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Cranberry

Pest Management in Wisconsin

2005

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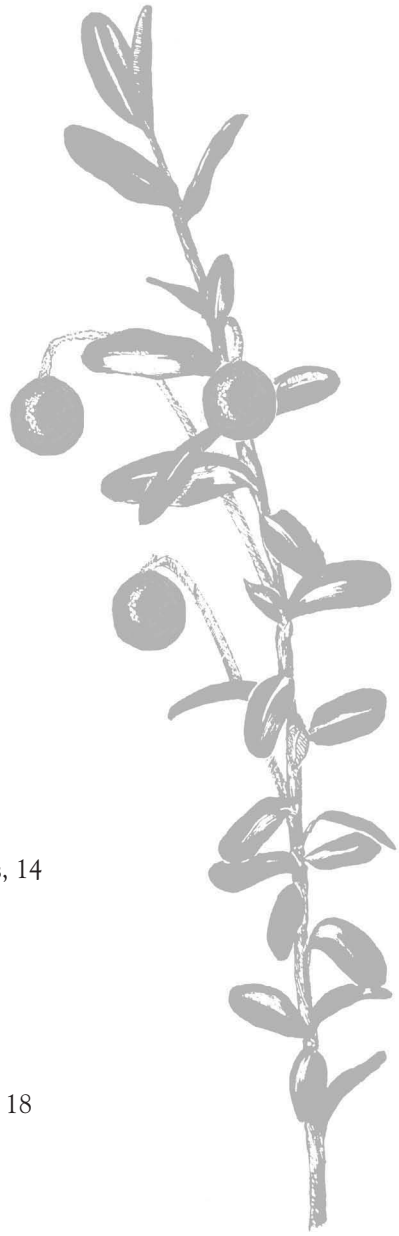

Not all cranberry pests will be present or economically important in your planting every year. Use the enclosed information and spray schedules as a guide in planning your own pest management program to fit your specific needs for the 2005 season.

It is important to keep careful records on chemicals used, strengths, amounts applied, and application dates. These records will be useful when planning future pest control practices.

Growers who use the chemical treatments described in this publication assume full responsibility for their use according to all current manufacturer label instructions. The Environmental Protection Agency (EPA) approves these instructions and their registration number appears on the label.

IN THE EVENT OF A PESTICIDE EMERGENCY, REFER TO PAGES 5–7

Recommendations in this publication expire December 31, 2005.

Pest management and pesticides

Controlling a pest is only part of a total pest management program. Pest control is a corrective measure; you use pesticides or some other control method to reduce a damaging (or potentially damaging) pest population. Pest management, however, includes preventative measures as well.

The primary goal of your pest management program is to maintain pest damage at an acceptable level. Years ago, especially with the advent of pesticides, people thought they could eradicate pests. We know now that this is rarely possible; pest populations merely adapt to our control tactics. In fact, our attempts at eradication may create more problems than they solve (pesticide resistance, secondary pest outbreaks, etc.). Pesticides are vital, effective tools for agriculture but they can no longer be viewed as a cure-all for all of our pest problems. Rather, they must be viewed in the context of a total pest management program.

Integrated pest management

Integrated Pest Management (IPM) is the coordinated use of multiple pest control methods. It encourages the use of all available techniques where practical and does not rely on a single-method approach. A sound IPM program can help us apply pesticides only when necessary.

IPM is by no means a new concept; some forms of integrated pest control have been practiced for centuries. The significance of today's IPM concept is that it is based on a scientific and systematic approach. You must be familiar with the crop, the pest, and all available control tactics to develop and implement an IPM program.

To help train growers, field scouts, and consultants, the University of Wisconsin conducts field scout training classes each year in Madison and River Falls, and a Wisconsin crop diagnosis training program at Arlington. In addition, IPM training seminars are available throughout the year for nursery crops. For more information about the Wisconsin IPM program, contact your county Extension agent or call the state IPM coordinator at 608-263-4073.

