetail (*Equisetum arvense*), Marsh St. John's Wort (*Triadenum sp.*), Orange-grass/pinweed (*Hypericum gentianoides*), *Hypericum* species, Sweet pepperbush (*Clethra alnifolia*), Plantain (*Plantago* or *Littorella sp.*), Smartweed (*Polygonum sp.*), Sorrel (*Rumex sp.*), and Wild Strawberry (*Fragaria sp.*)]

If weeds are scattered or of minor importance, consider potential vine stress or injury when choosing herbicide and rate. Consider hand-pulling instead. For localized weed patches, consider spot treatment. Postemergence treatment with glyphosate products may also offer some control. Combine herbicide treatments with steps to improve vine growth. Control of *Equisetum* generally requires 75 lbs/A or more Casoron. This weed is often confused with orange-grass; the same common name is often used for both plants in MA.

<u>CHEMICAL RECOMMENDATIONS</u>	
Casoron 4G	Use lowest rates possible. Apply in spring or fall. See 'Notes on Casoron'.
Weedar 64	Mix 1 part Weedar to two parts water for hockey-stick application. Best results are obtained when used in late June and July. Do not drip or touch vines. Labeled for <i>Hypericum</i> species and sweet pepper bush only.

ALGAE (*Green scum*) Algaecides are usually prescribed on an acre-foot basis. An acre-foot is the amount of water needed to cover one acre of bog with one foot of water (~300,000 gallons of water, assuming the bog is level).

<u>ALGAE - CHEMICAL RECOMMENDATIONS</u>		
Copper sulfate	4 lb/ acre-ft	Apply evenly on ice or in bog waters. When bogs are treated during winter months, water should be impounded for 5-7 days to allow for degradation in cool-temperature water. May also be used in late water.
Algae-Pro	0.75-1.5 gal/A-ft	Amount will vary depending on product, water volume, and algal density. Carefully read the label before application. See Notes on Copper Sulfate and Copper Complexes.
Cutrine-Plus	0.6-1.2 gal/A-ft	

WEED MANAGEMENT OUTSIDE OF BOG AREA

<u>AQUATIC WEEDS - CHEMICAL RECOMMENDATIONS</u>		
Diquat Reward	1-2 gal per surface acre	Use during summer months. Water use is restricted for various time periods depending on product and pattern of use. CHECK THE LABEL! Use only on <u>still water</u> areas outside of bog (i.e., farm ponds, reservoirs). DO NOT USE IN OR ON BOG DITCHES.
Rodeo	1.25% solution	Apply during the summer months. Rodeo is registered for use on noncrop land only. Use in interior ditches is not permissible. Recommended spray solution: 5 oz/3 gallons. <u>Add a nonionic surfactant</u> at the rate of 0.25-0.50% volume basis (1-2 oz or 2-4 Tbsp in 3 gal.).

WOODY AND BROADLEAF PERENNIALS (not in ditches or canal banks)

Hand-pulling is most beneficial in the spring and early summer when the soil is moist and the plants are fairly small.

CHEMICAL RECOMMENDATIONS – WOODY PERENNIALS – NON-BOG USE ONLY!!

Weedone CB	Do not dilute.	Apply in February and March. Spray to wet. Avoid drift onto bog. Controls woody plants on roadsides and non-crop areas. It is no longer produced, but available product may be used <u>off the bog</u> .
Crossbow	1.5-4 gal	Mix with enough water to deliver 10-30 gal/A. Application rates may vary. Read the label! See Notes on 2,4-D.

DITCH MANAGEMENT

WOODY AND BROADLEAF PERENNIALS ON DIKES (BOG-SIDE).

Cultural controls include mowing the ditch and dike areas during the summer months. Some areas may need to be done more than once. Hand-pulling is most beneficial in the spring and early summer when the soil is moist and the plants are fairly small. Controlling weeds on the dikes may be useful in reducing spread of these weeds onto bogs.

DITCH WEEDS (*i.e., Arrowhead, Pickerelweed, Pond lilies, Bur-reed, Duckweed*)

Clean ditches by hand or mechanically preferably twice a year. Draining ditches can sometimes be helpful in killing some aquatic weeds (*i.e., duckweed*). Preemergence herbicides registered for use on the bog may **NOT** be used in the ditches for weed control.

DITCH WEEDS - CHEMICAL RECOMMENDATIONS

Roundup WeatherMAX	Use as a <i>wipe</i> during the summer months in dry ditches. See Notes on Roundup.
Roundup WeatherMAX	Use as a <i>spray</i> during the summer months in dry ditches.
Ditch Weed Control	Use a 1-1.5% solution on a volume-to-volume dilution. Spray to just wet vegetation, not to run-off. Ditches must be kept dry at least 2 days after application.

CAUTIONS AND OTHER NOTES

1. Chemicals not registered for use on cranberries must not be used.
2. Herbicide use may weaken vines and crops may be reduced.
3. To be most effective, rain should follow the application of any dry herbicide formulation within 4 days or the bog should be irrigated.
4. Wash equipment with soap (or detergent) and water immediately after using. Rinse with ammonia after using hormone-type herbicides (such as 2,4-D).
5. Hand-wiping with glyphosate products is often practical with some weeds if roots are weakened. This is particularly useful for dewberries after late water or a summer flood.
6. Mowing of tall weeds helps to prevent shading and reduces seed formation.
7. Late water causes general reduction of annual grasses and reduces dewberry populations and re-growth.
8. Agricultural burning of brush or grass is allowed under regulations from the Director of Air Pollution Control, Southeastern Office of the Dept. of Environmental Protection and under permit from the local fire chief.
9. Review the Weed Management BMP in the UMass Best Management Practices Guide.

NOTES ON THE USE OF COMMON HERBICIDES

CASORON (Dichlobenil). Applications of Casoron are most effective when applied as close to the time of weed germination or emergence as possible. This is especially true for dodder control. Since Casoron volatilizes quickly, it must be washed in by irrigation or rainfall ASAP after application. Apply pre-budbreak or post-harvest. Avoid applying during warm temperatures. Application just prior to sanding or on weak or new vines may cause injury. Applications on top of sand or late applications can be made, but must be watered in *immediately*. Low rates (<40 lb/A) may be applied after removal of a late water flood to control dodder with minimal risk of phytotoxicity. In general, applications of preemergence herbicides are not recommended *after* the later water flood is withdrawn.

Casoron may be applied by air or by ground equipment. Multiple applications may be made as needed. Allow an interval of 3-6 wks between applications. Do not exceed 100 lb/A in any 12-month period. Single doses of high rates of Casoron may be needed to control some perennial weeds. However, some weeds are not controlled by Casoron at any rate due to their deep root systems. Plants with weakened root systems are more susceptible to stresses such as drought and may become more stressed with herbicide application. Some vine injury may occur from herbicide applications made in areas where puddling is a problem.

Distribute Casoron uniformly. Avoid overlapping of herbicide. Temporary reddening of vines may occur especially with late spring application or when applied on sandy bogs. Do not apply after bud elongation as yields may be reduced. Do not apply to young beds (less than 3 yrs old) or on bogs prior to or immediately after mowing vines. Do not sand (spring or fall) on top of a Casoron application. Casoron is labeled for application in the fall prior to ice sanding that winter or in the spring after ice sanding. The efficacy of fall applications for many weeds has not been documented, but growers have reported good success in some cases.

COPPER SULFATE and COPPER COMPLEXES (Algae-Pro, Cutrine-Plus). Copper sulfate may be used to control algal growth on winter or late water floods. Cutrine-Plus and Algae-Pro work best when water temperatures are warm (~ 60°F). These copper-complex products are formulated to last longer than copper sulfate in hard water (carbonates present). Copper-complex products work best when applied under calm and sunny conditions.

If you are holding a 4-week late water flood, plan to apply a copper product mid-way through the flooding cycle (for more details, see Prevention of Scum in the Late Water section). These products are typically applied directly through the irrigation systems (with heads on risers). For winter floods or late water floods of short duration, scout for algae and apply when growth is first visible on the water surface. Remember, these products only prevent further algal growth; they do not kill or remove what has already grown. Crystal copper sulfate will dissolve easily in water and can be applied as a spray solution. Though somewhat uncommon now, crystalline products can be placed in burlap bags and dragged across the water surface. When bogs are treated with copper sulfate during the winter months, water should be impounded for one week. Since late water floods tend to be warm, there is no need to impound these waters. Do not apply to water except as directed on the label. These products are toxic to fish.

