The Cranberry Institute

Cranberry Pest Management Strategic Plan

NORTHEASTERN Pest Management Center

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The national Cranberry Pest Management Strategic Plan is was organized and sponsored by
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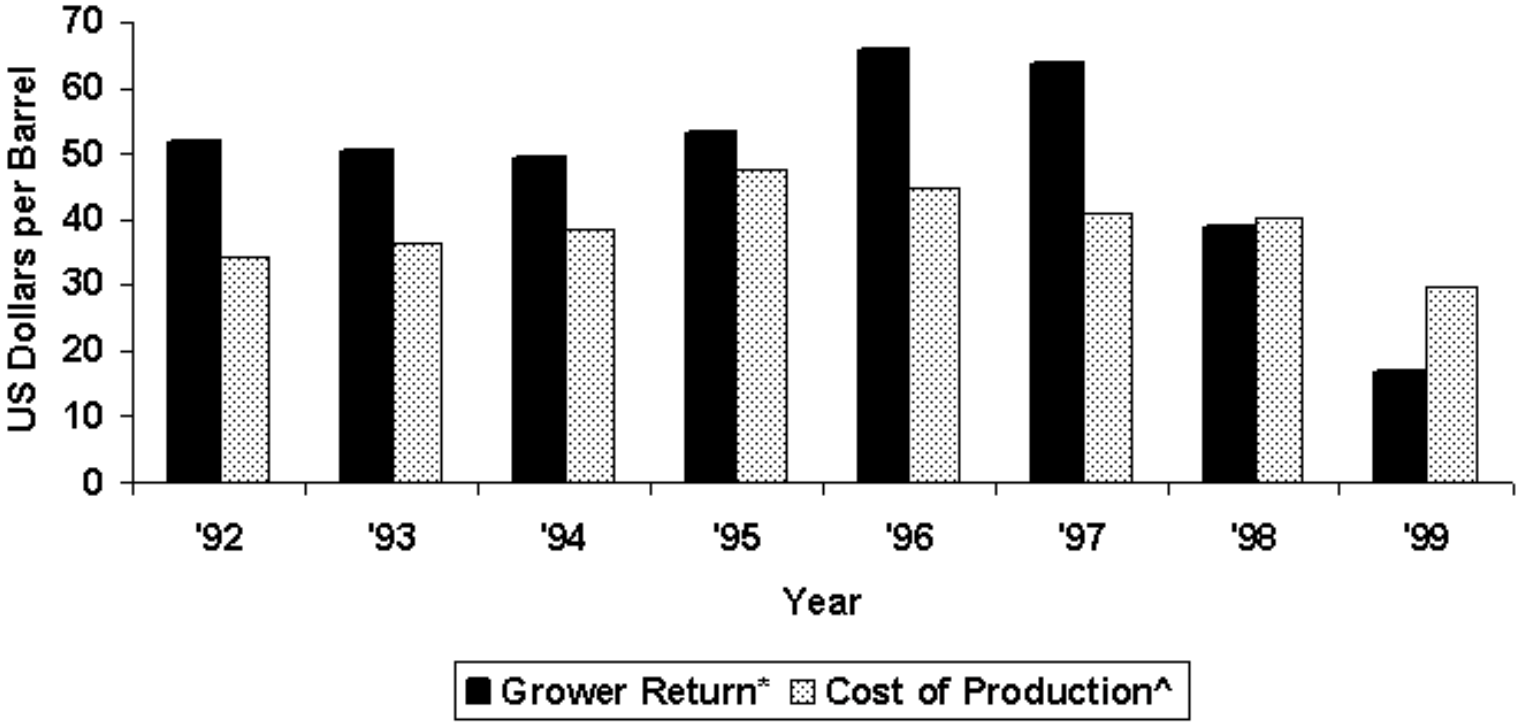
Section 1: Production and value

Cranberries are a moderately high value crop, particularly when sold as fresh fruit (4.1% of sales in 1997). According to the New England Agricultural Statistics Service, estimated farm-gate value was $350,147,000 in 1997. However, due to overproduction and declining per capita consumption, farm-gate receipts have fallen dramatically in the last two years. The cranberry crop was worth $211,301,000 in 1998. 1999 farm-gate receipts are estimated at approximately $70,000,000. This reflects an 83% reduction in per-barrel (100 lbs.) price from 1997 to 1999 (an average of $63.70 in 1997 to approximately $11 in 1999). The USDA Cranberry Marketing Committee invoked its authority to implement a marketing order in 2000 and 2001 under which growers can only sell 85 and 65 percent of their sales history, respectively, to their handlers. USDA hopes this will stabilize prices to growers and, with aggressive generic marketing programs, help to eventually increase grower prices. Canada, which produces the bulk of cranberries imported into the U.S., has also instated a market allocation program for the 2000 crop.

Due to the marketing restrictions and the decrease in returns, most growers have reduced their pesticide, fertilizer, irrigation, and pollinator inputs over the past two growing seasons. Many have further altered their farm management practices by turning to less expensive pest control measures, both chemical and cultural, whenever possible. Certain chemical applications have become cost prohibitive (Figures 2-5). Additionally, growers have flooded selected beds during bloom in order to abort the majority of the fruit on those sections. The oversupply of fruit has resulted in the average return per barrel to fall below the cost of production for many growers (Figure 1).

Wisconsin produces over 50% of the U.S. crop with Massachusetts second in production at 29% (see Table 1). In 2000, 564.2 million pounds of fruit were produced in the United States. Typically, 96% of the crop is processed into juices, sauces or dried, and 4% is sold as fresh fruit during Thanksgiving and Christmas. Canada produces approximately 75 million pounds of fruit per year, much of which is imported into the U.S.

Figure 1: **Cranberry production economics**



*Mean return to growers in the US calculated by the National Agricultural Statistics Service

^Mean cost of production in Massachusetts calculated by First Pioneer Farm Credit and the Cape Cod Cranberry Growers Association

Table 1: 1998-1999 Production Data

Production Area	Producing Acres		Percent Total US Acres		Percent Total US Production		Percent Processed	Percent Fresh Market
	1998	**1999**	**1998**	**1999**	**1998**	**1999**		
MA	14,400	14,800	39	39	34	29	96	4
WI	14,500	14,600	39	39	46	52	97	3
NJ	3,900	3,900	11	10	10	11	99	1
OR	2,200	2,300	6	6	6	5	100	0
WA	1,600	1,600	4	4	3	2	70	30
Other	±350	±350	<1	<1	<1	<1	100	0

Section 2: Introduction to Pest Control

(including General Pest Management Strategy)

The cranberry plant is subject to a wide range of pests that can affect the crop in many different ways. These pests range from insects that cause damage by feeding on the plants or fruit to fungal diseases affecting the plants or fruit to viral infections and other less common problems. There are numerous annual and perennial weeds that can compete with the cranberry vines for space and nutrients. Many of these pests can be and are currently controlled by broad spectrum pesticides, particularly insecticides but also fungicides. The industry has long recognized the need and desirability of reducing its dependence on broad spectrum pesticides and has worked diligently with the scientific and regulatory community too develop safer, more target specific pesticides. These efforts are resulting in the registration of new pesticides for use on cranberries that are reduced-risk and aimed at specific pests, some of which have become less sensitive to registered materials.