Federal pesticide-use law

When Congress amended the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) in 1972, it included a mandate for the Environmental Protection Agency (EPA) to evaluate all new and existing pesticide products for potential harm they may cause. It also made it illegal to use, except as provided by FIFRA, any pesticide in a manner inconsistent with its labeling. Deviations from the label not recognized by FIFRA are a violation of the law.

The Food Quality Protection Act (FQPA) of 1996 strengthens the system that regulates pesticide residues on food. Recognizeing that pesticide residues are present in more sources than just food, the FQPA sets limits on the total exposure from residues found in food, drinking water, and nondietary sources (such as household, landscape, and pet uses). As a result, the more uses a particular pesticide has, the greater the chance its total exposure will be met and, thus, some or all of its uses will be canceled.

If, during the pesticide registration process, the EPA finds a product to generally cause unreasonable adverse effects on the environment, including injury to the applicator, it will be classified as restricted-use. Because restricted-use products can be used only by certified applicators, the FIFRA amendments also called for each state to develop a program for training and certifying pesticide applicators. The certification program is designed to ensure that users of restricted-use products are properly qualified to handle and apply these materials safely and efficiently. A current list of restricted-use pesticides registered for use in Wisconsin may be downloaded from http://ipcm.wisc.edu/pat/other/factsheet.htm.

Wisconsin's training and certification program

In Wisconsin, responsibility for training lies with the University of Wisconsin-Extension's Pesticide Applicator Training (PAT) program, while actual certification is the responsibility of the Wisconsin Department of Agriculture, Trade, and Consumer Protection (WDATCP). The Wisconsin Pesticide Law requires that all commercial applicators for hire participate in the training and certification process if they intend to use any pesticide in the state of Wisconsin, whether or not it is restricted-use.

Since 1977, the PAT program has trained over 176,000 Wisconsin applicators in the safe handling of pesticides. The training prepares the applicators for the written certification exam administered by the WDATCP, which enforces Wisconsin's pesticide regulations.

The selection, use, and potential risks of pesticides vary depending on the method of application and what it is you want to protect from pests. Therefore, there is a separate training manual and certification exam for 21 pest control categories, including categories for: agricultural producers, the agricultural industry (10 categories), in and around commercial and residential buildings (6 categories), in right-of-way and surface waters (3 categories), and preserving wood. Certification is valid for 5 years, after which you can recertify by passing a new exam that is based on a revised training manual.

Nearly 100 percent of 4,500 applicators surveyed said training materials helped them to use pesticides properly. Over 86 percent changed their pesticide-handling practices as a result of the training. Finally, the regulated community—including pesticide manufacturers, dealers, and applicators—strongly support training and certification as a way to protect people and the environment while ensuring that pesticides remain an option in pest management. We encourage all applicators to take advantage of the training and certification process, whether or not you use restricted-use pesticides.

If you want or need to become certified or recertified, contact your county Extension office.

Wisconsin pesticide laws and regulations

Operating under the provisions of the Wisconsin Pesticide Law and Administrative Rule, Chapter ATCP 29 (Register, May 1998), the WDATCP has primary responsibility for pesticide use and control in the state. The Wisconsin Department of Natural Resources (WDNR) has responsibility for pesticide use involving "waters of the state," the control of birds and mammals, and pesticide and container disposal. The Wisconsin Division of Emergency Management (WDEM) has responsibility for helping communities evaluate their preparedness for responding to accidental releases of hazardous compounds, including pesticides, under Title III of SARA. Finally, it is your personal obligation to become familiar with all pertinent laws and regulations and to adhere to them explicitly.

Pesticides and Community Right-to-Know

Many communities are concerned about health and environmental consequences if a hazardous substance should spill in their area. To help communities evaluate their preparedness for responding to chemical spills, Congress passed the Emergency Planning and Community Right-to-Know Act. This law is part of a much larger legislation called the Superfund Amendments and Reauthorization Act (SARA) and is often referred to as Title III of SARA. Title III sets forth requirements for reporting of hazardous substances stored in the community and for developing an emergency response plan. Wisconsin passed a similar law, Wisconsin SARA Law, which establishes the reporting and planning structure in our state.