CROSSBOW, WEEDAR 64, WEEDONE CB (2,4-D). Crossbow and Weedone CB are labeled for **non-bog use only**. Be cautious! Crossbow contains trichlopyr for which there is NO FOOD TOLERANCE. Do not use Crossbow or Weedone CB on dikes or canal banks. Use it only on weeds located far away from the bog. These products have considerable potential to evaporate and cause crop injury. Avoid applying 2,4-D on hot, sunny, and humid days when there is little air movement. Weedar is the only 2,4-D product that can be used on the bog. 2,4-D products can be highly effective at controlling some weeds. However, the potential for significant vine injury may outweigh the advantages of using these materials. Please Note: Weedar 64 now has a 30-day PHI and may only be applied once per season.

DEVRIKOL (Napropamide). Do not exceed 30 lb/A Devrinol 10G on new plantings. On established bogs, this herbicide provides some control of grassy weeds and annual broadleaf plants at higher rates (60-90 lb/A for peat beds; 40-60 lb/A for mineral soils), but works best on weed-free areas. For best results, water in immediately. May be applied by air or ground. Using the appropriate rate for the age of the bog. Devrinol can be used under or on top of sand.

DIQUAT. This herbicide should only be used on water weeds growing in areas OUTSIDE OF THE BOG. Do not use in any ditch associated with the production area. Diquat will control water weeds such as bladderwort, coontail, elodea, and pondweeds. A non-ionic surfactant (e.g. X-77) may improve performance. Check the label for rate information.

EVITAL (Norflurazon). Vine injury may occur in areas where water stands several days after flooding or heavy rains. Be very conservative when applying Evital to new plantings! Vines have shown severe phytotoxicity to rates as low as 25 lb/A when applied 3-4 weeks after planting. Do not apply more than 80 lb/A on newly planted bogs. Do not apply more than 160 lb/A per season on an established bog. Use lower rates on stressed vines or sensitive cultivars such as Stevens and McFarlin. Growers have reported good results with low rates (50-75 lb/A) for fall applications on these varieties; spring applications should not exceed 60 lb/A. Sanding can be done on top of an Evital application, but it is not recommended especially on bogs that have drainage problems. Sanding after applications of 50 lb/A or less has given good results. Growers are currently testing if Evital can be safely applied on top of sanded vines.

FUMIGANTS. Basamid (dazomet) and Vapam (metam-sodium) are soil fumigants that can be used on beds scheduled for renovation. **DO NOT USE FUMIGANTS AS A SPOT-TREATMENT IF ANY VINES WITHIN A DIKED SECTION WILL BE HARVESTED.** If you are renovating an entire section, a portion of that section can be spot-treated with a fumigant. See 'New Plantings' section for more information on the use of fumigants.

IRON SULFATE. May be spread as a broadcast application through conventional fertilizer rigs, such as hand cranks. Traditional use has been with a 20% ferrous sulfate (fine powder) product, but other formulations are available. Application rates are listed in the Chart Book are for the 20% a.i. product. Adjust accordingly if using another percent active ingredient. Iron sulfate at rates exceeding 1.1 oz/sq. ft (20% a.i. product) may kill vines if they have been sanded within the past 18 months. Do not use on new bogs. To be most effective, rain should follow within 4 days of an iron sulfate application or the bog should be irrigated. When a 9:1 iron sulfate to salt combination is used, rain or sprinkling is not necessary.

POAST (Sethoxydim). This herbicide effectively controls emerged annual and some perennial *true grasses*. Sedges are not controlled. It may be used on bearing and non-bearing beds. There is a 60-day PHI on bearing beds. Do not apply more than 5 pints of product per season. Allow a minimum of 14 days between repeat applications. Phytotoxicity may result if the herbicide is applied during the heat of the day or during bloom. Application during cool periods of the day, but after dew has dried, is preferable. If you have never used this material before, it may be wise to test a small area before applying the product to a larger area.

Efficacy is enhanced by addition of crop oil concentrate or Dash HC, and either adjuvant should always be used. Other adjuvants may reduce efficacy or increase crop injury. Since crop oil concentrate or Dash HC can be mildly phytotoxic, Poast should not be applied during periods of crop stress or during flowering. Poast should not be mixed with other chemicals, particularly chemicals whose label warns against inclusion of an adjuvant.

Poast must be absorbed into the grass to be effective. Therefore, do not apply Poast if rainfall or irrigation is expected within one hour of application. Poast should be applied when grasses have 6 to 8 leaves to provide enough leaf surface for absorption. Apply Poast to grasses that are actively growing and free of stresses such as drought, disease, or mechanical injury.

POAST CANNOT BE APPLIED THROUGH THE IRRIGATION SYSTEM! Spot treatments with small sprayers are effective. **For one gallon Poast solution, mix 2 oz of Poast with 0.6 oz of Dash HC (or 1.3 oz of crop oil concentrate) in 1 gallon water.** Thoroughly wet the grass foliage, but do not let the solution run off the leaves.

Broadcast Application. Use standard high-pressure hollow cone or flat fan nozzles only. Use 5-20 gal of spray solution per acre at 40-60 psi. Inadequate coverage of grasses due to heavy cranberry canopy may reduce control. Do not use re-circulating sprays, wiper applicators or shielded applicators. Use of Poast with control drop application is not recommended due to erratic coverage. *Aerial Application.* Do not apply if wind speed is greater than 10 mph.

PRINCEP (Simazine). The Caliber 90 and Princep 4L formulations must be sprayed evenly with continuous agitation. The manufacturer has voluntarily canceled the label for Princep 80W. It is legal to apply this formulation, but no additional product will be marketed. Application through the sprinkler systems is not allowed. High rates may injure vines or crop. Thin or weak vines and new plantings one week to three years old are very susceptible to injury. However, Princep 80W applied within the first 7 days of planting may offer some weed control. May be used safely in successive years. The granular herbicide is most effective if rainfall occurs or irrigation is used within 4 days of application. Fall applications are not recommended. Growers under Zone II regulations will need permission to apply simazine. If you need more information concerning Zone II, contact the Cape Cod Cranberry Growers' Association (508-759-1041) or the MDAR (617-626-1773).

RODEO. This glyphosate product can only be used to control weeds that occur in dry ditches and canals outside of the production area. Application is spray to wet leaf surfaces, not to runoff. Extremely cool or cloudy weather following application may slow the activity of this herbicide. Best control is obtained when plants are at late growth stages approaching maturity. Weeds under stress will not be controlled as well as healthy plants. Rainfall within 6 hours of application may reduce effectiveness and heavy rainfall within 2 hours of application may necessitate reapplication. Do not add ammonium sulfate to Rodeo mixtures.

ROUNDUP (Glyphosate). Many RoundUp (e.g., RoundUp Ultra, RoundUp WeatherMAX) and glyphosate products are available on the market. Please read the label of any product you are using to ensure compliance. This product may be applied on bogs, by wiper or clipper, during the growing season. If you are using Round Ultra, you will need supplemental labels for dry ditch and postharvest sprays. If you are using WeatherMAX, these spray uses are incorporated into the label and additional labels are not needed. WeatherMAX is slightly more concentrated than Ultra, so keep that in mind when preparing solutions. Use 1%-1.5% solutions (2.5-3.8 TBL or 38-57 ml/gal) for dry ditch applications and 0.4%-0.7% solutions (~3.0-5.5 tsp or 15-27 ml/gal) for postharvest sprays. Recent research indicates that Howes may be slightly more sensitive to postharvest spray injury than Early Black.

It is not necessary to mix Roundup Ultra or WeatherMAX with any additional surfactants or additives (as with older glyphosate products). Add a dye to track leaf coverage. Technical information indicates that ammonium sulfate may improve uptake of these Roundup products when moderate to large amounts of carbonates ('hard water') are present in water (rarely a problem in MA). Roundup WeatherMAX is rainfast 1-2 hours after application. Available glyphosate products vary as to whether they carry a 'Caution' label or 'Warning' label. Look at the label!! When using Roundup, protective eyewear is not mandated; the REI for WeatherMAX is 4 hr. Thorough coverage is essential to maximize control of perennial weeds. Do not touch or allow material to drip onto vines. **Apply any time weeds are present except 30 days before harvest.** Make herbicide mixtures fresh each day for maximum effectiveness. Do not store in galvanized containers.

