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Cranberry Chart Book - Management Guide

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Spring 3-2015

2015 Chart Book

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Averill, Anne L.; DeMoranville, Carolyn J.; Ghantous, Katherine M.; Jeranyama, Peter; Rojas, Erika Saalau; Sandler, Hilary A.; and Sylvia, Martha, "2015 Chart Book" (2015). *Cranberry Chart Book - Management Guide*. 214.

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CRANBERRY 2015 CHART BOOK

MANAGEMENT GUIDE FOR MASSACHUSETTS

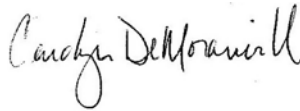
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Contents

Cautions	2 - 3
Resistance Management	4 - 7
Martha M. Sylvia	
Warnings	8
Diseases	9 - 17
Erika Saalau Rojas, Frank L. Caruso, and Martha M. Sylvia	
Insects	18 - 31
Anne L. Averill and Martha M. Sylvia	
Weeds	32 - 58
Hilary A. Sandler and Katherine M. Ghantous	
Nutrition	59 - 73
Carolyn J. DeMoranville	
Irrigation Water Management	74 - 77
Peter G. Jeranyama	
Late Water	78 - 81
C.J. DeMoranville, A.L. Averill, and H.A. Sandler	
Winter Management	82 - 84
Carolyn J. DeMoranville	
Groundwater Protection Regulations & Zone II	85 - 87
Martha M. Sylvia	
Measures and Conversions	88
Hilary A. Sandler	
Pesticide Storage	89
Hilary A. Sandler	
Index	90 - 93

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Carolyn DeMoranville, Director
UMass Extension Mailing Signoff

Revised March 2015

NOTICE: The Cranberry Station and its staff do not assume any responsibility for personal injury or property damage. All pesticides mentioned in this publication are registered and cleared for the suggested uses according to general registrations and state laws in effect on the date of this publication. The label is the law. Pesticides other than those listed have been registered for use on cranberry but are, for one reason or another, not currently recommended. When trade names are used for identification, no product endorsement is implied, nor is discrimination intended against similar materials.

A product of the Cranberry Station, College of Natural Sciences, University of Massachusetts Amherst, and UMass Extension. This material is based upon work supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, and Massachusetts Agricultural Experiment Station. The University of Massachusetts is an Affirmative Action/Equal Opportunity Institution.

2 Cautions

CAUTIONS

Fungicides

<u>Product</u>	<u>Maximum allowable formulation</u>	<u>Pre-harvest interval (PHI) (days)</u>	<u>Restricted entry interval</u>	<u>Maximum number of applications</u>
CHLOROTHALONILS (*Restricted Use)				
Bravo Ultrex, Equus DF	18 lb	50 days	12 hrs	3
Bravo Weather Stik	20 pt	50 days	12 hrs	3
Chloronil 720, Chlorothalonil 720 SC	20 pt	50 days	12 hrs	3
Echo 90DF	17.25 lb	50 days	12 hrs	3
Echo 720	20 pt	50 days	12 hrs	3
Equus 500 ZN, Initiate ZN	29 pt	50 days	12 hrs	3
Equus 720 SST, Initiate 720	20 pt	50 days	12 hrs	3
COPPERS (copper hydroxide)				
Badge X2	10.5 lb	No PHI	48 hrs	3
Badge SC	21 pt	No PHI	48 hrs	3
Champ DP Dry Prill	28 lb	No PHI	48 hrs	5
Champ Formula 2 Flowable	26.6 pt	No PHI	48 hrs	5
Champ WG	12.6 lb	No PHI	48 hrs	3
Copper-Count-N	24 qt	No PHI	48 hrs	3
Cuprofix Ultra 40 Disperss	15 lb	No PHI	48 hrs	3
Kentan DF	15.75 lb	No PHI	48 hrs	3
Kocide 2000	30 lb	No PHI	48 hrs	5
Kocide 3000	17.5 lb	No PHI	48 hrs	5
MasterCop	9 pt	No PHI	48 hrs	3
Nordox	24 lb	No PHI	24 hrs	3
Nordox 75 WG	15 lb	No PHI	12 hrs	3
Nu-Cop HB, Nu-Cop 50 DF	12.6 lb	No PHI	48 hrs	3
Nu-Cop 3L	17 pt	No PHI	48 hrs	3
Top Cop with Sulfur	6 qt	No PHI	24 hrs	3
3 lb Copper Flowable	32 pt	No PHI	24 hrs	3
MANCOZEB (EBDC'S)				
Dithane F-45 Rainshield	14.4 qt	30 days	24 hrs	3
Dithane M-45, Koverall	18 lb	30 days	24 hrs	3
Ferbam Granuflo (ferbam)	30 lb	50 days	24 hrs	5
ManKocide	21 lb	30 days	48 hrs	3
Manzate Flowable, Manzate Max	14.4 qt	30 days	24 hrs	3
Manzate Pro-Stick	18 lb	30 days	24 hrs	3
Penncozeb 75DF or 80WP	18 lb	30 days	24 hrs	3
Roper DF Rainshield	18 lb	30 days	24 hrs	3
Newer Products				
Abound (azoxystrobin)	92.3 fl oz	3 days	4 hrs	6
Indar 2F (fenbuconazole)	48 fl oz	30 days	12 hrs	4
Proline (prothioconazole)	10 fl oz	45 days	12 hrs	2
Phytophthora Fungicides				
Aliette WDG (fosetyl-al)	20 lb	3 days	12 hrs	4
Fosphite, Fungi-phite (phosphites)	na	No PHI	4 hrs	na
K-Phite, Rampart (phosphites)	na	No PHI	4 hrs	na
Metastar 2EC (metalaxyl)	21 pt	45 days	48 hrs	3
Phostrol (phosphites)	24 pt	3 days	4 hrs	4
ProPhyt (phosphites)	12 pt	No PHI	4 hrs	3
Ridomil Gold GR (mefenoxam)	105 lb	45 days	48 hrs	3
Ridomil Gold SL (mefenoxam)	5.25 pt	45 days	48 hrs	3
Ultra Flourish (mefenoxam)	10.5 pt	45 days	48 hrs	3

CAUTIONS

<u>Insecticides</u>	Maximum actual toxicant/A	Pre-harvest interval (PHI)	Restricted entry interval (REI)	Maximum number of applications
Actara (thiamethoxam)**	0.188 lbs	30 days	12 hrs	(12 oz/A)**
Admire (imidacloprid)	0.5 lbs	30 days	12 hrs	(0.5 lb ai/A)**
Altacor (chlorantraniliprole)	0.2 lbs	1 day	4 hrs	3 (9 oz/A)
Assail (acetamiprid)	0.26 lbs	1 day	12 hrs	2
Avaunt (indoxacarb)	0.44 lbs	30 days	12 hrs	(24 oz/A)**
Belay (clothianidin)	0.2 lbs	21 days	12 hrs	(12 fl oz/A)**
<i>B.t.</i> based products	NA	No PHI	4 hrs	-
Confirm (tebufenozide)	1 lb	30 days	4 hrs	4
Delegate (spinetoram)	0.305 lbs	21 days	4 hrs	6
Diazinon*	12 lb	7 days	5 days	3
Entrust (spinosad)	0.15 lbs	21 days	4 hrs	6
Imidan (phosmet)	15.6 lbs	14 days	24 hrs/3 days	(15.6 lb/A)**
Intrepid (methoxyfenozide)**	1 lb	14 days	4 hrs	(64 fl oz/A)**
Lorsban (chlorpyrifos)*	1.5 lbs	60 days	24 hrs	2
Nematodes	-	No PHI	0 hrs	-
Nexter (pyridaben)	1 lb	21 days	12 hrs	2
Oberon (spiromefesin)	0.75 lb	3 days	12 hrs	3
Orthene (acephate)	1 lb	90/75 days	24 hrs	1
Pyrenone or Pyronyl	60% PBO + 6% Pyrethrins	No PHI	12 hrs	-
Sevin (carbaryl)	4 lb	7 days	12 hrs	5

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

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

*** = No specific application limitations except the total amount applied per acre.

<u>Herbicides</u>	Maximum allowable formulation	Pre-harvest interval (PHI) (days)	Restricted entry interval (REI)	Maximum number of applications
Callisto (mesotrione)	16 fl oz	45 days	12 hrs	2
Casoron 4G (dichlobenil)	100 lb	N/A	12 hrs	N/A
Devrinol DF-XT (napropamide)	18 lb	N/A	24 hrs	N/A
Devrinol 2XT (napropamide)	18 qt	N/A	24 hrs	N/A
Evital 5G (norflurazon)	160 lb	N/A	12 hrs	1
Fusilade (fluazifop)	N/A	1 year	12 hrs	N/A
Poast (sethoxydim)	5 pt	60 days	12 hrs	N/A
QuinStar 4L (quinclorac)	16.8 fl oz	60 days	12 hrs	2
Reglone (diquat dibromide)	N/A	1 year	when dry	N/A
Roundup, Rodeo (glyphosate)	N/A	30 days	12 hrs	N/A
Roundup Weather Max (glyphosate)	N/A	30 days	4 hrs	N/A
Select Max (clethodim)	64 fl oz	30 days	24 hrs	N/A
Stinger (clopyralid)	16 fl oz	50 days	12 hrs	2
Weedar 64*	N/A	30 days	48 hrs	1
2,4-D granular*	N/A	N/A	12 hrs	N/A

Recommended water-holding times: (Check the label on the product you are using to verify information.)

At least 1 day: Avaunt

At least 3 days: Chlorothalonil products (e.g., Bravo), Nexter, and Diazinon.

At least 5 days: Chlorpyrifos (e.g., Lorsban) products and Actara.

At least 14 days: Abound fungicide.

Time Needed for Certain Pesticides to be Rainfast

Roundup	6 hr	Callisto	4 hr	Confirm, Intrepid	6 hr	Poast	1 hr
Select Max	1 hr	QuinStar 4L	6 hr	Roundup WeatherMax	1-2 hr	Stinger, Nexter	5 hr

4 Resistance Management

RESISTANCE MANAGEMENT 2015

Prepared by Martha M. Sylvia

In an effort to manage resistance with our pesticides, many labels now come with a “group” number assigned to them. The group ID is specific among insecticides, herbicides and fungicides. Many of our cranberry pesticides are in their own group. The largest groups with the same ID are the organophosphates and neonicotinoids. The following 3 pages show the groupings for our cranberry pesticides. The goal in resistance management is for growers to not repeatedly use compounds that fall within the same group. Resistance management may include alternating products with different modes of action or limiting the total number of applications per season.

Fungicide Resistance Action Committee (FRAC) (<http://www.frac.info/home>)

The group that advises for fungicide resistance is the Fungicide Resistance Action Committee (FRAC). Their goal is to prolong the effectiveness of fungicides that are likely to encounter resistance problems and to limit crop losses should resistance appear. For cranberry, Ridomil and Abound are fungicides that are at high risk for resistance development, while Indar and Proline are at medium risk. They should not be used repeatedly and should be carefully alternated with other fungicides from other groupings. See grouping of cranberry fungicides on page 7. A box like this would appear on the front of the label:

GROUP **11** FUNGICIDE

Herbicide Resistance Action Committee (HRAC) (<http://www.hracglobal.com/pages/Home.aspx>)

The Herbicide Resistance Action Committee developed a classification of herbicides according to their mode of action. A similar system to FRAC has been developed by the Weed Science Society of America (WSSA) using numbers instead of letters to designate the categories. This classification is found on a few herbicide labels, for example Callisto labels have this marking:

GROUP **27** HERBICIDE

Herbicide resistance is a world wide phenomenon with 218 documented cases. Selection of herbicide-resistant weed populations is often the result of the continuous use of the same herbicide or herbicides with the same mode of action. A key step in resistance management is to minimize the continuous use of herbicides with the same mode of action through rotations and combinations of products. One of the purposes of these classification systems is to make it easier for farmers and farm advisors to understand which herbicides share the same site of action without having to actually know the biochemical basis.

In cranberry, our biggest concern is our new reliance on Callisto. Be sure to rotate other compounds into your herbicide schedule. Do not treat the same bog with Callisto year after year. See table of cranberry herbicides by grouping on page 6.

Insecticide Resistance Action Committee (IRAC) (<http://www.iraconline.org/>)

An Insecticide Resistance Action Committee (IRAC) has been formed to assemble the information for insecticides. Their goal is to manage resistance to keep agriculture sustainable. For cranberry, organophosphates and neonicotinoids have the most compounds within their group. We are reliant on several compounds in these groupings. As long as growers remember to alternate between groupings and not repeat same mode-of-action compounds over and over, we should be able to keep newer compounds viable for decades. See Cranberry Insecticides by grouping on the next page. Insecticides are grouped clearly by chemical makeup and most insecticide labels now included markings such as this:

GROUP **5** INSECTICIDE

INSECTICIDE RESISTANCE ACTION COMMITTEE (IRAC) GROUPING
 FOR CRANBERRY INSECTICIDES

GROUP 1	ORGANOPHOSPHATES AND CARBAMATES Acetylcholine esterase inhibitor	Diazinon Imidan Lorsban Orthene Sevin	diazinon phosmet chlorpyrifos acephate carbaryl
GROUP 3	PYRETHRINS Sodium channel modulators	Pyreth-It Pyganic	pyrethrin pyrethrin
GROUP 4	4A NEONICOTINOIDS Nicotinic Acetylcholine receptor agonists	Actara Admire Assail Belay Scorpion/Venom	thiamethoxam imidacloprid acetamiprid clothianidin dinotefuran
GROUP 5	SPINOSYNS Nicotinic Acetylcholine receptor allosteric activators	Delegate Entrust	spinetoram spinosad
GROUP 11	Microbial disruptors of insect midgut membranes	Dipel, Xentari Biobit	<i>Bacillus</i> <i>thuringiensis</i>
GROUP 15	Inhibitors of chitin biosynthesis	Rimon	novaluron
GROUP 18	Ecdysone agonists / molting disruptors	Confirm Intrepid	tebufenozide methoxyfenozide
GROUP 21	Mitochondrial complex / electron transport inhibitor	Nexter	pyridaben
GROUP 22	Voltage-dependent sodium channel blockers	Avaunt	indoxacarb
GROUP 23	Inhibitors of acetyl CoA carboxylase	Oberon	spiromesifen
GROUP 28	DIAMIDES Ryanodine receptor modulators	Altacor	chlorantraniliprole

HERBICIDE RESISTANCE ACTION COMMITTEE (HRAC) GROUPING FOR CRANBERRY HERBICIDES

Group numbering at right from Weed Science Society of America (WSSA) as on pesticide labels

HRAC GROUP	SITE OF ACTION	CHEMICAL FAMILY	ACTIVE INGREDIENT	BRAND NAME	WSSA GROUP
A	Inhibition of acetyl CoA carboxylase (ACCase)	Aryloxyphenoxy-propionate 'FOPs'	fluazifop-P-butyl	Fusilade	1
		Cyclohexanedione 'DIMs'	clethodim sethoxydim	Prism, Select, Poast	1
C1	Inhibition of photosynthesis at photosystem II	Triazine	simazine	Princep	5
F1	Bleaching: Inhibition of carotenoid biosynthesis at the phytoene desaturase step (PDS)	Pyridazinone	norflurazon	Evital	12
F2	Bleaching: Inhibition of 4-hydroxyphenyl-pyruvate-dioxygenase (4-HPPD)	Triketone	mesotrione	Callisto	27
G	Inhibition of EPSP synthase	Glycine	glyphosate	Roundup	9
K3	Inhibition of VLCFAs (Inhibition of cell division)	Acetamide	napropramide	Devrinol	15
L	Inhibition of cell wall (cellulose) synthesis	Nitrile	dichlobenil	Casoron	20
L	Inhibition of cell wall (cellulose) synthesis	Quinoline carboxylic acid	quinclorac	Quinstar	26
O	Action like indole acetic acid (synthetic auxins)	Quinoline carboxylic acid	quinclorac	Quinstar	4
O		Phenoxy-carboxylic-acid	2,4-D	2,4-D Weedar 64	4
O		Pyridine carboxylic acid	clopyralid	Stinger	4

FUNGICIDE RESISTANCE ACTION COMMITTEE (FRAC) GROUPING FOR CRANBERRY FUNGICIDES

Mode of Action	TARGET SITE	GROUP NAME	CHEMICAL GROUP	COMMON NAME	TRADE NAME	FRAC CODE	comments
A	A1: RNA polymerase I	PA - fungicides PhenylAmides	acylalanines	mefonoxam metalaxyl	Metastar Ridomil Ultra Flourish	4	High Risk
C	C3: cytochrome bc1 at Qo site	QoI-fungicides Strobilurins	methoxy-acrylates	azoxystrobin	Abound	11	High Risk
			dihydro-dioxazines	fluoxastrobin	Evito	11	High Risk
G	G1: c14-demethylase in sterol biosynthesis	DMI-fungicides DeMethylation Inhibitors	triazoles	fenbuconazole prothioconazole	Indar Proline	3	Medium Risk
Unk	Unknown	phosphonates	ethyl phosphonates	fosetyl-Al aluminum-tris	Aliette Legion	33	Low Risk
				phosphorous acids and salts	Fosphite Fungi-Phite K-Phite, Phostrol ProPhyt, Rampart	33	Low Risk
MS	Multi-site contact activity	inorganic	inorganic	copper (salts)	Champ Kocide	M1	Low Risk
MS	Multi-site contact activity	dithiocarbamates EBDC's Ethylene bis dithio carbamate	dithiocarbamates	ferbam	Ferbam	M3	Low Risk
				mancozebs	Manzate Dithane Penncozeb		
MS	Multi-site contact activity	chloronitriles	chloronitriles	chlorothalonil	Bravo Chloronil Echo, Equus Initiate	M5	Low Risk

8 Warnings

WARNING!!

PESTICIDES ARE POISONOUS. READ AND FOLLOW ALL DIRECTIONS AND SAFETY PRECAUTIONS ON LABELS. HANDLE CAREFULLY AND KEEP ORIGINAL LABELED CONTAINERS IN LOCKED STORAGE AREA. DO NOT CONTAMINATE FORAGE, STREAMS OR PONDS. DISPOSE OF EMPTY CONTAINERS IN A LEGAL MANNER.

REPEATED EXPOSURE TO ORGANOPHOSPHATE (SUCH AS DIAZINON, IMIDAN AND LORSBAN) INSECTICIDES MAY, WITHOUT SYMPTOMS, INCREASE SUSCEPTIBILITY TO PHOSPHATE POISONING. ALL PESTICIDE TREATED BOGS MUST NOT BE ENTERED UNTIL RESTRICTED ENTRY TIMES HAVE ELAPSED (SEE LABEL). WORKERS SHOULD BE NOTIFIED PRIOR TO TREATMENT. TELL FAMILY AND CO-WORKERS. MAKE CERTAIN YOUR DOCTOR UNDERSTANDS. AFTER AN ACCIDENT, THERE MAY NOT BE TIME.

IF SYMPTOMS OF ACUTE PESTICIDE POISONING OCCUR, IMMEDIATELY TAKE VICTIM AND THE APPROPRIATE PESTICIDE LABEL OR CONTAINER TO THE NEAREST HOSPITAL EMERGENCY ROOM. FOR INFORMATION AND ADVICE AT ANY TIME OF DAY OR NIGHT, CALL THE MASSACHUSETTS POISON CONTROL SYSTEM AT: **1-800-222-1222**.

REMINDER FOR RESPONSIBLE APPLICATORS

RESTRICTED USE COMPOUNDS (ACTARA, BRAVO, DIAZINON, INTREPID, LORSBAN, WEEDAR 64, AND SCORPION/VENOM) REQUIRE A PRIVATE APPLICATOR CERTIFICATION TO BUY, HANDLE, AND APPLY. THIS CERTIFICATION IS AVAILABLE THROUGH THE MASSACHUSETTS DEPARTMENT OF AGRICULTURAL RESOURCES (MDAR):

(<http://www.mass.gov/cea/agencies/agr/pesticides/pesticide-applicator-and-dealer-licensing.html>).

DIAZINON AND LORSBAN ARE FEDERALLY RESTRICTED. ACTARA, ALL CHLOROTHALONIL PRODUCTS (BRAVO, ETC.), INTREPID, AND SCORPION/VENOM ARE STATE RESTRICTED DUE TO GROUNDWATER CONCERNS. WEEDAR 64, CROSSBOW, AND WEEDONE (2,4-D) ARE STATE RESTRICTED DUE TO TOXICITY.

REMEMBER THAT ALL CHLOROTHALONIL PRODUCTS (BRAVO, ETC.), DIAZINON, IMIDAN, LORSBAN AND NEXTER ARE EXTREMELY TOXIC TO FISH AND CAN CAUSE FISH KILLS. ABOUND, AVAUNT, COPPER FUNGICIDES, INDAR, MANCOZEBS, AND SEVIN ARE ALSO TOXIC TO FISH.

TO AVOID CONTAMINATION, DO NOT CLEAN EQUIPMENT OR DISPOSE OF WASTES NEAR OPEN WATER. DRIFT OR RUNOFF OR RELEASE OF CONTAMINATED DITCH WATER FROM TREATED AREAS MAY BE HAZARDOUS TO FISH OR OTHER AQUATIC ORGANISMS IN ADJACENT AQUATIC SITES.

FOLLOWING ANY PESTICIDE APPLICATIONS, HOLD WATER AS LONG AS POSSIBLE.

CAUTIONS

1. 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 CCCGA website for more info on sign posting: (<http://www.cranberries.org/growers/advisories.html>).
2. **READ AND FOLLOW LABEL INSTRUCTIONS.** The label is the law! Current labels and MSDS can be found on the CDMS website: (<http://www.cdms.net/LabelsMsds/LMDefault.aspx>). 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.
3. Make all pesticide applications in a manner to prevent contamination of streams, ponds, and public ways, and impound water as long as possible after applying.
4. Be aware of and adhere to guidelines regarding distances from site of chemical application to protected areas. Consider addition of drift retardants.
5. Many insecticides are highly toxic to bees. Check label and choose options that are least toxic.
6. Stored pesticides may deteriorate. Avoid freezing of liquid formulations. It is usually not advisable to use the heldover materials in opened containers. Follow regulations of the MDAR Pesticide Program when disposing of pesticides and their containers.
7. **CONCENTRATE SPRAYS** may injure new growth, bloom and small berries particularly in hot, humid weather or if the emulsifiable concentrate (EC) content nears 50% of mixture.

DISEASE MANAGEMENT 2015

Prepared by Erika Saalau Rojas, Frank Caruso, and Martha M. Sylvia

UPRIGHT DIEBACK

Cranberry plants affected by this disease typically have individual uprights that die back from the growing point toward the runner. Every upright may be infected on some runners, while other runners may only have one or a few infected uprights. In severe cases, the entire runner will be stressed or dying. Scattered uprights may be infected in the bed or whole patches of dieback may show up, particularly in younger beds. There are three phases during the season when symptoms appear: one shortly after the winter flood has been withdrawn, another in June and early July, and another phase in late August and September. Damage caused by this disease appears to be worse during growing seasons that have prolonged periods of drought or heat stress. This weakens the vines making them more susceptible to infection by fungal pathogens.

Three different fungi have been associated with this disease. *Phomopsis vaccinii* (the fungus that causes viscid rot in fruit) is routinely isolated from symptomatic uprights and has been proven to cause symptoms by artificial inoculations. *Fusicoccum putrefaciens* (often) and *Synchronoblastia crypta* (rarely) are also isolated from infected uprights and have been shown to cause symptoms in artificial inoculations. Other fungi that may possibly infect uprights are *Aureobasidium*, *Colletotrichum*, and *Pestalotia*. Infection by these fungi in the field probably occurs at or shortly after bud break when the tissue is particularly susceptible. Infection may also occur during the entire growing season. Symptoms do not appear, however, until weather-related stresses weaken the plants. At this point, the tips are killed at the growing point and the symptoms progress downward on the upright.

The disease can be partially controlled through **avoidance of stress on the plants** through the hottest (and potentially the driest) portion of the growing season. **Early-season fungicide applications at bud break** and/or early bud expansion have given excellent control of the disease. Spores of the primary causal agent *Phomopsis* begin to be produced from overwintering cranberry tissue in April and May and the emerging buds are particularly susceptible to the infection. Fungicides targeted for fruit rot control also provide a degree of protection against this disease during early and mid-season infection periods.