However, the availability of the novel, target specific pesticides does not mean that the broad spectrum pesticides are no longer necessary and can be eliminated. For many years, the use of the broad spectrum pesticides has suppressed other pests in addition to the primary pests at which the applications were directed. A complete cessation of use of the broad spectrum pesticides would likely result in a resurgence of those secondary pests with possible devastating effects on the industry. One example, which illustrates this point, is false blossom disease. In the early 1920's there were over 11,000 acres of cranberries in New Jersey. By the early 1960's only about 3,000 acres remained in production. The causal agent of this disease is a phytoplasma; the pathogen is vectored by the blunt-nosed leaf hopper. Although false blossom disease is still present, it is currently not a problem in commercial beds because blunt-nosed leaf hoppers are being suppressed by secondary applications of broad spectrum insecticides aimed at other pests. However, recent observations at the Rutgers Blueberry and Cranberry Research Station at Oswego,NJ show that discontinued use of broad spectrum pesticides over a 3-4 year period will result in the reemergence of the blunt-nosed leaf hopper as a major pest. The reemergence of this vector would likely lead to an explosion of false blossom since most cranberry cultivars are susceptible.

For many classes of pests there are no effective target specific pesticides available at this time. Although some of those pests may not currently be major pests they may emerge or reemerge as such as we move more and more toward target specific pesticides.

Additionally, growers often use broad spectrum pesticides to control several classes of major and minor pests with a single pesticide application. This approach is cost-effective, considering that several of the new generation insecticides are target specific with a very

narrow spectrum of biological activity, expensive, and require multiple applications. For the Cranberry Pest Management Strategic Plan to be both economically and biologically viable it is important that a multitude of control options (broad spectrum and target specific) exist for insects, diseases and weeds. Consequently, although the industry recognizes the need for and supports the development and use of target specific pesticides, it realizes the importance of retaining the availability of broad spectrum pesticides.

General IPM Strategy Statement for Cranberry

Results from a 1997 EPA-sponsored (PESP) commodity-wide assessment of cranberry pest management show that 94 percent of North American growers monitor for pests.

As an example of IPM implementation, of those that monitored for pests in Massachusetts, 96 percent use sweep netting, 59 percent use pheromone traps to monitor adult insect populations of Sparganothis fruitworm, cranberry girdler, cranberry fruitworm, and/or blackheaded fireworm, and 52 percent of growers construct weed maps. Over 85 percent of all Massachusetts growers utilize action thresholds from insect sweep counts as a decision aid in pesticide control actions.

Implementation of IPM-based alternative practices such as sanding, winter flooding, summer flooding, and “late water” is high. For instance, 98 percent of growers in Massachusetts use sanding, 92 percent use winter flooding, and 18 percent flood for specific species, such as cranberry girdler. Twenty-six percent of all Massachusetts growers have used “late water”. Late water is a 30-day spring reflood applied several weeks after the winter flood has been removed and before the plants break dormancy. Late water has been employed for the control of fruit rot, dewberry, Southern red mite, cranberry fruitworm, false armyworm, and gypsy moth and greatly reduces the need for pesticides to control these pests.

Section 3: Cranberry Insect and Mite Pests

Contents of Section 3

SOUTHERN RED MITE (SRM), *Oligonychus ilicis* (McGregor)

CRANBERRY ROOTWORM, *Rhabdopterus picipes* (Oliver)

SPOTTED FIREWORM, *Choristoneura parallela*

LOTISMA FRUITWORM

Carpsed

• Insecticide use

Seventy nine percent of all cranberry acres treated with insecticides are treated with organophosphates. National usage estimates (percentage of acreage treated) for major insecticides used on cranberries in 1998 are found in Table 2.

Table 2: Selected insecticide use by state in 1998

State	**Total cranberry acres**	**Percent of acreage treated**				
		Diazinon	**Chlorpyrifos**	**Azinphos-methyl**	**Acephate**	**Carbaryl**
WI	14,211	70.0	57.2	66.4	24.9	36.8
MA	13,370	77.4	86.8	17.7	14.9	51.0
NJ	3,795	1.3	71.2	17.4	2.2	5.9
OR	2,121	60.6	29.3	3.1	11.7	7.7
WA	1,617	73.8	33.1	15.0	66.9	5.6
US	**35,114**	**65.1**	**67.2**	**36.5**	**19.8**	**35.7**

Table 3: IR-4 Progress - Cranberry Insecticides, August 2001

PR & year	Product	Target Pest	Registrant	Comments
5745 1997	Imidacloprid	Soil grubs, cranberry rootworm	Bayer	Petition submitted to EPA in 2000. EPA review scheduled for 2001.
6823 1998	Spinosad	Fireworms, spanworms, Sparganothis, other leps	Dow Agrosciences	Petition submitted to EPA in 2000. Tolerance proposed in June 2000. EPA review scheduled for 2001.
7355 1999	Methoxy-fenozide	Cranberry fruitworm,Fireworms, Sparganothis, other leps	Dow Agrosciences	Analyses complete and lab report received. Field notebooks have been received. Petition may be in submitted 2001.
7754 2000	Thiameth-oxam	Cranberry weevil, cranberry fleabeetle, and cranberry tipworm	Novartis	Final trials were conducted in six locations including MA, NJ, WI (2 sites), and OR (2 sites). Submission to EPA is expected in 2002.

Organophosphate and Carbamate Insecticides Registered on Cranberry

General application parameters for organophosphate and carbamate insecticides are as follows:

Acephate: A Section 24c label exists for acephate (Orthene) in Washington, Oregon, Massachusetts, New Jersey and Wisconsin. The 24c label allows a maximum of two applications per season; one of which can be applied after bloom. PHI is 75 days. Acephate may be applied by ground, air, or chemigation. It is applied at the rate of one-pound active ingredient per acre.

Azinphos-methyl: Maximum of three applications per season. PHI is 21 days. Azinphos-methyl may be applied by ground, air, or chemigation. It is applied at the rate of ½ to one pound active ingredient per acre

Carbaryl: Applied, as needed, five applications per season. PHI is seven days. Carbaryl may be applied by ground, air, or chemigation. It is applied at the rates of one to two pounds active ingredient per acre.

Chlorpyrifos: Maximum of two applications per season. PHI is 60 days. Chlorpyrifos may be applied by ground, air, or chemigation. It is applied at the rate of 1½ pounds active ingredient per acre. It is often used effectively at rates as low as one-half the labeled rate (cite Sandler et al. 2000 (UMass. Chart book))

Diazinon: Applied, as needed, four to six applications per season, two to three quarts per application. PHI is seven days. Diazinon may be applied by ground, air, or chemigation. It is labeled for use at rates from two (fireworm) to three (cranberry fruitworm) pounds active ingredient per acre.

Phosmet: Up to 15.6 pounds of product per season at rates ranging from 1.33 to 4.0 pounds per acre (lower rates recommended for gypsy moth and fireworms, higher rate recommended for spanworms and cranberry fruitworm). PHI is 14 days. Phosmet may be applied by ground, air, or chemigation.

Section 4: Cranberry Disease Pests

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[General comments for disease control in cranberry]

[Action items for cranberry diseases]

Fungicide use

Depending on disease severity, up to 95% of state acreage is treated with fungicides. Fruit rot fungicides are very important in the Northeast and Pacific Northwest U.S., while fungicides used to control cottonball are important in Wisconsin. National usage estimates (percentage of acreage treated) for major fungicides used on cranberries in 1998 are found in table 4.