Roundup Products	Mix 1 part glyphosate with 4-9 parts water (10-20% solutions). No additional additives, buffers, or surfactants are needed. However, the addition of ammonium sulfate may sometimes improve performance.
+ A marker dye (i.e., Blazon Blue)	Add according to manufacturer's recommendations.
Glyphosate products	Mix 1 part glyphosate with 4-9 parts water (10-20% solutions).
+ Surfactant	1 oz (2 tablespoons) per gallon of glyphosate mixture.
+ Ammonium sulfate	3 oz (6 tablespoons) per gallon of glyphosate mixture.
+ A marker dye (i.e., Blazon Blue)	Add according to manufacturer's recommendations.

OTHER GLYPHOSATE PRODUCTS. Glyphosate is sold under several product names. CHECK THE LABEL! To enhance control with glyphosate products other than Roundup WeatherMAX, add a nonionic surfactant (i.e., X-77) and ammonium sulfate (see rates above). Other label differences include: Do not apply if rainfall is expected within 6 hr of application. Do not irrigate within 6 hr of application. The REI is 12 hr for these products. Note also that glyphosate products other than Roundup WeatherMAX may carry a 'Warning' label, instead of a 'Caution' label. Always use a dye to track your coverage with any wipe product. Check the label for appropriate protective clothing.

Clipper Applicators (Roundup only). Concentrations of 50-100% Roundup have worked well. The herbicide should flow out consistently, but not so fast that herbicide drips from the blades. Be sure to use a dye. Clip weeds close to the ground, without contacting the vines. Roundup must contact the stem as you are cutting! 'Clip and dab' or 'mow and wipe' techniques may have reduced efficacy as the herbicide is not applied simultaneously with the cut. Late-season treatments give better results than early-season treatments. The effectiveness of post-harvest treatments with clippers is not known. Be sure to clean the blades after use to prevent corrosion. Availability of commercial clippers has become more scarce over the past few years. Growers may need to manufacture their own clippers.

General Wiping Tips. Use a small sponge or applicator that permits excellent coverage with minimal dripping. Adequate coverage of each stalk must be obtained. Several leaves (at least 50%) on each stalk must be treated with the herbicide. Repeat applications to remaining plants the following year. Be patient. Most treatments will not give 100% control in the first year. Applications in subsequent years should be less time-consuming.

Hand-wipe Technique for Controlling Dewberries or Other Prostrate Weeds. Application by hand with sponges or specially designed applicators may be necessary with low-growing weeds (e.g., bristly dewberry, poison ivy). Repeat applications within a season are legal and may be necessary, especially for well-established perennial weeds. Poor

growing conditions such as drought stress, disease, or insect damage may reduce effectiveness. Avoid touching or dripping material onto cranberry plants during application.

SUPPLEMENTAL LABEL USES. Supplemental labels are needed only if you are using Ultra for post-harvest sprays (0.5%-1%), applied as a spot-treatment, or sprays in dry ditches (1%-2%); these uses are permitted under regular labeling for WeatherMAX. These labels can be obtained at a local ag supplier or by request from the Cranberry Station. If you are unsure about using a supplemental label, call the Cranberry Station (ext. 21) for information.

SALT. Salt (sodium chloride) may be used as a spot-treatment for control of certain weeds (e.g., wild bean, rushes). Judicious applications do not inhibit re-colonization of cranberry vines once the weed dies. Do not use during bloom. Use of calcium chloride or other types of salts is not recommended. Salt is corrosive to machinery. Be sure to wash equipment thoroughly after application.

SELECT (clethodim). Similar to Poast with regards to target species, timings, and applicators. Note these differences. Apply when weeds are 2-4 inches high and actively growing. Use of crop oil concentrate is recommended with Select. For a 1-gal mixture, use 0.4 oz Select with 1.3 oz COC. Select has a 30-day PHI. Do not apply more than 8 oz per application per acre. Do not exceed 32 oz/acre per season. Allow 14 days between applications. You can use 3-10 gallons water with aerial applications, 10-30 gal/A otherwise.

STINGER (clopyralid). Stinger is a selective, postemergence herbicide used to control: wild bean, narrow-leaved goldenrod (NLGR), asters, clover, ragweed, pitchfork (and other members of the Composite family), and certain other weeds within the treated area. Growers have reported effective control (and reduced vine injury) when using lower rates than recommended on the label. This is particularly true for wild bean control.

Apply when weeds are actively growing. It is best to apply Stinger when vines are dormant, if possible. For weeds that emerge late (NLGR, wild bean, etc.), wait until after fruit set to apply. It is not recommended to apply Stinger when vines are going through active growth spurts (e.g. budbreak-roughneck stage). Stinger has a 50-day PHI. Stinger may be applied as a wipe or as a spray. Spray to just wet the weeds, but not to run-off. BE VERY CAREFUL! Overspray can cause injury that may take 1-3 years for full vine recovery. Minimize drift when applying as a spray. Results may be slow to show; be patient. Two applications per season are permitted, not to exceed a total of 1 pint per acre. Stinger cannot be applied by air or through the irrigation system.

SULFUR. Determine soil pH in the weedy area prior to sulfur application. If pH is 5.0 or above, use two applications of 500 lb/A each (or 4 applications of 250 lb/A) to reach 1,000 lb. of elemental sulfur per season. Begin application in late spring when soil is drained and sprinkling for frost is over. Most growers allow 3-6 weeks between applications. Do not apply sulfur to puddled or waterlogged areas as resultant production of hydrogen sulfide can cause severe vine toxicity. Changes in pH can be very slow. Granular applications may take up to nine months to reduce pH enough to affect weed populations. The smaller the sulfur pellet size, the faster the pH is lowered. Use pelletized sulfurs only. Do not use flours of sulfur; they can be phytotoxic and are difficult to apply. Do not use potassium sulfate. Yearly sulfur applications may be needed as the pH can creep up in subsequent years. Test soil pH yearly to determine the effectiveness of sulfur applications. The effect of lowered pH on control of cinquefoil is moderate. Eye protection and dust masks are recommended when making sulfur applications.

NUTRITION MANAGEMENT FOR PRODUCING BOGS 2005

Prepared by Carolyn J. DeMoranville

APPEARANCE

Decisions regarding nitrogen dose for a cranberry bog should be based in part on the length and density of uprights. By mid-June (hook stage), the minimum total growth on the new uprights should be 2.25 inches for 'Early Black' and 'Howes', and 2.5 inches for 'Ben Lear' and 'Stevens'. Flowers on uprights longer than 4 inches may be poorly pollinated and fruit poorly colored. Flowering uprights should have 1.5 to 2 inches of leafy length above the flowers and fruit. Presence of adequate foliage (length) by mid-June is significantly correlated with yield later that season. Small, stunted uprights early in the season are associated with poor crops. The average upright density for a productive bog should be about 600 uprights/sq. ft. for 'Early Black' and 400 uprights/sq. ft. for 'Howes', 'Ben Lear', and 'Stevens'. Ideally, 200 or more of these uprights should be the flowering type. An adequate stand of vegetative uprights is also important, as about 80% of these will flower next year. Even and adequate vine cover is the key to good production: 200 flowering uprights/sq. ft., each producing an average of 1.5 berries, will give a crop of approximately 300 bbl/A. To sample upright density: count all uprights in a circle 4 inches in diameter. Total upright density (approximate) for 'Early Black' should be 50/sample; density for 'Howes', 'Ben Lear', or 'Stevens' should be 35/sample.