DISEASE/ TIMING	PESTICIDE/ FORMULATION	RATE (amt/A)	COMMENTS/RESTRICTIONS
APRIL 25 THROUGH MAY 15	Champ DP Dry Prill Champ Formula 2 Flowable Champ WG	5.3 lb 5.33 pt 4.2 lb	Must be applied pre-bloom. 48-hour restricted entry interval.
<u>CHLOROTHALONIL FORMULATIONS</u>			
	Bravo Ultrex	3.8 – 6 lb	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. 12-hour restricted entry interval.
	Bravo Weather Stik	4 – 6.5 pt	
	Chlorothalonil 720 SC	4 – 6.5 pt	
	Chloronil 720	4 – 6.5 pt	
	Echo 720	4 - 7 pt	
	Echo 90DF	3.25 - 5.75 lb	
	Equus DF	3.8 – 6 lb	
	Equus 500 ZN	5.75 – 9.25 pt	
	Equus 720 SST	4 – 6.5 pt	
	Initiate ZN	5.75 – 9.25 pt	

For all above chlorothalonil formulations: Hold water for 3 days after application. When chlorothalonil formulations are to be used in a bed subject to Zone II regulations, growers must follow the required process to determine if these products may be used. See Zone II section. The maximum allowable number of chlorothalonil applications is 3. **If a chlorothalonil application is used for upright dieback control, only 2 fruit rot applications are allowed.**

10 Diseases

PHYTOPHTHORA ROOT ROT

Adequate control of the disease can be achieved only through several integrated strategies. It is essential that drainage be improved in low areas of the bed. Tile, stones, or other materials can be utilized, and new ditches can be dug. Existing ditches should be maintained to the proper depth as well. Areas of dieback should receive a uniform addition of sand to get the areas up to grade with the remainder of the bed. Stressed plants on the margin of dieback areas should be given an extra dose of fertilizer to stimulate root growth. Use of a soil fumigant should be employed on renovations. After the drainage has been improved, fungicides should be applied several times per season until the vines have completely filled in the bare spots. Once this has been achieved, only a single spring application should be necessary.

Precautions should be taken to avoid spread of the pathogen from infested beds to uninfested beds. Machinery, equipment, footwear, etc., should be sterilized using steam, bleach (10% Clorox solution), or alcohol. If possible, the sequence of flooding the beds during water harvest should be adjusted to flood heavily infected beds last. When vines are purchased from other growers, the grower should be certain that they have not come from infected beds. Though very few roots are present in such vine deliveries, it only takes a few infected roots to initiate infection in a new location.

Three fungicide 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 first application should go on between April 25 and May 15th. The second application should occur 60-90 days after the first but 45 days before harvest if using mefenoxam (e.g., Ridomil). A third application can be done after harvest, preferably prior to November 15.

The drainage should be improved BEFORE applying any fungicide to the affected bed.

DISEASE/ TIMING	PESTICIDE/ FORMULATION	RATE (amt/A)	COMMENTS/RESTRICTIONS
APRIL 25 THROUGH MAY 15 (1 st app)	Aliette WDG	5 lb	Rates are for chemigation application!
	Fosphite	2-4 qt	
	Fungi-Phite	1-2 qt	Do not tank mix!
	Helena ProPhyt	4 pt	Read label for each product to
Foliar applications	K-Phite 7LP AG	2-4 qt	determine application interval, re-entry
	Phostrol	5-6 pt	period, and number of applications per
	Rampart	2-4 qt	season.
Soil applications	Metastar 2EC	4-7 pt	Ground or chemigation only. No air!
	Ridomil Gold SL	1-1.75 pt	
	Ultra Flourish	2-3.5 pt	
Water fungicide in!	Ridomil Gold GR	20-35 lb	Ground or air only. No chemigation!
*Any formulation can be used for spot treatment if the affected area(s) are small.			

Soil applications 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 inch of rainfall is forecasted or if sprinklers will run for more than 5 hours during the first few days after the application.

FRUIT ROT

This is the most prevalent disease problem that cranberry growers face from season to season. Cranberry fruit can be infected by a large number of different fungal pathogens.

Fruit rot, some of the most common in MA include:

Allantophomopsis lycopodina and *A. cystispora* (black rot)

Botryosphaeria vaccinii (Botryosphaeria fruit rot)

Coleophoma empetri (ripe rot)

Colletotrichum gloeosporioides (bitter rot)

Colletotrichum acutatum (bitter rot)

Fusicoccum putrefaciens (end rot)

Phomopsis vaccinii (viscid rot)

Phyllosticta vaccinii (early rot or bull's eye rot)

Phylospora vaccinii (blotch rot)

The degree of fruit rot that occurs in different beds during different growing seasons is dependent on many factors. Weather is probably the most important variable that affects the amount of rot that occurs. Temperature, humidity, rainfall, as well as special events such as hailstorms, are important on a regional basis. Local microclimatic variations can also lead to particular sections of a bog that are more prone to the development of rot. The density of vine growth and drainage are important because they have a direct bearing on the length of time vines remain wet from rain, fog, dew or irrigation. Excessive vine growth and poor drainage prevent rapid drying and favor the infection by rot fungi. Practices that promote rank (excessive) vine growth, such as excessive fertilizer, frequent late water, holding water high in ditches, and too frequent irrigation should be avoided to minimize conditions that are favorable for fruit rot development.

Spores of the fungi are dispersed from overwintering sources by wind or wind-driven rain. These spores land on the blossom or small developing fruit and, if there is a suitable layer of moisture present for 6-8 hours, the fungi will infect the plant tissue. If conditions are favorable and the cultivar is susceptible, berries may show rot symptoms 1 week after fungal infection. If conditions are unfavorable and if the cultivar is less susceptible, symptom development may be delayed. Many of the fruit rot fungal pathogens infect the berry but remain latent, and no rot symptoms will be apparent. Once the berry reaches a certain maturation or physiological stage, fungi will break down plant tissues and rot symptoms will be visible. Symptoms may not be visible until later in the growing season, or they may not be visible until after the berries have been harvested and held in storage.

Fungicides are an important strategy for the control of fruit rot. For adequate fruit rot control, fungicide applications should have good coverage and take place before fungi infect plant tissues. Most berry infection occurs during the bloom period. Applications typically begin during early bloom (mid-June). Once the fruit has set and begun to increase in size (mid-late July), fungicides are no longer necessary or effective. The choice of fungicides, the rate of the fungicide, and the time interval between applications are dependent on the individual bed and its past incidence of fruit rot.

Fungicide decisions should be based on the Keeping Quality Forecast (KQF) found on the Station's website (<http://www.umass.edu/cranberry/cropinfo/keepqf.html>) and products allowed by fruit handlers. If the KQF forecast is good to excellent, consider fewer applications and/or longer application intervals. Cranberry beds prone to fruit rot may need up to 4 fungicide applications. 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. The goal of management is to reduce rot to 3% or less. If in doubt, call the Extension Plant Pathologist (Ext.18).

12 Diseases

DISEASE/ TIMING	PESTICIDE/ FORMULATION	RATE (amt/A)	COMMENTS/RESTRICTIONS
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FRUIT ROT (Continued)

EARLY AND MID BLOOM (20-50%), THEN AT 10-14 DAY INTERVALS

NEWER CHEMISTRIES

Abound	6.0-15.5 fl oz	No more than 2 apps. See Resistance Management notes below and on pages 4 & 7. Hold water for 14 days. Use Abound very carefully and avoid drift if the bed is next to a McIntosh apple orchard, as the fungicide is highly phytotoxic to this cultivar.
Indar 2F	6.0-12 fl oz	No more than 2 apps. Do not use prior to bloom. 30-day PHI.
Proline 480SC	5 fl oz	No more than 2 apps. 45-day PHI.

FUNGICIDE RESISTANCE MANAGEMENT

Fungicide resistance, defined as reduced fungicide sensitivity in fungal populations, is a real and serious threat in MA and it could severely impact the efficacy of fungicides that help control fruit rot pathogens. Repeated and inadequate use of certain fungicides can accelerate the development of resistant pathogen populations and once this occurs, fungicide applications will provide very little or no disease control.

Newer fungicides (listed above) can be highly effective in controlling fruit rot fungi and are considered as less harmful to human and environmental health when compared to older chemicals. However, these fungicides have a **single-site mode of action**, which poses a much higher risk of selecting for fungicide-resistant pathogens than older fungicides with a **multi-site mode of action** (e.g., chlorothalonil and EBDCs). In order to preserve the effectiveness and durability of fungicides such as Abound, Indar, and Proline, it is **CRITICAL** to incorporate the fungicide resistance management strategies listed below:

- Follow ALL label instructions, including application interval and recommended rate. Never use less than the lowest recommended rate on the label.
- Alternate or mix fungicides with different modes of action.
 - Use FRAC codes on labels to determine mode of action. Same FRAC codes indicate that fungicides have the same mode of action. For example, Indar and Proline have a different trade name and active ingredient, but they have the SAME mode of action and FRAC code (3).
- For best fruit rot control and fungicide resistance management, mix Abound with Indar or Proline.
- Apply Indar/Abound and Proline/Abound during bloom period and use multi-site contact fungicides (chlorothalonil or mancozeb) in later applications.

DISEASE/ TIMING	PESTICIDE/ FORMULATION	RATE (amt/A)	COMMENTS/RESTRICTIONS
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FRUIT ROT (Continued)

EARLY AND MID-BLOOM (10-50%), THEN AT 7-10 DAY INTERVALS

CHLOROTHALONIL FORMULATIONS

Bravo Ultrex	3.8-6.0 lb	Use the maximum rate in beds with high rot incidence on a 10-day schedule. Zone II restricted. 3 apps. per season, 12-hr REI, hold water for 3 days.
Bravo Weather Stik	4-6.5 pt	
Chloronil 720, Initiate 720	4-6.5 pt	
Chlorothalonil 720 SC	4-6.5 pt	
Echo 720	4-7 pt	
Echo 90DF	3.25-5.75 lb	
Equus DF	3.8-6.0 lb	
Equus 500 ZN	5.75-9.25 pt	
Equus 720 SST	4-6.5 pt	
Initiate ZN	5.75-9.25 pt	

For all chlorothalonil formulations: When chlorothalonil formulations are to be used in a bed subject to Zone II regulations, growers must follow the required process to determine if these products may be used. See Zone II Section. 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, note 6.5 day eye irritant! Do not release irrigation water for at least 3 days following application.

Ferbam Granuflo	6 lb	Do not apply more than 5 times. Apply at 14-day intervals. Using rates below recommended rate will be ineffective. 50-day PHI, 24-hr REI.
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EARLY AND MID-BLOOM (10-50%), THEN AT 7-10 DAY INTERVALS

MANCOZEB

Dithane F-45 Rainshield	2.4-4.8 qt	Addition of spray adjuvants will improve distribution and deposition for all of the mancozeb compounds. May delay color development!
Dithane M-45	3-6 lb	
Penncozeb 75DF	3-6 lb	
Penncozeb 80WP	3-6 lb	
Koverall	3-6 lb	
Roper DF Rainshield	3-6 lb	
ManKocide	7 lb	
Manzate Flowable	2.4-4.8 qt	
Manzate Max	2.4-4.8 qt	
Manzate Pro-Stick	3-6 lb	

MID-BLOOM (>50%), THEN AT 7-10 DAY INTERVALS

COPPERS

Cuprofix Ultra 40 Disperss	5 lb	Do not mix copper fungicides with insecticides. Do not tank mix with Aliette or phosphites unless spray solution has been buffered first.
Top Cop with Sulfur	2 qt	


14 Diseases

FRUIT ROT (Continued)

MAXIMUM RESIDUE LEVELS (MRLs)

The European Union (EU) recently revised the allowable amount of chlorothalonil (e.g., Bravo) residues on cranberry fruit. The new cranberry MRL of 0.01 ppm (previously 2.0 ppm) severely limits the use of chlorothalonil for fruit rot control on export-certified fruit, and all growers should communicate with their fruit handlers before making any chlorothalonil applications this year.

In order to comply with the EU MRL, no chlorothalonil applications will be allowed for fruit rot control. Below you will also find an efficacy rating of fungicides currently available for fruit rot control along with some observations that should be taken into consideration when planning your 2015 fungicide fruit rot applications. For chlorothalonil alternatives and fruit rot control recommendations, please contact the Extension Plant Pathologist.

	Fungicide	Trade Names	Comments
High efficacy  Low efficacy	Chlorothalonil	Bravo, Echo, Equus, etc.	Restricted in EU markets.
	Mancozeb	Dithane, Manzate, Penncozeb, etc.	May delay fruit color. Efficacy comparable to chlorothalonil. Low risk of resistance. Should be used as a resistance management tool if using 'newer' fungicides (see resistance management section).
	Prothioconazole	Proline	Moderate risk of resistance. No more than 2 applications recommended. For best results and resistance management, use during bloom and combine with azoxystrobin.
	Fenbuconazole	Indar	
	Azoxystrobin	Abound	High risk of resistance. No more than 2 applications. For best results combine with prothioconazole or fenbuconazole.
	Ferbam and Coppers	Champ, Kocide, etc.	

FRUIT ROTS - CULTURAL CONSIDERATIONS

Late Water: Holding late water (flooding from 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. The number of fungicide applications can be reduced and the lowered rates can also be used 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 on the bog 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 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 in the late morning or early afternoon to cool the vines and berries and may 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 7 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, varying levels of disease resistance against fruit rot among varieties should be considered. A summary chart with some of the most common cultivars and their relative field rot resistance (highest-moderate-low) is presented below.

Highest field rot resistance	Moderate field rot resistance	Lowest field rot resistance
Scarlet Knight, Mullica Queen, Howes, Haines, Black Veil	Stevens, Crimson Queen, Demoranville, Early Black	Ben Lear

Note: One or two fungicide applications during the first two years after planting will help reduce fungal inoculum and may reduce fruit rot in subsequent years.

16 Diseases

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 give limited benefits to the vines and have no effect on the fungal pathogen(s).

DISEASE/ TIMING	PESTICIDE/ FORMULATION	RATE (amt/A)	COMMENTS/RESTRICTIONS
MAY	Abound Indar 2F	15.5 fl oz/30-100 gal 12 fl oz/30-100 gal	Make first application at bud break. Measure ring diameter and add 10 feet to the diameter. Irrigate for 1-2 hours before and following application. Repeat 2-4 weeks later if necessary.
JUNE - JULY	Ferbam Granuflo	9 lb/100 gal	Apply 1 gal of this mixture to 1 sq ft area. Treat the area 3 feet beyond the advancing line of dying vines and 2 feet within the line. Do not apply after July 31. Only 1 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 vines out-compete the fungus.

DISEASE 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. RESISTANCE DEVELOPMENT to Abound, Indar, and Proline by the fruit rot fungi is a very real and serious threat. Applications of the fungicide should be made pre-infection rather than post-infection to minimize resistance development. See Resistance Management section.
These products are most effective when applied during early to mid bloom (20-50%) and it is highly recommended to mix Abound with Indar or Proline. The number of fungicide applications should be based on the label instructions and the KQF.
4. When applying half-rates, the maximum number of applications (not material applied) must not be exceeded. It is not recommended to use a rate below the lowest recommended rate on the label.
5. Use Abound very carefully and avoid drift if the bed is next to a McIntosh apple orchard, as the fungicide is highly phytotoxic to this cultivar. See Resistance Management section.
6. REFLOODING for black-headed fireworm control in June is likely to INCREASE FRUIT ROT and MAY SERIOUSLY REDUCE THE CROP.
7. 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 or any of the phosphites for Phytophthora unless appropriate precautions have been taken to buffer the spray solution or severe phytotoxicity will result.
8. Consider delaying harvest to obtain acceptable color in thick vines or when Mancozeb is used.
9. SANDING and FERTILIZING. Frequent resanding and fertilizing helps reclaim beds infected with false blossom disease. 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.
10. SPREADER STICKERS are contained in most fungicides. The addition of wetting agents or spreader stickers to Bravo, Echo, or Equus may cause phytotoxicity damage. Please check the fungicide label. NOTE: the addition of spray adjuvants will improve the distribution and deposition of all mancozeb chemicals.
11. 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.
12. Review the Disease Management BMP in the UMass Best Management Practices Guide: (<http://www.umass.edu/cranberry/pubs/bmps.html>).
13. Organic Options. Some fungicides are certified organic for disease management in cranberry. They include many of the coppers, OxiDate (128 fl oz/100 gallons of water; apply 25-100 gal/solution/treated acre), and Serenade ASO, MAX, or Optimum; a biofungicide labeled for mummy berry, botrytis, and bacterial canker at 2-6 qts/A. Check with OMRI or your certifier.

18 Insects

INSECT MANAGEMENT 2015

Prepared by Anne L. Averill and Martha M. Sylvia

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

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

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

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

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

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

Pheromone traps. Traps should be used for timing management of cranberry girdler, black-headed fireworm, and *Sparganothis* fruitworm and should be up by June 1. Use 1 trap/10 acres. Place on upwind side of bog. Check and clean traps weekly, recording number of moths captured. Change bait every 3 weeks. Check descriptions of adult moths in extension materials because non-target species are sometimes caught. Intrepid, Confirm, and Altacor sprays need to go on several weeks earlier than conventional insecticide sprays (such as Diazinon).

Based on pheromone trap catches...

For black-headed fireworm: when treating summer generation with Intrepid or Confirm, apply insecticide 2 weeks after **onset** of moth flight, and again 10 days later. Timing for conventional insecticide is 10 days after **peak** moth flight, usually during bloom (mid – late June).

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

For girdler: treatments are usually in July. Refer to the section on cranberry girdler for timing of specific treatments. Even though trap catches are low, serious larval infestations can exist.

Altacor (diamide-based compound). Altacor is the first insecticide registered in the diamide class of chemistry, and provides a new mode of action compared to all other classes of insecticides. This compound causes paralysis of the insect by sustained contraction of the muscles. It is an excellent fit in IPM programs in that it is a selective insecticide with low toxicity to beneficial arthropods, most importantly, pollinators. In addition to exhibiting excellent activity against our key lepidopteran pests (i.e., cranberry fruitworm and Sparganothis fruitworm), it also has long residual activity and is safe to key mite predators. It is labeled for use at 3.0 to 4.5 oz. per acre. A good chemigation system, under 6 minutes, will likely be necessary to get good efficacy. Ground applications using at least 30 gallons of water per acre, and preferably between 100-150 gallons per acre, may be the most effective applications. Must target eggs and tiny larvae only, this compound will not manage larger caterpillars effectively. This is the pollinator-safe compound we have been waiting for!

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

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

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

Neonicotinoid products. Neonicotinoids are a relatively new class of chemicals that act on the neurotransmitters of the insect. They bind the nicotinic acetylcholine receptors leading to hyperexcitation of the nervous system resulting in death. Neonicotinoids have low human toxicity and were heavily adopted in the last 10 years. Research has shown that the neonicotinoids have long-term detrimental effects on bee populations. They are the most toxic insecticides to bees. There are a number of neonicotinoid compounds

20 Insects

registered in cranberry including Actara (thiamethoxam), Assail (acetamiprid), Belay (clothianidin), Scorpion/Venom (dinotefuran) and Admire (imidacloprid). While these compounds could help us manage our insect complex, the risks to bees have made them undesirable. If you choose to use them, do so after bloom and be aware of bee toxicity and long-term residues for export qualified fruit.

NOTE: Restricted Use Pesticides (Actara, Diazinon, Intrepid, Lorsban, and Scorpion/Venom) A pesticide license (private applicator certification) is required to purchase, handle and apply these compounds to your bog.

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

EARLY SEASON CATERPILLARS

CUTWORMS (BLOSSOMWORM, FALSE ARMYWORM) AND HUMPED GREEN FRUITWORM

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

Avaunt 6 oz FIFRA 2EE recommendation. 7 days between applications, do not use on flow-through bogs, hold water 1 day.

Dipel ES 1-4 pt *Bacillus thuringiensis (B.t.)* products. Multiple applications, addition of an adjuvant, and good coverage in low gallonage are essential.
 Biobit, Xentari, Dipel DF 0.5-2 lb

Delegate WG (spinetoram) 3-6 oz Do not exceed 19.5 oz/season. 7 days between applications. Only use lower rates if rinse time is 4 minutes or less.

Diazinon 50 W	4-6 lb	FIFRA 2EE recommendation. Hold water for at least 3 days. 5 day REI!! 3 apps/season, 7-day PHI, and 14-day spray interval, except AG500 which has a 7-day minimum spray interval.
Diazinon AG 500	2-3 qt	
Diazinon AG 600	51-76.5 fl oz	

Intrepid 2F	10-16 fl oz	Insect growth regulator products, these compounds need to be eaten to work. Intrepid is more active and has greater residual than Confirm. Note, however, Intrepid is restricted use and Zone II restricted. See product discussion on page 19. Safe for pollinators and natural enemies.
Confirm 2F	16 fl oz	

Late Water False armyworm and blossomworm may be managed with late water. See page 78.

Lorsban 4E, Nufos 4E	3 pt	2 apps/season. Do not mix with other insecticides. Observe 60-day PHI. Impound water for 5 days, then release gradually. Note: 75 WG formulation is not restricted use.
Chlorpyrifos 4E AG	3 pt	
Lorsban Advanced, Hatchet	3 pt	
Lorsban 75 WG	2 lb	

Orthene 97, Acephate 97, 97UP	1 lb	Do not apply within 10 days of start of bloom due to bee concerns. 1 application/season. Observe 90-day PHI, except 75-day PHI with some Acephate 90, 97, 97UP only – check label.
Acephate 90 WSP, 90 WDG	1.1 lb	
Acephate 90 Prill	1.1 lb	

Sevin XLR Plus	2 qt	5 applications/season, 7-day spray interval, 7-day PHI.
Sevin 4F, Carbaryl 4L	2 qt	
Sevin 80S (Solupak)	2.5 lb	

Spring Flood Flood in May for 48 hours, see page 30.

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

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

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

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

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

Green spanworm caterpillars start to appear in early season sweeps; brown spanworm caterpillars appear later. A flight of brown moths in June may be an indication of a brown spanworm problem but only target caterpillars with sprays! Big cranberry spanworms appear in mid-June. They can be very destructive, occurring in patches. Caterpillars are dark brown with bumps across their back and grow to 2.5" in size. Spot treating may work.

Scout for winter moth much earlier than other spanworms. Winter moth is a spanworm species and is likely present as early as May 1. If you have a history of winter moth infestation, you may need to apply a prophylactic spray early in the season. Populations may reoccur as larvae balloon in. Injury may be done to the developing tips before populations can be detected.

Other miscellaneous spanworms appear in patches and grow larger than the common green and brown spanworm, so it may be advisable to lower the action threshold by half if these infestations occur.

22 Insects

BLACK-HEADED FIREWORM

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

Altacor	3-4.5 oz	New chemistry. Low rinse time required for efficacy. See product discussion on page 19. Must target eggs or tiny larvae only.
Avaunt	6 oz	7 days between applications. 30-day PHI. Do not use on flow-through bogs, hold water 1 day.
Delegate WG (spinetoram)	3-6 oz	Do not exceed 19.5 oz/season. 7 days between applications. Only use lower rates if rinse time is 4 minutes or less.
Diazinon 50 W	4 lb	It is advisable to hold water for at least 3 days. 5-day REI!! 3 applications/season, 7-day PHI, and 14-day spray interval, except AG500 which has a 7-day spray interval.
Diazinon AG 500	2 qt	
Diazinon AG 600 WBC	51 fl oz	
Imidan 70W	1.33-4 lb	Efficacy may be reduced at pHs found in bog water (pH 6-7). REI 3 days, 10-day spray interval, 14-day PHI.
Intrepid 2F	10-16 fl oz	Insect growth regulator products; these compounds need to be eaten to work. Intrepid is more active and has greater residual than Confirm. Note however, Intrepid is restricted use and Zone II restricted. See product discussion on page 19. Safe for pollinators and natural enemies.
Confirm 2F	16 fl oz	
Lorsban 4E, Nufos 4E	3 pt	2 apps/season. Do not mix with other insecticides. Observe 60-day PHI. Impound water for 5 days, then release gradually. Note: 75 WG formulation is not restricted use.
Chlorpyrifos 4E AG	3 pt	
Lorsban Advanced, Hatchet	3 pt	
Lorsban 75 WG	2 lb	
Orthene 97, Acephate 97, 97UP	1 lb	Do not apply within 10 days of start of bloom due to bee concerns. 1 application/season. Observe 90-day PHI, except 75-day PHI with some Acephate 90, 97, 97UP only – check label.
Acephate 90 WSP, 90 WDG	1.1 lb	
Acephate 90 Prill	1.1 lb	
Sevin XLR Plus	1.5-2 qt	5 applications/season, 7-day spray interval, 7-day PHI.
Sevin 4F, Carbaryl 4L	1.5-2 qt	
Sevin 80S (Solupak)	1.88-2.5 lb	
Spring Flood		Flood in May for 48 hours, see page 30.