Table 4: Selected fungicide use by state, 1998

State	**Total acreage**	**Percent of acreage treated**		
		Chlorothalonil	**Mancozeb**	**Ferbam**
WI	14,211	7.7	11.3	0.0
MA	13,370	76.2	27.7	28.4
NJ	3,795	95.0	95.0	75.0
OR	2,121	83.8	26.9	16.3
WA	1,617	56.2	77.6	12.3
US	35,114	50.1	30.6	20.5

Table 5: IR-4 Progress - Cranberry Fungicides June 2000

PR & year	Product	Target Pest	Registrant	Comments
6853 1998	Fenbuconazole	Fruit rots, cottonball	Dow AgroSciences	Petition submitted November 2000. EPA scheduled to review in 2002. Issue with all triazole fungicides may delay.
6859 1999	Azoxystrobin	Fruit rots, cottonball	Syngenta	EPA approved a reduced data set. Trials conducted in WI, OR, and MA. Petition to be submitted November 2001. EPA scheduled to review in 2002.
6320 1999	Propiconazole	Cottonball in Wisconsin	Syngenta	Project to support label in Wisconsin. Petition submitted June 1997. Propiconazole issues holding up review at EPA.
7359 1999	Propiconazole	Cottonball in Pacific Northwest	Syngenta	Project to support label in Pacific Northwest. Funded by the Washington State Commission on Pesticide Registration. Submission date not determined due to propiconazole issues. Will be submitted once issues cleared-up.

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Fungicides Registered on Cranberry

General application parameters for fungicides are as follows:

Chlorothalonil: Maximum three times per season. Applications should be made at early bloom and repeated at ten to fourteen day intervals for fruit rot control. There is a Section 24(c) registration for application at budbreak (April 25 through May 15) for control of upright dieback in all major cranberry-producing states. PHI is 50 days. Chlorothalonil may be applied by ground, air, or chemigation. It is applied at the rate of 3 to 5¼ pounds active ingredient per acre

Copper compounds [including copper hydroxide (e.g., Kocide®, Champ®, and Champion®), metallic copper (Copper-Count-N®), and copper sulfate (Top-Cop®)]: These are registered for control of fruit rot and upright

dieback disease. Copper fungicides are tolerance exempt and there is a zero day PHI. Copper hydroxide products and copper sulfate are recommended for control of fruit rot beginning at mid-bloom followed by one or two applications at ten to fourteen day intervals. Copper hydroxide products are recommended at the rate of three to five pounds active ingredient per acre per application, depending on product. Top-Cop® is recommended at the rate of ¼ pound active ingredient per acre per application.

Fosetyl-Aluminum: Applied as a foliar spray at a rate of 5 lb of product per acre to combat root rot induced by *Phytophthora sp*. Applications may not exceed four pounds per year or 20 lb per acre. PHI is 3 days.

Ferbam: Maximum of five applications per year. For fruit rot, applications of 4½ pounds active ingredient per acre should be made early bloom and repeated at fourteen-day intervals. PHI is 50 days. For fairy ring control, ferbam is applied at the rate of 0.07 pound active ingredient per *square foot* of infected bed. Ferbam applications should be made immediately after harvest. However, there is a Section 24(c) registration in Massachusetts for an application in June or July for control of fairy ring. Ferbam may be applied by ground, air, or chemigation.

Mancozeb and Maneb: Mancozeb is applied at 2.25 to 4.8 pounds active ingredient per acre per application, depending on product selected. Mancozeb applications should begin at mid-bloom and be repeated at seven to ten day intervals, with a maximum of 14.2 to 14.4 pounds active ingredient per acre per season, again depending on product selected. Maneb is applied at 2.4 to 4.8 pounds active ingredient per acre in a similar fashion with a maximum of 14.4 pounds active ingredient per acre per season. If more than one EDBC product is used in the same season the total poundage of active ingredient per acre may not exceed any one of the specified individual maximum allowable active ingredient seasonal limits. There is a 30-day pre-harvest interval. Either product may be applied by ground, air, or chemigation.

Mefenoxam: Registered for control of soil-borne diseases caused by *Phytophthora*. Mefenoxam is recommended at the rate of 0.48 to 0.85 pound active ingredient per acre per application. The first application is recommended in the fall after harvest, the second in the following spring, and the third 45 days before harvest. No more than 2.55 pounds active ingredient per acre may be applied in a single season.

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Diseases Pests

FRUIT ROTTING FUNGI, numerous species including:

Coleophoma empetri, Allantophomopsis lycopodina, Colletotrichum acutatum, Allantophomopsis cytisporea, Colletotrichum gloeosporioides, Coleophoma empetri, Fusicoccum putrefaciens, Phyllosticta elongata, Monilinia oxycocci, Physalospora vaccinii, Phomopsis vaccinii, Strasseria geniculata, **and** ***Phyllosticta vaccinii***

Cause field rot

May also cause leaf spots or blossom blights

Field rot is a serious problem every year in Massachusetts and New Jersey

Has become a more prevalent problem in the Pacific Northwest and Wisconsin.

Fruit rot fungi found wherever cranberries are grown, degree of infection is greatly affected by weather conditions.

FIELD ROT

Registered pesticides

Chlorothalonil

Good to excellent efficacy

Occasional phytotoxicity problems in WI, MA, and NJ (during bloom and during early shoot elongation)

Possibly related to formulation

Northwest growers typically apply fewer applications and lower rates

50 day PHI

Ferbam

Fair to good efficacy

Efficacy related to chemigation pressure

EBDC

Good efficacy

Can inhibit color development

Copper compounds

Poor to fair efficacy

Have a limited scope on cranberry fruit rot diseases.

Is a necessary tool in some circumstances (e.g. organic production)

Can be used as a late application fungicide

Poor efficacy in WI, OR, WA

Non-chemical controls:

Four week late water flood

Good to excellent efficacy

Reduces fruit rot in Massachusetts' tests

Works in following year to reduce fungicide applications

Has not been well tested in other areas

Late water apparently enhances fruit rot in New Jersey.

Sanding on a regular (i.e. 3-4 year) cycle

Good efficacy

Reduces inoculum

Sanding on a regular cycle may increase incidences of cottonball infection, based on limited data (all in one line)

Based on limited data

Vine pruning

Good efficacy

Decreases periods of vine wetness

STORAGE ROT:

No fungicides are registered for post-harvest application. Pre-harvest applications are relied upon to combat storage rot fungi. Rot development while in storage is applicable only to fresh fruit.