Leaf greenness is related to the pigment, chlorophyll, which is involved in carbohydrate production through photosynthesis. Along with adequate growth (length) of the uprights, chlorophyll content is an important determinant of yield. Overall intensity and shade of leaf greenness (chlorophyll) is related to adequate N nutrition. With experience, growers can assess intensity of greenness by visual observation. As an alternative, SPAD Chlorophyll Meters may be used. Measurements should be taken on 25-30 detached leaves/A, using only healthy, clean leaves (no feeding damage or residue on surface). Old or new leaves may be monitored in June or July, while only new leaves should be monitored in August. Meter readings vary by cultivar and year. Values below standard indicate the need for N fertilizer. Standard minimum SPAD values are as follows:

Cultivar	Leaves:	Roughneck to hook stage (June)		Bloom to fruit set (July)	Pre-harvest (August)
		old	new	old or new	new only
Early Black		40	25	35	35
Howes		45	30	40	40
Stevens		40	30	35	40
Ben Lear		40	25	35	40

A bog with thin vine cover, pale leaves, or stunted vines may not be getting enough nitrogen. Remember also that vines which are too long and too dense are related to diversion of nutritional assets to vegetation (small berries), shading of fruit, poor fruit color, increased fruit rot, and inability of bees to reach pollination sites.

SOIL AND TISSUE TESTS

Soil and tissue tests are tools which a cranberry grower can use for several purposes. These include: (1) diagnosing deficiencies of mineral elements; (2) monitoring soil pH; and (3) aiding in the decision making process for choosing fertilizer (tissue tests). Soil and tissue tests are important for these reasons. However, there are no 'cookbook' type formulas for fertilizing a cranberry bog based on the test results. There are several reasons why such an approach will not work for cranberry production: (1) standard soil tests poorly predict availability of nutrients and poorly correlate with yield in cranberry; (2) as a perennial plant, cranberries store nutrients from the previous season(s) making it impossible to base fertilizer choices only on soil content and yield potential; (3) there is virtually no variability in soil test N values from bog to bog; (4) tissue test N concentration varies depending on length of upright (N concentration in the tissue does not correlate well with added N); (5) nutrient availability changes with soil pH and soil pH is not uniform from bog to bog; and (6) common soil test methods for P do not give results which correlate well with cranberry yields due to very acid soils in cranberry production - P tests are of no value if soil iron is above 200 ppm.

With these warnings in mind, tissue and soil analyses can be beneficial as a long-term record of changes in your bog. Soil and tissue tests are particularly useful when compared to one another - a soil test alone is virtually useless in determining a fertilizer recommendation for cranberry. Tissue tests are more useful for setting target fertilizer ranges. We recommend sampling every 3-5 years for soil, every 2-4 years for tissue. Keep the results and use them in conjunction with your records of your bog management and performance (growth and cropping) to aid in making fertilizer decisions. Use periodic soil testing to monitor any change in soil pH. For further information regarding tissue testing, refer to 'Cranberry tissue testing for producing beds in North America' (available at the Cranberry Station).

When and how to test

The results you receive from a soil or a tissue test are only as good as the sample you supply to the analytical lab. It is important to remember that the sample that you submit for testing for nutritional elements is not the same as the sample you would collect and submit for other purposes, for example the diagnosis of a disease. Sample bags for the UMass lab in Amherst are available at the Cranberry Station, bags for other labs can be obtained at local Ag Suppliers or directly from the labs. Remember, a properly collected and handled sample of soil or tissue is essential to an accurate analysis.

Tissue samples: Samples for cranberry tissue analysis should NEVER contain roots, soil, runners, fruit, or trailing woody stems. In general all of these contaminants contain less nutrients than the leaves. Including them will give a falsely low analysis. Tissue samples are best collected from **mid-August to mid-September**. Samples collected at that time should include **upright tips only** (do not strip off the leaves). Collect no more than the **top 2 inches** of new growth (mix flowering and vegetative uprights). As you walk a transect across the bog, collect enough material to fill the sample bag (provided by the commercial lab) to the indicated mark. This may be done in the field as samples should not be washed. Collect samples when the plants are not wet. Do not mail samples in plastic bags. Moldy samples give poor results. Always request nitrogen determination. This increases the cost, but nitrogen levels in the tissue test are an important indicator of plant status and the success of fertilizer programs.

Sampling other than in August-September: Tissue samples may be collected at other times of year if absolutely necessary. However, nutrient levels change more rapidly outside of the recommended time and make interpretation of the results more difficult. If sampling in the spring, samples should be collected in June and consist of **new upright tissue** only. Do not include last season's leaves - they will lead to a falsely low result. *In June samples, nitrogen should be 1.2-1.5%, phosphorus 0.15-0.19%, and potassium 0.7-0.9%.* Call the Cranberry Experiment Station for interpretation of other elements.

TISSUE STANDARDS (August 10 to September 15 collection)			
These standards were developed in conjunction with researchers throughout the cranberry growing areas of the United States.			
Major Element	Concentration in dried tissue <i>percent</i>	Minor Element	Concentration in dried tissue <i>ppm</i>
Nitrogen (N)	0.90-1.10	Boron (B)	15-60
Phosphorus (P)	0.10-0.20	Zinc (Zn)	15-30
Potassium (K)	0.40-0.75	Copper (Cu)	4-10
Calcium (Ca)	0.30-0.80	Iron (Fe)	problem if less than 20
Magnesium (Mg)	0.15-0.25	Manganese (Mn)	problem if less than 10, if greater than 500-600, check bog drainage
Sulfur (S)	0.08-0.25		

Tissue samples should be collected when deficiency is suspected or diagnosis of a specific problem is needed. For problem diagnosis collect 2 separate samples - one from the problem area, one from nearby 'normal' vines.

Samples collected after mid-September give lower analysis values than those collected earlier. This is especially true for nitrogen. Late in the season the uprights become more woody so that more of a tip sample is stem tissue. Stems have less nutrient content than do leaves so the overall result is a lower analytical value.

Soil samples: Samples for analysis of soil nutrients should NOT contain stems, leaves, or the surface duff layer (trash). These are all organic contaminants and will bias the organic matter (OM) determination for the sample. The inclusion of some roots is generally unavoidable. Use a soil probe with a 1-2 inch diameter to collect cores of 4-6 inch depth. Minimum requirements: 4 cores for up to 1 acre; and 1 core for each additional 2 acres up to a total of 10 cores/bog. After the trash layer on the surface of each is discarded, these cores are combined to make a sample. Collect enough soil to fill the sample bag (from the commercial lab to which you will send the sample) to the indicated level. Dry the soil at room temperature for a day or two. The resulting sample will weigh less and cost less to mail. Fill soil bags from the commercial lab with the air-dried samples and send to the lab for analysis. OM determination (usually an additional charge) is often useful. Methods of analysis vary by lab - pick a lab and stick with it. Research has shown that the Bray test is the most accurate for cranberry soil P testing, check to be sure your lab uses this test. However, even this test is of limited value in cranberry soils. The best time to sample cranberry bogs is when the soil is not waterlogged. Wet soils give falsely high P values. Soil samples may be collected with tissue samples in the late summer. Fall samples are acceptable if no sanding is planned.

SOIL STANDARDS (ppm)

Ammonium acetate extraction unless otherwise indicated.

Element	Deficient below	Normal	Excess above
Phosphorus (Bray)*	20	20-60	80
Phosphorus (P)	4	4-9	10
Potassium (K)	10	10-40	50
Calcium (Ca)	20	20-80	90
Magnesium (Mg)	10	10-25	25
pH	4.0-5.0		

Base saturation: Ca should roughly equal the sum of K and Mg.

Base saturation is the *proportion* of the various positive cations in the soil. In acid soils 45-70% should consist of hydrogen ions (these replace much of the Ca that would be found in higher pH soils).

Cation Exchange Capacity (CEC): Measures ability of soil to hold positive ions (cations or bases). If CEC is low (<10), base saturation proportions are important. If CEC is high and all cations are in the normal range, the proportions in the base saturation are less critical.

*Preferred method for cranberry soil P.