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

2nd generation is active during bloom. Use pheromone traps to time management of 2nd generation. Black-headed fireworm moths are only 1/4" long and are black and gray; be aware that the pheromone trap often picks up a much larger, non-pest moth. When treating summer generation with growth regulators (Intrepid or Confirm), timing is 2 weeks after **onset** of moth flight, and again 10 days later. For other insecticides, such as Diazinon, Delegate, or Avaunt, apply insecticide 10 days after **peak** moth flight, usually during bloom. Choosing these insecticides during bloom will interfere with pollination.

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

YELLOW-HEADED FIREWORM

Lorsban, Orthene, Sevin, and spinosyn products (**Delegate** and Entrust) can be used as specified for black-headed fireworm (see page 22).

Intrepid and **Diazinon**, FIFRA 2EE recommendations, can be used as specified for black-headed fireworm (page 22).

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

SPARGANOTHIS FRUITWORM

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

*** indicates restrictions from handlers. Please check with handler before using.**

Altacor	3-4.5 oz	See product discussion on page 10, new chemistry. Low rinse time required for efficacy. Do not exceed 9 oz/season. 7 days between applications. Must target eggs and small larvae.
*Assail 30 SG	4.0-6.9 oz	7 days between apps, 2 apps. Handler restrictions, use with caution.
Delegate WG (spinetoram)	3-6 oz	Do not exceed 19.5 oz/season. 7 days between applications. Only use lower rates if rinse time is 4 minutes or less.
Intrepid 2F	10-16 fl oz	Insect growth regulator products, these compounds need to be eaten to work. Intrepid is more active and has greater residual than Confirm. Note, however, Intrepid is restricted use and Zone II restricted. See product discussion on page 19. Safe for pollinators and natural enemies.
Confirm 2F	16 fl oz	
*Lorsban 4E, Nufos 4E	3 pt	<u>Poor choice for most bogs</u> , nearly all populations are resistant. Limit 2 apps/season. Do not mix with other insecticides. Observe 60-day PHI. Impound water for 5 days, then release gradually. Note: 75 WG formulation is not restricted use.
*Chlorpyrifos 4E AG	3 pt	
*Lorsban Advanced, Hatchet	3 pt	
*Lorsban 75 WG	2 lb	
*Orthene 97, Acephate 97UP	1 lb	<u>Poor choice for most bogs</u> , nearly all populations are resistant. Do not apply within 10 days of start of bloom due to bee concerns. 90-day PHI except 75-day PHI with some Acephate formulations.
*Acephate 90 WSP, 90 WDG	1.1 lb	
*Acephate 90 Prill	1.1 lb	

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

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

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

24 Insects

GYPSY MOTH

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

*** indicates restrictions from handlers. Please check with handler before using.**

*Assail 30 SG 4.0-6.9 oz 7 days between apps, 2 apps maximum.

Bacillus thuringiensis (B.t.) products See product discussion page 19.

Delegate WG (spinetoram) 3-6 oz Do not exceed 19.5 oz/season. 7 days between applications.

Intrepid 2F 10-16 fl oz Insect growth regulator products, these compounds need to be eaten to work. Intrepid is more active and has greater residual than Confirm.
Confirm 2F 16 fl oz Note, however, Intrepid is restricted use and Zone II restricted. See product discussion on page 19. Safe for pollinators and natural enemies.

Late Water Holding late water kills eggs laid on the bog as well as prevents establishment of tiny caterpillars that drift in from infested uplands. See Late Water section.

*Orthene 97, Acephate 97, 97UP 1 lb Do not apply within 10 days of start of bloom due to bee concerns.
*Acephate 90 WSP, 90 WDG 1.1 lb 1 application/season. Observe 90-day PHI, except 75-day PHI with
*Acephate 90 Prill 1.1 lb some Acephate 90, 97, 97UP only – check label.

***Sevin XLR Plus** 1.5-2 qt 5 apps/season, 7-day spray interval.
***Sevin 4F, Carbaryl 4L** 1.5-2 qt
***Sevin 80S (Solupak)** 1.88-2.5 lb

Insecticides (**Avaunt**, Diazinon, **Delegate**) applied for cutworms or spanworms may provide control. Action threshold is an average of 4.5 larvae/25 sweeps. Check for patchy infestations and spot treat, i.e., along 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.

CRANBERRY WEEVIL

Actara (thiamethoxam) 2-4 oz Effective against both spring and summer adult populations. Lower rates effective. Restricted Use and Zone II restricted. Do not apply by air or to flow-through bogs. Highly toxic to bees – do not apply within 5 days of bee arrival. Hold water 5 days. Do not apply in spring if possible, neonicotinoid gets into pollen and nectar.

***Belay** (clothianidin) 4 fl oz Use only for summer adult populations after bees are gone. Highly toxic to bees and for more than 5 days after treatment! 12-hr REI, 21-day PHI. If you use Belay for weevil, you cannot use it for soil application. Total amount allowed is 12 oz. Beware, handler restrictions.

Avaunt (indoxacarb) 6 oz Effective against spring weevil populations only. Do not use after bloom against weevil in summer. Only 2 apps allowed targeting weevil in spring, prior to bloom. 7 days between applications. No flow-through bogs, hold water 1 day. Toxic to bees.

Lorsban 4E, Nufos 4E 3 pt Poor choice for most bogs, many populations are resistant.
Lorsban Advanced, Hatchet 3 pt 60-day PHI. Impound water for 5 days, then release slowly.
Lorsban 75 WG 2 lb Note: 75 WG formulation is not restricted use. Toxic to bees.

Action threshold is an average of 4.5 weevils in 25 sweeps for spring population, and 9 weevils in summer. Summer feeding is not as damaging as spring feeding and egg-laying. Adult weevils are found throughout the growing season. See sweep netting section page 18. Sweep when warm, sunny, and calm. Let net contents settle: weevils "play dead" when disturbed. Do not count non-pest gray weevils. Spring weevils move in from outside bog; consult sweep records from previous years to determine invasion pattern. Even if threshold is exceeded, sometimes it is advisable to wait 1-2 wks in spring to treat. Weevil numbers may continue to rise as more weevils move in. However, waiting too long becomes risky if blossom buds have appeared and eggs are being laid. Late water is not effective against weevil.

CRANBERRY FRUITWORM

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

*** indicates restrictions from handlers. Please check with handler before using.**

For most bogs, a properly timed first cranberry fruitworm spray is the most important one of the season.

Altacor	3-4.5 oz	See product discussion on page 19, new chemistry. Low rinse time required for efficacy. Do not exceed 9 oz/season. 7 days between applications. Bee safe! Recommended for first fruitworm at 50% out of bloom but only on early cultivars and where pressure has generally been moderate to heavy!
*Assail 30 SG	4.0-6.9 oz	7 days between applications, 2 apps maximum, 1-day PHI. Toxic to bees.
Delegate WG (spinetoram)	3-6 oz	FIFRA 2EE recommendation. Do not exceed 19.5 oz/season. Highly toxic to bees, but thoroughly dried residues are safe. Thus, sprays must go on at night and dry by morning if sprayed during bloom
Diazinon 50 W	4-6 lb	Toxic to bees. It is advisable to hold water for at least 3 days. 5 day REI!! 3 applications/season, 7-day PHI, and 14 days between sprays, except AG500 which has a 7-day minimum spray interval.
Diazinon AG 500	2-3 qt	
Diazinon AG 600 WBC	51-76.5 oz	
*Imidan 70W	1.33-4 lb	Toxic to bees. Efficacy results have been very variable. If chosen, use higher rate. Efficacy may be reduced at pHs found in bog water (pH 6-7). REI of 3 days, 10-day spray interval, 14-day PHI.
Intrepid 2F	10-16 fl oz	FIFRA 2EE recommendation. Zone II restricted. Ground applications <u>only</u> are highly effective. Chemigation gives moderate to good level of control in well-timed systems. Safe for bees and natural enemies.
Late Water		Holding late water is an excellent choice as it severely reduces fruitworm. However, moths may move into late water-treated beds from other areas of infestation, so it is advisable to spot check for eggs. Refer to Late Water Practice on next page.
*Lorsban 4E, Nufos 4E	3 pt	Toxic to bees. 2 apps/ season. Handler restrictions, beware.
*Lorsban Advanced, Hatchet	3 pt	Observe 60-day PHI. Impound water for 5 days, then release slowly.
*Lorsban 75 WG	2 lb	Note: 75 WG formulation is not restricted use.
*Sevin XLR Plus	1.5-2 qt	Toxic to bees. Sevin XLR Plus is formulated to have minimal bee toxicity once the spray dries. Limit of 5 applications/season, 7-day spray interval, 7-day PHI. Handler restrictions, beware.
*Sevin 4F, Carbaryl 4L	1.5-2 qt	
*Sevin 80S (Solupak)	1.88-2.5 lb	

CRANBERRY FRUITWORM MANAGEMENT

FOR ALL PRACTICES

1. Every pump system should be scouted separately as one piece.
2. To be valid, sampling of berries by size and bog area must be random because moths select larger berries particularly along bog margins and inner ditches.
3. Use a magnifier to look for eggs. Look at eggs carefully to be sure they are alive. As you move into the season, many eggs are dead or parasitized. Do not count these.
4. Target only eggs. Do not treat in attempt to control caterpillars in the fruit. Research shows that sprays made after caterpillars have entered fruit are minimally effective.
5. For beds with very high fruitworm pressure and large fruited varieties, it may be cost effective to apply Intrepid 2F in lowest water gallonage/acre even before or 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 unusually warm or cool weather during fruit set, it is advisable to shorten or lengthen accordingly the interval between 50% out-of-bloom and the first spray.
7. It is not necessary or desirable to mix compounds for effective control.

26 Insects

STANDARD PRACTICE

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

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

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

For Howes -- Apply 1st treatment 7-9 days after 50% out-of-bloom.

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

Timing of this spray is critical. If fruitworm pressure has been high in previous years and berries are sizing up, spray should occur very soon after 50% OOB in early cultivars. Altacor is the compound of choice for during-bloom sprays. Delegate, sprayed only at night when residues can be dried by morning, is another option. Keep in mind that most insecticides, with the exception of Altacor and the growth regulators (Confir and Intrepid), are toxic to bees.

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

ADDITIONAL TREATMENTS - MONITOR EGGS TO TRIGGER SPRAYS

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

SCOUTING PRACTICE

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

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

ADDITIONAL TREATMENTS USING SCOUTING PRACTICE

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

LATE WATER PRACTICE

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

TREATMENTS - MONITOR EGGS TO TRIGGER SPRAYS

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

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

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

SOIL INSECTS

BLACK VINE WEEVIL AND STRAWBERRY ROOT WEEVIL

Nematodes	Availability limited—need to plan ahead and order well in advance of application. Target immatures in soil. Apply in early evening in May and/or September. Best results occur when soil temperatures are higher than 56°F. Irrigate before and after application. Chlorpyrifos (e.g., Lorsban) has been reported to adversely affect nematodes.
Fall Flood	Flood for 10-14 days as soon as possible after harvest. May also negatively impact vines to some degree. Warmer water enhances 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. Adult beetles emerge in June; they must feed for about 4 weeks before egg-laying starts. Night sweep for weevils at edge of weevil-damaged areas, starting after dusk but before dew forms 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.

SCARAB GRUBS

Admire Pro	7-14 fl oz	Imidacloprid products, rate per acre. Use soil drench treatment for oriental beetle. May suppress cranberry root grub and cranberry white grub, but data are lacking and multiple years likely required to see effect. Limit 2 apps/season <u>but 1 app at higher rate is recommended</u> . No aerial app, 30-day PHI. <i>Best results are achieved when the compound is present just prior to egg hatch—timing is post bloom immediately after bees are removed. Oriental beetle flight can be monitored with pheromone traps starting in late June-early July. Application should be made 3 weeks after peak flight of the beetles (or slightly earlier).</i> Irrigate before and after application, but do not apply to saturated soil. Compound has very long soil residual. Highly toxic to bees; do not apply when pollinators are on bog.
MANA Alias 4F	8-16 fl oz	
Wrangler	8-16 fl oz	
Admire 2F	16-32 fl oz	
Alias 2F	16-32 fl oz	
Nuprid 2F	16-32 fl oz	
Widow	16-32 fl oz	

*Belay (clothianidin) 12 fl oz Highly toxic to bees. Apply as a soil drench only after bees have been removed or all bloom gone. 12-hr REI, 21-day PHI. If you use Belay as a soil drench, you cannot use it as a foliar application on weevil, flea beetle or fruitworm. Total amount allowed is 12 oz. *Handler restrictions, check with handler before using.

Summer flood Remove winter flood and allow bog to dry out. Reflow mid-May and keep well flooded until mid-July. This will eliminate cranberry root grub and cranberry white grub larvae, as well as the crop for that year. Oriental beetle and *Hoplia* are probably also impacted by the summer flood.

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

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

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

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

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

28 Insects

CRANBERRY GIRDLER

Nematodes	Availability limited—need to plan ahead and order well in advance of application. Apply Nematodes 2 weeks after end of moth flight. Target immatures in soil.
Fall Flood	Flood for 1 week as soon as Early Blacks are harvested, starting no later than Sept. 25. Vines must be completely covered. It may be necessary to flood late varieties with berries on the vine. May also negatively impact vine health to some degree.
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. Be aware of girdler's true appearance; a very similar non-pest moth is also picked up in traps. A bad girdler infestation can exist even with low pheromone trap catches. Just below the trash line, look for old feeding damage that may be quite deep in the wood of the vine. Thorough trash flows are beneficial.

STRIPED COLASPIS

Admire Pro	7-14 fl oz	Imidacloprid products. Soil drench <u>targets immatures</u> in soil. When adult beetles are picked up in net, application should be made to target larvae as eggs hatch. Compound has very long soil residual. No aerial application. Limit 2 apps/season, but <u>1 app at higher rate is recommended</u> . Irrigate before and after application. Highly toxic to bees; apply after bloom in mid-late July. 30-day PHI.
MANA Alias 4F	8-16 fl oz	
Wrangler	8-16 fl oz	
Admire 2F	16-32 fl oz	
Alias 2F	16-32 fl oz	
Nuprid 2F, Widow	16-32 fl oz	
*Belay (clothianidin)	12 fl oz	Highly toxic to bees. Apply as a soil drench targeting immatures in the soil only after bees have been removed or all bloom gone. 12-hr REI, 21-day PHI. If you use Belay as a soil drench, you cannot use it as a foliar application on weevil or flea beetle. Total amount allowed is 12 oz. *Handler restrictions, check with handler before using.
Diazinon 50 W	4-6 lb	FIFRA 2EE recommendation <u>targets adults</u> . It is advisable to hold water for at least 3 days. Check labels; most are 3 apps/season, 5-day REI, 7-day PHI, 14-day spray interval, except AG500 which has 7-day minimum spray interval.
Diazinon AG 500	2-3 qt	
Diazinon AG 600 WBC	51-76.5 fl oz	
*Sevin XLR Plus	1.5-2 qt	FIFRA 2EE recommendation <u>targets adults</u> . Do not apply when bed is in bloom. 5 apps/season, 7-day spray interval, 7-day PHI. *Handler restrictions, check with handler before using.
*Sevin 4F & Carbaryl 4L	1.5-2 qt	
*Sevin 80 WSP & 80S	1.88-2.5 lb	

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

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

MISCELLANEOUS PESTS

CRANBERRY TIPWORM

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

CRANBERRY FLEA BEETLE

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

*** indicates restrictions from handlers. Please check with handler before using.**

Actara	2-4 oz	May only provide suppression of flea beetle. Restricted Use and Zone II Do not apply by air or to flow-through bogs. Hold water 5 days!
*Belay (clothianidin)	4 fl oz	Foliar applications targeting adults. Highly toxic to bees and foliage is toxic for more than 5 days after application. Use only after bees are removed or bloom is complete. If you use Belay as a foliar application, you cannot use it for a soil application. Total amount allowed is 12 oz.
OR		
*Belay (clothianidin)	12 fl oz	Post-bloom application - apply as a soil drench targeting immatures in soil after adults were seen. Highly toxic to bees. 12-hr REI, 21-day PHI. If you use Belay as a soil drench, you cannot use it as a foliar application on weevil or flea beetle.
Delegate WG	3-6 oz	FIFRA 2EE recommendation. Delegate may only provide suppression of flea beetle. Do not exceed 19.5 oz/season. 7 days between applications.
*Sevin XLR Plus	1.5-2 qt	5 applications/season, 7-day spray interval, 7-day PHI.
*Sevin 4F, Carbaryl 4L	1.5-2 qt	
*Sevin 80S (Solupak)	1.88-2.5 lb	
Diazinon 50 W	4-6 lb	FIFRA 2EE recommendation. Hold water for at least 3 days.
Diazinon AG 500	2-3 qt	Check labels; most are 3 apps/season, 5-day REI, 7-day PHI, and
Diazinon AG 600 WBC	51-76.5 fl oz	14-day spray interval, except AG500 which has a 7-day minimum.

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

SOUTHERN RED MITE (SRM)

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

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

30 Insects

MANAGEMENT NOTES FOR ALL INSECT RECOMMENDATIONS

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

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

3. **REFLOODING OPTIONS** –

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

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

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

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

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

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

6. **FOR COMPLETE GUIDELINES** – Management guidelines provided here serve only as reminders. Review the Insect Management BMP in the UMass Best Management Practices Guide: <http://www.umass.edu/cranberry/pubs/bmps.html>.

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

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

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

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

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

Late Water -- Holding late water is an excellent choice to greatly reduce cranberry fruitworm pressure; however, moths may move into late water-treated beds from other areas of infestation. False armyworm, blossomworm, gypsy moth, and southern red mite may be managed with late water. See Late Water Section.

Fall Flood -- May be used to reduce cranberry girdler populations. Flood for 10-14 days as soon as possible after harvest. May also impact vines to some degree. Warmer water temperatures enhance effectiveness.

Sanding -- If you can sand, populations of most insects should be less abundant.

Winter Flood -- If you can maintain a good winter flood, populations of most insects should be less abundant.

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

Azadirachtin products

Aza-Direct	1-3.5 pt	Target small caterpillars with this biological insecticide – it serves as a repellent, antifeedant, and interferes with the molting process. Restricted.
Neemix 4.5	4-16 fl oz	

Bacillus thuringiensis (B.t) products

Dipel DF (<i>kurstaki</i> strain)	0.5-1 lb	These compounds are most effective when applied multiple times in low gallonage against small caterpillars feeding on foliage. Treating early infestations is critical. Well-timed chemigation systems are critical for good efficacy (6 minutes or less rinse time). Beware, not all B.t.'s are certified organic or have cranberry on the label.
Biobit HP (<i>kurstaki</i> strain)	0.5-1 lb	
Xentari (<i>aizawai</i> strain)	0.5-1.5 lb	

Entrust 80W	1.25-3 oz	This compound is an effective, fast-acting, but short-lived spinosyn insecticide. More effective than Bt once caterpillars have reached a larger size. When chemigating, a short rinse time (6 minutes or less) is necessary for good efficacy. Only use lowered rates if chemigation system is 4 minutes or less. <u>Spinosyn compounds are highly toxic to bees, but thoroughly dried residues are safe. Thus sprays must go on at night and dry by morning. Apply when drying conditions are optimal overnight.</u>
Entrust SC	4-10 fl oz	

Grandevo	2-3 lb	No chemigation allowed. <i>Chromobacterium subtsugae</i> strain.
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M-pede Insecticidal Soap	1-2% solution	No chemigation allowed.
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Neem Oil Products

Trilogy	Useful as a dormant application for suppression of southern red mite egg hatch. Do not chemigate. Use 1% rate for ground application or 1 qt/A for aerial application in 10 gallons of water. Be aware that it accelerates plant growth stage and adjust frost protection accordingly. Also suppresses eggs and motile mites post bloom.
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Nematodes Availability limited. Expensive but available organic option for grub and girdler management.

Pyganic EC 1.4	16-64 fl oz	Restricted. Spot treating using low gallonage may be helpful for patchy infestations. Note: other Pyrethrins with added piperonyl butoxide are not allowed.
Pyganic EC 5.0	4.5-18 fl oz	

WEED MANAGEMENT 2015

Prepared by Hilary A. Sandler and Katherine M. Ghantous

Adjuvants.....	p. 46	Off-bog.....	p. 57
Aquatic Uses.....	p. 56	Poast.....	p. 51
Callisto.....	p. 49	Quinstar.....	p. 50
Casoron.....	p. 46	Renovations.....	p. 58
Conservation Seed Mix.....	p. 56	Roundup.....	p. 52
Devrinol.....	p. 48	Select Max.....	p. 52
Ditch Management.....	p. 55	Specific weeds	
Evital.....	p. 48	by importance.....	p. 33
Herbicides.....	p. 46	Stinger.....	p. 50
Non-producing bogs.....	p. 58	Weedar 64.....	p. 54

New herbicides and updates.

Check our web site (www.umass.edu/cranberry/) and upcoming newsletters for further information about any new uses or products. The manufacturer of Devrinol has discontinued production of the 10G formulation and has re-labeled the 50DF as DF-XT. It is still legal to use both products; please check with local ag suppliers for availability. Follow the label of the product you are using! Cranberries have been removed from the Princep label; recommendations for its use have been deleted. The tolerance is still in place, so please use any remaining stock now.

Weed Life Cycles. *Annual plants* complete their life cycle in one year and reproduce by seed (e.g., dodder). They germinate from seeds, grow to maturity, flower, and make seeds all within a single growing season. *Biennial plants* take two years to complete their life cycle. They typically germinate from seeds and grow vegetatively in the first year, then enter a period of dormancy over the winter. They flower and make seeds the following growing season. *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 priority groups. (1=no tolerance; 2=serious concern; 3=less concern; and 4=lowest concern)

Weeds are grouped into priorities based on their likelihood to cause yield loss, ability to spread, and the difficulty of control. Priority group 1 weeds cause severe losses, spread rapidly, and are difficult to control. Weeds in this group are extremely damaging to cranberry yields and may kill vines. Weeds in Priority group 2 are less damaging to yields than those in priority 1, but they are still aggressive and difficult to control. Weeds in group 3 may reduce yields, but yield impact is low. Spread or growth of these weeds is relatively slow. The lowest-concern weeds are grouped in priority 4. These plant species are primarily found in bare spots, areas of poor cranberry vine growth, or at bog edges. Deal with the most yield-threatening weeds first.

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. Growers may change and adapt weeds into priority groups to best fit their own management program.

PRIORITY ONE WEEDS

DODDER (A) *Cuscuta gronovii*

Dodder is an abundant seed producer. All management efforts should be directed towards minimizing or eliminating seed production. A single plant can produce thousands of seeds in one season. The seed bank is very long-lived (>13 yr), so do everything possible to eliminate seed production and/or reduce seed viability.

Dodder is an obligate parasite and must have a host plant to survive. Woody cranberry stems are somewhat less appealing to dodder, so control of succulent weeds (such as goldenrod, loosestrife and asters) early in the season may be important.

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 before they are placed in beds that are dodder-free. This is especially important for custom harvest operations.

Dodder may also be spread vegetatively; pieces of stem can be moved on equipment 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. Equipment should be sanitized in these situations!