Pre-harvest pesticides registered for storage rot

Chlorothalonil

Fair efficacy in NJ, WI, OR, WA

Good to excellent efficacy in MA

Ferbam

Poor efficacy in WI, OR, WA

Fair to good efficacy in MA

EBDC

Poor efficacy in WI, OR, WA

Good efficacy in MA

Copper compounds

Poor efficacy

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UPRIGHT DIEBACK,

Phomopsis vaccinii or *Synchronoblastia crypta* (Uecker et Caruso)

Present in all regions

Sporadically serious

Develops during spring and summer when hot weather, drought, or too much moisture stresses vines

Infection occurs at bud break, symptoms do not appear until plants are stressed

Infected uprights, that appear scattered among healthy vines, take on a yellowish cast and eventually turn brown

Pesticides registered for upright dieback

Chlorothalonil

Good efficacy

Timing is critical for adequate control

Phytotoxicity can be problematic

Copper compounds

Champ is only registered material

Fair efficacy

Limited data to support efficacy

Non-chemical controls:

Reduction of heat related stress through use of irrigation

Good efficacy

Vine pruning

Good efficacy

Decreases periods of vine wetness

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PHYTOPHTHORA ROOT ROT,

Phytophthora cinnamomi, P. cryptogea and *P. megasperma*:

Major disease in MA and NJ, minor in WI, OR, WA

Primarily affects areas of beds with poorly drained soils

Infected roots result in crop loss and vine death

New vines planted where symptomatic vines were removed usually die unless a fungicide is used or drainage is improved.

Root rot will lead to increased fruit rot.

Beds will become more susceptible under economically stressed times because bed drainage maintenance is expensive.

Pesticides registered for Phytophthora root rot

Mefenoxam

Excellent efficacy for all species but *P. megasperma*

Cost is a limiting factor

Improve drainage prior to use

Multiple applications will be necessary

Fosetyl-aluminum

Excellent efficacy

Less expensive than mefenoxam

Improve drainage prior to use

Multiple applications will be necessary

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TWIG BLIGHT, Lophodermium spp.:

A major disease on the West coast. MA, NJ and WI are currently unaffected. Uprights become infected in July and August and die the following Spring. Severe infection can result in entire bed loss.

Pesticides Registered for twig blight

Chlorothalonil

Excellent efficacy

May take up to 3 applications.

Full control is expensive

EBDC

Fair to good efficacy

Mancozeb often used as the 3rd application to reduce chlorothalonil residues

COTTONBALL, *Monilinia oxycocci*:

A major disease in WI and minor in other regions. Infected fruits are unfit fit for fresh or processed markets.

Reported with greater frequency in NW

Could get worse if cranberry beds not sanitized well by trash removal

No fungicides are currently fully registered for control of cottonball

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Propiconazole

Excellent efficacy

FAIRY RING:

A major problem in NJ. Minor problems in MA, but infection rates appear to be increasing. A recently isolated fungus (species unknown) is presumed to cause infection. The infection cycle and rate of spread is poorly understood.

Can be spread from one bed to another through transport of vines uprooted and carried on equipment during harvest

Damage appears to be most severe during periods of water stress

Pesticides registered for fairy ring

Carbamate

Fair to good efficacy

Difficult and unpleasant to apply

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ROSE BLOOM Exobasidium oxycocci

The disease occurs occasionally in some Pacific Northwest bogs. It has a 1-year life cycle--infections that occur in spring do not develop symptoms until the next spring. Basidiospores produced on thickened lateral shoots infect nearby lateral buds. Spores are forcibly discharged, and wind carries them about the bog.

Symptoms: The fungus normally attacks only the auxiliary buds, causing them to produce abnormal branches with thickened, hyper-trophied, rose-color leaves that resemble miniature roses - hence the name. The fungus occasionally attacks terminal buds and blossoms. Infected blossoms are deformed and usually enlarged. Affected berries are deformed. Yield on infected fruiting uprights is reduced by a third; that is, yield falls 5% in a bed with 15% infected uprights

Copper compounds

Excellent efficacy

RED LEAF SPOT *Exobasidium rostrupii*

Disease may be severe on newly planted vines treated with high-nitrogen fertilizers for rapid growth during the first and/or second year. Shaded areas with poor air circulation may contribute to disease development. Fruit buds and blossoms injured by frost or insects are very susceptible. Symptoms may appear during rainy (misty), cloudy weather beginning in midsummer on the new growth.

Symptoms: One or several glossy red spots appear on the upper leaf surface. Spots may coalesce to form large blotches. The lower leaf surface is covered with cream-colored spores beneath the spots. The petiole and stem may become infected, enlarge, and turn red. If severe, terminal growth on uprights and runners dies and the next crop is reduced. Fruit is attacked occasionally. Reddened tissues often turn black as the black spot fungus, Mycosphaerella nigro-maculans, invades them. In combination, the two diseases occasionally do serious damage but only if incidence of red leaf spot have been high.

Pesticides registered for red leaf spot

Copper compounds

Excellent efficacy

Non-chemical control

Reduce nitrogen application to reduce vine vigor

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FALSE BLOSSOM

Blunt-nosed leafhopper has something to do with this, and we need a write-up

STEM GALL (Canker)

The etiology is not certain, but probably caused by the bacterium Erwinia herbicola (=Pantoea agglomerans). Galls develop on upright shoots and runners, eventually encircling them

and killing all tissues above the galls. Occurs sporadically in all growing regions (possibly worse in WI), with losses ranging from minor to severe. Disease is apparently worse where vines have been damaged by harvest equipment or winter injury.

Chemical control currently not recommended

Copper compounds are bactericidal and therefore might be effective, but there are no data on this.

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General comments for disease control in cranberry

Unregistered fungicides in IR-4 queue or at EPA awaiting decision:

Azoxystrobin

Undergoing registration

Has shown consistent control of fruit-rot organisms

As effective as propiconazole against cottonball under low disease pressure based on limited data.

Resistance a potential problem

Possible label requirement of rotation with compounds of different mode of action (e.g. chlorothalonil, EBDC, fenbuconazole, propiconazole)

Fenbuconazole

Undergoing registration

Resistance a potential problem

Has shown consistent control of fruit-rot organisms

As effective as propiconazole against cottonball

Propiconazole

Undergoing registration. .

Resistance a potential problem

See IR-4 Progress on page 17 for details.

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Action items for cranberry diseases:

Research

New pesticide research, particularly with strobilurin fungicides

Timing and biology of fungi

Storage quality forecast models.

Implementation of new controls in fruit rot spraying schedule

Innovative floods

Biopesticides

Sanding/ fairy ring /flea beetle interaction

Harvesting and storage technology for improving quality

Need work done on virus and virus-like diseases including false blossom phytoplasma

General disease (including nematodes) etiology

Regulatory

Register azoxystrobin, fenbuconazole, and propiconazole

Impact of eliminating insecticides that control blunt nosed leafhopper on reoccurrence of false blossom disease.

Education and training

Educate growers on resistance management for new chemicals.

Section 5: Weed Pests

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Herbicides for Cranberry

Table 6: IR-4 Progress. Cranberry Herbicides June 2000

PR & year	Product	Target Pest	Registrant	Comments
3152 1993	Pronamide [Propyzamide]	Dodder	Dow AgroSciences	Product is rated as a B^2 carcinogen. Registration is uncertain.
3882 [1991] 1999	Clopyralid	Wild bean, asters, beggar-ticks, white clover	Dow AgroSciences	Petition submitted in 2001. EPA review scheduled for 2002.
6482 1998	Thiazopyr	Sedges, dodder, and some grasses	Dow AgroSciences	Petition preparation on hold because cranberry label dependent on alfalfa registration. Alfalfa registration not expected for several years.
3023 2001	Chlorimuron	Silverleaf, nutsedge	DuPont	Field trials initiated in 2001.