CONVERSIONS FOR SOIL TEST RESULTS

lb/A K, Ca, Mg or P	divide by 2.27 to get ppm
lb/A K ₂ O	divide by 2.75 to get ppm K
lb/A P ₂ O ₅	divide by 5.2 to get ppm P

MAJOR ELEMENTS

NITROGEN, PHOSPHORUS, AND POTASSIUM (NPK):

Most often these elements are added together in 'complete' NPK fertilizer. Research indicates that 1-2-1, 1-1-1, or 1-2-2 ratios give the best results. The amount to apply depends on the desired N dose. When low N dose is required (generally pre-bloom), low N materials (3-13-26 or 5-15-30) or no N materials (0-25-25) may be used. However, a study of P fertilizer has indicated that high P doses do not increase yield compared to that with moderate P doses and that excess P in the soil may be associated with lower yield. If tissue P is in the sufficient range, we do not recommend exceeding a 1:2 ratio of N to P. N dose is chosen based on vine appearance, tissue test, soil type, previous response, and weather (spring temperature). Based on bog history - use the lowest N dose that gives adequate vegetative growth and maintains productivity. A nitrogen rate of 20-25 lb/A (a bit higher for hybrids) for the season is a reasonable starting point if you are unsure about dose.

<u>Plant/soil condition</u>	<u>Recommended fertilizer rate</u>
<u>Nitrogen (N)</u>	
Yellow, short, or low N vines	40-60 lb/A
Normal vines	10-40 lb/A
Rank vines or excessive N	0-20 lb/A (none pre-bloom)
High yielding 'Stevens'	20-60 lb/A
<u>Phosphorus (P)</u>	
Tissue tests normal	supplied in NPK, no more than 1:2 ratio NO MORE than 20 lb/a P recommended (45 lb/a P₂O₅)
Soil and tissue tests low	use NPK with higher P (1:3 or 4 ratio)
Soil P normal, tissue P low	2-4 lb/A foliar P (pre-bloom)
P excessive in soil	avoid NPK with high P
<u>Potassium (K)</u>	
Soil and tissue tests normal	supplied in NPK, 40-120 lb/a recommended
Soil and tissue tests low	120 lb/A as 0-0-22-11 (best), or 0-0-50
K excess	use no supplements
<u>Calcium (Ca)</u>	
Soil or tissue deficient	20-30 lb/A (actual Ca) as gypsum AVOID LIME
<u>Magnesium (Mg)</u>	
Soil or tissue deficient	10-30 lb/A as 0-0-22-11 or magnesium sulfate (Epsom salts)

Soil balance of K, Mg, and Ca is important. Excessive use of any one can induce deficiency of the others. This is especially a risk with high Ca use. Lime can have adverse effects by changing soil pH. Use of materials high in chloride (Cl) may lead to decline in production. Avoid use of high rates of 0-0-60.

MINOR ELEMENTS

- Minor element deficiencies are rare in cranberries due to low requirements and high availability on acid soils. See the following section on removal of minerals. Deficiencies may be brought on by soil mineral imbalances or stress conditions (drought, waterlogging).
- When deficiencies are suspected (visual symptoms), confirm with tissue testing. Once confirmed, deficiencies are best corrected with foliar sprays. Such sprays are applied between bud break and hook stage.
- CALCIUM-BORON (5% Ca, 0.5% B, no other minor elements) sprays were the only minor element

supplements to give increased crops in our research on non-deficient bogs. Response was greatest on bogs yielding at or below State average crops. We found that 2 applications of 2 qt/A improved fruit set.

TIMING: 10% bloom, mid-bloom. The second application seems most effective. Application by aircraft is more effective than sprinkler application. This is a foliar feed - apply accordingly.

- CAUTIONS:**
1. Manganese containing fertilizers or fungicides (Maneb or Mancozeb) may cancel beneficial effect of CaB if applied with or around the same time as CaB.
 2. DO NOT use when leaf analysis is above 75 ppm B.
 3. If B levels are elevated, you should eliminate the FIRST application.

APPLYING FERTILIZER TO CRANBERRY BOGS

- **SPRINKLER SYSTEMS** may be used to apply liquids, flowables, and foliar feeds. Make sure not to mix incompatible materials (jar test first). When using sprinkler systems to apply fertilizer - make sure that coverage is **ADEQUATE AND UNIFORM**. **EVERY EFFORT SHOULD BE MADE TO PRESERVE WATER QUALITY** - avoid application of fertilizer to water in ditches and canals.
- Foliar feeds should not be washed off the leaves. Liquid fertilizers should be washed onto the soil. Be sure that you know which you are applying.
- **FISH FERTILIZER** is a liquid fertilizer. It should be washed in.
- Make sure ground application equipment is properly calibrated.

FERTILIZER SOURCES FOR CRANBERRY PRODUCTION

General information:

- The best available evidence indicates that cranberries respond poorly to nitrate N; the **AMMONIUM FORM** is preferable. Light doses of urea are suitable to correct N deficiencies quickly (when the urea is dissolved and used as a foliar feed). Use blended fertilizers with ammonium N and excellent uniformity of particle size. Non-uniform blends will sort during application, giving poor results.
- **FISH HYDROLYSATE FERTILIZER** is available commercially and has been shown to be a suitable substitute for granular, inorganic NPK. It may provide benefits in soil conditioning and reducing movement of nutrients out of the root zone. Fish fertilizer is a good choice where the bog holds water poorly and/or has a history of needing larger than normal fertilizer doses. The nitrogen in fish fertilizer is tied up in organic compounds. As these degrade in the soil, nitrogen is slowly released for use by the cranberry plants. Leaching losses of nitrogen are reduced. Therefore, 20% lower nitrogen doses provided as fish fertilizer should give the same result as a higher nitrogen dose provided in granular, inorganic fertilizer. This has been demonstrated on commercial bogs. Fish is especially useful in the spring and as a replacement for fall fertilizer (see timing for fish-granular NPK program).
- Use of **SULFUR** containing fertilizers (SulPoMag, ammonium sulfate) may help to keep soil pH low, and acid is released into the soil as the plants take up ammonium N. However, to substantially lower soil pH, elemental sulfur (S) application is used. Soil pH may influence the types of weeds that invade a bog. See the Weed Management section for information on the use of S for weed suppression. Advice from experts prior to S application is recommended. Apply no more than 500 lb/A/season in one or two applications. **Apply elemental S only to well drained soils.**

Use this table (courtesy of the Wisconsin Cranberry Crop Management Newsletter) to calculate the amount of S needed to lower soil pH based on desired amount of change and soil organic matter content from the soil test. This is a **SLOW** process depending on bacterial activity in the soil - pH change will occur over a period of months. Change will be fastest when soil is warm.

Desired pH change	Soil organic matter content (%)					
	0.5-2.0	2-4	4-6	6-8	8-10	>10
	----- Amount of sulfur needed (lb/A) -----					
0.25 units	250	750	1200	1700	2300	2800
0.5 units	500	1500	2500	3500	4600	5500
1 unit	1000	3000	5000	7000	9200	11000

- CALIBRATION AND EVEN APPLICATION of granular materials becomes more difficult when the rate falls below 75-100 lb/A. When you plan to apply low N doses, a higher rate of a low assay fertilizer may be a better choice than a low rate of a more concentrated material. Example: 100 lb/A 5-15-30 compared to 42 lb/A 12-24-12 to apply 5 lb N/A. However, avoid excessive P in high N:P ratio materials. See Major Elements section.

Nitrogen (N): Nitrogen is most often added with phosphorus and potassium in NPK fertilizers. To determine dose of N in granular fertilizers, multiply the percent N (first number on the bag) by the amount of fertilizer to be used. For liquid formulations, the calculation must include a correction for the weight of the liquid.

For example: 9-18-9 liquid contains
9% N by weight

Multiply 9% by the weight of a gallon to
determine the pounds of N in a gallon

Other N fertilizers:

Ammonium sulfate	21-0-0	this material may also be used to control moss (4 lb/15x15 ft)
Ammonium phosphate		found in 'complete' NPK fertilizers
Urea	46-0-0	(urea breaks down to form 2 ammonium molecules)
Fish fertilizer	2-4-2	most common - 10 gal provides 2.5 lb N, 2 lb P, 2 lb K
Slow release fertilizers		IBDU, methylene urea, sulfur coats, resin coats
Organic fertilizers		Composted chicken manure, fish fertilizer, feather meal
Other organic N forms		Seaweed and humate compounds have not given a positive response in cranberry research plots. Avoid sludge based products (e.g. Miloganite) as they are high in heavy metals which become very plant-available in acid soils.