Where dodder infestations are just beginning, **careful scouting and hand removal** of seedlings prior to infection is a good practice. Weeds that are infected with dodder should be completely removed from the bed; dodder stems will re-grow if haustoria (the part of the parasite that penetrates the host) remain embedded in the weed. Infected cranberry vine tips can be cut off and thrown away.

Scouting

Begin scouting for dodder in early-mid April (unless your bog history or unusual weather conditions indicate otherwise). Mild winter temperatures may promote earlier emergence of dodder. Scout in areas where infestation has occurred in the past. Often, dodder seed will accumulate in the areas where berries are removed from the beds at harvest. Dodder seedlings may also be seen in warm, bare areas or newly sanded areas. Newly emerged seedlings are usually yellow in color, very slender, and 0.5 to 3 inches long. If the vine cover is good, move the vines aside so that you can see the duff layer; this is where early emerging seedlings will be seen.

Dodder populations in MA emerge slowly at first, but then quickly peak (50-90% germinate 30-45 days after first or early emergence) and subside. In addition, as the seeds accumulate year after year in the soil, seedlings emerge later and later, creating overlapping generations. The most vigorous population is the one most recently seeded (from last year). It is not known how variable dodder populations are from bog to bog but variation from farm to farm is likely. Growers should consider previous successful experiences, along with scouting, and plan applications of preemergence herbicides accordingly.

PRIORITY ONE WEEDS (Continued)

DODDER (A) *Cuscuta gronovii* (continued)

Preemergence Herbicide Use

Scouting is necessary for correct timing of preemergence herbicide application. Herbicides should be applied within 10-14 days of early seedling emergence, so that the chemical is present when the peak in germination occurs.

Casoron may control dodder germination. Traditionally growers have used 30-60 lb/A. Some growers have experienced poor control with 30-40 lb rates. If this is your experience, consider increasing the rate for improved control. Split applications at least 3 weeks apart can be used (not to exceed 100 lb/A in a 12-month period), and may be more effective than a single application if there are many frost irrigation events or a lot of rainfall. See Notes on Casoron, page 46.

Handlers may be restricting Quinstar use so check before using! Quinstar can be used during the preemergence and postemergence phase. Time preemergence QuinStar (8-16 fl oz/A) application as described for Casoron, targeting the majority of the seed population as they are germinating and emerging. Two applications are permitted (not to exceed 16 fl oz/A in a 12-month period) but a minimum of 30 days must elapse between applications. See notes on Quinstar, page 50.

We do not know if Callisto will control dodder populations when applied preemergence, though some growers have experimented with this application timing. Please contact the Station (508-295-2212 x21 or x43) and share your observations.

Postemergence Control

Raking: For heavy infestations, raking can prevent the onset of upright dieback caused by infection, prevent leaf-drop due to shading of the cranberry by the dodder canopy, and reduce dodder seed production. Raking is more effective at reducing seed production if it is done before the seeds are formed (flowering). Raking too early may not be effective because the dodder stems can re-grow from the portions embedded within the cranberry. No benefit is gained from raking more than once. For light to moderate dodder infestations, raking is not recommended.

Trash floods: A good trash flow after harvest is helpful in removing seed capsules from the bed, but is not a replacement for prevention since subsequent infestation occurs. Growers could consider multiple trash flows if seed production is high.

Chemigating herbicides: Control has been reported when Callisto is chemigated but overall, results seem better when this herbicide is used as a spot-treatment. Chemigating Callisto definitely appear much less effective when dodder is attached to cranberry. Dodder will turn white after application, and may re-grow. Applications made before dodder flowers seem more effective than those made after flowering; higher rates are better. See notes on Callisto, page 49.

Spot-treatment with Herbicides: Research from 2014 indicated that spot-treatments with a single application of concentrated Callisto and COC (crop oil concentrate) significantly reduced dodder seed production. Treatments made before dodder flowered reduced seed production more than applications made after flowering had started (though both were better than the untreated). If you spot-treat with Callisto, you must not exceed 8 oz/A limit (2 applications permitted per year)! At 1.5 oz/gal, you can only spray out 5.3 gallons per acre per application to stay within the label rate. Lower rates (1 oz/gal or less) might also be effective and allow you to treat more area, but we have not tested this. We are in the process of working with the registrant to add spot-treatment mixture language to the label. If you have any questions regarding this usage, please contact the Station (508-295-2212 x21 or x43).

Other spray options: Growers report backpack applications of sea water and COC can give some control. We do not have enough data to say whether or not plant growth regulators adequately control dodder.

PRIORITY ONE WEEDS (Continued)**DODDER (A) *Cuscuta gronovii* (continued)**

Thermal Weeding: Spot treating small areas of dodder with flame cultivation (thermal weeding) may control dodder. Cranberry plants exposed will also be injured but will recover. Reports from New Jersey indicated that short exposures may not kill the haustoria that are embedded inside the plant. Repeat applications or longer exposure times may be needed. Thermal treatments may need to be applied to an area slightly larger than what is obviously infected.

Spring Floods. Recent research and grower experience has shown that short (24-48 hr) floods in early to mid-May may be effective for reducing dodder infestations. Floods should cover vine tips adequately. No adverse vine or yield impact has been reported when growers have held these spring floods. Dodder floods may coincide with floods used to control black-headed fireworm. Flooding dodder 3-4 weeks after early seedling emergence appears to be more effective (compared with flooding 1-2 weeks after early seedling emergence).

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

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. Control of established plants with glyphosate products 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 partial control. See notes on Roundup, page 52. Wipes with Weedar 64 may also be effective when used in late June and July. See notes on Weedar 64, page 54.

Callisto will discolor and injure dewberries, however, the long-term management of this weed with Callisto is not yet known. Use 2 applications of Callisto (at least 14 days between applications) to manage dewberry infestations. Repeated annual applications will likely be necessary to reduce infestations. If dewberries are in a mixed canopy with tall weeds, target the spray to reach the lower portion of the canopy (where the dewberries are). See notes on Callisto, page 49.

Non-chemical options

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.

Recent research indicates that using flame cultivation (thermal weeding) can reduce dewberry plant size. One short duration (3-6 sec/yd² if using an open flame torch; longer times, 15-30 sec are needed with infrared torches) exposure made mid-summer seems effective (reduces shoot and root biomass). Cranberry vines will be injured when exposed to thermal weeding but they will recover. Typically, however, few cranberry vines are present in heavy dewberry infestations, so the risks are much lower than in well-vined areas. Contact the Station (508-295-2212 x21 or x43) if you have interest or questions about thermal weeding.

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

PRIORITY ONE WEEDS (Continued)

GLAUCOUS GREENBRIER *Smilax glauca* (Silverleaf sawbrier)

Greenbriers are very difficult to control because they have extensive underground storage organs. Glaucous greenbrier (silverleaf or sawbrier) is more difficult to control than common greenbrier (greenleaf). Sawbrier 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.

Sawbrier 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 sawbrier may necessitate bog renovation. Weedar 64 and Callisto may be used on sawbrier as per dewberry recommendations. Flooding is not effective against sawbrier. Recent research indicates that one exposure of a mid-summer thermal weeding (hand-held flame cultivators or torches) treatment may not be effective for reducing sawbrier growth.

POISON IVY *Toxicodendron radicans*

Poison ivy (PI) is getting worse on many bogs. Treat small infestations early and eradicate! Control is very difficult because the weed 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. Research has shown that clipping the stems with Roundup-dispensing applicators may offer partial control. Early-mid September applications may give better control than August applications. There is a 30-day PHI. Late applications 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. Adding 1 part Weedar 64 to 4 parts of the Roundup mixture may be helpful but will likely increase the possibility of crop injury. See 2,4-D cautions, page 54.

Recent research indicated that repeated annual applications of a concentrated Callisto + Poast mixture decreased PI cover and increased cranberry cover, especially where PI infestations were severe. We tested many spray mix combinations of concentrated Callisto + Poast + COC or NIS (non-ionic surfactant); adding Poast to the spray mix did not increase weed control compared to Callisto by itself. Our results showed slightly better control with mid-June applications compared to late May applications. On the other hand, we heard of one report of very good control using 0.8 tsp/gal Callisto + 2 oz Poast + NIS in early May. If you spot-treat with Callisto, you must not exceed 8 oz/A limit (2 applications permitted per year)! At 1.5 oz Callisto/gal, you can only spray out 5.3 gal per acre per application to stay within the label rate. Lower rates (1 oz Callisto/gal or less) might also be effective and allow you to treat more area, but we have not tested this. We are currently working with the registrant on label language for spot-treatment applications. Please call the Station (508-295-2212 x21 or x43) for updates and rate information.

Consider resistance management concerns when using Callisto.

DO NOT USE thermal weeding or burning for poison ivy control. The toxic plant components can become air-borne and cause significant health problems.

Many people are highly allergic to poison ivy. Protective lotions and soaps are available that minimize the irritation caused by the poison ivy oils; these work very well when applied according to label instructions. Lotions are usually applied prior to exposure and soaps are used to remove oils after exposure to the plant. Rinse with a lot of cool water; small amounts of water may only spread the oils.

PRIORITY TWO WEEDS

POVERTY GRASS

Poverty grass (little bluestem (*Schizachyrium scoparium*) and broomsedge (*Andropogon virginicus*)) is being reported as increasingly problematic. These species reproduce by seeds. To control these perennial grasses, control effort should be directed at all life stages. It is important to stop seeds from germinating (preemergence herbicides), stop adult plants from making seeds (mowing and postemergence herbicides) and also to control adult plants (postemergence herbicides, hand weeding/digging out clumps).

Poverty grass (PG) is a slow-grower; it does not begin to grow rapidly until later in the summer (mid-July). In the spring and early summer, plants are at the same height or lower than the cranberry canopy, making problem areas hard to identify.

Preemergence / Post-cranberry harvest

In recent demonstration plots, Evital (80 lb/A) in the spring or fall knocked back existing plants but did not prevent new plants in the spring. The spring application of Evital seemed to give better control of existing plants than the fall application, and also decreased the appearance of new PG plants. The spring application did cause visible symptoms of vine stress (on Stevens). The stress did not result in yield loss. Growers report good control when winter sanding followed a fall Evital application (60-75 lb/A).

Devrinol DF-XT (18 lb/A) applied in the fall or the spring did not appear to result in control of existing plants or decrease the emergence of new plants. Some growers feel that they got control with the granular Devrinol and are not seeing control with the liquid forms. Spring Casoron (80lb/A) seemed to provide only slight control of existing plants.

Roundup sprayed directly into the base of grass clumps in the fall injured existing plants but did not reduce seed production (PG had already make and shed seeds at this point) or new plant growth in the following year. Poast sprayed directly into the base of grass clumps in the fall also injured existing plants, but was less effective than Roundup.

Postemergence

Postemergence herbicides that work on grasses include sethoxydim (Poast) and clethodim (Select Max, Intensity, and other registered products with this active ingredient). A grower reported good control with a pre-bloom (cranberry) spray of Select by air. Recent research showed that individual clumps treated in mid-July with one application of Select, Intensity, or Poast at recommended Chart Book rates reduced PG biomass compared to the untreated and the PG did not produce seeds.

Roundup wipes of the grass clumps during the summer may also offer control, but should be done before PG begins to make seeds. Roundup **sprays** can only be done during the season if the plants are **in the ditches** and the water level is dropped prior to treatment.

Hand weeding PG clumps is effective. After weeding, we did not observe any regrowth from root fragments left behind. Weeding done before plants make seeds will help control the emergence of new plants the next year. However, hand weeding can be done anytime to control existing plants, including after harvest.

Mowing: Try to mow as early as you can. Remove the seed heads from the bog (bag them) if possible. Even if seed heads appear immature when they are mowed, we have seen seed heads open up within several days after being cut down.

PRIORITY TWO WEEDS (Continued)

ASTER *Aster spp.*

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. Some growers report efficacy with Callisto against asters, but results were not always compelling. Iron sulfate and Weedar 64 may also be effective. Higher rates of Stinger offer the best option; use care to avoid contact with cranberry vines during application to minimize any vine injury. For a spray use 0.33-0.5 fl oz (2-3 tsp) per gallon. As a wipe use 2.5 fl oz (5 Tbsp) per gallon (2% solution).

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

The impact of cinquefoil is variable, but infestations seem to be getting worse, thus its classification as a Priority 2 weed. Colonization of cinquefoil may indicate a problem with vine growth and higher than ideal pH. Improvement of fertilizer program may help control this weed. If the soil pH is greater than 5.0, the use of sulfur to lower pH will favor the growth of the cranberry vines over that of the weed. See Notes on Sulfur, page 54.

Callisto seems to work well on this weed, but it takes a while for symptoms to appear and for the weed to die; be patient! Hand wiping or hand pulling can also be used to eliminate small patches. Growers report using 60 lb Casoron in early May (as a spot-treatment) with very good results. Iron sulfate may also work when applied in the summer.

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

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, page 52. Digging up the root system is not practical and will cause significant vine and bog damage.

NARROW-LEAVED GOLDENROD *Euthamia tenuifolia*

Narrow-leaved goldenrod (NLGR) causes little direct yield loss, but it's 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.

Data indicates that Callisto works very well against NLGR. Stinger applications should also offer reasonable control of NLGR. Use the lowest effective rate of Stinger as cranberry vine injury is likely with over-application or off-target coverage. Wipes with Roundup or Weedar 64 may also offer control.

PRIORITY TWO WEEDS (Continued)**WILD BEAN** *Apios americana* (Ground Nut)

Repeated annual applications may be needed for large or severe infestations. Nuts may be dug out and removed from the bog.

Wild bean can be well controlled with Stinger applications. It is very sensitive to Stinger at rates lower than the usual label rate. As a spray use 0.06-0.12 fl oz (0.37-0.75 tsp) per gallon. As a wipe use 2.5 fl oz (5 Tbsp) per gallon (2% solution). When using wipes, stake the wild bean vines to make wiping easier.

Some growers have reported good wild bean control with Callisto; Stinger provides superior control but carries a greater risk of vine injury. Glyphosate products can also be used to wipe wild bean. A salt water solution applied after berry set can also be used to burn the bean tops off (1 lb/gal water, do not exceed 200 gal/A).

Preemergence options can include Casoron 4G (75 lbs/A) followed by Devrinol DF-XT (15 lb/A) or 2XT at 15 qt/A. Allow 10 days between applications.

YELLOW LOOSTRIFE *Lysimachia terrestris*

Yellow loosestrife (YLS) can cause moderate yield reductions. It may also serve as an early-season host for dodder and tips may harbor *Sparganothis* larvae. Since loosestrife is difficult to control, efforts should begin while patches are still small and before they have a chance to spread.

Fall or spring applications of Casoron may offer some control of loosestrife. Wipes with Roundup or Weedar 64 may also provide control. Efficacy of Callisto on YLS seems low.

Reports from NJ indicated that Quinstar at 0.25/b ai/A plus NIS or COC in mid-July controls YLS. The evidence of control is seen in the year AFTER application. This timing may coincide with YLS post-bloom. Handler restrictions may apply for QuinStar – please check with you handler before using.

PRIORITY THREE WEEDS

CHOKEBERRY *Pyrus melanocarpa*

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.

LEATHERLEAF *Chamaedaphne calyculata*

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.

ORANGEGRASS *Hypericum gentianoides* (Pineweed)

Orangegrass is becoming more problematic on bogs, especially new plantings. Other common names are used (horsetail, horseweed, or mare’s tail), but those are very different plants. High rates of Casoron should control orangegrass but be careful using Casoron on new plantings. In Wisconsin, growers reported good control with 30 lb/A Casoron. Some growers are trying fall applications (postharvest) of Poast, but efficacy is not yet verified. There has been a report of efficacy with preemergence applications of Callisto at 8 fl oz/A, but this has also NOT been verified. Success with combinations of Callisto and Devrinol (both as PRE) on new plantings has also been reported. Orangegrass can be hand-pulled if infestations are not too large.

PERENNIAL GRASSES

These grasses often colonize bare areas and are becoming more problematic, especially on newer bogs. Encouraging vine growth may reduce potential for problems. Some species may be difficult to eradicate once established.

Preemergence herbicides Casoron or Evital (spring or fall) or Devrinol (spring only) may all offer control. Postemergence herbicides which work on grasses include sethoxydim (Poast) and clethodim (Select Max, Intensity, and other registered products with this active ingredient). Clethodim product usually have better efficacy against perennial grasses.

Roundup wipes or sprays that are directed into the base of the grass clumps may also offer control.

PREEMERGENCE OPTIONS

<i>Barnyard grass</i>	Evital. Apply in the fall.
<i>Broad-leaved panicgrass</i>	Evital. Gives partial control.
<i>Mannagrass</i>	Use Casoron (Spring).
<i>Poverty grass</i>	Devrinol applications combined with repeated mowing to remove seed heads is the best recommendation we have at this point. See page 37.
<i>Rattlesnake grass</i>	Casoron (Spring). Clean ditches in infested area. Pulling helps a little.
<i>Rice cutgrass</i>	Best choice is Devrinol applied before April 10. Casoron and Evital can also be used; give partial control. Improve drainage. Can tolerate pH<3.
<i>Smokegrass</i>	Evital (Spring).
<i>Summergrass</i>	Devrinol, Casoron or Evital. Hard to mow.
<i>Switchgrass</i>	Evital (Fall). Difficult to control, repeated mowing helps. Best to dig out plants prior to seed formation.
<i>Velvetgrass</i>	Casoron

PRIORITY THREE WEEDS (Continued)

PHRAGMITES *Phragmites australis* (Common reed)

This highly invasive species and aggressive weed has been observed on a few commercial bogs. It should be treated and controlled immediately!! The best treatment is glyphosate applications in early to mid-summer (before it gets too tall) followed by mowing approximately 3-4 weeks after herbicide application. You can also mow first and then glyphosate about 4 weeks later. Control any infestations that are occurring near the bog as well.

RED MAPLE AND OTHER TREES

The best management strategy is to pull saplings before the root system becomes established (hopefully less than 1 year old). Larger trees must be dug out. Glyphosate or Weedar 64 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. Wisconsin reports best results with early applications of Callisto at high rates with crop oil concentrate. A weed wrench or pliers can be helpful for removing large saplings.

RUSHES *Juncus* spp.

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.

Casoron and/or Devrinol applied in the spring may offer partial control of rushes. Evital may also offer some control. Salt (1-3 tsp) applied at the base of each clump in the spring can also be effective. Glyphosate wipes can be used in summer. We have preliminary evidence that flame cultivation (thermal weeding) may help to control rushes, and may be practical for use in ditches and along bog edges. Call the Station (508-295-2212 x21 or x43) if interested in more information.

SHEEP LAUREL *Kalmia angustifolia*

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, page 52).

SEDGES

Management of sedges combines both cultural and chemical controls. Hand dig and/or 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 on the next page 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.

PRIORITY THREE WEEDS (Continued)

SEDGES (Continued)

<u>CHEMICAL RECOMMENDATIONS FOR SEDGES</u>			
<u>HERBICIDE</u>	<u>RATE</u>	<u>WEEDS CONTROLLED</u>	<u>NOTES</u>
<u>Preemergence Options</u>			
Devrinol DF-XT	12-18 lb/A	Nut sedge (nutgrass)	Rate for peat-based bogs.
2-XT	12-18 qt/A		
Devrinol DF-XT	8-12 lb/A		Rate for mineral soils.
2-XT	8-12 qt/A		
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 Dig up clumps	Needlegrass is difficult to hand pull. Broomsedge may be controlled with glyphosate wipes.
<u>Postemergence Options</u>			
Callisto	4-8 fl oz/A	Nut sedge, perhaps others	Spot treatment or chemigation. See Notes on Callisto.
Weedar 64		Three-square (bulrush)	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.

UPRIGHT BRAMBLE *Rubus allegheniensis* (Blackberry)

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. This weed is not common on cranberry farms.

PRIORITY FOUR WEEDS

ANNUAL GRASSES

Generally, annual grasses are most likely to appear in bare patches and/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.

Devrinol, Casoron, and Evital give effective preemergence control for annual grasses.

Postemergence herbicides that work on grasses include sethoxydim (Poast) and clethodim (Select Max, Intensity, and other registered products with this active ingredient). Callisto may provide variable control.

CLOVER AND VETCH *Trifolium repens* and *Vicia* spp.

Clover and vetch tend to occur in areas of high pH. 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, page 54. 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. See Stinger notes, page 50. Control clover early in the spring prior to budbreak.

Callisto can also control clover (see Notes on Callisto, page 49). However, vine overgrowth has been reported in heavily infested (treated) areas after clover dies back (apparently acts like a green manure, releasing nitrogen into the soil).

FEATHER, ROYAL, CINNAMON, AND SENSITIVE FERNS

Dryopteris thelypteris, *Osmunda regalis*, *Osmunda cinnamomea*, *Onoclea sensibilis*

Spring (S) or Summer (Smr) follow the weed name in the chart below to indicate when applications are preferred. When using iron sulfate treatments, apply a small amount to each plant. See Notes on Casoron, page 46 and Iron Sulfate, page 47.

CHEMICAL RECOMMENDATIONS FOR FERNS			
HERBICIDE	RATE	WEEDS CONTROLLED	NOTES
<u>Preemergence Options</u>			
Casoron 4G	up to 100 lb/A	Bracken fern (S) Royal fern (S)	Appears on bogs showing signs of stress Spot-treat and use moderate rates.
<u>Postemergence Options</u>			
Iron sulfate	2 oz/sq ft	Feather fern (Smr) Sensitive 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.
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.

PRIORITY FOUR WEEDS (Continued)

HARDHACK *Spiraea tomentosa* (Steeplebush)

Hardhack is a solitary plant that does not spread except through seed. Wiping with Roundup or pulling this weed is very effective, but the roots of hardhack can be woody and larger plants may cause damage to the bog when pulled.

JAPANESE KNOTWEED *Polygonum cuspidatum* (Mexican bamboo, Fleeceflower)

This is an invasive species that has been seen on bog ditches and rarely on the bog itself. It is common (relatively) on new plantings. Japanese Knotweed has heart-shaped leaves that become quite square at the end close to the stem. It produces abundant white flowers in June-July. It is a perennial plant and can form dense patches (large rhizome system underground). It may die back at the end of the season and form a dense mat of dead material.

The best control is prevention!! Cutting, mowing and flame cultivation should also provide control of established plants, but it is absolutely best to eradicate before the plant establishes.

JOE-PYE WEED *Eupatorium dubium*

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. Stinger should also control this weed.

MEADOWSWEET *Spiraea latifolia*

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

MINOR WEEDS

Blue joint (*Calamagrostis canadensis*), Hawkweed (*Hieracium* spp.), Horsetail (*Equisetum* spp.), *Hypericum* spp., Marsh St. John's Wort (*Triadenum* spp.), Sweet pepperbush (*Clethra alnifolia*), Plantain (*Plantago* or *Littorella* spp.), Smartweed (*Polygonum* spp.), Sorrel (*Rumex* spp.), Wood-sorrel (*Oxalis* spp.; aka false shamrocks) and Wild Strawberry (*Fragaria* spp.)

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.

Casoron will control many of these minor weeds. Use 75 lb/A Casoron for horsetail control. Postemergence Roundup wipes may also control these minor weeds. Weedar 64 wipes are labeled to control *Hypericum* species and sweet pepper bush. A grower has reported success controlling horsetail with 60-75 lb/acre Evital in the fall followed by winter sanding.

PRIORITY FOUR WEEDS (Continued)

MOSSES *Polytrichum* spp. (*Haircap moss*), *Sphagnum* spp. (*Sphagnum moss*)

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.

Iron sulfate has historically been recommended for use at 3 oz/ft² for spot-treatment of sphagnum moss in March-April. Crop damage has sometimes been associated with use of this high rate. Recent testing has shown that use of ½ - ¼ of this rate (4.7-9.4 lb/100 ft²) still provided good moss control, even when applied in the summer, with no visible damage to the crop. Other regions report very good results with chemigating iron sulfate, but we have no local experience with this application.

A 20% acetic acid product by Weed Works, Inc., is sold as a horticultural biopesticide for use on food crops. Applications of 20% acetic acid have shown good control of moss; actively growing cranberry plants were damaged but recovered. Use of 5% acetic acid (store-bought vinegar) is mostly ineffective.