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Herbicides Registered on Cranberry

General application parameters for herbicides are as follows:

2,4-D: Formulations are registered for control of numerous annual and perennial broadleaf weeds. The granular formulation should be applied in early spring after removal of the winter flood at ten to 20 pounds product per acre. Weedar 64®, a liquid 2,4-D formulation, is applied as a wipe in a ratio of 1:2 in water. One application is allowed per season.

Clethodim: A selective postemergence herbicide used to control annual and perennial grasses. Clethodim is labeled at a rate of 0.09 - 0.125 pound active ingredient per acre along with a crop oil concentrate.

Clopyralid: A selective, postemergence, broadleaf herbicide used to control wild bean,

narrow-leaved goldenrod, asters, clover, ragweed, pitchforks and other weeds. It received a Section 18 label for use in cranberries in 2000 in the states of Massachusetts, New Jersey, Oregon, Washington and Wisconsin. It is applied by either spot spray or wiper application at a rate of 0.09375 to 0.25 pound active ingredient per acre.

Dichlobenil: The single most important herbicide used in cranberry. It is used as a pre-emergence herbicide to control numerous perennial and annual, broadleaved and grassy weeds, including dodder, yellow loosestrife, narrow-leafed goldenrod, asters, rushes, and sedges. Dichlobenil is applied in early spring or post-harvest. Multiple applications are allowed with no more than four pounds active ingredient per acre allowed in a twelve-month period.

Glyphosate: A non-selective, non-residual herbicide, used to control annual and perennial grasses and broadleaf weeds by wiper application or cut-stem treatment only. It is recommended against dewberry, greenbriar, yellow loosestrife, brambles, poison ivy (vine damage possible because of low-growing nature of poison ivy), leatherleaf, spireas, and other tall woody or herbaceous weeds. The University of Massachusetts and the University of Wisconsin both recommend a 10 to 20 percent solution applied above the crop by wick or other wiper applicator anytime weeds are present. Can be sprayed in dry ditches and post harvest spot treatment. PHI is 30 days.

Napropamide: Used for the pre-emergence control of grasses, sedges, rushes, and wild bean (in combination with dichlobenil) at the rate of up to nine pounds active ingredient per acre. Up to three pounds active ingredient per acre may be applied on newly planted beds. It does not control established weeds. (check if rushes even on label – see Hilary Sandler)

Norflurazon: A soil-applied, pre-emergence herbicide recommended for the control of annual and perennial grasses, sedges, and rushes. Norflurazon is applied as a single ground or aerial application at four to eight pounds active ingredient per acre in the early spring after removal of winter flood and before weed growth resumes, or in the fall after harvest at least two weeks before winter flood. Application rates vary depending on the weed species present, soil type, and cranberry vine health status. Norflurazon is limited to one application per twelve months, not to exceed four pounds active ingredient in a newly planted bed or eight pounds per acre for established beds.

Pronamide (propyzamide): A pre-emergence herbicide that received a Section 18 label in New Jersey and Massachusetts in 2000 for the control of dodder. One application of ¾ pound active ingredient per acre was recommended.

Simazine: A pre-emergence herbicide registered for control of most annual grasses and broadleaf weeds. Growers are allowed to apply up to four pounds active ingredient per

acre. Although labeled for fall use, the University of Massachusetts and UW-Madison recommend against use of this product.

Sethoxydim: A postemergence herbicide registered for the control of annual and perennial grasses. It should be applied to actively growing weeds at no more than 0.45 pounds active ingredient per acre with a seasonal maximum of 9 pounds. The PHI is 60 days.

Sulfosate: Registered but not commonly used in industry. Non-bearing, broad spectrum.

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Weed Pests

Some of the most economically significant weeds include: *Cuscuta gronovii* (dodder), *Rubus hispidus and Rubus flagellaris* (bristly and prickly dewberry, respectively), *Smilax glauca* (glaucous greenbriar), *Apios americana* (wild bean), *Toxicodendron radicans* (poison ivy), *Smilax rotundifolia* (common greenbriar), *Lysimachia terrestris* (yellow loosestrife), *Euthamia tenuifolia* (narrow-leafed goldenrod), *Aster spp*. (asters), *Rubus allegheniensis* (blackberry), *Potentilla Canadensis* and *P. simplex* (cinquefoil),*Potentilla pacifica* and *Potentilla spp*. (lotus, silverleaf),*Equisetum spp*., *Pyrus melanocarpa* (chokeberry), *Kalmia angustifolia* (sheep laurel), *Chamaedaphne calyculata* (leatherleaf), *Juncus spp.* (sedges, rushes), perennial grasses, *Polytrichum spp*. (mosses), red maple and other trees, *Euphatorium dubium* (joe-pye weed), *Spirea latifolia and S. tomentosa* (meadowsweet and hardhack, respectively), *Bidens frondosa* (pitchfork), *Ambrosia artemisiifolia* (ragweed), *Erechtites hieracifolia* (fireweed), *Viola lanceolata* (white violet), annual grass, ferns, clover and vetch.

Native and introduced plant species are considered weeds when they invade managed cranberry beds.

Compared to other crops, cranberry has a very diverse and unique weed complex.

Weeds reduce yield and quality through competition with cranberry vines for light, air, water, and nutrients needed for growth, color, and fruit development

Heavy stands of weeds slow harvest operations

Some weeds directly damage fruit skin during harvest

One weed (dodder) is directly parasitic on the cranberry plant.

Weeds are numerous and varied

Woody and herbaceous broadleaf perennial weeds may also be found in the interior and marginal ditches as well as on ditch banks. Controlling weeds on the ditch bank may be useful in reducing the colonization of these weeds onto the bed itself.

Pre-emergence herbicide action dependant on soil type

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ANNUAL GRASSES:

Herbicides registered:

Clethodim

Excellent efficacy:

Post emergence

Dichlobenil

Fair efficacy

Pre-emergence

Not recommended for use on new beds

Glyphosate

Excellent efficacy

Broad spectrum

Post emergence

Norflurazon

Good to excellent efficacy

Variable control depending on soil type

Pre-emergent

Can have phytotoxicity problems even with lower rates on new plantings

Simazine

Poor to fair efficacy

Current formulations not as efficacious

Ground water issues

Not generally recommended, better products available.

Sethoxydim

Excellent efficacy:

Efficacy not good on annual bluegrass and fine fescue

Post emergence

Napropamide

Good to excellent efficacy on new beds

Efficacy drops on established beds.

Pre-emergence.

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PERENNIAL GRASSES:

Herbicides registered:

Clethodim

Excellent efficacy:

Post emergence

Dichlobenil

Poor to good efficacy

Dependent on soil type and target species

Glyphosate

Excellent efficacy

Broad spectrum

Post emergence

Norflurazon

Poor to good efficacy

Fair to good on weeds emerging from seeds

Poor to good on resprouting weeds

Sethoxydim

Fair to good efficacy

Multiple applications required

Napropamide

Good to excellent efficacy on new beds

Efficacy drops on established beds.

Pre-emergence.

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ANNUAL BROADLEAVES:

Herbicides registered:

2,4 – D

Fair to good efficacy

Granular and Weedar formulations used differently

Granular used in combination with Casoron

Use varies by region more use in WI and NW, less in NE

Weedar more for perennial woody weeds

Clopyralid

Fair to excellent efficacy

Efficacy variable according to target species (please add specific weeds by region)

Currently Section 18 registration only, high priority for registration nationwide.

Post emergence wipe or spray.