Phosphorus (P): Recent research showed that P applied at 20, 40, or 60 lb/A gives increased yield compared to using no P fertilizer. However, there were no differences in yield among the three rates. Phosphorus is generally added with nitrogen and potassium (NPK) or as super phosphate (0-25-0) or triple super phosphate (0-45-0). Research indicates that foliar P, bone meal, or rock phosphate can supply the P needs of cranberry bogs as well. *To determine pounds of P in 100 pounds of fertilizer, multiply 0.43 by the second number on the fertilizer label.*

Potassium (K): Potassium is generally added with nitrogen and phosphorus (NPK) or with magnesium (SulPoMag or similar product), but may be applied as a foliar spray (of little value in research trials) or as potassium sulfate (0-0-50). Muriate of potash (KCl, potassium chloride, 0-0-60) may be less desirable due to the adverse effects of chloride on cranberry vines. To determine pounds of K in 100 pounds of fertilizer, multiply 0.83 by the third number on the fertilizer label.

TIMING - WHEN TO APPLY FERTILIZERS TO CRANBERRIES

NPK fertilizer may be added in several forms (see previous section). The form chosen will determine the time schedule for applications. Information is presented below for sample programs based on various NPK forms. Plan nitrogen fertilizer applications based on soil type and soil temperature. On sandy soils (<1% organic matter), nitrogen fertilizer may be applied throughout the season. On more organic cranberry soils and older beds, applications should be based on soil temperatures. For typical cranberry bogs (1-4% organic matter), applications of N should not be necessary early in the spring. From flood removal until soil temperatures exceed 55°F, adequate N should be available through biological processes (mineralization). Nitrogen is slowly released from the soil early in the spring when the cranberry plants are dormant. This leads to a 'flush' of ammonium availability when the plants are breaking dormancy. At soil temperatures from 55°F to 70°F, release of N through mineralization is only moderate. Fertilizer applications should be beneficial. This corresponds to the period from roughneck stage through bloom. During spells of hot weather, when soil temperatures exceed 70°F and air temperatures exceed 85°F, soil N release increases and crop development slows, so planned fertilizer N applications should be reduced, delayed, or eliminated.

It is best to time fertilizer applications by the growth stage of the plants. This is especially true when weather has been unusual and plant development is off-schedule. For a cold spring, delay soil amendment applications. Fertilizer applications will be less effective if soil temperature is below 50°F because roots will not take up nutrients effectively in cold soil. Dates listed are only approximate, based on an average weather year. See major element section for information regarding doses.

Abbreviation:	Stage:	Timing (avg. weather year):			
ES	Early spring	mid-April to mid-May			
BB	Bud break	mid-May			
RN	Roughneck (1" new growth)	late May			
HK	Hook	early June			
E-BL	Early (10%) bloom	2nd week June			
BL	Mid-Bloom	late June			
ST	Fruit Set (pea size)	2-3 wks. after BL			
BD	Bud development	early August			
EF	Early Fall	late August to September			
PH	Post harvest	mid-October through November			

Programs					
Stage	NPK granular	Slow release NPK	Slow/fast NPK	NPK granular/Fish	Fish (2 alternatives)
BB		100% total N		10-20 gal/A fish	50% 25%
RN	20-25% total N		40% total N		
HK					25%
BL	25-30% total N		60% total N	30-35% total N as granular	
ST	25-30% total N			30-35% total N as granular	50% 25%
BD	20-25% total N				
EF				10-20 gal/A fish	25%

Optional for any program

ES	Soil amendments	Correct P, K, Ca, Mg deficiencies
	Soil conditioners	0-0-22-11 or similar at 100-300 lb/A (100-150 recommended)
BB to HK	Minor element supplements	Foliar sprays for deficiencies only
E-BL and BL	CaB	2 qt/A
EF	Fish as fall fertilizer	5-10 gal/A
PH	Fall fertilizer	no more than 5 lb N/A; high K materials best if any used

IMPORTANT CONSIDERATIONS FOR CRANBERRY FERTILIZING

REMINDERS:

- GOOD DRAINAGE AND ADEQUATE IRRIGATION are essential for best response to fertilizer. Monitor and maintain adequate soil moisture. Small, frequent irrigations are not adequate to provide moisture to the root zone. For further information, refer to the irrigation section.
- SANDY BOGS CANNOT HOLD NUTRIENTS WELL - apply lower fertilizer rates more frequently. Slow-release fertilizers are also recommended for bogs planted on mineral soils.
- Cranberry bog soil has little capacity to HOLD cations, i.e., K, Mg, Ca. Much of the holding capacity is taken up by hydrogen ions. It is important to maintain a BALANCE among cations. Overuse of one can induce deficiency of the others. When you test bog soil for pH, check this balance as well.

WHEN SYMPTOMS OCCUR- rule out disease and pest problems first. Then look at nutrition. Collect tissue for testing if necessary.

- **KEEP GOOD RECORDS.** Comparison of dose/material and crop response over time will help to refine fertilizer practices tailored to YOUR bog. **OBSERVE YOUR BOGS OFTEN** -- fertilizer timing depends on growth stage/plant development. Dose can be refined as plants respond during the growing season.
- **REVIEW** the Nutrient Management BMP in the Best Management Practices Guide for Massachusetts Cranberry Production available from the Cranberry Station.

CAUTIONS:

- **PRESERVE SURFACE WATER QUALITY** - avoid applying fertilizer to water in ditches and canals.
- **AVOID LARGE DOSES APPLIED AT ONE TIME**, particularly on bogs constructed on mineral soils or very sandy bogs. Such applications may lead to lateral movement of fertilizer into water.
- **EXCESSIVE NITROGEN FERTILIZATION** leads to overvegetative plants. This may increase susceptibility to disease, spring frost or insect feeding. High nitrogen doses may also lead to poor fruit quality and delay color development in the fruit. High nitrogen doses can have adverse carry-over effects in following years. Excess applied nitrogen leads to high nitrogen concentrations in plant tissues such as stems and roots that can be remobilized in the plant and lead to excess vegetation, particularly when more nitrogen is added to the soil.
- **FALL FERTILIZER** (after harvest application) is often unnecessary, particularly if crop was small and no deficiencies have been noted. Late season applications may not be properly taken up by the plants depending on soil temperature and state of dormancy. Generally, if uptake does not occur in the fall, the nutrients are no longer available the following spring. Organic types of fertilizers may be the exception.

EFFECTS OF WEATHER

- **WINTER INJURY.** If leaf drop occurs after withdrawal of winter flood, early spring fertilizer applications will aid in recovery by encouraging rapid, early production of new leaves. Do not skip spring fertilizer. SulPoMag (or similar material) at 100-200 lb/A may also aid recovery.
- **COLD SOIL/AIR TEMPERATURES**, particularly in the spring, will lessen or eliminate response of cranberry plants to fertilizer applications. If plants are already under stress, they may respond even less. If this occurs, care should be taken not to reapply before you are sure that the plants are not going to respond to the initial application. Soil temperatures should rise to 50°F before application of fertilizer to ensure response. If long-lasting or organic forms were used, reapplication may not be necessary -- response may only be delayed.
- **IF FLOWER BUDS ARE DAMAGED BY SPRING FROST**, heavy N fertilization can lead to overgrowth. Use lighter doses.

EFFECTS OF PESTS AND CULTURAL PRACTICES

- Decreasing pre-bloom N may impact TIPWORM populations by limiting lush growth for insect feeding.
- **BOGS CONSTRUCTED ON MINERAL SOILS** without a permeability restricting or confining layer have little ability to hold nutrients in the root zone. Use organic or slow-release N and avoid large doses applied all at once.
- **DECREASE** fertilizer dose if the bog has been **SANDED**. Sanding promotes production of new vegetative uprights from the runners. Sanding combined with high fertilizer rates can lead to overgrowth.
- **DECREASE** fertilizer dose if **LATE WATER** has been held. Spring fertilizer dose may be eliminated on late water bogs. Overall fertilizer dose may be decreased 30% or more. However, do not decrease fertilizer N by more than 40% at the risk of adverse impact on the following season crop.
- **ELIMINATE** fertilizer applications for the entire season if the bog has been subjected to a long **SUMMER FLOOD** (May-July, see Insect section) for grub control.
- If eliminating crop using a **FLASH FLOOD**, reduce fertilizer dose. A light dose in the spring and mid-season should suffice to support the plants.
- **PRUNING** stimulates growth - reduce spring fertilizer on heavily pruned bogs. However, if the bog has been mowed, fertilizer applications are required to encourage the production of new uprights.