High rates (15 oz/100 ft²) of ammonium sulfate (21-0-0) applied in the spring may also offer some control of haircap moss. If used, fertilizer must be adjusted accordingly. Growers report using 100 lb/A Evital in the spring against Sphagnum moss with good results. Other products may be available. Contact the Weed Specialist for updates.

PITCHFORK, RAGWEED, AND FIREWEED (A)

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

Casoron may be applied in the spring or fall for control of ragweed. Weedar 64 wipes may be used for ragweed control postemergence. Stinger (wipes or spray) may be used for pitchfork, ragweed, and fireweed control.

WHITE VIOLET *Viola lanceolata*

Found most often in bare patches on beds, white violet is thought to compete poorly with established vines. Thus, the best management approach is to 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.

HERBICIDES

ALWAYS read the label of any chemical before use, and always comply with the manufacturer recommendations.

Preemergence – (PRE) These are herbicides that are applied prior to the emergence of weeds. In general they work by prevent weeds that are germinating from seeds from growing, but can also act on perennial plants that spread by rhizomes, tubers, and stolons. Their application is timed to coincide with when the target weeds are about to begin germinating. They prevent new weeds from establishing, but do not impact weeds that are already growing.

Multiple frost or rain events in the spring following the herbicide application might affect herbicide effectiveness. Preemergence herbicides move through the soil at different rates. We do not have good information on how these chemicals move in cranberry soils. Based on information from noncranberry soil types, Evital has high soil mobility. Devrinol is also likely to leach through the soil profile. In a loamy sand soil, it will move about 1 inch for every inch of rain or water. Casoron is relatively less likely to leach but we have no numbers for Casoron (like with Devrinol). Sandier soils are less likely to hold onto herbicides than soils with some organic matter. Whenever possible, it is best to delay applications of herbicides until a reasonable window of dry weather is predicted.

Postemergence – (POST) These herbicides work on actively growing weeds. They can be absorbed by the leaves or roots of the plants, depending on the chemical.

Adjuvants – These products are added to a pesticide mixture to improve its effectiveness. They include surfactants, stickers, penetrants, compatibility agents, etc. Pesticide labels may list specific types of adjuvants that will maximize effectiveness of the pesticide. Be sure to use the proper category of adjuvant if the manufacturer makes a specific recommendation.

Several herbicides require the use of adjuvants, commonly either nonionic surfactants or crop oil concentrates. Nonionic surfactants (NIS) spread the spray droplet evenly over the leaf surface and help it adhere to the leaf. It increases penetration of the herbicide through the leaf cuticle. Common commercial products include Induce or Activator 90. Crop oil concentrates (COC) may consist of petroleum, vegetable, or methylated vegetable or seed oils designed especially for use in agricultural pesticide spray programs. Many COCs are available and may be sold as Crop Oil or under other trade names such as Herbimax.

CASORON 4G (Dichlobenil) – Used PRE

Annual allowable formulation	Restricted entry interval (REI)	Preharvest interval (PHI)	Max number of applications
100 lb/Acre	12 hrs	N/A	N/A

Casoron is a preemergence herbicide that works on germinating seeds, very small seedlings, and also some perennial weeds that propagate by rhizomes, tubers, and stolons. It is effective against both grasses and broadleaf weeds. Applications of Casoron are most effective when applied as close to the time of weed germination or emergence as possible. Casoron is labeled to be applied in early spring (pre-budbreak) while perennial weeds are still dormant and annual weeds have not started to germinate, or in late fall after the crop has been harvested. The efficacy of fall applications for many weeds has not been documented, but growers have reported good success in some cases.

HERBICIDES (Continued)

Casoron may be applied by air or by ground equipment. Since Casoron volatilizes quickly, avoid applying during warm temperatures (air and soil temps should be <60°F). It must be incorporated by irrigation or rainfall ASAP after application. Do not exceed 100 lb/A in any 12-month period. Multiple applications may be made as needed. Allow an interval of 3-6 weeks between applications. Single doses of high rates of Casoron may be needed to control some perennial weeds. Traditionally growers have used 30-60 lb/A for dodder control. Some growers have experienced poor control with 30-40 lb rates. If this is your experience, consider increasing the rate and/or number of applications for improved control.

Cranberry vines with weakened root systems are more susceptible to stresses such as drought and may become more stressed with herbicide application. Application of Casoron to stressed vines may cause yellow vine syndrome symptoms or other injury. Vine injury is likely with mid to higher rates if the buds have begun growth. 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 vine injury may occur and yields may be reduced. Do not apply to young beds (less than 3 years old unless root systems are well established) or on bogs prior to or immediately after mowing vines. Do not sand (spring or fall) on top of a Casoron application. 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.

After Casoron is applied and is incorporated by initial irrigation or rainfall, it binds to soil particles. The efficacy of Casoron may be reduced if excessive irrigation or rainfall (+ 0.5 inches) follows application, as the chemical will be washed too deeply into the soil to affect germinating seeds. It is not known if frequent frost protection impacts the efficacy of Casoron.

Casoron is labeled for use on:

Sensitive fern	Rice cutgrass	Tideland clover
Bracken fern	Bunch grass	Ragweed
Royal fern	Muskrat grass	Sorrel
Haircap moss	Nutsedge (Nutgrass)	Wild strawberry
Common horsetail	Short wiregrass	Aster
Water horsetail	Wideleaf grass	Buckbean
Rush (Juncus spp.)	Stargrass	Hawkweed
Dodder	Woolgrass	Western Lilaeopsis
Bluejoint grass	Cotton grass	Marsh pea
Rattlesnake grass	Needle grass	Plantain
(Manna grass)	Oniongrass	Smartweed
Summer grass	Arrowleaved tearthumb	Pacific silverleaf
Velvetgrass	Beggarticks	Marsh St. Johnswort
Bent grasses	Knotweed	Crabgrass
Little hairgrass	Loosestrife	

IRON SULFATE – Used PRE

May be spread as a broadcast application through conventional fertilizer rigs, such as hand cranks. Traditional use has been with 2-3 oz/ft² of a 20% ferrous sulfate (fine powder) product, but other formulations are available. Application rates 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 irrigation is not necessary for incorporation.

HERBICIDES (Continued)

DEVIRINOL DF-XT and 2-XT (Napropamide) - Used PRE

	Annual allowable formulation	Restricted entry interval (REI)	Preharvest interval (PHI)	Max number of applications
Established beds				
Peat beds: DF-XT	18 lb/Acre	24 hrs	N/A	3
2-XT	18 qt/A			
Sand beds:DF-XT	12-18 lb/A	24 hrs	N/A	3
2-XT	12-18 qt/A			
New plantings	6 lb or qt/Acre	24 hrs	N/A	3

Use up existing stocks of Devrinol 50DF as it is being replaced by DF-XT and 2-XT. Devrinol is a preemergence herbicide and will not control existing weeds. Unlike Devrinol 10G (has been discontinued but is still legal to use, and must be applied by air or ground), the DF formulation can be injected through the irrigation system. Be sure to get the supplemental label at the point of purchase. It is typically applied in the spring before growth begins, but it may also be applied in the fall after harvest. Do not apply when beds are under winter flood. The efficacy of fall applications for many weeds has not been documented.

Rate differences for the soil types (higher rates with more OM) are primarily due to efficacy issues rather than toxicity or groundwater concerns. The label states that it should be applied with sufficient water to wet the soil to a depth of 2 to 4 inches. Use the appropriate rate for the age of the bog and soil type. Devrinol can be used under or on top of sand.

This herbicide provides some control of grassy weeds, nutsedge, and annual broadleaf plants, but works best on weed-free areas. Since Devrinol will control grasses, give careful consideration to use of 50DF if you are trying to establish grass on ditch banks and your irrigation system delivers coverage to the ditch bank area.

EVITAL 5G (norflurazon) - Used PRE

	Annual allowable formulation	Restricted entry interval (REI)	Preharvest interval (PHI)	Max number of applications
Established beds	160 lbs/Acre	12 hrs	N/A	1
New plantings	80 lbs/Acre	12 hrs	N/A	1

Apply Evital 5G as a single application in the early spring after removal of winter flood and before weed growth resumes OR in the fall after harvest at least 2 weeks before winter flood. Only one application per 12 month period can be made. Vine injury may occur in areas where water stands several days after flooding or heavy rains. 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 be careful especially on bogs that have drainage problems or sensitive varieties. Sanding after applications of 50 lb/A or less has given good weed control. Growers have reported that applications of Evital (50-60 lb or less) on top of sanded vines work adequately on healthy well-drained beds. Although higher rates may injure cranberry, the product label does recommend using higher rates for poverty grass control (120-160 lbs).

Be conservative when applying Evital to new plantings! Usually, new vines are very sensitive to Evital. However, growers have reported using 35 lb/A in the fall on Stevens that were planted in the same year with good success. In other instances, vines have shown severe phytotoxicity to rates as low as 25 lb/A when applied 3-4 weeks after planting.

HERBICIDES (Continued)

CALLISTO (Mesotrione) - Used PRE and POST

Annual allowable formulation	Restricted entry interval (REI)	Preharvest interval (PHI)	Max number of applications
16 fl oz/Acre	12 hrs	45	2

Callisto is a systemic preemergence and postemergence herbicide. It works mainly on broadleaf weeds, and does not work well against most grasses. When used preemergence, weeds take up the product through the soil during emergence. When used as a postemergence, susceptible weeds absorb the herbicide through the treated foliage and also through the soil.

Please note that you CANNOT exceed the maximum allowable amount of Callisto used, regardless of how you apply it. For example, if you chemigate 8oz/acre twice, you CANNOT also spot treat. You can chemigate once at 8 oz/acre and spot treat once at 8 oz/acre, etc.

Chemigating with Callisto

Callisto can be used through the chemigation system; this method is commonly used by growers. Adjuvants may be added for postemergence use. Use a “per acre” rate for the adjuvant (e.g., 1-2 pt/A), not a % or v:v rate. Under chemigation situations, the amount of adjuvant would be very large, very costly, and difficult to handle logistically (mixing issues) if applied at volumes other than on a “per acre” rate. NIS and COC should work equally well with Callisto; however, some COC may cause injury on cranberry, under certain conditions.

Spot-treatment with Callisto

Some growers also used Callisto to spot treat weeds using backpack sprayer applications. If you want to add a dye to the herbicide mix, the manufacturer recommends using Spray Tracer; we recommend AGAINST using Blazon Blue (this product is NOT labeled for food crops). Add a nonionic surfactant (NIS) at 0.25% v:v or 1.9 tsp per gallon or crop oil concentrate (COC) at 1% v:v or 2.5 Tbsp per gallon with all postemergence applications, regardless of Callisto rate.

Suggested amounts of Callisto per gallon of water for spot-treatments:

<u>Callisto</u>	<u>Solution description</u>	<u>Max solution per acre per application</u>
0.8 teaspoon	approximates 4 oz/acre rate	30 gal
1.9 teaspoons	approximates 8 oz/acre rate	30 gal
3 Tablespoons	very concentrated, for woody weeds like PI	5.3 gal

Plants affected by Callisto will turn white. Injury may take several days or weeks to show. Allow a minimum of 14 days between applications. Hardier weeds will likely need 2 applications per year over a period of successive years for control. Callisto should work well against crabgrass but is weak against foxtails. Callisto is rain-fast in less than 4 hours and has no known bee issues.

Use on New Plantings. Callisto is an excellent choice for use on newly planted vines. Growers have first applied Devrinol (within 3 weeks of planting) and then followed up with one or two Callisto applications; this combination seems to have worked well. No injury has been reported. Some growers have applied Callisto within days of planting with no injury (especially so for rooted cuttings). Lower rates are often a good choice as many of the early weeds are grasses or annual weeds.

Resistance Management Concerns. Resistance to Callisto has been reported in other crops after only 7 years of use. It is important that we do not lose this tool for dodder and general weed management. Occasionally rotate Callisto out of your herbicide sequence and substitute other herbicides. Use non-chemical forms of weed control whenever possible. Do not use Callisto repeatedly year after year. You CANNOT exceed two applications per year, even if you remain below the 16 oz/acre annual maximum.

HERBICIDES (Continued)

QUINSTAR 4L (quinclorac) - Used PRE and POST

<u>Annual allowable formulation</u>	<u>Restricted entry interval (REI)</u>	<u>Preharvest interval (PHI)</u>	<u>Max number of applications</u>
16.8 fl oz	12 hrs	60 days	2

There are export issues with this herbicide. Check with your handler before using, because handler restrictions may apply. Do not apply to crops that are stressed. Do not apply by air.

Dodder, loosestrife, and other broadleaf and grasses may be controlled by this herbicide. A maximum of 2 applications (8.4 oz/A each) are permitted per 12 month period, not to exceed 16.8 fl oz/A. Applications must be separated by at least 30 days. COC at a rate of 2 pt/A may be added to the spray mixture.

Quinclorac is taken up through roots and leaves. Adequate rainfall after application and good soil moisture is important for root uptake. Symptoms include twisting, stunting, reddening and chlorosis; symptoms on perennial plants may take more than 3 weeks to show. The full effect of the herbicide may not be evident for 3-6 months after application. Some growers report good dodder control the year after application, even if they did not see results the same year as applying.

STINGER (Clopyralid) – Used POST

<u>Annual allowable formulation</u>	<u>Restricted entry interval (REI)</u>	<u>Preharvest interval (PHI)</u>	<u>Max number of applications</u>
16 fl oz	12 hrs	50 days	2
<u>Type of application</u>	<u>Rate</u>		
Wipe	2% solution - 2.5 oz (5 Tbsp) per gallon		
Spray (wild bean)	0.06-0.12 fl oz (0.37-0.75 tsp) per gallon		
Spray (asters, ragweeds, etc.)	0.33-0.5 fl oz (2-3 tsp) per gallon		

Stinger **CANNOT** be applied by air or through the irrigation system! Do not apply within 5 hours of expected rainfall or irrigation.

Stinger is a postemergence herbicide used to control wild bean, narrow-leaved goldenrod (NLGR), asters, clover, ragweed, pitchfork (and other members of the Aster and Legume families), 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. Cranberry plants are most sensitive to Stinger applied prior to bloom. Do not apply Stinger from 1 week prior to bloom until 1 week after bloom. After bloom, Stinger can be applied up until 50 days prior to harvest. Higher rates of Stinger can be applied to cranberry plants post-bloom because the plants are less sensitive to Stinger than during the spring flush. Stinger can also be applied in autumn after harvest.

Stinger may be applied as a broadcast spray, as a wipe or as a spot treatment with a handheld sprayer. 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.

HERBICIDES (Continued)

POAST (Sethoxydim) - Used POST

Annual allowable formulation	Restricted entry interval (REI)	Preharvest interval (PHI)	Max number of applications
Broadcast: 5 pts/A	12 hrs	60	N/A
Spot treat: 1-1.5% solution	12 hrs	60	N/A

Poast **CANNOT** be applied through the irrigation system! It may be applied by broadcast applicator or air. Spot treatments with small sprayers are effective.

Poast is a postemergence herbicide that controls true grasses (most annual grasses and some perennial grasses). Sedges and rushes are not controlled. Poast is absorbed through foliage after application. The effects range from slowing or stopping growth (generally within 2 days), to foliage reddening and leaf tip burn. Subsequently, foliage burnback may occur. These symptoms will generally be observed within 3 weeks. 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.

Cranberry plant injury may occur if the herbicide is applied during the heat of the day or during bloom (due to added COC). 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.

Poast should always be used with a crop oil concentrate (COC) or Dash HC. Physical incompatibility, reduced weed control, or crop injury may result from mixing Poast with other pesticides (fungicides, herbicides, insecticides, or miticides), additives, or fertilizers.

For spot treatment use a 1-1.5% solution. To make one gallon of a 1.5% Poast solution, mix 2 fl oz of Poast with 0.6 fl oz of Dash HC (or 1.3 fl 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.

Use on New Plantings. Poast can be safely used on newly planted vines. Wait for roots to develop before application. Growers report mid-July applications approximately 6 weeks after planting worked well. Grass control was enhanced when Poast applications were followed by Callisto applications.

RODEO – Used POST

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.

HERBICIDES (Continued)

SELECT MAX, INTENSITY, ARROW, etc. (Clethodim) – Used POST

Clethodim herbicides **CANNOT** be applied through the irrigation system! They may be applied by broadcast applicator or air. Spot treatments with small sprayers are effective. Clethodim is similar to Poast (sethoxydim). It is also a postemergence herbicide that controls true grasses (most annual grasses and some perennial grasses). Sedges and rushes are not controlled.

There are several products registered for use in cranberry which contain the active ingredient clethodim. The labels are different for each product (rates and adjuvants). Please read the label carefully and follow the manufacturer recommendations. For example, you can use an NIS with SelectMax but not with Select 2EC.

Select Max 9-16 fl oz/A per application (not to exceed 64 fl oz/A per year). Add 0.25% v/v non-ionic surfactant (NIS). For each gallon, mix 1.3 Tbsp (0.65 fl oz; 19 ml) + 0.65 Tbsp (0.33 fl oz; 10 ml) NIS for a mid-range rate. Allow 14 days between applications. Do not apply between hook and full fruit set. 30-day PHI.

Intensity 6-8 fl oz/A per application (do not exceed 32 fl oz/A per year). Add 1% v/v crop oil concentrate. For each gallon, mix 0.25% to 0.50% (0.33 fl oz. to 0.65 fl oz/gal.) and include crop oil concentrate at 1% (1.3 fl oz/gal.). Treat to wet vegetation, while not allowing runoff of spray solution. Allow 14 days between applications. Do not apply between hook and full fruit set. 30-day PHI.

ROUNDUP and other Glyphosate products – Used POST

Many Roundup and glyphosate products are available on the market. **Please read the label of any product you use to ensure compliance.** Available glyphosate products vary as to whether they carry a 'Caution' label or 'Warning' label. Check the label for appropriate protective clothing. These products may also vary in the amount of active ingredient, the REI times, and length of dry time before they are rain-fast. Check the label. For example: Roundup Weathermax has 48.8% active ingredient (a.i.) while Roundup Ultra has 41% a.i.

Most Roundup products do not need an additional surfactant. It may be necessary to add a nonionic surfactant to other glyphosate products (again, check the label of the specific product you are using). Ammonium sulfate may improve uptake of these Roundup products when moderate to large amounts of carbonates ('hard water') are present in water, but this rarely a problem in MA. Follow instructions on the label.

Make herbicide mixtures fresh each day for maximum effectiveness. Do not store in galvanized containers. Always use a dye to track your coverage with any wipe product. Depending on the label, glyphosate products can be applied by wiper, by clipper, as a spot treatment spray in dry ditches, and as a spot treatment post-harvest spray.

Glyphosate is absorbed into plants through the leaves. Cranberry vines are very sensitive to glyphosate and can be killed by exposure. Avoid cranberry plants and do not allow material to drip onto vines during application. Glyphosate can be applied any time weeds are present, and repeat applications are permitted. There is a 30-day preharvest interval.

During the growing season glyphosate can be applied (on bog) by wiper. Some products (but not all) are also labeled for clipper use (stump-cut). Some products are also labeled for spray use in DRY ditches, and ditches must remain dry for 2 days after application.

HERBICIDES (Continued)

ROUNDUP (Continued)

<u>Type of application</u>	<u>Rate</u>
Wiper	10-20% (1 part glyphosate product to 4-9 parts water)
Dry ditch spray	1-1.5 % (2.5-3.8 Tbsp or 38-57 ml per gallon water)
Clipper	50-100% (use full strength or dilute by half)
Post-harvest spray	0.4 – 0.7% (3-5.5 tsp or 15-27 ml per gallon water)
IF additives are needed	
Surfactant	1 oz (2 tablespoons or 30 ml) per gallon of mixed solution
Ammonium sulfate	3 oz (6 tablespoons or 90 ml) per gallon of mixed solution

Wipes - Use an applicator that permits excellent coverage with minimal dripping. Adequate coverage of weeds must be obtained for glyphosate to be absorbed. Several leaves (at least 50%) on each stalk must be treated with the herbicide. 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. Some growers have had success staking the vines (tomato stakes or similar) for wiping and allowing them to dry prior to laying them back on the vines. This certainly reduces vine injury.

Clipper Applicators (Roundup only) - Roundup products are the only products currently labeled for use in clipper application (Section 2ee-'Cut Stump'). Availability of commercial clippers has become limited over the past few years. Growers may need to manufacture their own clippers.

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.

Spray application to DRY ditches - Some products are also labeled for spray use in DRY ditches. The ditch should be dry for 1 day before application, and ditches must remain dry for 2 days after application.

Post-harvest sprays - Certain products allow for post-harvest sprays. Supplemental labels may be needed with certain generic glyphosate products when doing post-harvest sprays (0.5%-1%), applied as a spot-treatment, or sprays in dry ditches (1%-2%). These uses are included in the regular labeling for Roundup WeatherMAX and PowerMAX. CHECK THE LABEL of the product you are using for specific uses. Recent research indicates that Howes may be slightly more sensitive to postharvest spray injury than Early Black.

HERBICIDES (Continued)

WEEDAR 64 (2,4-D) – Used POST

Weedar 64 is a State-restricted use product!! These products have considerable potential to evaporate and cause crop injury. 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.

Avoid applying 2,4-D on hot, sunny, and humid days when there is little air movement. Weedar 64 is the only 2,4-D product that can be used on the bog. Weedar 64 has a 30-day PHI and may only be applied once per season. For wipers, 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.

SALT – Used POST

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. It may be sprinkled at the base of weeds (for rushes use 1-3 teaspoons per clump) or sprayed in a solution. For wild bean, 1 lb/gal water used after fruit set can help to control this weed. Do not exceed 200 gallons per acre. One grower recently reported that they obtained some control of dodder using a salt water spray. 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.

FLAME CULTIVATION (FC) or THERMAL WEEDING – Used POST

We have evidence that the use of hand-held propane torches can provide control of some weeds (e.g., dewberry, rushes, and dodder). Applications (in test studies) have been made in the summer months. FC is a good option on organic farms or as an alternative to continual POST herbicide use. Several torches, called open flame (OF) or infrared (IR) are available. Cranberry vines can be injured during a FC application but the vines will recover. Short exposures (~8 sec) provide control when using OF; longer exposures are needed (~30 sec) with IR.

VINEGAR – Used POST

Vinegar (acetic acid). We have data that show efficacy with 20% acetic acid for moss control, but this injured cranberry vines. Data is limited for control of other weeds. In our experience, applications of vinegar (especially store-bought, 5%) are mostly ineffective and may cause injury. Washington studies showed control of false lily-of-the-valley with soil drench applications (7500 gpa).

Soil pH management to improve weed control

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 the need for frost protection 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 9 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. Reducing soil pH below 4.0 may weaken the cranberry vines. Do not use potassium sulfate since sulfate will not lower soil pH. 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.

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 (e.g., 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 (e.g., duckweed). Preemergence herbicides registered for use on the bog may **NOT** be used in the ditches for weed control. Roundup use is permitted in dry ditches as a wipe or a spray. See notes on Roundup. Evidence also suggests that flame cultivation may be an effective nonchemical tool for ditch weed management.

AQUATIC WEEDS on bog (*Hydrilla, Elodea, Water lettuce, etc.*)

Make sure any aquatic weed control that is performed within the bog system (irrigation laterals, ditches) is done with a product labeled for CROP use. Nautique (by SePro) has crop uses on its label. It is labeled to control floating, emersed, and submersed vegetation in still or flowing aquatic sites such as reservoirs, ponds, slow-flowing water bodies, crop and non-crop irrigation systems. Application rate varies by vegetation density and depth of treated area. Please read the label. If you have any questions, please consult with a Weed Extension specialist prior to treating.

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). Barley straw can also be used to help control algae. When water temperatures are cool (<50°F), it may take 6-8 weeks for the straw to decompose; 1-2 weeks if water temperature is >68°F. The bales should be contained in nets and maintained at the surface (floats can be inserted) to be most effective. Manufacturers recommend 4 bags (5-7 lb each) per 0.25 acre.

The products listed below are legal for use in cranberry farms. Many other available algaecide products are not for use in food crop systems; check with the Weed Specialist if you have questions about other products.