To avoid phytotoxicity issues use minimum effective dose at appropriate timing.

Dichlobenil

Good to excellent efficacy

Pre-emergence

Glyphosate

Excellent efficacy

Post emergence

Harder to selectively apply on low growing weeds

Simazine

Poor to fair efficacy

Current formulations not as efficacious

Ground water issues

Not generally recommended, better products available.

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PERENNIAL BROADLEAVES:

Herbicides registered:

2,4 – D (It would be helpful to separate these two formulations)

Good efficacy

Granular formulations works well on some species.

Not very effective on poison ivy

Less expensive than some of the alternatives.

Weedar is post emergence used as a wipe, granular is pre-emergence, granular is used more commonly.

Need for care in application with Weedar to prevent off target damage.

Clopyralid

Fair to excellent efficacy

Efficacy variable according to target species (please add specific weeds by region)

Currently Section 18 registration only, high priority for registration nationwide.

Post emergence wipe or spray.

To avoid phytotoxicity issues use minimum effective dose at appropriate timing.

Dichlobenil

Poor to good efficacy

Dependant on weed species, region, soil type (please add specifics)

Continues high use can lead to problems with vine vigor.

Glyphosate

Excellent efficacy

Post emergence

Harder to selectively apply on low growing weeds

Simazine

Poor to fair efficacy

Current formulations not as efficacious

Ground water issues

Not generally recommended, better products available.

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WOODY PERENNIALS:

Willows, maples, poison ivy, leather leaf, brambles, briar, dewberry, bog rosemary, St. John’s wort, (please add to list)

Cultural controls may be best.

Few controls available, severe infestations require complete renovation or replanting

Wipe with glyphosate is effective on some species.Prostrate growing perennials like brambles are not economical to wipe. For larger plants a cut stump application of glyphosate is also registered.

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DODDER**:**

Herbicides registered:

Dichlobenil

Good efficacy

Pre-emergence

Needs to be applied before dodder germinates

Very low rates still provides good control

Expensive due to split applications

Primary control material for other cranberry weeds and there is a limit of 100 pounds per acre annually.

Unregistered fungicides in IR-4 queue or at EPA awaiting decision:

Thiazopyr

Efficacy trials are limited

Has shown consistent control of dodder, nutsedge and other weeds

A number of issues are holding up registration

Mycoherbicide (Smolder)

Good efficacy

Registration petition has been submitted to EPA (BPPD)

Pronamide

Good to excellent efficacy

Efficacy is dependant on chemigation uniformity.

Section 18

Pre-emergence

Specific for dodder, easy to apply, less stress on vines,

Longer residual for long germination period of dodder

Economical

Other management aids:

Sanitation

Efficacy

Trash floods

Weed spreads with equipment, sanitation of equipment important

Water will move seeds

Seed pods buoyant

Also has established itself in swamps

Sanding

At least an inch inhibits germination

Make sure uniform application

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SEDGES and RUSHES

OTHER (mosses, horsetail, ferns)

Non-chemical controls:

Late water may effectively control dewberry and other weeds.

Fair to good efficacy

Tests are ongoing.

Sanitation may decrease spread of many weeds including dodder.

Efficacy

Universal good practice

Fall floods – targeting dewberry

-Work ongoing

-Fair to good control

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Action items for cranberry weeds:

Research

New pesticide research, particularly with sulfonylurea herbicides

Spot renovation with biocide (Basamid)

Innovative floods

Woody perennial control – herbicide and cultural controls

Post emergent application of Roundup (or other) to dormant vines

Regulatory

Register products in queue

Education and training

Implementation of new controls in weed control (pesticidal and cultural

---

Section 6: Vertebrate Pests

There is a host of vertebrate pest of cranberries. Their occurrence is species and location dependent. The following tables indicate the most common vertebrate pest and in what growing regions they are most problematic. There are no registered on-bed chemical controls of these pests. Large mammals, like elk or deer, can be fenced out or shot. Some rodents can be trapped, controlled by flooding, or baited using bait stations outside of the beds. Control of bird pests is difficult.

Table 7: Vertebrate pest by region

	Presence of Vertebrate Pest Problems in Cranberry			
Vertebrate pest	**Northwest**	**Wisconsin**	**Massachusetts**	**New Jersey**
Bear	X	X		
Deer	X	X	X	X
Elk	X	Not now, but could become when introduced		
Geese	X	X	X	X
Swans & ducks			X	X
Muskrat & nutria	X	X	X	
Voles	X	X	X	X
Beaver	X	X	X	
Mice	X	X	X	X

Section 7: Cranberry Industry Priorities

RESEARCH

High:

- New, cost iffective methods for managing all cranberry pests, including, but not limited to, cultural controls and traditional pesticides.
- Procurement of control measures, including pesticides, with alternate modes of action to aid in pest resistance management.
- Control alternatives for woody perennials and broadleaf weeds
- Control alternatives for dodder (*Cuscuta gronovii*)
- Basic biology studies for fungal pathogens

Moderate / low

- Study secondary pest outbreaks due to transition to target-specific pesticides
- Revision of ecconomic thresholds for insect pests
- Storage quality models and technology

REGULATORY

Section 3 for thiamethoxam for cranberry weevil, flea beetle, tip worm and other pests (in short term a section 18)

EPA move to complete registrations for cranberry, (1) fenbuconazole, (2) azoxystrobin, (3) propiconazole,

Section 3 registrations for (1) Clopyralid (all), (2) Pronamide (MA, NJ)

Section 3 registrations for imidacloprid, spinosad, methoxyfenozide

Continued registration of existing broad spectrum pesticides: for insecticides, the risks for some materials (azinphosmethyl, chlorpyrifos) may exceed the benefits, and loss of individual materials, as long as others remain registered, would not unduly impact cranberry pest management.

EDUCATION/TRAINING

Work together with Canadian cranberry growers

Resistance management practices through education and demonstration

Transitional uses of new registrations – demonstration/large scale use

Cultural pest management strategies - demonstrations

Section 8: Cranberry Pest Management Plan Summary

Production

Primary production areas include Wisconsin, Massachusetts, New Jersey, Oregon, and Washington. In Canada, the provinces of British Columbia and Quebec also produce cranberries.

Approximately 37,550 total acres harvested in the U.S. annually

96% processed into juice, sauce, or dried; 4% goes to fresh market

79% of all cranberries treated with insecticides are treated with OP's

Pesticides

OP's are critical to the continued production of cranberries in the US:

Chlorpyrifos and diazinon are the most widely used insecticides in cranberry production

The only insecticide to control Sparganothis spanworm and cranberry weevil in Massachusetts is chlorpyrifos

Carbaryl is not as effective as chlorpyrifos or diazinon for some pests

Phosmet is a new registration and needs further research to determine full spectrum of control.

Bt. is limited by short persistence, application systems (e.g., by irrigation in MA) and timing considerations

Cost is an increasingly important consideration in the choice of control due to a precipitous decline in cranberry price. While OP insecticides are favored by this economic climate, the use of "no cost" or low-cost controls, including innovative floods, is also favored (see Appendix 1, page 26)

IPM:

IPM practices are currently implemented on 94% of cranberry acres. Programs involve the use of scouting techniques, pheromone traps, economic thresholds, cultural practices such as flooding and sanding, augmentation of predaceous nematode populations, biopesticides and pheromones, and the use of traditional insecticides (procedures have been developed to improve timing of pest controls to coincide with critical stages of the pests life cycle). The extent of use of these tools varies between pest, season and region.