NUTRIENTS REMOVED FROM 'EARLY BLACK' CRANBERRY BOGS

<u>Nutrient</u>	<u>Removed in old leaves and stems*</u>	<u>Removed in 200 bbl/A crop</u>	<u>Total</u>
		lb/A	
N	13.6	10.0	23.6
P	2.2	2.0	4.2
K	3.4	17.4	20.8
Ca	14.2	1.6	15.8
Mg	3.5	1.2	4.7
		ounce/A	
B	1.3	0.4	1.7
Cu	0.1	0.3	0.4
Mn	8.6	0.5	9.1
Fe	2.6	0.7	3.3
Zn	0.6	0.4	1.0

*assumes detrashing during water harvest or after dry harvest removes 75% of leaves and stems shed during the season. Presume that for more robust hybrids such as Stevens removal may be greater due to greater leaf mass shed during the season (larger leaves).

LATE WATER AND CRANBERRY MANAGEMENT

Prepared by C.J. DeMoranville, A.L. Averill, F.L. Caruso, and H.A. Sandler

Late Water (LW) is a 30 day spring reflood applied several weeks after the winter flood has been removed and before the plants have lost dormancy (not yet fully green). LW suppresses some insects and Southern red mite (SRM). Fruit rot disease is reduced on LW bogs and keeping quality is improved. LW has also been shown to suppress growth of dewberries (brambles).

Significant reductions in pesticide inputs may be achieved with the use of late water.

FLOOD MANAGEMENT

When to use LW: Late water should be used no more than one year in three. If the previous summer was very sunny and none of the adverse weather conditions listed below are present, the use of LW should be considered for its benefits in insect, mite, disease, and weed control (see below).

When not to use LW: To minimize crop reduction, late water should not be used more often than once every three years. Bogs with poor quality water supplies may not be good candidates for late water. Do not use LW if the winter has been unusually cold or abnormally warm (particularly if the fall was also warm). ***Do not use LW in the spring following a fall flood.*** Inspect the bog after withdrawing the winter flood - if stress, winterkill or leaf-drop are apparent, do not use LW. Do not use LW if the bog was sanded the previous fall or winter. However, barge sanding in the LW flood has been successful. Experience has shown that in some years (on average, 1 in 10 years) late water bogs may produce significantly (>10%) lowered yields. Overall, however, this low yield may be offset by higher yields in subsequent years. Costs in the LW year should also be less, particularly if inputs are reduced due to reduced pest pressure, helping to offset any losses. It is not known exactly what factors contribute to these occasional lower yields, but avoiding LW in the conditions listed above should provide some insurance against a large crop loss.

When to apply the flood: The flood should be applied in the spring prior to the breaking of bud dormancy. The leaves will be beginning to lose their dormant red color but the flower buds should still be red and tight. Generally, the 30 day LW flood will be applied between April 15th and 20th. If temperatures in late March - early April are warm (5°F per day above normal) or the season is early due to warm winter temperatures, the flood may be applied earlier (up to one week). Do not apply the flood if the buds have broken dormancy. We recommend putting sprinkler heads in place prior to the flood. This allows easy application of algaecide if needed (see below) and ensures that you will be ready if a frost night occurs immediately after flood removal.

Depth and temperature: The flood depth should be maintained so that all vines are well covered by water. Shallow floods and/or flood temperatures consistently greater than 65°F should be avoided to prevent injury and crop reduction. Flood water temperatures will generally be cooler if the flood is deep (> 12 inches above the vines). Beds that are severely out of grade may be poor candidates for LW.

Prevention and treatment of scum: Algae (scum) often forms in LW floods. Water temperature is a major factor in the development of scum: shallow floods and inland, warmer locations may be more prone to this problem. If your flood is shallow or if you have had scum problems in LW or winter floods, plan to treat using a liquid copper algaecide applied two weeks into the flood period (see the Weed section for choices). The material is injected into the sprinkler system running at 20 psi (30 minute injection, you may continue running for 1-2 hours after to disperse the material). Rates are calculated using label information and the number of acre-feet to be treated. To calculate acre-feet, multiply the number of acres by the depth of the flood in feet (take into account variation due to non-uniform flood depth). If you do not use this treatment, you must scout shore ditch edges for the presence of algae and treat with copper compounds as soon as scum is observed. Remember that copper only prevents further algal growth (it doesn't eliminate existing scum), so prompt treatment is necessary. If scum is severe, early withdrawal of the flood may be necessary. If heavy scum is present after the flood, it should be broken up mechanically so that light can reach the vines. Even so, crop reduction may occur when scum is severe.

Late Water Flood Timing

Location	Apply the flood around:	Remove the flood:
Inland Areas	April 10-15	no later than May 15th
Coastal Plymouth County	April 15-20	about May 20th
Cape Cod	April 20 or later	late May

Choose actual application timing based on weather (see previous page) and hold for approximately 30 days.

Draining: Release the flood slowly over the top board to protect water resources. The date of flood removal will vary with location and date of application. If air temperatures are unseasonably warm, and flood water temperature becomes too high, the LW flood may need to be removed prior to 30 days. If the flood is removed early, pest management benefits may be affected (see insect management below).

MANAGEMENT AFTER LATE WATER:

Irrigation: There should be no need to irrigate (unless protecting for frost) for at least 2 weeks after the LW flood is withdrawn. Always schedule irrigation based on soil moisture status.

Frost protection: After removal of the LW flood, cranberry buds are sensitive to frost injury. During LW, the appearance of the terminal bud is arrested at the spring dormant stage. However, internal changes in the bud lead to a loss of frost tolerance despite appearances.

When using LW, frost management should be based on the actual duration of the flood, rather than the appearance of the buds. After more than one week of flooding, appearance of the buds will not be an accurate predictor of tolerance. A one-week flood early in the spring has no impact on frost tolerance -- protect the buds based on appearance. After LW of longer than 1 week, protect the bogs for 27°F (flood duration = 2 weeks) or 30°F (any duration longer than 2 weeks).

Fertilizer use: LW bogs respond readily to fertilizer: N dose should be reduced to avoid overgrowth. A 30-40% reduction of N is possible by eliminating the spring application and/or reducing the fruit set dose. Further reductions may have impact on bud development for the following year. Remember, fertilizer applied in the current season has the greatest impact on the *following* season's crop. The best tactic for a LW bog is to add no fertilizer for at least 2 weeks after flood withdrawal and then add small amounts with close monitoring of response. Generally, no fertilizer should be needed until bloom. Time your applications by the plant's development. This is especially important when development has been shifted in time by the use of LW. If the LW flood was terminated early (duration of 3 weeks or less), standard fertilizer regimens may be followed.

Disease management: Late water is an excellent cultural control strategy against fruit rot.

Processed fruit and fresh fruit Howes, year of the LW flood - Use reduced rates and number of applications of fungicides. Fungicides may be eliminated on processed-fruit beds if keeping quality is forecast to be good. If one application is to be made, apply at 50% bloom. If two fungicide applications are made, apply the first at 10% bloom and the second two weeks later. *Reduced fungicide rates should be employed*, especially for Howes, which has greater resistance to rot. Experience with Stevens in LW is limited, but generally it has even better rot resistance than Howes.

First year after LW has been held - Fungicide applications and rates can still be reduced without sacrifice in fruit quality.

Second year after LW has been held - Fungicide applications and rates should be increased to a normal schedule. Otherwise, fungal inoculum will increase and may cause significant field and storage rot losses.

New Plantings - Late water held in a newly planted (one or two year-old) bog will help prevent inoculum buildup, as well as helping the vines spread over the surface of the soil. Both of these factors will help reduce the amount of rot during the initial two crop seasons. Late water may also slow down weeds on new bogs (see next page).

Insect and mite management: Many insects are affected by LW. Emergence is delayed, and when a type of insect does appear, emergence is often synchronous permitting better management. LW can be used to manage several pest insects:

Early season insects - False armyworm and Gypsy moth may be suppressed. In general, cutworms have not been a problem in recent years on LW bogs. Pre-bloom sprays are seldom needed, but sweep net **scouting** should still be carried out -- cutworm moths may be attracted to the wet bog just after flood removal as a site for egg laying. If this happens, infestation may be quite severe. In addition, spanworms have sometimes been found on LW bogs.