CHEMICAL RECOMMENDATIONS FOR ALGAE

Copper sulfate	4 lb/A-ft	Apply evenly 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, page 56.
Citrine-Plus	0.6-1.2 gal/A-ft	

NOTES ON CONSERVATION SEED MIXES FOR DIKES AND DITCHES

Several criteria were used to compose the seed mix recommended by Plymouth County Conservation District. The seed mix needed to contain perennial species, must contain at least one nitrogen-fixer, must be drought-resistant, must not introduce known weed seeds, contain at least 3 species and be economical to purchase. The current seed mix is creeping red fescue (39.7%) with a germination rate of 85%, perennial ryegrass (34.2%) with a germination rate of 90%, empire birdsfoot trefoil (24.5%) with a germination of 70%, and 5% hard seed and some inerts.

Mixes may also contain timothy grass, riverbank rye, switchgrass, Virginia wildrye, orchardgrass, deer tongue, perennial wildrye, and clover. For more information on planting rates and cost, please contact the West Wareham office at 508-295-5495 Ext 4.

Other seed mixes may be used for dike stabilization but if you want to take advantage of cost-sharing, be sure to confer with NRCS prior to using a non-standard, non-recommended seed mix. Creeping red fescue and hard fescue may offer good stabilization coupled with low maintenance. You may want to consider the addition of an annual ryegrass (small proportion of total) for quick colonization along with the fescues. If you wish the fescues to predominate, be sure to mow the ryegrass prior to seed production (late summer-early fall).

Use herbicide with caution when re-seeding dikes, as some herbicides will control grasses and legumes present in seed mixes. A UMass Cranberry Station greenhouse study showed that red clover was susceptible to injury from Callisto applications. Hard and creeping red fescue and switchgrass showed symptoms briefly but recovered within a few weeks.

AQUATIC USES

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. Do not use any other algaecide products; consult with the Weed Specialist if you have any questions.

Nautique is a copper carbonate (double-chelated copper formulation) product that can be used to control certain aquatic plants in irrigation systems (ditches, canals) in crop systems. It is highly corrosive and carries a **DANGER** label. It may be fatal if absorbed through the skin. Be very careful with this product!! Wear all recommended protective equipment. Fish toxicity is dependent on the hardness of the water; in soft water, trout or other fish may be injured or killed. Do not use if carbonate hardness of the water is less than 50 ppm (this is generally the case in MA). If applying to public waters, check with the local authorities for permit process. Nautique can be mixed with other aquatic herbicides; check the label. When applying to irrigation ponds, hold water for a minimum of 3 hours before irrigating plants.

NON-CROP USE !! OUTSIDE OF BOG AREA – WEED MANAGEMENT

AQUATIC WEEDS. Reports of grower problems with aquatic weeds have been increasing. Aquatic weeds can be submersed, floating plants, floating leaf plants or emergent plants. Common aquatic species for our area may include fanwort, variable watermilfoil, bladderwort, hydrilla (a new one to look out for), duckweed, and water lilies. Be sure to get a correct identification of the weed problem before treating. Treatment of some water areas may require a permit. Non-chemical methods (e.g., harvesting, suction, hand pulling, dredging) are available but are very expensive. The use of grass carp for aquatic weed control is NOT permitted per MA Fish and Wildlife. Call 508-389-6300 for more information.

CHEMICAL RECOMMENDATIONS FOR AQUATIC WEEDS

Diquat	1-2 gal per surface acre	Use during Summer months. Water use is restricted
Reward	(37% ai diquat bromide)	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 (e.g., farm ponds, reservoirs). Water temperature should be >50°F for best activity. Do not use in or on bog ditches.
Rodeo	(54% ai) 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 fl oz/3 gallons. <u>Add a nonionic surfactant</u> at the rate of 0.25-0.50% volume basis (1-2 fl oz or 2-4 Tbsp in 3 gal.). More effective against cattails and water lilies. Not effective against submersed weeds.

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. Both of these herbicides are restricted use compounds. Be sure you have the proper license or use licensed personnel to do the application.

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	up to 2 gal/A	Mix with enough water to deliver 10-30 gal/A. Application rates vary depending on target species and application method. Drift to desirable plants may cause injury (esp. grapes and tomatoes). Do not apply to water. Read the label! See Notes on 2,4-D.

58 Weeds

CROSSBOW, WEEDONE CB (2,4-D). **State Restricted use!!** Crossbow and Weedone 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. They have the potential to drift very far from the site of application, and can injure nearby plants such as apple trees, grapes, etc. Avoid applying 2,4-D on hot, sunny, and humid days when there is little air movement. 2,4-D products can be highly effective at controlling some weeds.

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.

RENOVATION AND NON-PRODUCING BOGS

FUMIGANTS. Basamid (dazomet) and Vapam (metam-sodium) are soil fumigants that can be used on cranberry beds. **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. More information on the use of fumigants may be found in the Planting New Cranberry Beds Fact Sheet (available on the Station website, Fact Sheet page).

REGLONE (Diquat dibromide). Non-selective herbicide. Reglone should only be used on bogs that will be renovated or will not be harvested for 1 year. The intended use is as a site-preparation product, not for use for spot weed control on an active farm. This product works as a plant desiccant and should be used as a directed spray. Reglone cannot be applied by chemigation. Use 1.5-2 pt/15 gallons water by ground. May need repeat applications. Add NIS.

FUSILADE (FLUAZIFOP). This selective grass herbicide can only be used on non-producing bogs. It is used postemergence for control of true grasses. Sprayed grass will turn yellow and die back over a 1-4 week period depending on climatic conditions. It is rainfast after 1 hour. Add a COC at 0.5-1% v:v or 0.25-0.5% v:v if using a NIS. Use 0.75 fl oz herbicide per gallon water. REI is 12 hr.

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 may reduce 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.
<http://www.umass.edu/cranberry/pubs/bmps.html>.

NUTRITION MANAGEMENT FOR PRODUCING BOGS 2015

Prepared by Carolyn J. DeMoranville

Nutrient management decisions should be based on the needs of the plant. The plant is primarily made up of carbon compounds (the products of photosynthesis) and water. Mineral elements, the materials provided in fertilizer and the soil, are present in much smaller quantity, making up only about 10% of the plants dry mass. The essential mineral elements are required for the plant to complete its growth and development and for the production of fruit. All three (carbohydrates, water and mineral nutrients) are needed. For maximum crop production, cranberry bed management must optimize photosynthesis by assuring adequate leaf area, provide adequate but not excess water, and provide the required mineral elements in the right amounts, in the right form and at the right time. Management must be flexible, adjusted for changing weather and observations of the plants. It should also be implemented in an environmentally sound way.

Cranberry is a perennial plant. As such, many of the mineral elements and carbon compounds are stored in the winter in stems and roots, then remobilized to support new growth in the spring. In addition, decaying biomass (fallen leaves, decaying roots) in the soil, through the process of mineralization, can provide minerals, especially Nitrogen (N) and Phosphorus (P) back to the growing plants. In a mature cranberry bed, these processes account for about half of the plant's need for mineral nutrition. The rest is supplied in fertilizers. The plants in new sand-based cranberry plantings depend primarily on fertilizers for their nutrients.

Cranberry is a plant that evolved in acidic, sandy, nutrient-poor soils. Therefore, its requirements for nutrients are less than those for many other crops. Those requirements must be met to assure optimum growth and to achieve the yield potential possible for each cultivar. It should be remembered, however, that insufficient nutrition is only one potential cause of reduced yield. The plant must be healthy, with an adequate root system in order for it to take up the nutrients it needs. Overly saturated or dry soil or soil outside the pH range optimal for cranberries (4.0 to 5.5) can limit yield. Uniform irrigation is essential to maintain moist, but not saturated soil. Pest pressure, frost, or shading are other potential limiting factors. Additional fertilizer applications will not compensate for any of these problems.

The recommendations in the Chart Book are developed from a knowledge of how much mineral content is in a healthy productive plant. The recommendations focus largely on N, Potassium (K) and P. Added nutrients are required to replace those removed in the harvested crop and associated leaf trash. N is the element that is removed in the greatest quantity and that is found in the highest concentration of all of the nutrient elements when plant tissue is analyzed. Decades of research trials support the need for added N in cranberry production. Potassium is the mineral nutrient found in the highest concentration in cranberry fruit and as a result, K removal in crop harvest is similar to that of N. P removal in crop harvest is much less than that of N and K but research trials support the need for a modest annual addition of P to producing cranberry beds. The remaining mineral elements are seldom deficient in plant tissue tests and/or are found in substantial quantity in the bog soil. Therefore, their application is primarily recommended when a deficiency exists and not on a routine basis.

NITROGEN

Nitrogen rates.

For sustained yield, cranberries require annual additions of N fertilizer. The N fertilizer is not primarily used to produce fruit in the current year; rather it supports the building of the new growth that is the photosynthesis factory to support future production. In our research, current season N applications correlated to current season yield only 10-15% of the time, while in almost all cases applied N correlated significantly with production in the following two years.

60 Nutrition

With the implementation of newer cultivars, the base rate recommendations for N have been revised and split out by cultivar groups. These rates are based on analysis of the concentration of N in fruit tissue and in the biomass removed in harvest operations multiplied by the amount of biomass of fruit and leaves produced and then removed in harvest and detaching operations. To replace the removed N, we need to apply fertilizer. The amount of N removed is then multiplied by a correction factor of 1.4 to account for the less than 100% efficiency of fertilizer uptake. The base rates calculated are then adjusted up or down based on seasonal conditions, observed plant growth, previous summer tissue tests, and historic bog responses.

The N *concentration* in fruit and new growth is similar among the cultivars but the amount of biomass (crop load) and leaf area produced and then lost in harvest operations differs among the groups. The tissue biomass calculations for Early Black are well researched and established. Each 100 bbl of fruit has 5.1 lb of N. Since N concentration in all cultivars is similar, as crop increases, for all of them, we can just scale up from the 5.1 lb/100 bbl to the numbers of bbl/A produced or expected. Early Black detaching during harvest removes 13.4 lb N per acre in plant biomass above what is removed in the fruit. That amount is likely similar in Howes. But as we look at larger fruited cultivars, we observe that the plants and particularly the leaves are larger than those of the natives. For Ben Lear and first generation hybrids such as Stevens and Grygleski, we multiply the 13.4 lb N for plant biomass in Early Black by 1.5; for the newer Rutgers and University of Wisconsin hybrids, we multiply by 2. The base range reflects varying crop loads: up to 600 bbl/A for the newest hybrids and up to 300 bbl/A for the others. This does not mean that higher yields necessarily would require more N. In fact, for all but the newest cultivars, adding more N than required can result in yield *decline*.

Recommended base Nitrogen rates.

Cultivar group	Base N rate lb/A	Other considerations
Natives: Early Black and Howes	25-40	Reduce to 25-30 for crops less than 200 bbl/A
Older hybrids and large fruit: Ben Lear, Stevens, Grygleski, Pilgrim	35-50	Reduce to 35-40 for crops less than 200 bbl/A
Rutgers and University of Wisconsin cultivars: Crimson Queen, Demoranville, Mullica Queen, HyRed	50-80	Reduce to 50-60 for crops less than 300 bbl/A

With N fertilization, the aim is to provide enough N to produce stand of uprights with optimal density and length that will support an optimal crop of good quality fruit. When the upright stand is too dense or too long, shading occurs, pollinators may be impeded, and conditions are perfect for fungal rot infections. A thin, stunted stand will not support a large crop since there will not be adequate leaf area, leading to a deficit in photosynthesis and a shortage of carbohydrates for making fruit.

Within the recommended rate ranges, previous observed outcomes, tissue test results (see page 69), and observations of the plants color and growth should be used to choose your rate. Some potential yearly adjustments to the recommendation based on growth and tissue test N:

- If vines are stunted or yellowed and tissue N is low - use more
- If vines are stunted or yellowed and tissue N is high - look for other limiting factors
- If vine growth is adequate (see below) and tissue test is in the normal range - continue with the chosen rate
- If vines are rank or leggy and tissue N is low - use less or change timing, vegetative growth is being favored over production
- If vines are rank or leggy and tissue N is high or adequate - use less
- If yield potential is limited by pest damage or frost - use less.

Vine appearance.

Decisions regarding nitrogen (N) rate for a cranberry bog should be based in part on the length and density of uprights. The table shows adequate stand density and upright length for four common cultivars assessed at hook stage (mid-June). Uprights generally should not be longer than 4 inches. An adequate stand of both flowering and vegetative uprights is important, as about 80% of this year’s vegetative uprights 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 berry, will give a crop of 200-300 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.

Cultivar	Early Black	Howes	Ben Lear	Stevens
Upright density	600	400	400	400
Minimum Upright total length (in)	>2.25	>2.25	>2.5	>2.5

Density of total uprights per sq ft, >40% should be flowering

Upright length above the fruit on a flowering upright should be 1.5 to 2 in.

Observations at hook stage (mid June)

Leaf greenness is related to the pigment chlorophyll that 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.

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

Nitrogen timing.

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. As soil temperatures increase 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

62 Nutrition

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 N applications by the growth stage of the plants. Cranberries primarily use N during three stages, early season leaf production, fruit set, and bud set. When N is applied pre-bloom, it is rapidly taken into the plant and moved to the new leafy growth. While such applications can assure adequate upright length, adding too much N at this stage can lead to excessive growth. Fruit production is a very high demand period that extends from earliest set to about 3 weeks after the final fruit are set. Bud set is occurring during fruit set, so set applications also support this function.

Since the fruit set window is such a high N demand period, it is not unusual to see some loss of green color in the leaves above the fruit as the fruit are drawing N from both those leaves and the soil. Minor yellowing is normal, severe overall yellowing can indicate inadequate N fertilization. This should not be confused with Yellow Vine (see page 66), a patterned yellowing related to root stress and not improved by the addition of N.

Stage/formulation	% of total N for the season
<i>Slow release</i>	
Pre-roughneck (mid-May)	50-100%*
<i>Fast-acting, soluble sources</i>	
All but the newest cultivars	
Roughneck to hook	up to 20%
75% in bloom (early set)	50-60%
75% out of bloom (late set)	30-40%
<i>Fast-acting, soluble sources</i>	
Rutgers and U-WI cultivars	
Roughneck to hook	up to 20%
First fruit set	30-35%
7 days later	30-35%
7 days later	20-30%

*if less than 100%, apply remainder at set using fast-acting sources

Nitrogen sources.

Most cranberry growers in MA apply N in NPK fertilizer (aka 'complete fertilizers') primarily to reduce application costs when N, P, and K are all needed. In such fertilizers, the first number on the bag is the percent N in the material. Since P requirements are substantially less than those for N and K, materials with high middle numbers (phosphate) should be avoided. This is especially true of materials with the middle number higher than the first.

The best available evidence indicates that cranberries often respond poorly to nitrate N especially in the absence of ammonium N; the AMMONIUM FORM is recommended, monoammonium phosphate is an excellent source but can provide excess P (see the Phosphorus section below),

ammonium sulfate is also an excellent source. Light rates 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 or ammoniated materials. Non-uniform blends may sort during application, giving poor results.

FISH HYDROLYSATE FERTILIZER is available commercially, is useful for organic production, 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 rates. 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 rates provided as fish fertilizer should give the same result as a higher nitrogen rate provided in granular, inorganic fertilizer. This has been demonstrated on commercial bogs. Fish is especially useful in the spring.

PHOSPHORUS

PHOSPHORUS (P) RATES OF 10 LB/A (20 LB/A P₂O₅) OR LESS ARE STRONGLY RECOMMENDED UNLESS A DEFICIENCY IS DOCUMENTED.

Phosphorus is important for plant metabolism; it plays a key role in energy transfers, in transporting the sugars produced in photosynthesis, and is part of the DNA molecule. If P is deficient, growth and yield can be impacted. However, P does build up in the upper soil layers and some of that is available to the plants. This stratification often confounds P soil test results, making them difficult to interpret. Therefore, application recommendations are based on crop use and tissue testing. In addition, of the three main nutrients, P is required in the smallest amount (compared to N and K) with crop and harvest trash removal only accounting for about 5 lb/A in a 250 bbl/A crop (about 0.8 lb/100 bbl of fruit).

Phosphorus rates.

IMPORTANT CONSIDERATIONS REGARDING P USE AND USE REDUCTION:

Research in Massachusetts and Wisconsin has shown that cranberries require additions of phosphorus fertilizer for sustained productivity. However, there is no evidence in *any* research plot work or commercial bed observations that more than 20 lb/A actual P is required for productive cranberries. In some studies on high P sand soils, there was no response to P fertilizer on beds with adequate tissue P. In other studies, on native cultivars, the greatest yields were on plots receiving 10-15 lb/A P, with no improvement at higher rates. In our most recent MA plot work, rates well below 10 lb/A gave the best yields if tissue P was in the sufficient range, while in deficient beds, 20 lb/A gave the best yield.

At several commercial sites, growers applying an average of 10 or less lb/A/yr P over a period of years have seen either no change or an *improvement* in their crops. Very little P is removed from the bog in the harvested crop; a yield of 250 bbl/A contains approximately 2 lb P and 500 lb of vine prunings contains about 1/2 lb P. Based on these data and observations, the P rate recommendations in this Chart Book were developed. The only exception to these recommendations are new beds with fresh sand planting medium (the recommendation for those is to use up to 20 lb/A at planting and no more than *a total* of 30 lb/A for the first season on new or renovated beds).

P can be an environmental pollutant. Adverse environmental impacts are reduced by using moderate P rates (no more than 20 lb/A per season) and by careful attention to harvest flood management. When bogs are flooded, especially when soil and water are warm, P from the soil can move into the flood water. The mechanism for this movement is under investigation. Three

64 Nutrition

possible explanations have been suggested: 1) dissolved P in the soil water moves into the flood, 2) P previously bound to iron in the soil is released as oxygen is depleted during the flood, and 3) loosely bound P forms in the soil are released. It is likely that the explanation will be a combination of all three. When the flood is released, the dissolved P then leaves the bog system.

To minimize P release in harvest floods: 1) Hold harvest floods for 2-4 days to allow settling of P-containing particles, then release gradually (to avoid flushing particles) so that discharge is completed within 10 days. Research has shown that holding floods beyond 10-12 days in the fall can result in oxygen depletion and release of P from iron in the soil. 2) Use no more than 20 lb/A P in fertilizer -- laboratory research showed that with higher P use, P movement into the flood begins immediately upon flooding and then accelerates as oxygen depletes. With low to moderate P use, P release into water is minimized.

Recommended Phosphorus rates.

Production system	Recommended P rate lb/A	as P ₂ O ₅ lb/A	Notes
New plantings	up to 30	up to 68	Initial year only
Established beds, tissue test >0.16%	no more than 10	no more than 23	
Established beds tissue test, 0.11-0.15% and stable	no more than 15	no more than 34	Trying a lower rate (e.g. 10) is encouraged
Established beds, tissue test <0.12% and trending down	up to 20	up to 45	15 lb/A P with testing should suffice
Established beds, tissue test <0.10%	20	45	

Based on production research, 10-15 lb/A P is sufficient to maintain productivity if tissue test P is in the sufficient range (0.1-0.2%). In fact, in plots and demonstration sites, production and fruit quality were maintained with an average of 10 lb/A and no significant relationship between P rate and yield was observed. As P fertilizer use was reduced, P output from the bog (in flood water) also decreased. Based on these studies, growers have reduced P applications well **below** the previously recommended maximum of 20 lb/A (5-year rolling average of ~10 lb/A) with no reduction in crop. When implementing a reduced P rate, it is important to collect August tissue tests and follow these recommendations: If P is <0.10% - increase the P rate and retest next season; if P is 0.10-0.11% - maintain the P rate and retest next season; if P is 0.12-0.15% - maintain the reduced P rate and retest in 2-3 years; if P is 0.16% or more - further P reduction should be considered.

Phosphorus timing and sources.

Phosphorus ties up in the soil quickly, binding to iron and aluminum. Therefore, P should only be applied when the plants are actively growing. Most growers apply P with N in NPK fertilizers: see N timing section.

When choosing fertilizers, remember that research indicates there is **no horticultural benefit** to high P rates (in excess of 20 lb/A actual P per season) and that high P applications can be associated with degradation in water quality. If tissue P is in the sufficient range, we do not recommend fertilizers with high P (middle bag number). In fact, excellent results have been seen in recent years with 1:1 or near 2:1 N:P ratios (for example, 18-8-18). **It is highly recommended that growers use reduced P ratio fertilizer on their bogs, especially if high N applications are planned.**

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. The second number on the bag of NPK fertilizer is *phosphate* - P₂O₅.

To determine pounds of P in 100 pounds of fertilizer, multiply 0.44 by the second number on the fertilizer label.

Use no more than 20 lb/A actual P (~45 lb/A P₂O₅) per season except on new beds. See calculations on the last page of the Nutrition section.

POTASSIUM

The amount of K in cranberry leaves is second only to nitrogen among the mineral nutrients and K is the element in the greatest abundance in the fruit. Potassium is important in the movement of sugars in the plant, in maintaining plant hydration, and in many enzyme reactions in the plant. Cranberry sand soils are naturally low in K, leading an annual requirement for K additions.

Potassium rates.

K is often added with N in NPK fertilizers and is the third number on the bag. Fertilizer convention is such that the third number is actually percent potassium oxide (K₂O) so to calculate the actual K, that number is multiplied by 0.83. When tissue and soil tests are in the sufficient range, the K requirement is roughly similar to that for N, so choosing an NPK with similar first and third numbers works well.

Recommended Potassium rates.

	Recommended K rate lb/A	Other considerations
Soil and tissue tests normal	up to 100	look for NPK with similar first and third numbers
Soil and tissue tests low	60-100	Consider a supplement like SulPoMag or KMag at 100-150 lb/A
Tissue test high	0-60	Use no supplements

66 Nutrition

Potassium timing and sources.

Supplemental K may be applied as soon as the soil warms in the spring, generally in early May. Otherwise, K is generally added with nitrogen and phosphorus (NPK).

Supplemental K is often added 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 when used at high rates over years. However, modest rates appear to have no adverse impact.

OTHER ELEMENTS

Calcium and Magnesium.

The other major elements, Calcium (Ca) and Magnesium (Mg) are seldom lacking in cranberries. However, Mg is often added with K in SulPoMag or KMag. On bogs with Yellow Vine (see below) Magnesium Sulfate (Epsom salts) may alleviate symptoms. Diagnosed deficiencies (using tissue tests) of Mg or Ca may be treated with 30 lb/A of that element in granular form applied in the spring or with liquid supplements pre-bloom.

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 large soil applications of Ca. Lime can have adverse effects by changing soil pH and is not recommended for use in cranberry production. Products that supply Ca may improve fruit quality or firmness. Examples of Ca supplements suitable for cranberry include those that are gypsum based (gypsum and some formulations of Solu-Cal) and liquid supplements such as Full Measure CAL 30TM (this material increased Ca concentration in cranberry fruit in research trials).

Yellow vine (YV) manifests as an apparent nutrient deficiency. Beginning with older leaves, yellowing presents along leaf margins and between the veins on the leaf, leaving green only along the veins. Tissue tests of such leaves often show higher than standard potassium and low-normal magnesium. However, extensive investigation has shown that the nutrient imbalance is *secondary* to the primary problem – root insufficiency due to too much or too little moisture. Cranberry bogs with patches of YV were found to have soil water content (in the YV areas) that was either much higher or much lower than that in the surrounding green areas. Additionally, in greenhouse experiments, plants subjected to very shallow or very deep water table conditions developed YV. The consistent finding in the field has been that the rooting depth in YV areas is shallower than that in unaffected areas. In most cases, YV appears in areas that were too wet early in the season leading to poor rooting depth. Rooting depth can be improved by keeping the bed well drained early in the season. When the water table is closer than about 6 inches below the surface, root development and root function is impaired. Examine your drainage and irrigation practices if you see YV on your bog. Another symptom of poor drainage is high manganese (Mn) in the tissue test. YV usually appears as temperature and water stress increase during mid-summer and may be more severe if Casoron has been used since this herbicide can affect rooting and root function.

Minor elements.

- Minor element deficiencies are rare in cranberries due to low requirements and high availability on acid soils. 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 (Mancozeb group) 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, but below 75 ppm, 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.