The first step in emergency planning is to know which chemicals can cause health problems and environmental damage if accidentally released. The EPA prepared a list of such chemicals and called them extremely hazardous substances. These substances are subject to emergency planning and the threshold planning quantity, the smallest amount of a substance which must be reported. Some of the chemicals listed are commonly used in agricultural production (see table 1).

Table 1. Examples of agricultural chemicals subject to Title III of SARA

Active ingredient	Trade name	Threshold planning quantity (lb or gal of product)
azinphos-methyl	Guthion 35WP	28.5 lb
dimethoate	Dimethoate 4EC	125 gal
endosulfan	Thiodan 50W	20 lb
paraquat	Gramoxone Max	3.3 gal

A complete list of EPA's extremely hazardous substances is available from the Local Emergency Planning Committee in your county or from the EPA web site: www.epa.gov/swercepp/ehs/ehslist.html.

Any facility, including farms, that produces, uses, or stores any of these substances in a quantity at or greater than their threshold planning quantity must notify the WDEM and their Local Emergency Planning Committee (LEPC) that it is subject to the emergency planning notification requirements of Title III of SARA. Notification must include the name and location of the facility, kinds and amounts of extremely hazardous substances stored, and name of a contact person.

In addition to emergency planning notification, agricultural service businesses with one or more employees are subject to two community right-to-know reporting requirements: submission of material safety data sheets (MSDS) and submission of Tier II inventory forms. Tier II forms request specific information on each hazardous chemical stored at or above its threshold. They are due March 1 annually. There are fees associated with reporting requirements: a one-time emergency planning notification fee and an annual inventory fee based on the number of chemicals that are reported on Tier II forms. Farms employing the equivalent of 10 or more full-time employees also are subject to these community right-to-know reporting requirements and associated fees.

Worker Protection Standard (WPS) for agricultural pesticides

The federal Worker Protection Standard (WPS) for Agricultural Pesticides took effect January 1, 1995. Its purpose is to reduce the risk of employee exposure to pesticides. You are subject to the WPS if you have at least one employee who is involved in the production of agricultural plants in a nursery, greenhouse, forest, or farming operation.

The WPS requires employers to do the following:

- Display pesticide safety information in a central location.
- Train uncertified workers and handlers on general pesticide safety principles.
- Provide personal protective clothing and equipment to employees.
- Provide a decontamination site (water, soap, towels, and coveralls).
- Provide transportation to an emergency medical facility for employees who are poisoned or injured by pesticide exposure.
- Provide notification to employees about pesticide applications (see below).

For more information about the WPS and the training requirements for uncertified workers and handlers, ask for a copy of EPA's *How To Comply* manual from your county Extension office.

Oral notification and posting

The WPS requires employers to give notice of pesticide applications to all workers who will be in a treated area or walk within 1/4 mile of a treated area during the pesticide application or during the restricted entry interval (described below). Notification may either be oral warnings or posting of warning signs at entrances to treated sites; both are necessary if the label requires dual (oral and posting) notification. A current list of dual-notice pesticides registered for use in Wiscosnin may be downloaded from http://ipcm.wisc.edu/pat/other/factsheet.htm.

Wisconsin's ATCP 29 posting rule is designed to protect the general public as well as workers. Thus, it requires posting of areas treated with pesticides having a dual notification

statement or, for nonagricultural pesticide applications, if the label prescribes a restricted entry interval for that particular application. Refer to *On-Farm Posting of Pesticide-Treated Sites in Wisconsin* for a flow chart guiding users through a series of questions to determine when posting of treated sites is needed, what warning sign to use, and where the sign should be located. It also covers the separate posting requirements for chemigation treatments. This publication is available from your county Extension office or it may be downloaded from http://ipcm.wisc.edu/pat/other/factsheet.htm.