OP's and IPM:

Organophosphate use is an integral part of successful cranberry IPM programs. Few alternatives to OP's exist for the control of most cranberry pests. Tebufenozide and a carbamate (carbaryl) are the only alternatives. Until other chemistries are registered (e.g., spinosad, thiamethoxam and methoxyfenozide), the OP's will continue to play a critical role in cranberry pest control and production.

Alternatives:

The cranberry commodity has invested heavily over recent years (±$225,000; 1996-9), with grower and handler funding, in the identification, field development and registration of new reduced risk alternatives to the OP's and carbamate insecticides currently registered. Some of these products are now registered and available as Section 18's, but grower education must occur to facilitate broad implementation in the near future. Safer products include tebufenozide, spinosad, methoxyfenozide, thiamethoxam, two mating disruption pheromone products (for Sparganothis and Blackheaded fireworm), natural pyrethrins, and synthetic Cryolite bait. These products will be incorporated into existing cranberry IPM programs.

Section 9: Sources of Information

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Appendices

Appendix 1.: Pesticide common and trade names

Table 8: Pesticide Common names and Trade names

Common Name	**Trade Name**
2,4-D	2,4-D
Acephate	Orthene
Azadirachtin	Neemix
Azinphos-methyl	Guthion
Azoxystrobin	Heritage, Quadris, Abound
Bacillus thuringiensis	Bt
Beauvaria bassiana	
Blackheaded Fireworm Sprayable Pheromone	BHFW Pheromone Mating Disruptor
Canola oil	Canola oil
Carbaryl	Sevin
Chlorothalonil	Bravo
Chlorpyrifos	Lorsban
Cinnamaldehyde	Cinnacure, Cinnamite
Clethodim	Select
Clopyralid	Stinger
Copper compounds	Kocide, Top-Cop, Champ, Champion, Copper-Count-N
Diazinon	Diazinon

Dichlobenil	Casoron
Emamectin benzoate	Proclaim
Esfenvalerate	Asana
Fenbuconazole	Indar, Enable
Ferbam	Ferbam
Fosetyl-AL	Aliette
Glyphosate	RoundUp
Harpin protein	Messenger
Imidacloprid	Admire
Mancozeb	Dithane
Maneb	Maneb
Mefenoxam	Ridomil Gold
Methoxyfenozide	Intrepid
Napropamide	Devrinol
Norflurazon	Evital
Other Nematodes	NA
Phosmet	Imidan
Pronamide	Kerb
Propargite	Omite
Propiconazole	Tilt, Orbit
Pyrethrin	Pyrenone

Pyridaben	Pyramite
Sethoxydim	Poast
Simazine	Princep
Sodium alumino-fluoride	Cryolite Bait
Sparganothis Sprayable Pheromones	Sparganothis Pheromone Mating Disruptor
Spinosad	SpinTor, Success
Steinernema carpocapsae	Nematodes
Tebufenozide	Confirm
Thiamethoxam	Actara
Thiazopyr	Visor

Appendix 2: Pesticide material costs

Figure 2: Cost of selected insecticide applications (per acre) at maximum labeled rates