SOIL pH

The optimal pH for cranberry soil is between 4.0 and 5.5. Use of sulfate containing fertilizers (SulPoMag, ammonium sulfate) does not affect soil pH. However, acid is released into the soil as the plants take up ammonium N. Otherwise, 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. Prior to making S applications, seek advice from Extension specialists or consultants. Apply no more than 500 lb/A/season in one or two applications. **Apply elemental S only to well drained soils and test soil pH prior to application.**

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

SOIL AND TISSUE TESTS

Soil and tissue tests are tools that 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 may vary depending on length of upright (N concentration in the tissue does not always 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 that correlate well with cranberry yields due to very acid soils in cranberry production – standard P tests are of no predictive 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 (but see also P use and P reduction section above). 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” fact sheet (available at http://scholarworks.umass.edu/cranberry_factsheets/6/).

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 (e.g., the diagnosis of a disease). Soil can be collected into 1 qt zipper plastic bags (air dry the soil before sealing the bag); tissue should be collected into paper bags. Some analytical labs supply collection bags. Remember, a properly collected and handled sample of soil or tissue is essential to an accurate analysis. Collect one composite sample for each management area as instructed below. A management area may vary in size but will be all one variety that is treated uniformly, often under one sprinkler system.

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 upright tips. 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 make about 1 cup (at least 50 upright tips). You may collect directly into marked bags 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 Station for interpretation of other elements.

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, and one from nearby 'normal' vines.

Samples collected after mid-September give lower analysis values than those collected earlier. This is especially true for nitrogen (it is transported out of upright tips and stored in older tissue as dormancy approaches). Also, 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.

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,
Sulfur (S)	0.08-0.25		if greater than 500-600 check bog drainage

* = As high as 1.3 % has been seen for Stevens, but monitor growth closely if N is > 1.1 %.

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 a 1 qt plastic bag about ¾ full. At home, open the bags and dry the soil at room temperature for a day or two. Clearly mark each sample bag. OM determination (usually an additional charge) is often useful. Methods of analysis vary by lab - pick a lab and stick with it. The Bray test for soil P is the most commonly used in the eastern United States. However, this test, like all common P soil tests, 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 if no sanding is planned. Otherwise, sample soil in the spring.

70 Nutrition

UMass provides soil and tissue analysis services at the Amherst lab for a fee. Submission forms and soil boxes for this lab are available at the Cranberry Station. Also see the UMass web site for downloadable forms and schedule of fees (<http://soiltest.umass.edu>). Follow the links at the top of the page.

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

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.

If soil iron is above 200 ppm, soil P tests will not accurately reflect P availability.

IMPORTANT CONSIDERATIONS FOR CRANBERRY NUTRITION

- REVIEW the Nutrient Management BMP in the Best Management Practices Guide for Massachusetts Cranberry Production available from the Cranberry Station and on our website. Excellent information and decision trees for planning N and P management are available as well: (<http://www.umass.edu/cranberry/pubs/factsheets.html>) select Nitrogen or Phosphorus for Bearing Cranberries articles. The recently published Nutrient Management Guide for Oregon (em8672) is also a good resource. It can be downloaded here:
<https://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/54896/em8672.pdf>
- GOOD DRAINAGE AND ADEQUATE IRRIGATION are essential for best response to fertilizer. Monitor and maintain adequate soil moisture. Small, frequent irrigations may not be adequate to provide moisture to the root zone. For further information, refer to the Irrigation section and BMP.
- KEEP GOOD RECORDS. Comparison of rate/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. Rate can be refined as plants respond during the growing season.
- Cranberry bog soil has little capacity to HOLD cations (e.g., 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 water management issues, disease, and pest problems first. Then look at nutrition. Collect tissue for testing if necessary.

CAUTIONS:

- PRESERVE SURFACE WATER QUALITY - avoid applying fertilizer to water in ditches and canals. As possible, lower water levels in ditches prior to fertilizer application and impound water during and after fertilizer applications.
- AVOID HIGH RATES 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 rates are associated with poor fruit quality** and may delay color development in the fruit. High nitrogen rates 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 not recommended, 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. If you choose to use fall fertilizer, use low N and low or no P formulations.

72 Nutrition

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 55°F before application of fertilizer to ensure response. If long-lasting, slow-release, or organic forms were used, reapplication may not be necessary -- response may only be delayed.
- **IF FLOWER BUDS ARE DAMAGED BY SPRING FROST,** high N rates can lead to overgrowth. Use lower rates.

EFFECTS OF PESTS AND CULTURAL PRACTICES

- **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 rates applied all at once.
- **DECREASE** fertilizer rate 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 rate if late water has been held. Spring fertilizer rate may be eliminated on late water bogs. Overall fertilizer rate 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 rate. A low rate applied 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.

CALCULATING FERTILIZER N AND P RATES -- IMPORTANT FOR P PLANNING

Basic information - How to calculate rates from the N-P-K on the bag

- Pounds of N = pounds of fertilizer multiplied by the first number as a decimal
 - example: 150 lb 12-24-12 = 18 lb N (150 x 0.12)
- Pounds of actual P = pounds of fertilizer multiplied by the middle number as decimal multiplied by 0.44 to convert to actual P (the bag number refers to the amount of P₂O₅)
 - example: 175 lb 15-15-15 = 11.55 lb P (175 x 0.15 x 0.44)
- Pounds of K = pounds of fertilizer multiplied by the last number as a decimal multiplied by 0.83 to convert K₂O to actual K
 - example: 200 pounds of SulPoMag (0-0-22) = 36.5 lb K (200 x 0.22 x 0.83)

Example #1

Since we fertilize based on nitrogen -- decide how much N you need. Then choose a fertilizer and calculate how much P you will apply.

My bog requires 35 lb N/A; I want to use 12-24-12

To get 35 lb N -- how much 12-24-12?

- divide amount of N needed by percent N (first number as decimal) in fertilizer
 - 35 divided by 0.12 = 291.7 pounds of fertilizer is needed
- to calculate P - multiply pounds of fertilizer by middle number as decimal and then by 0.44 (to convert to actual P)
 - 291.7 x 0.24 x 0.44 = 30.8 pounds of P applied

That's more P than I expected. What if I switch to 15-15-15?

- Figure out how much 15-15-15 to get 35 lb N
 - 35 divided by 0.15 = 233 pounds fertilizer
- Now calculate the P
 - 233 pounds fertilizer x 0.15 x 0.44 = 15.4 pounds of P applied

Example #2

I always use 400 lb/A 12-24-12. How much N and P am I applying?

- For N - multiply the pounds of fertilizer by 0.12 (the percent N in 12-24-12)
 - 400 x 0.12 = 48 pounds of N
- For actual P - multiply the pounds of fertilizer by 0.24 (the percent P₂O₅ in 12-24-12) and then multiply by 0.44 to convert to actual P
 - 400 x 0.24 x 0.44 = 42.2 pounds of actual P

WOW! That's a lot of P!! Maybe I want to try that 18-8-18 I am hearing about - how much should I use?

- To get 48 pounds of N with 18-8-18, divide 48 by 0.18 to get pounds of fertilizer
 - 48 / 0.18 = 267 pounds of 18-8-18
- So - how much P is that? Multiply fertilizer by 0.08 to get pounds of P₂O₅ then convert to P by multiplying by 0.44
 - 267 x 0.08 x 0.44 = 9.4 pounds of actual P

IRRIGATION WATER MANAGEMENT 2015

Prepared by Peter Jeranyama

Water management is arguably one of the most critical issues affecting the cranberry industry for four major reasons: (a) crop production, (b) environmental concerns, (c) costs and (d) regulatory scrutiny. The objective of this section is to (i) introduce the concept of crop water stress index (CWSI), and (ii) discuss soil moisture monitoring devices such as tensiometers, moisture sensors and water level floats.

An evaporative demand study conducted by Bruce Lampinen showed that for many weeks during the growing season, most cranberry beds were too wet. Wet conditions as a result of inadequate drainage or excessive irrigation in cranberry production potentially result in increased root rot and fruit rot diseases, poor nutrient uptake, inhibition of root development, reduced fruit retention and reduced productivity. Traditionally, cranberry beds received one inch of water per week from either rain, capillary action from the groundwater, irrigation or some combination of these. But conditions can vary from bog to bog so the **one inch (1") rule** does not always result in ideal soil moisture conditions. In general the following bog conditions exist in MA (i) new renovations and constructions (0-10 years old) those with a constructed sub-grade, (ii) renovated beds that have a peat/hardpan natural underlayment, and (iii) older beds that, after sanding, have developed a layered soil in the root zone, alternating sand and layers with root mass (organic layers). The layering structure of these older bogs will present challenges to getting uniform contact with monitoring devices.

Plants maintain hydration and internal temperature through a process called transpiration in which water is moved from the soil, through the roots and shoots and out through pores (stomata) in the leaves. As this process occurs, moisture is depleted from the soil. The plant can control the rate of transpiration by controlling the opening of the leaf stomata to let the water out. However, there is evidence that cranberry has poor control over its stomata and therefore, its transpiration process. In other crops, crop water stress index (CWSI) is used to measure plant transpiration from canopy temperature and air dryness. Because of the poor control of transpiration in cranberry, we as yet have no such index specific to cranberry. And since there is evidence that cranberry has poor control over its transpiration process, leaf measurements alone may not sufficiently define CWSI for cranberry. There is a need to use a cafeteria approach that includes plant processes but also looks at the soil-water matrix to quantify water stress at different soil water conditions. This can then be used as the basis for irrigation scheduling over a wide variety of cranberry bogs. At present, our recommendations for irrigation management are based on soil water conditions only.

Measurement of soil water status is based on two technologies: (i) measuring the amount of water in the soil (e.g. 'feel test', water float, or volumetric water sensor) and (ii) measuring the energy status (water potential) of the water (e.g. tensiometer).

Appearance and Feel Method. Although measuring soil water by appearance and feel is not precise, with experience and judgment, farmers have been able to estimate soil moisture level with a reasonable degree of accuracy. **However, this can be very challenging in sandy soils and is not a recommended method for cranberry.**

Soil probing can be used as a check on other monitoring methods and is especially useful in monitoring the depth of penetration of irrigation applications and rainfalls.

Sometimes other problems, like compacted soil layers, can be detected from the probing. The following guideline is usually used on coarse textured soils, sandy loams and loamy sands. If soil in the hand is (i) dry, loose, flows through fingers - 0 to 25% available moisture, (ii) looks dry, will not form ball with pressure - 25 to 50% available moisture, (iii) will form a loose ball under pressure, will not hold together even with easy handling - 50 to 75% available moisture, and (iv) forms weak ball, breaks easily, will not 'slick' - 75 to 100% available moisture. But, as mentioned previously, this is a very imprecise method for the extremely sandy soils in a cranberry bog.

Water Level Floats. In cranberry, water level floats have been used to determine when to irrigate, but they only measure the level of the water table and do not include any plant processes or plant evaporative demand. And yet, it is the plants that in large part control the use of the soil water, thus depleting it and triggering the need for irrigation. Water level floats have the advantage that you can see the level of the water table without walking onto the bog. Instructions for constructing a water level float are available from UMass Cranberry Station website at: <http://www.umass.edu/cranberry/pubs/factsheets.html>.

Water demand by vines can be assessed by comparing the water level in the center of the bed to the water level in ditches to see if water is moving fast enough across the bed. By observing the water level float through several irrigation cycles, you can determine the number of hours required for an adequate irrigation. Note that this technology depends on the presence of a water table in the bed.

Tensiometers. A tensiometer is a sealed, water-filled tube with a vacuum gauge on the upper end and a porous ceramic tip on the lower end. A tensiometer measures the soil water potential in the soil. As the soil around the tensiometer dries out, water is drawn from the tube through the ceramic tip. This creates a vacuum in the tube that can be read on the vacuum gauge. When the soil water is increased, through rainfall or irrigation, water enters the tube through the porous tip, lowering the gauge reading.

Tensiometers provide a valuable measure of the energy status of water in the soil, thus providing a rigorous indication of the water availability to plants, with values that allow comparisons between a set of growing conditions.

A tensiometer reading in the **2 to 5 cbar** range should be expected as long as the water table is between 8 and 18 inches. This range is adequate for cranberries (see Table on next page).

NOTE: Tension readings are technically negative, but for simplicity of concept, we have chosen to report them in this book as positive numbers.

Volumetric Water Content. Soil water content indicates how much water is present in the soil. It can be used to estimate the amount of stored water in a profile or how much irrigation is required to reach a desired amount of water. Soil volumetric water content sensors provide a tool to measure the water content of the soil. Installing these sensors into the soil allows you to collect long-term measurements.

Based on our current research, cranberry bed soil appears to be saturated when volumetric water content is 30 to 40%. At this water content, the free air spaces are filled with water. Irrigation should be stopped before saturation to promote water and solute uptake by the plant. On the other hand, field capacity occurs at around 10% volumetric water content. Field capacity is the water content after a saturated soil has been drained of all free water. This corresponds to when you should to start to irrigate.

Volumetric water content measurements are simple, reliable and inexpensive.

76 Irrigation Water Management

Recommendations: A general problem with estimation of soil moisture arises because of the heterogeneity within soils, with single point measurements rarely being representative. Ideally, several devices should be distributed across the management area covered by an irrigation system.

We have shown through research that zone of saturation, when all air pores are filled with water, was reached between 30% and 40% volumetric water content depending on the soil subsurface. This volumetric water content corresponds to a tension of 1 and 2 cbar (or kPa). Field capacity is reached when the soil has drained all its free water and at this stage the soil is ready for irrigation. In our research, field capacity was reached between 5% and 15% which corresponds to a tension of 4 and 5 kPa. In simplicity, irrigation should be initiated when a tension of 4.5 kPa (at field capacity) has been reached and stopped when a tension of 2kPa (before saturation) has been achieved. Using a volumetric water sensor, irrigation should be started when a water content of 10% is recorded and stopped before 30% moisture content.

Table. Critical levels of tension, volumetric water content and water table level for irrigation scheduling on cranberry beds. Use these as a guide for when to irrigate.

	Morning tension	Midday tension	Volumetric water content	Water table level
	-----cbar-----		%	inches below surface
Too wet	0 to 2	0 to 2	>30	0 to 6
Adequate	>2 to 5	>2 to 10	15 to 29	>6 to 18
Too dry	>5 to 80	>10 to 80	<12	>18

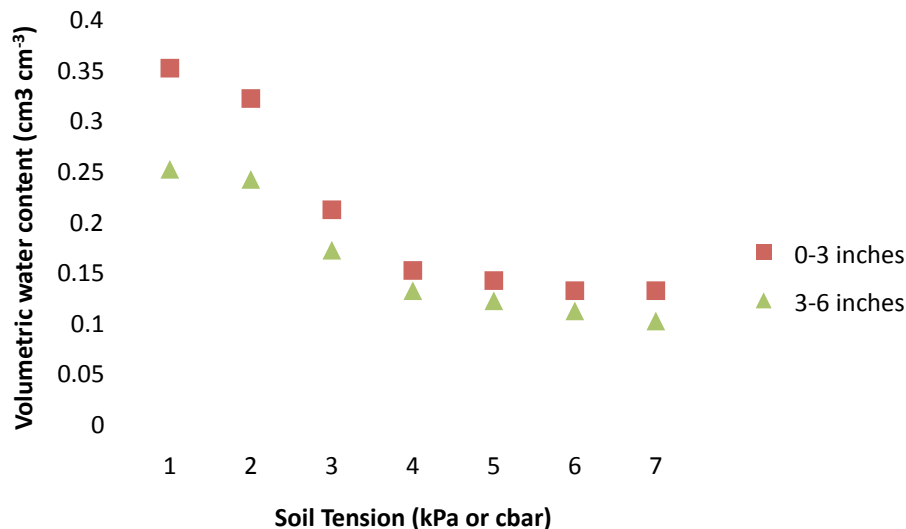


Figure 1. Water retention curve from a cranberry bog at 0-3 inches and 3-6 inches soil depth.

The graph shows that irrigation in response to the drying of the soil should be initiated at 4.5 kPa where the graph flattens. Further increases in tension are associated with very little changes in water content in the soil as the remaining water is being tightly held by soil particles and is not readily available for plant uptake.

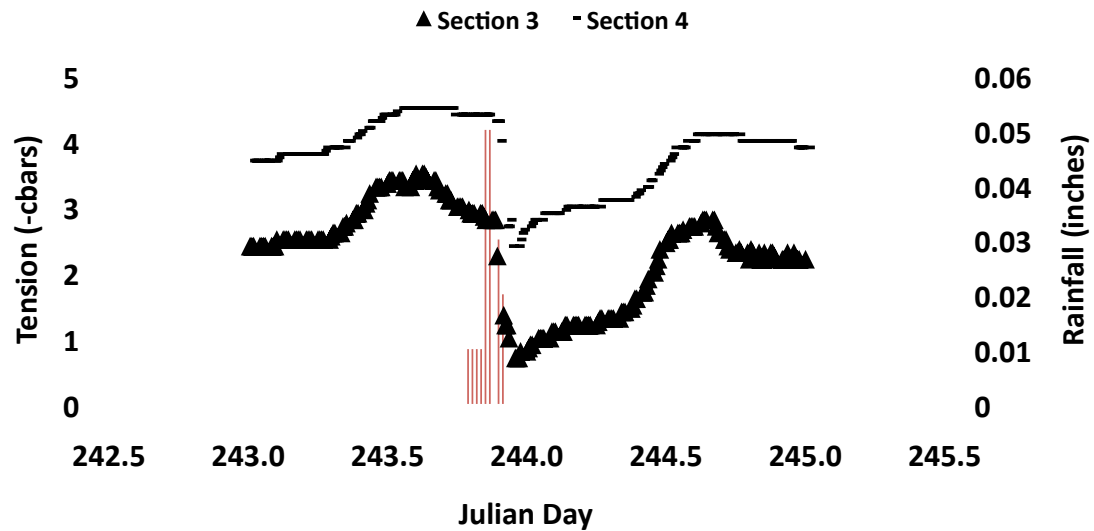


Figure 2. Precipitation (rainfall; vertical gray lines) effect on soil tension; section 3 is tension reading in one field and section 4 is reading from an adjacent field.

The graph shows that section 4 is drier than section 3 as indicated by the higher tension readings at any given time. Precipitation of 0.1 inches dramatically dropped tension readings by <-1.5 cbars on both fields. Section 3's tension was dropped to water saturation levels on Julian day 244 (September 1, 2014), but tension readings rose again as the field gradually dried up. Worth noting is that a slight precipitation caused the tension readings to remain less than -4.5 cbars (trigger point to set irrigation) and even three days after the precipitation, the tension did not rise to previous levels (especially in section 3). This provides solid evidence that irrigating every other day in summer may be too high a frequency, as the field will remain considerably too wet, providing a good environment for disease development.

LATE WATER AND CRANBERRY MANAGEMENT 2015

Prepared by C.J. DeMoranville, A.L. Averill 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. LW suppresses some insects and Southern red mite (SRM). Fruit rot disease is reduced on LW bogs and keeping quality is improved. LW has been shown to suppress growth of dewberries (brambles). LW delays and reduces bloom (generally compensated by greater % fruit set), can affect fruit shape, and reduces the nitrogen requirement for that year.

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. Any condition that leads to reduction in the plant's carbohydrate reserves can lead to a poor LW outcome. Such conditions include a heavy crop, abnormally warm late fall, low previous year sunshine, oxygen deficiency, and winter temperature extremes. 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. If the bog holds a flood well, costs in the LW year should also be less, particularly if inputs are reduced due to reduced pest pressure, helping to offset any losses. All factors that contribute to these occasional lower yields are not entirely understood, 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 ensures that you will be ready if a frost night occurs immediately after flood removal.

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 and hold for approximately 30 days.

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 (Algae-Pro, Cutrine Plus, etc; see the Weed section for more information). 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.

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 next page).

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 1 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.

80 Late Water

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 (cocoon), 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. Flight is synchronized making management easier.

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 2 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 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, clipping, flame cultivation or 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 preemergence 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 preemergence 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.

82 Winter Management

WINTER MANAGEMENT 2015

Prepared by Carolyn J. DeMoranville

Cranberry vines may be injured or killed by severe winter weather. The most common 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. That injury is known as 'winterkill'. The symptoms are leaf discoloration and eventual 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 winds (10 mph or greater) occur. Injury is prevented by a winter flood that should be in place when winterkill conditions exist. It is thought that 2-3 days with temperatures below 20°F will be enough to freeze the soil. New plantings (first year) are less susceptible to winterkill but should still be protected in severe conditions.

If crop elimination by mowing or flooding is planned for the following season, the winter flood may be eliminated.

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. The flood may be delayed as long as winterkill conditions are not forecast if the plants are fully dormant. Exposure to moderately cold temperatures will encourage deeper dormancy leading to lower oxygen and carbohydrate demand and greater cold tolerance. However, an early cold snap following a warm fall could lead to actual cold injury in the plants (similar to frost injury). Under such conditions, the winter flood should be in place even before winterkill conditions are reached. 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 (above 50°F is much preferable). It may be combined 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 1 hour of sunny conditions after application to ensure proper set of the material on the leaf surface. Vapor Gard will persist on the plant for several months, so application should be planned for the fall (November typically has favorable conditions). Other products such as Wilt-Pruf or Moisturin are available, but we do not have much experience with these.

Oxygen deficiency injury:

Historic research by Bergman, indicated that a lack of dissolved oxygen in the winter flood water was the cause of injury to cranberry plants, resulting in leaf drop and reduced yield potential. Plants, like animals, use oxygen in respiration so lack of oxygen could lead to plant injury. Bergman stated that oxygen deficiency injury may occur when oxygen levels in the winter flood water drop below 4 mg/l (full oxygenation = 10+ mg/l). Bergman further stated that lack of light penetration led to poor photosynthesis and it was the lack of photosynthesis that led to poor

oxygenation in the water. The recommended remedy was to remove water from under the iced-over flood if light penetration was poor.

Removal of water from beneath the ice is standard practice in WI and in cold conditions in MA. In WI, the removal of remaining water is done as soon as a thick ice layer forms on the surface. Air then penetrates along edges and through cracks in the ice so that the vines are exposed to atmospheric oxygen. If the flood remains unfrozen as is often the case in MA and NJ, oxygen readily mixes into the water from the surrounding air.

Recent research in both MA and WI has caused us to re-examine Bergman's theories and recommendations. Research by Justine Vanden Heuvel and Teryl Roper showed that cranberries require very little light for photosynthesis and the light that penetrates snow or sand may be sufficient for this purpose. Further, in a bog with a full layer of water beneath ice, even with 9 inches of snow on the ice, oxygen in the water beneath remained at 8 mg/l or greater. In WI, covering ice with black cloth, sand, or snow did not lead to leaf drop or crop reduction in the plants below the treatments. In MA, plants held flooded in darkness and low oxygen did not show reduced carbohydrate (the product of photosynthesis) or leaf drop.

So what is the cause of the leaf drop that is observed after the winter at certain bogs? Definitely, loss of leaves is a sign of some sort of stress on the plants. It is unlikely that lack of light is the cause. Lack of oxygen remains a possibility if the levels actually become severely depleted. A likely scenario for this would be pulling the water from beneath the ice and leaving a shallow layer of water in low spots. The smaller volume of water could become oxygen depleted where a large volume had not.

As wetland plants, cranberries can survive periods of poor oxygenation during flooded conditions. In particular the plants can tolerate low oxygen levels in saturated soil. However, survival under these conditions requires using up carbohydrate (food) reserves. Plants with poor carbohydrate reserves due to large crops, poor sunshine the previous fall, or other stresses may have less ability to tolerate low oxygen stress and may show injury the next spring. In those cases, failure to prevent oxygen deficiency can result in leaf drop, inability of blossoms to set fruit, and crop reduction.

Certainly, any risk associated with using a winter flood is far outweighed by the benefit of protection from winterkill injury.

To assure that leaf drop potential is minimized:

- Remove the water from beneath a frozen flood as soon as is practical – this also minimizes mobilization of soil phosphorus into the flood water due to soil anoxia.
- If water is being held beneath ice in order to expedite sanding, monitor oxygen levels in the underlying flood. Do not allow water with <3 mg/l oxygen to remain beneath the ice. Consider acting at a reading of 5 (mg/l) on a standard color kit.
- Try to avoid shallow layers of water beneath ice, they may lose oxygen more readily than deeper layers of water.
- If you pull the water from beneath ice -- make sure that you leave no puddles behind. Vines trapped in these puddles under the ice are particularly susceptible to leaf drop in the spring.
- Manage plantings during the season so that stress is minimized -- in particular, irrigate properly.