There are separate posting requirements for applications involving chemigation.

Restricted entry interval (REI)

A restricted entry interval (REI) is the length of time that must expire after pesticide application before people can safely enter the treated site without using personal protective equipment. Pesticide residues on a treated crop or in a treated area may pose a significant hazard to workers or others who enter the area after treatment. Therefore, nearly all pesticides affected by the WPS (see above) have an REI (see table 3). Check the Agricultural Use Requirements section on the label for the specific restricted entry interval for your product. These intervals must be strictly observed.

Pesticide tolerance levels

In Public Law 518, the Food and Drug Administration (FDA), a division of the U.S. Department of Health and Human Services, warns "Food shipments bearing residues of pesticide chemicals in excess of established tolerances will be contraband and subject to seizures as adulterated." This applies to both raw and processed foods.

The amount of pesticide residue in or on a food material at harvest must fall into established tolerances, expressed in parts per million (ppm). The actual amount of pesticide chemical found in a food at harvest depends in part on the amount applied to the crop and the length of time since the last application. Therefore, growers are responsible for strictly following label information with regard to maximum spray dosage and the interval between the final pesticide application and harvest. The FDA advises pesticide users to follow directions on recently registered labels, so they don't exceed the residue tolerances for the specific materials. Use table 3 as a guide to the interval between the last pesticide application and harvest. The pre-harvest intervals refer to pesticide use on cranberries only; other crops may have different intervals. The pesticide label also lists this information.

Pesticide toxicity

There are four common ways in which pesticides enter the human body—through the skin (dermal), the mouth (oral), the lungs (inhalation), and the eyes. Absorption through the skin is the most common route of poisoning of agricultural workers.

Perhaps the greatest hazard for the applicator is in loading and mixing the pesticide concentrate, which presents a significant risk of exposure to the chemical in its most toxic form. Although hazards associated with the actual application are frequently much less severe, they can still be substantial, especially if there is significant drift or if appropriate precautions are ignored. A pesticide may be toxic as a result of exposure to a single dose (acute toxicity) or as a result of repeated exposures over time (chronic toxicity).

Acute toxicities are normally expressed as the amount of pesticide required to kill 50% of a population of test animals (usually rats or rabbits). For oral and dermal exposure, this is referred to as the LD_{50} or "lethal dose to 50%" in milligrams of toxicant per kilogram of body weight (mg/kg). For inhalation exposure, it is expressed as the LC_{50} or "lethal concentration to 50%" in parts per million (ppm) of toxicant in the total volume of air when the toxicant is a gas or vapor, and in micrograms per liter (µg/l) when the toxicant is a dust or mist. ***Pesticides with greater acute toxicities have lower LD_{50} and/or LC_{50} values; that is, it takes less of the chemical to kill 50% of the test population.***

A label must indicate the relative level of toxicity. It does so through the use of signal words and symbols that are established by law and reflect general categories of toxicity. The toxicity category is assigned on the basis of the highest measured toxicity, be it oral, dermal, or inhalation; effects on the eyes and external injury to the skin are also considered.

Table 2. Toxicity categories of pesticides

	Toxicity category			
	I	II	III	IV
Measure of toxicity	Highly toxic	Moderately toxic	Slightly toxic	Relatively nontoxic
Oral LD_{50} (mg/kg)	0–50	50–500	500–5,000	>5,000
Dermal LD_{50} (mg/kg)	0–200	200–2,000	2,000–20,000	>20,000
Inhalation LC_{50}				
gas/vapor (ppm)	0–200	200–2,000	2,000–20,000	>20,000
dust/mist (μg/l)	0–2,000	2,000–20,000	20,000–200,000	>200,000
Eye effects	corrosive	irritation for 7 days	irritation for <7 days	none
Skin effects	corrosive	severe irritation	moderate irritation	mild irritation
Signal word/ symbol	DANGER or DANGER/POISON [a] with skull & crossbones	WARNING	CAUTION	CAUTION

mg/kg = milligrams per kilogram
ppm = parts per million
μg/l = micrograms per liter
< = less than
> = greater than

[a] Products assigned to Category I due to eye effects or external injury to the skin do not have the word "poison" or the "skull and crossbones" symbol on the label.