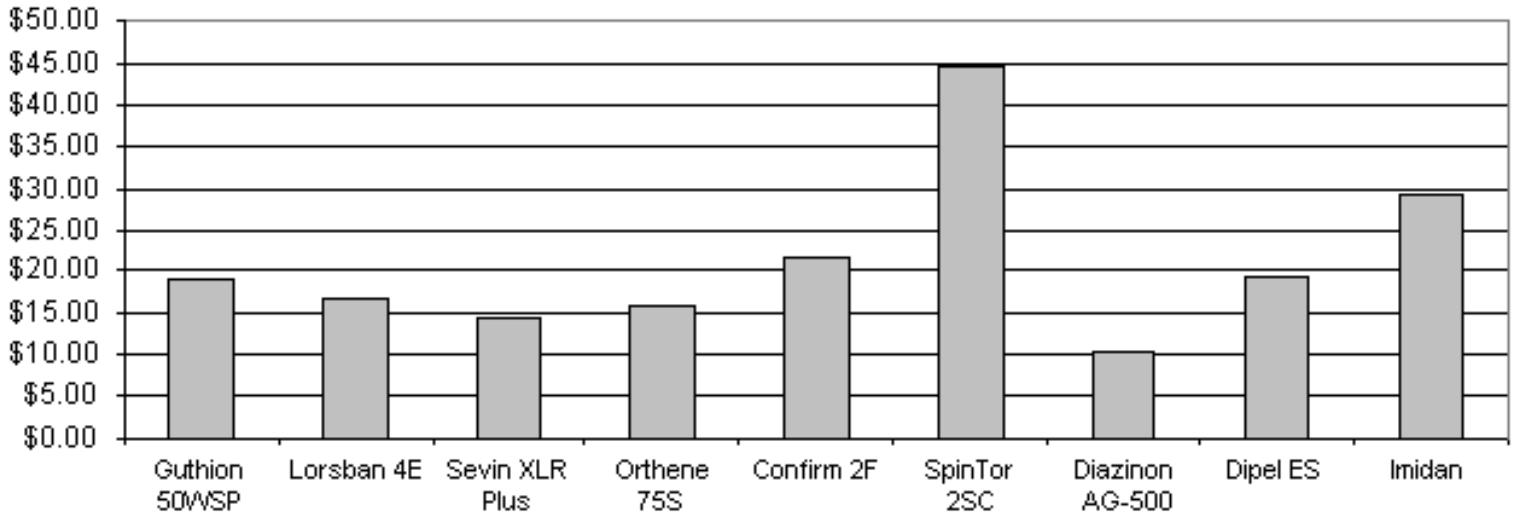


Figure 3: **Cost of selected fungicide applications per acre at maximum rates.**

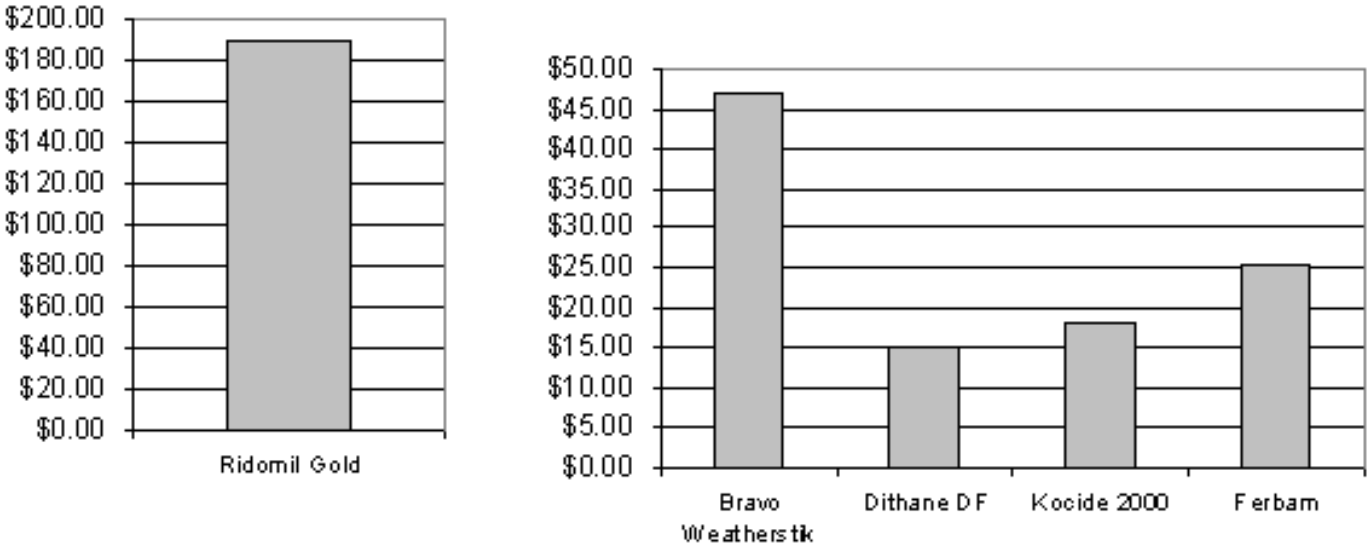
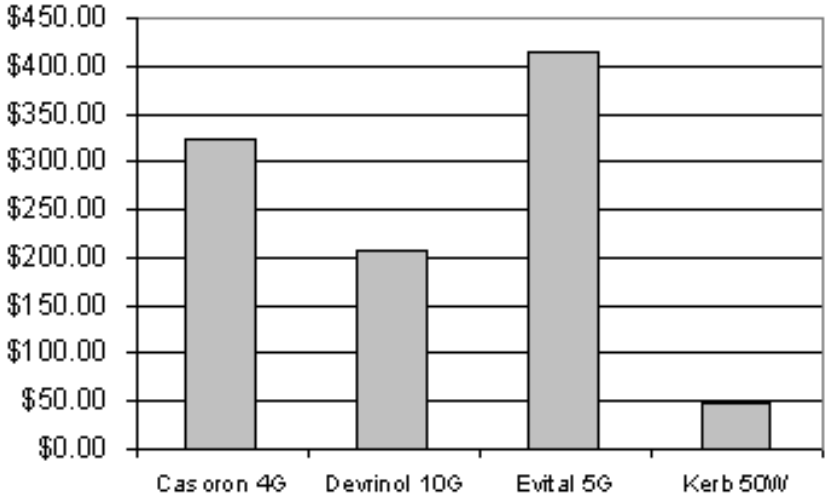


Figure 4: **Cost of selected herbicide applications (per acre) at maximum labeled rates**



Appendix 3: Efficacy Tables

Table 9: Insect Management Efficacy

Ratings: Poor, **F**air, **G**ood, **E**xcellent, **V**ariable**, NL** = Not Labeled**,**
? = More research needed

MANAGEMENT TOOLS	Cranberry fruitworm	Blackheaded fireworm	Sparganothis fruitworm	Cranberry weevil	Cranberry tipworm	Cranberry girdler	Black vine weevil	Spanworms	Cranberry flea beetle	Scarab beetles	Cutworms	Gypsy moth	Southern red mite	Cranberry rootworm	Spotted Fireworm
Organophosphates															
Acephate	G	E	V	P		NL	P-F	G		NL	G	E	NL	NL	E
Azinphos-methyl	E	E	V	P	G	NL	NL	NL		NL	F-G		NL	NL	E
Chlorpyrifos	E	E	V	P		NL	NL	G-E		NL	E		NL	NL	E
Diazinon	E	E	NL	NL	G-E	F-G	NL	NL	G	NL	G-E		NL	NL	E
Carbamates															
Carbaryl	F-G	E	NL	NL		NL	NL	NL	G	NL	F-G	E	NL	NL	
Other insecticides used															
Azadirachtin															
Bt		F-G						F-G			F-G	F-G			F-G
Canola oil															
Esfenvalerate															
Propargite															
Pyrethrin		V	V	P-F				G							V
Sodium alumino-fluoride							G-E								
Tebufenozide	F-G	F-G	G			?		G-E			G-E	E			F-G
New Chemistries (IR-4)															
Emamectin benzoate															
Imidacloprid				P		?	?							G-E	
Methoxyfenozide	E	E	E			?		E			?	E			E

Pyridaben													E		
Spinosad	E	E	E		?			E			?	E			E
Thiamethoxam				E/?	?	?			?	?				?	
Indoxacarb		?	?		?					G					
Thiacloprid	?	?	?			?	?								
Other Pest management Practices															
Fall flooding						F-G			?					?	
Summer flooding						F-G		?		?					
Winter flooding							G-E								
Sanding						E		?							
Sprayable Pheromones		V	V			?				?					
Late Water											?	?	E		
Pheromone traps															
Biological controls															
Beauveria bassiana						P-F									
Nematodes						V	V		?						
Steinernema carpocapsae							?								
Heterorhabditis sp.							?								
Biopesticides															
Pheromone/mating disruption															

Table 10:Disease Management Efficacy – Cranberry (prepared 6/20/01)

Ratings = **P**oor, **F**air, **G**ood, **E**xcellent, **NS** (not stand alone)

? = More research needed

Disease **Management Tool**	Field Rot	Storage Rot	Upright dieback	Phytophthora root rot	Twig blight	Cotton ball	Fairy ring	Rose Bloom	Red Leaf Spot	Stem Gall
B2 Carcinogens										
Chlorothalonil	F-E	F-G	G	NL	E	NL				
EBDC	F-G	V		NL	F-G	NL				
Other disease control pesticides used										
Cinnamaldehyde										
Copper compounds	P-F	P	F			NL		E	E	?
Ferbam	F-G	V					F-G			
Harpin protein										
Mefenoxam				E						
Fosetyl-AL				E						
New chemistry (IR-4) Pipeline										
Azoxystrobin						F-G				
Fenbuconazole						E				
Propiconazole						E				
Other management practices										
Late water	G-E									
Heat reduction/irrigation			G							
Improved drainage										
Sanding	G									
Vine Pruning	G		G							

Table 11:Weed Management Efficacy

Ratings = **P**oor, **F**air, **G**ood, **E**xcellent

X = registered/recommended

? = more research needed

Weed **Management Tools**	Annual grasses	Annual broadleaves	Perennial grasses	Perennial broadleaves	Woody perennials	Dodder	Brambles	Briars	Rushes	Sedges
2,4-D		F-G		G						
Clethodim	E		E							
Clopyralid		V		V						
Dichlobenil	F	G-E	V	V		G				
Glyphosate	E	E	E	E	V					
Napropamide	G-E		G-E							
Norflurazon	G-E		V							
Pronamide						G-E				
Simazine	P-F	P-F		P-F						
Sethoxydim	E		F-G							
New Chemistries IR-4 Pipeline										
Thiazopyr						?				
Mycoherbicide						G				
Other management aids										
Late water										
Sanitation						V				
Hand Pulling					V					
Sanding						V				

Appendix 4.: Cranberry PMSP Workshop Participants

Thirty-seven stakeholders representing growers, grower organizations, land grant universities and government agencies are initially participating in development of the Pest Management Strategic Plan for Cranberry. Participants represent 7 states including all with significant cranberry production, the province of Ontario, and the District of Columbia.

The following is a list of participants. Those designated with an * attended the initial workshop in Providence, RI on 8/16-17, 2001.

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