Cranberry fruitworm - Cranberry fruitworms, that overwinter in the bog in hibernacula (cocoons), have been shown to be greatly reduced by LW. Mortality is higher when the flood is warm (approx. 60°F). Shorter duration (2.5-3 weeks) LW floods appear to have little effect on mortality in the hibernacula; populations are suppressed very little, compared to those on unflooded beds and significantly less than those on beds receiving a 4-week flood (see table below). Monitoring for infestation is important (see the insect section for scouting practice after LW). Fruitworm sprays may be eliminated on LW bogs. Second and third sprays are seldom needed but scouting for eggs should continue as populations may move in from surrounding beds.

Effect of late water duration on cranberry fruitworm mortality. Data based on failure of insect to emerge from hibernacula following flood.

Site	Flood length	CFW mortality	
		flooded	no flood
1	2.5 weeks	50%	28%
2	2.5 weeks	45%	13%
3	2.5 weeks	40%	34%
	4 weeks	98%	20%
4	3 weeks	41%	37%
	4 weeks	94%	71%

Sparganothis fruitworm is not controlled by LW.

Southern red mite - Mites can be severely impacted by holding late water. Intense infestations can be essentially eliminated in the year of late water. The mites begin to increase in the second year following the flood, but even then, may stay much below the original infestation level prior to the flood. Generally, LW affords two years of control for this pest.

Weed management: While LW may delay weed development and suppress the growth of some perennial weeds, this technique alone does not result in *control* of most established weeds. LW does not control dodder.

Dewberries (running bramble) - Some success in retarding the growth of dewberries (*Rubus* spp.) by holding late water has been shown. Sawbrier (*Smilax glauca*) was less affected. LW suppression of dewberries should be followed up with other controls such as hand-wiping or clipping with glyphosate. Fall flooding also suppresses dewberries. However, severe crop loss resulted when LW was used in the spring following a fall flood. Do NOT combine these practices.

Herbicide use:

- Do not apply pre-emergence herbicides prior to a late water flood.
- Low rates of Casoron (up to 40 lb/A) may be applied *after* the late water flood is withdrawn for the control of **dodder**. Apply herbicide as soon as possible after the withdrawal of the flood (be sure the vines are dry and the soil has drained).
- No other pre-emergence herbicides should be applied after the flood is withdrawn.

Bees: Bees for pollination may be more important on late water bogs due to the fact that the period of flowering is of shorter duration than that for early water bogs. Protect bees from pesticide exposure.

WINTER MANAGEMENT

Prepared by Carolyn J. DeMoranville

Cranberry vines may be injured or killed by severe winter weather. The injury is classified as a 'physiological drought' when moisture lost from the vines due to wind and evaporation cannot be replaced due to freezing in the root zone. The common term used to describe this injury is 'winterkill'. The symptoms are leaf discoloration and eventual leaf drop. Such injury can occur within 3 days if the root zone is frozen to a depth of 4 inches, air temperature is below freezing, and strong drying winds (10 mph or greater) occur. Injury is prevented by protecting vines with a winter flood that should be in place when winterkill conditions exist. Bogs that have not been harvested and new plantings (first year) are less susceptible to winterkill.

General winter flood management:

The winter flood may be applied as early as December 1 and should remain on the bog as long as winterkill conditions are present or forecast. Delay the flood as long as winterkill conditions are not forecast. Exposure to moderately cold temperatures will encourage deep dormancy leading to lower oxygen demand and greater cold tolerance. Generally, the flood should not need to be held any later than March 15. However, holding the flood for a few days past that date will not harm the bog.

To be effective, the flood should cover the plants entirely (no vine tips sticking out). It is particularly important to maintain a sufficiently deep flood on new plantings to prevent heaving of the plants during freeze/thaw cycles during the winter.

For bogs that cannot maintain a winter flood:

On bogs that cannot maintain a winter flood, additional winter protection may be gained by the application of an antitranspirant. These waxy or resin-based materials reduce the amount of water loss from the leaves by providing an additional physical layer on the leaf surface. Research with Vapor Gard has shown that one application, made prior to the onset of winterkill conditions, may offer some protection against winter injury. Vapor Gard should be applied at the rate of 1 gal/A. Since the material becomes quite thick at low temperatures, application is best when done at temperatures above 45°F. It may be mixed with hot water to facilitate mixing. It can be applied through the irrigation system, by boom sprayer or tank spray apparatus. Vapor Gard needs at least one hour of sunny conditions after application to ensure proper set of the material. Vapor Gard will persist on the plant for several months, so application should be planned for the fall (November typically has favorable conditions).

Oxygen deficiency injury:

A lack of dissolved oxygen in the winter flood water will cause injury to the plants, which in turn reduces the yield potential. Oxygen deficiency injury may occur when oxygen levels in the winter flood water drop below 4 mg/l (full oxygenation = 10+ mg/l). If the flood remains unfrozen (open water) or light penetrates the ice covering the flood, oxygen levels in the flood should remain adequate. However, if the ice is cloudy or covered by snow or sand, oxygen levels will begin to fall as the plants use the oxygen supply. Plants with poor carbohydrate (food) reserves due to large crops, poor sunshine the previous fall, or other stresses have less ability to recover from oxygen deficiency stress and may show injury the next spring. Failure to prevent oxygen deficiency can result in leaf drop, inability of blossoms to set fruit, and crop reduction.

Management to avoid oxygen deficiency injury:

Determine if dangerous conditions exist:

Four inches of snow or one inch of sand on the iced-over flood will prevent light penetration and will begin the oxygen deficiency process if water remains under the ice. Under such conditions, growers should monitor oxygen levels and remove water from beneath the ice when oxygen levels are 5 mg/l or less. A reading of 5 on the standard oxygen test kit (color change test) corresponds to the critical level of 5 mg/l. Bogs with high organic content will deplete oxygen from the water more quickly than will sandy bogs. Be aware that sample collection in areas with significant algal growth can give falsely high readings. Readings will vary under clear ice compared to under cloudy ice; it is best to test in several places or concentrate on areas of concern such as under cloudy or covered ice or in areas of deep flood. Cutting the ice in order to test for oxygen can change the oxygenation of the water. Drilling a hole is preferable to chopping with an ax. It is best to make a hole and then wait for up to one hour before testing the water for oxygen. If testing several locations - cut all holes first and then go back and test the water in the same order that you cut the holes.

What to do if your bog has reached the critical point:

Water must be removed from under the ice so air (oxygen) may circulate to the cranberry plants. Note that a stream flowing through the bog is no guarantee that oxygen deficiency conditions will not be present on the parts of the bog away from the stream. When drawing the flood, pull all but the bottom plank and draw water well down in the ditches. Vines crushed (by the weight of ice) into puddles of water in low spots will be hurt quickly and severely by oxygen deficiency.

Management after a mid-winter thaw:

If the water has been removed from beneath the ice to prevent oxygen deficiency, the remaining ice may melt during a mid-winter thaw, leaving the vines exposed. Bogs may be left exposed as long as winterkill conditions are not present (see above). However, long exposures to abnormally warm temperatures (>55°F) may lead to loss of chilling. The result could be a reduction in hardiness and greater susceptibility to spring frost. Depending on the conditions prior to the winter flood, loss of chilling during a mid-winter thaw could also lead to reduction in bud break and flowering the following season. This is especially true if the previous fall was warmer than usual, leading to lack of chilling accumulation. To guard against these possibilities, re-flood the bog if a long warm spell is forecast during mid-winter. The water will cool at night and re-warm slowly during the day, buffering against the warm daytime temperatures.

Management after the winter flood:

Once the flood has been removed, the cranberry buds will break dormancy in response to exposure to warm temperatures. The earlier the flood is removed, the sooner the plants will experience enough heat units to break dormancy. To avoid the need for frost protection during the first half of April, hold the winter flood until March 10-15. In the early spring, cranberry buds will survive exposure to at least 18°F. As the buds lose their dormant color and begin to expand, they must be protected from frost damage. The tolerance varies by variety and growth stage. Refer to the "Frost protection guide for Massachusetts cranberry production" and the Frost Management BMP for further information.