Human poisoning

Pesticide poisoning. The effects of organophosphate and carbamate poisoning are rapid. ***Poisoning must be recognized early for effective treatment.*** Early symptoms are usually a headache, feeling of weakness, blurred vision, excessive perspiration, and nausea. Abdominal cramps, vomiting, and excessive salivation may set in with, or without, diarrhea. The throat and chest will feel constricted and breathing will be difficult. In mild cases of poisoning, some of these symptoms may be absent.

In case of human poisoning. Call a doctor at once if you suspect organophosphate or carbamate poisoning. If symptoms develop and the patient is conscious, give two atropine tablets (1/100 grains each) immediately. Move the individual from the area of exposure. Remove contaminated clothing and wash skin with plenty of soap and water to remove all traces of the chemical. If chemical is swallowed, induce vomiting by giving warm soapy water. Avoid all further exposure to phosphate or carbamate insecticides. Victims are very susceptible to even small exposures until blood and tissue cholinesterase regenerate.

Atropine is not an antidote for all pesticides. If there is any doubt, read the pesticide label before acting. Each pesticide has treatment information on the label. Begin this treatment as soon as possible. Take the victim to professional medical help immediately. Take along a copy of the pesticide label, or at least the chemical and common names of the active ingredient(s) and the name and address of the manufacturer. A medical emergency phone number often is listed on the pesticide label.

Poison Control Center (1-800-222-1222). You may call the Poison Control Center at any hour for information regarding proper treatment of pesticide poisoning. While other hospitals and medical facilities may have some information, the Poison Control Center has the most complete and current files and their personnel are specifically trained to deal with poison cases.

Most labels also list a phone number that you (or medical personnel) can call for specific information on poisoning (or other accidents) involving that particular product.

Pesticide safety

Before you handle pesticides, ***stop and read the label.*** Labels contain human safety precaution statements and list the specific personal protective clothing and equipment that you need to wear. Some of the following may be label requirements; others are commonsense guidelines that will help minimize pesticide exposure to you, your family and neighbors, and the environment.

- Wear a long-sleeved shirt, long trousers, shoes, and socks when handling pesticides.
- Wear coveralls (fabric or chemical-resistant) over your work clothes for an added layer of protection.
- Unless the label states otherwise, always wear chemical-resistant gloves whenever you work with pesticides.
- Wear chemical-resistant footwear, gloves, eyewear, and respirator (if the label requires one) when mixing, loading, or applying pesticides.
- If you wear fabric coveralls, also wear a chemical-resistant apron when mixing and loading pesticides.
- Stand in the crosswind when mixing or loading pesticides.
- Never apply pesticides when there is the likelihood of significant drift.
- Never leave a spray tank containing pesticide unattended.
- Avoid back-siphoning into the water source.
- Never eat, drink, or smoke when handling pesticides.
- Wash hands thoroughly after handling pesticides.
- If you splash pesticide on yourself, remove contaminated clothing immediately and wash yourself thoroughly.
- Wash contaminated clothes separately from other household laundry.
- Keep pesticides in original containers.
- Store and lock pesticides out of the reach of children.
- Observe restricted entry intervals on a treated crop or area.

Pesticide accidents

Pesticide spills. Regardless of the magnitude of a spill, the objectives of a proper response are the same—you must ***control*** the spill, you must ***contain*** it, and you must ***clean it up***. A thorough knowledge of appropriate procedures will allow you to minimize the potential for adverse effects.

The Wisconsin Spill Law provides specific guidelines for reporting spills to the WDNR. You do NOT need to report the spill if it is completely confined within an impervious secondary containment, and the spilled amount can be recovered with no discharge to the environment. On the other hand, a spill of any amount is reportable if it occurred outside of secondary containment and it caused, or threatens to cause, adverse effects on human health or the environment (e.g., back siphoning). The spill is exempt from the WDNR reporting requirements if you deem the spill will not cause, or threaten to cause, such adverse effects, and the amount spilled would cover less than 1 acre if applied at labeled rates and, if a SARA pesticide, is less than the reportable quantity.