Management after a mid-winter thaw:

Once the water has been removed from beneath the ice, 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.

84 Winter Management

This is especially true if the previous fall was warmer than usual, leading to lack of chilling accumulation. To guard against these possibilities, reflood 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", the Frost Management BMP, and frost alerts on the Station's webpage for further information: <http://www.umass.edu/cranberry/index.html>.

GROUNDWATER PROTECTION REGULATIONS AND ZONE II IN 2015

Prepared by Martha M. Sylvia

The Massachusetts Department of Agricultural Resources (MDAR) is charged with maintaining clean groundwater. To this end, they have issued Groundwater Protection Regulations. These Regulations are intended to prevent contamination of public drinking water supply wells through regulating the application of pesticide products on the Groundwater Protection List within primary recharge areas. A primary recharge area is either an “Interim Wellhead Protection Area (IWPA)” or a “Zone II”. In this publication, we refer to all primary recharge areas including IWPA as Zone IIs. The Zone IIs are updated yearly. The pesticide groundwater protection regulations ONLY apply to public drinking water wells that pump greater than 100,000 gallons of water per day (gpd).

Some products registered for use on cranberry (listed below) have the potential to leach through the soil and as a result have been placed on the Groundwater Protection List. If you are in a Zone II, you should review the particulars for each compound to determine if you can use it in your situation. If you are able to use a compound, you must follow these rules:

- ❖ **MDAR notification** within 10 days of the end of the month for each application. You may use one form to report multiple applications that occurred in the same month. Forms are available at the Cranberry Station, CCCGA, points of purchase, or online:
<http://www.mass.gov/eea/agencies/agr/pesticides/groundwater-protection-program-notification-form.html>.
http://www.cranberries.org/growers/alerts.html#alerts_zone2 (click on form).
 This reporting form must be filed in addition to the Pesticide Applicator Form that reports annual use to the state.
- ❖ Confirmation of 50% foliar cover. Assume an established working bog has at least 50% foliar cover but a new planting likely does not.
- ❖ An approved IPM program (use of Cranberry Chart Book) and an acreage-specific IPM plan.
- ❖ A support letter from UMass Extension and/or a copy of this chart book showing you have confirmed that your conditions allow the application.
- ❖ Proper documentation showing failure of alternatives. Generally, IPM records will suffice.

Cranberry Compounds on the Groundwater Protection List

chlorothalonil	Bravo Echo, Equus Chloronil, Initiate Chlorothalonil	While these compounds are listed on the groundwater protection list, you may still use them within a Zone II area if you meet the conditions (outlined on p. 87) for each one and there are no viable alternatives.
methoxyfenozide	Intrepid	There are alternatives available (Altacor, Confirm, Delegate) and this product cannot be used in Zone II areas. In very special cases permission may be given during bloom for management of black-headed fireworm infestations. Contact Cranberry Station.
thiamethoxam	Actara	There are alternatives available (Avaunt spring, Belay summer) and should be used in Zone II areas. However, if your handler has restricted Belay use, then you may use Actara in summer for the second generation weevil in Zone II areas (complete paperwork).
dinotefuran	Scorpion/Venom	There are alternatives available (Altacor, Avaunt, Delegate, Diazinon) and this product cannot be used in Zone II areas.

Guidelines provided by Massachusetts Department of Agricultural Resources (MDAR):

Greater detail is provided at the MDAR website (<http://www.mass.gov/eea/agencies/agr/pesticides/water-quality-and-pesticides.html>) or from the Cape Cod Cranberry Growers' Association (at their website, <http://www.cranberries.org> under Grower services, then Grower advisories, then Groundwater protection).

Are you applying a product that is listed on the Groundwater Protection List within a regulated primary recharge area?

The pesticide groundwater protection regulations ONLY apply to public drinking water wells that pump greater than 100,000 gallons of water per day (gpd). The primary recharge area is designated as a Zone II or an Interim Wellhead Protection Area (IWPA) by the Massachusetts Department of Environmental Protection (DEP). Listed below are several ways to establish if you are in a regulated primary recharge area.

Determining The Location of a Regulated Primary Recharge Area - Zone II or IWPA.

To determine if the application site falls within a Zone II or IWPA, you can use the following options:

Bound Map Books

You should check the updated bound map books available at your local Ag dealers, the Cranberry Station, or the CCCGA. These books are provided by the Cape Cod Cranberry Growers' Association. The maps are organized alphabetically by town. Main roads, waterways, Zone IIs and cranberry bogs are easy to identify on the maps.

Internet Option

If you have access to the internet, you can go to the MDAR website: (<http://www.mass.gov/eea/agencies/agr/pesticides/water-quality-and-pesticides.html>). Click on “Public Drinking Water Supply Protection”. On the right menu, click the link “List of MA Towns with Zone II Areas” and then select the name of your town from the list. A map will open with tools to zoom in on specific areas of the town. The Cape Cod Cranberry Growers' Association also has a set of internet maps accessible at: http://www.cranberries.org/growers/alerts.html#alerts_zone2.

Link directly to Mass GIS system called Oliver http://maps.massgis.state.ma.us/map_ol/oliver.php and after advancing into your bog area, click on right the plus sign for “Regulated Areas”, then within that group “Wellhead Protection Area” and then click on “Zone IIs” and the Zone II areas will be highlighted in pink hatch.

Other Options

Check with the regional DEP office, DEP Southeast Regional Office: 508-946-2700.

Are you applying pesticides in an area that has less than a 50% foliar cover?

If your area of application is located within the primary recharge area, you must determine if you are applying to an area with less than or greater than 50% foliar ground cover.

Assume an established, harvestable bog has at least 50% foliar cover.

If your bog is a new planting or it has not vined in to at least 50% foliar cover, and you wish to apply a pesticide listed on the groundwater protection list within a Zone II or IWPA, then the applicator must submit a Pesticide Management Plan (PMP) to MDAR for that use pattern and have it approved prior to the application. If this is the case, contact CCCGA or MDAR to develop this plan.

What is an Integrated Pest Management Program?

Pesticides on the groundwater list must be applied as part of an Integrated Pest Management (IPM) program from an MDAR approved source. These include:

- Use of the current "Cranberry Chart Book" published by the UMass Cranberry Station.
- UMass Extension generated fact sheets that outline IPM practices specific to the pest problem.
- IPM Programs specifically developed to meet the requirements of the Groundwater Protection Regulations.

The Department does not require the submission of IPM plans for approval. Instead the applicator should maintain a copy of their IPM program in their records. The plan should be specific to the pest problem requiring management with the Zone II chemical. The plan information should include:

- The name of the applicator.
- The location (Zone II and property) and dates of the application.
- A problem statement that outlines the reason for using the pesticide product on the Groundwater Protection List.
- An account of the method used by the applicator to identify the problem. Any laboratory diagnosis of the pest problem must also be maintained.
- An account of the IPM measures that have been taken to manage the problem.
- A letter or statement from the appropriate UMass Cranberry Station personnel stating that there is no viable alternative to the use of the product on the Groundwater Protection List to control the particular pest problem.

CONDITIONS TO ALLOW APPLICATION OF COMPOUND

Chlorothalonil - Bravo, Echo, Equus, Chloronil, Chlorothalonil, Initiate

If your cranberry bog is located in Zone II and you wish to apply a chlorothalonil product, you must consider the following conditions and select the most appropriate scenario that applies to your situation:

- If you have traditionally had good fruit quality (less than 3% rot at delivery), you should use any of the fungicides that do not have chlorothalonil as the active ingredient. It is advisable to keep records of fungicide performance (i.e., level of fruit rot incidence). This will provide evidence and documentation in case you need to use a chlorothalonil fungicide in the future due to the failure of alternatives.
- If you have previously used non-chlorothalonil fungicides on the bed located in the Zone II and you can show that these alternatives performed poorly or failed, you can use the chlorothalonil fungicides because you have no other viable option. You must have some documentation (scouting reports, IPM notes, delivery records with more than 3% rot present) that indicates fruit rot was not controlled with previous non-chlorothalonil fungicide applications.
- If you have previously used non-chlorothalonil fungicides on the bed located in the Zone II and you can NOT show that they did not perform poorly or failed, you must continue to use non-chlorothalonil fungicides. You cannot use chlorothalonil products until and unless you can document that alternatives do not work.
- If there was a significant amount of upright dieback in the bed located in the Zone II during the previous growing season and a pre-bloom application is warranted, Champ can be used instead of a chlorothalonil fungicide for control of this disease. If you do not get adequate disease control using Champ, a chlorothalonil fungicide can be used in the subsequent growing season.

General Information

The chlorothalonil fungicides are considered to be a necessary component of an integrated approach to control fruit rot in cranberry. Many years of field testing in MA have proven that they are the best of the fungicides registered for cranberry fruit rot and upright dieback control. One of their strengths are sticking agents that help to adhere the fungicide tightly to the target tissue, which allows the fungicide to better withstand degradation by sunlight and washoff by rainfall. They are especially important in beds devoted to production of fresh fruit, where excellent fruit quality is desirable, particularly since these berries may be stored for two months. The chlorothalonil fungicides have consistently afforded the best control of storage rot (at 8 weeks after harvest) in field trials at State Bog.

MEASURES AND CONVERSION CHART 2015

Prepared by Hilary A. Sandler

Liquid Measures

1 oz = 2 tablespoons = 6 teaspoons = 29.6 ml
1 cup = 8 oz
1 pint = 2 cups = 16 oz
1 quart = 2 pints = 4 cups = 32 oz
1 gallon = 4 quarts = 8 pints = 16 cups = 128 oz
1 cup = 237 ml
1 pint = 473 ml = 0.473 liters
1 quart = 946 ml = 0.946 liters
1 gallon = 3.78 liters = 3,785 ml
1 acre-foot water = 326,000 gallons
0.1 inch water per acre = 2717 gallons

Mass Conversions

1 oz = 28.4 grams
1 lb = 454 g = 0.454 kg
1 kg = 2.2 lb = 35.2 oz

Temperature Conversions

$^{\circ}\text{F} = (9/5 \text{ }^{\circ}\text{C}) + 32$ (guesstimate: double $^{\circ}\text{C}$, add 30)
 $^{\circ}\text{C} = 5/9 (\text{ }^{\circ}\text{F} - 32)$

Length and Area Conversions

1 acre = 43,560 sq. ft = 0.405 hectares
1 hectare = 2.47 acres
1 meter = 1.09 yards = 3.28 feet = 39.4 inches
1 yard = 3 feet = 36 inches = 0.914 meters
1 cm = 0.39 inches
1 inch = 2.54 cm
1 rod = 16.5 ft
1 sq. rod = 272.2 sq. ft
1 square meter = 10.76 square feet
1 cubic meter = 35.29 cubic feet = 1.30 cubic yards
1 inch layer of sand per acre = 134 cubic yards

Other Conversions

pt/A * 0.473 = liters/A
pt/A * 1.167 = liters/ha
lb/A * 0.454 = kg/A
lb/A * 1.12 = kg/ha
gal/A * 3.78 = liter/A
gal/A * 9.33 = liter/ha
ton/A * 2,245 = kg/ha
bbl/A * 0.112 = Mg/ha
 $\text{g}/\text{ft}^2 * 0.958 = \text{bbl}/\text{A}$

PESTICIDE STORAGE GUIDELINES 2015

Prepared by Hilary A. Sandler

Always read the label of the pesticide when you have specific questions concerning storage or disposal. Pesticides should be stored in properly designed storage facilities that are well ventilated and maintain a cool, dry environment. Affix fire extinguishers on the outside and the inside of the building. Be sure to inform your local Fire Department which buildings on your property are storage facilities.

Avoid carry-over of pesticides; buy only what you will need for the current season. It is not advisable to use pesticides that have been held over in opened containers. Take the precautions necessary to prevent cross-contamination of all pesticides and fertilizers when stored in the same facility. If you have many different kinds of materials in your storage facility, it is helpful to place all insecticides in one area, all herbicides in another, etc. All materials should be clearly labeled. Post a list of materials outside of the building if possible.

Dry pesticides (e.g., granulars, powders) should be stored in a cool, dry place. Generally, no other special precautions are needed with these materials. Liquid or emulsified products may have restricted temperature ranges at which they should be stored. CHECK THE LABEL! In general, liquid or emulsified materials should not be stored at temperatures below 45°F or at temperatures that frequently exceed 100°F. These pesticides may form crystals at the lower temperatures. If crystals form, bring the pesticide into a warm place and gently agitate the pesticide container to redissolve the pesticide. NOTE: If you are storing Roundup, do not use galvanized or unlined steel (except stainless steel) containers. A highly combustible gas mixture may form.

Properly dispose of used containers. Check with your local supplier for any available recycling programs. A paper bag is considered by DEP to be empty if “all wastes have been removed that can be removed by shaking or equivalent means...”. No more than one inch of material should remain. In addition, consider placing the pesticide bag in a plastic trash bag prior to disposal. For liquid-type materials, triple-rinse the container. Plastic containers should be recycled or reconditioned. For further information, contact the Pesticide Bureau at (617) 626-1776.

2
2,4-D..... 36, 54, 58

A

Abound 4, 12, 16, 17
acetic acid.....45
Actara 5, 20, 24, 29, 30
action threshold..... 18, 20, 21, 24
adjuvants.....46
Admire..... 5, 27, 28, 30
algae.....55, 56, 79
algaecide55
Alias 27, 28
Alette 10, 17
Altacor 19, 22, 23, 25
annual grasses.....43, 58
annual plants.....32
antitranspirants.....82
aquatic weeds55, 57
Assail 23, 24, 25
asters.....33, 38, 50
Avaunt 5, 20-22, 24, 30
Azadirachtin31

B

B.t 19, 21, 24, 31
barley straw.....55
Basamid.....58
bees 20, 30, 81
Belay..... 24, 27, 28, 29
biennial plants.....32
biopesticide45
black vine weevil.....27
blackberry.....42
black-headed fireworm 17-19, 22, 23, 31, 35
bladderwort.....57, 58
Blazon Blue49
blossomworm 18, 20, 30, 31
brambles.....35, 78
brown spanworm18, 21
burning36, 58

C

calcium-boron.....67
Callisto..... 4, 34, 36, 38-43, 49, 51, 56
carbohydrate loss83
Casoron 27, 34, 38-40, 42, 43, 46, 47, 66, 81
cattails.....57
chemigation..... 10, 19, 29, 31, 58
chlorothalonil 9, 13, 87

chokeberry 40
cinquefoil 38, 54
clippers..... 53
clipping35, 36, 41
clover 43, 50
Confirm 19, 20
conservation seed mixes 56
copper17, 56, 79
copper sulfate 55, 56
cranberry flea beetle..... 29
cranberry fruitworm 18, 19, 25, 26, 30, 31, 80
cranberry girdler18, 19, 28, 31
cranberry root grub 27
cranberry weevil18, 24, 25, 31
crop oil 49, 51
crop oil concentrates 46
crop water stress index..... 74
Crossbow 58
Cutrine-Plus..... 55, 56
cutworms18, 20, 24, 80

D

Delegate 5, 19, 20-26, 29, 30
Devrinol.....32, 40, 41, 48, 49
dewberry..... 35, 40, 53, 54, 58, 81
dewpoint..... 15
dichlobenil..... 46, 48, 49, 50, 51
dike stabilization 56
Diquat 57, 58
ditch stabilization 56
ditch weeds..... 55
dodder..... 33, 34, 39, 47, 49, 50, 54, 81
drainage..... 10, 40, 45, 48, 66, 69
duckweed..... 55, 57

E

egg monitoring 26
elodea 58
emersed weeds 55
Entrust 19, 31
evaporative demand..... 74
Evital40, 42, 48

F

fairy ring 16
fall floods 35
false armyworm.....18, 20, 30, 31, 80
false blossom 17
fanwort 57
Ferbam..... 13, 16
ferns..... 43

<i>fertilizer</i>	
<i>applying</i>	67
<i>calculating rates</i>	73
<i>effects of weather</i>	72
<i>fall, use of</i>	71
<i>fish</i>	67
<i>late water</i>	72, 79
<i>minor elements</i>	66
<i>pest, cultural practices</i>	72
<i>soil and tissue</i>	68
<i>soil samples</i>	69
<i>tissue samples</i>	68
<i>yellow vine</i>	66
<i>fireweed</i>	45
<i>fireworms</i>	18
<i>fish fertilizer</i>	63
<i>fish toxicity</i>	8
<i>flame cultivation</i>	35, 41, 44, 54, 55, 81
<i>flea beetle</i>	18, 27, 28, 29
<i>floating weeds</i>	57
<i>floods</i>	
<i>black vine weevil</i>	27
<i>dodder</i>	35
<i>fall</i>	27, 28, 35, 78, 81
<i>fireworm</i>	17, 22, 23
<i>flash</i>	72
<i>girdler</i>	28
<i>grubs</i>	27
<i>harvest</i>	15, 63
<i>insects</i>	30
<i>southern red mite</i>	29
<i>spring</i>	35
<i>summer</i>	27, 35, 58, 72
<i>trash</i>	15, 28, 34
<i>winter</i>	15, 22, 27, 31, 41, 79, 82
<i>fluazifop</i>	58
<i>frost protection</i>	31, 79, 84
<i>frost, effect on herbicide movement</i>	46
<i>fruit rot</i>	9, 11, 15, 17, 61, 80, 87
<i>fruitworm egg monitoring</i>	26
<i>fumigants</i>	58
<i>Fusilade</i>	58
G	
<i>girdler</i>	19, 28, 30, 31
<i>glyphosate</i>	35, 38, 40-42, 44, 51-53, 58, 81
<i>goldenrod</i>	33, 38, 50
<i>grass carp</i>	57
<i>grass seed</i>	56
<i>grasses</i>	40, 43, 48, 49, 51, 52
<i>green manure</i>	43
<i>green spanworm</i>	18, 21, 30
<i>greenbrier</i>	36, 38
<i>greenleaf</i>	36, 38
<i>greenleaf sawbrier</i>	38
<i>groundwater protection list</i>	85, 86, 87
<i>growth regulator</i>	19
<i>grubs</i>	27
<i>gypsy moth</i>	18, 24, 30, 31
H	
<i>handheld torches</i>	54
<i>handler restrictions</i>	25, 34, 50
<i>hardhack</i>	44
<i>harvest floods</i>	
<i>P reduction</i>	63
<i>herbicide movement after rain or frost</i>	46
<i>herbicides</i>	46
<i>Hoplia equina</i>	27
<i>humped green fruitworm</i>	20
<i>hydrilla</i>	57
I	
<i>Imidan</i>	21, 25
<i>Indar</i>	16, 17
<i>insecticidal soap</i>	31
<i>Intrepid</i>	18-26, 30
<i>invasive species</i>	41, 44
<i>iron sulfate</i>	43, 47
<i>irrigation</i>	13, 15, 47, 48, 50-52, 55, 56, 59, 66, 74-76, 79, 82
J	
<i>Japanese knotweed</i>	44
<i>joe-pye weed</i>	44
K	
<i>keeping quality forecast</i>	11
<i>knife-raking</i>	35
L	
<i>late water</i>	30, 47
<i>algae</i>	56
<i>bees</i>	81
<i>cranberry fruitworm</i>	80
<i>crop reduction</i>	78
<i>fertilizer</i>	72
<i>fertilizer</i>	79
<i>fruit rot</i>	15
<i>herbicides</i>	81
<i>insects</i>	18, 20, 24, 25, 31
<i>mites</i>	29
<i>out-of-bloom</i>	26
<i>pesticide reduction</i>	78
<i>sanding</i>	17
<i>scouting practice</i>	26

92 INDEX

- southern red mite29, 81
- weeds.....58, 81
- leaf drop83
- leafminer30
- leatherleaf40
- loosestrife 23, 33, 39, 50
- lush vines
 - fruit rot15
- M
- MA Fish and Wildlife.....57
- mancozeb13, 17
- meadowsweet44
- Mexican bamboo.....44
- minor element66
- minor weeds44
- mites.....29, 81
- moisture sensors.....74
- mosses45
- N
- napropamide48
- narrow-leaved goldenrod38, 50
- Nautique55, 56
- Neem31
- nematodes..... 27, 28, 31
- neonicotinoids19
- new plantings 40, 44, 48, 82
- Nexter5, 29, 30
- nitrogen 43, 56, 59-63, 66, 68, 69, 71, 73
- nutrient deficiencies66
- O
- Oberon.....29
- OMRI31
- orangegrass.....40
- organic..... 17, 19, 31, 54, 63, 67, 69, 72, 74
- organic insect management.....31
- oriental beetle27
- out-of-bloom25, 26
- oxygen deficiency82
- P
- perennial grasses.....40
- perennial plants.....32
- pesticide storage89
- pheromone traps 18, 22, 23, 27, 28
- phosphorus..... 59, 63, 64, 69
- phragmites41
- physiological drought82
- phytophthora root rot10
- pinweed40
- pitchfork45, 50
- plant growth regulators..... 34
- Poast..... 40, 51
- Poison Control phone number 8
- poison ivy 36, 53
- potassium54, 59, 65, 66, 69
- preemergence herbicides..... 46
- Princep 32
- Private Applicator Certification..... 8
- protective lotions 36
- pruning 15, 35
- public waters 56
- Pyganic 21, 31
- Q
- Quinclorac..... 50
- QuinStar..... 34, 39
- R
- ragweed..... 45, 50
- rainfast 3
- raking..... 34
- red maple..... 41
- reducing inputs 18
- Reglone58
- resistance management4, 17, 36, 49
- resistant varieties 15
- restricted use 8, 20
- Reward..... 57
- Ridomil..... 4, 10
- Rodeo..... 51, 57
- root grub..... 27
- Roundup..... 35, 36, 38, 41, 52, 53, 89
- rushes..... 41, 54
- S
- salt43, 47, 54
- sanding 17, 28, 30, 31, 69, 72, 74, 78, 83
- sanitation..... 33
- sawbrier 36, 81
- scald..... 15
- scarab grubs 27
- scouting 18, 26, 30, 33, 80, 87
- scouting practice..... 26
- scum..... 55, 79
- sedges 41
- seed mix..... 56
- Select 52
- sheep laurel 41
- silverleaf 36
- soil samples..... 69
- soil standards..... 70
- southern red mite29, 78, 81
- spanworm18, 21, 24

spanworms 20, 21, 24, 80
Sparganothis fruitworm 18, 19, 23, 81
spinosyn-based products 19
Spray Tracer 49
spring floods 35
Stinger 38, 39, 43, 44, 50
strawberry root weevil 27
striped colaspis 28
submersed weeds 55, 57
sulfate 45
sulfur 38, 43, 54, 67
SulPoMag 67, 72
summer re-flood 27, 35
surfactant 52
sweeping 18, 22

T

tank mixes 10, 17
tensiometer 74, 75
thermal weeding 35, 41, 54
tipworm 29
tissue samples 68, 69
tissue standards 69
trash 15, 22, 28, 34, 69, 89
trash removal 15

U

Ultra Flourish 10
upright bramble 42
upright dieback 9, 13, 34, 87

V

Vapam 58
Vapor Gard 82
vetch 43
vinegar 54
virginicus 37

W

water lettuce 55
water level floats 74, 75
water lilies 57
water quality 71
water-holding times 3, 9
watermilfoil 57
weed life cycles 32
weed maps 32
weed priority group 32
Weedar 64 36, 40, 42, 54
Weedone CB 58
weeds
 aquatic 55, 57
 ditch 55
 invasive species 41, 44
weeds, minor 44
weevil 18, 24, 27-29
Wellhead Protection Area 85
white grub 18, 27
white violet 45
Widow 27, 28
wild bean 39, 50, 54
winter flood 82
winter moth 21
winterkill 78, 82, 83
wiping tips 53

Y

yellow loosestrife 39
yellow vine 47, 66
yellow-headed fireworm 23

Z

Zone II 9, 13, 19-25, 29, 85-87