Reportable spills involving SARA substances (see "Pesticides and Community Right-to-Know," above) are to be reported to the WDEM, your LEPC, and the WDNR. Spills of any other compound need to be reported only to the WDNR. To simplify emergency notification requirements to state agencies, call the WDEM spill hotline (1-800-943-0003, 24-hour number) whenever a spill of any compound occurs. Calling this hotline will not, however, remove your responsibility of notifying your LEPC.

Spills of some compounds may require that you notify federal authorities by calling the National Response Center (1-800-424-8802). Your call to the WDEM spill hotline should provide you with assistance in determining whether federal authorities need to be notified.

Pesticide fires. In the event of a fire, call the fire department and clear all personnel from the area to a safe distance ***upwind*** from smoke and fumes. Isolate the entire area. Always inform the fire department of the nature of the pesticides involved and of any specific information that may help them in fighting the fire and protecting themselves and others from injury. For information on cleanup and decontamination, contact the WDEM and the pesticide manufacturer(s).

Livestock poisoning. When you suspect animal poisoning by pesticides, first call your veterinarian. If the cause of poisoning cannot be determined, call the WDATCP's Animal Toxic Response Team at 608-224-4500.

Wildlife poisoning or water contamination. Contact the WDNR district office. District offices are located in Spooner, Rhinelander, Eau Claire, Green Bay, Milwaukee, and Fitchburg.

Pesticide drift

It is impossible to totally eliminate pesticide drift. Drift occurs because of unforeseen wind variations and other factors, many of which are beyond the applicator's control. People living in areas subject to pesticide drift worry about the acute and chronic effects of exposure to pesticides. State rules governing pesticide drift attempt to strike a balance between the intended benefits of pesticide use and the potential risks to those exposed to pesticide drift.

According to state law, people living adjacent to land that is aerially sprayed with pesticides can request to be notified at least 24 hours before application. Beekeepers also are entitled to notification of applications that occur within a 1.5-mile radius of their honey-bee colonies. Both ground and aerial pesticide applications are subject to advance notification requirements to beekeepers who request such notification.

For ground applications, you can minimize drift by following these recommendations:

- Follow all label precautions for specific drift-reduction measures.
- Spray when wind speed is low.
- Use the maximum nozzle orifice without sacrificing pest control activity.
- Keep pressure at the lowest setting possible without distorting spray pattern and distribution.
- Use drift-control agents when permitted by product label.
- Consider using nozzles specifically designed to reduce drift.
- Leave an untreated border strip next to adjacent property.

For more information about drift—what it is, how it occurs, and drift management principles—ask for *Managing Pesticide Drift in Wisconsin: Field Sprayers* from your county Extension office. This publication also describes the critical role the pesticide applicator plays in deciding whether to spray when arriving at the site.

Pesticides and groundwater

Agricultural chemicals are essential to the production of our nation's food and fiber. However, trace amounts of these same chemicals are now appearing in our nation's groundwater. To minimize further contamination, many pesticide labels contain precautionary statements either advising against or prohibiting use in areas vulnerable to groundwater contamination. A summary of these precautionary statements is included under "Remarks" for each pesticide in this publication.

To protect our state's water resources, Wisconsin's Groundwater Law created two guidelines to limit the presence of fertilizer and pesticides in groundwater: ***enforcement standards*** are maximum chemical levels allowed in groundwater and ***preventive action limits*** are set at a percentage of the enforcement standard. When contamination approaches preventive action limits, the responsible party must implement corrective measures to prevent further contamination.

Since 1984, several groundwater monitoring studies have been conducted in Wisconsin to determine the extent of contamination. The results of these studies indicate widespread pesticide and nitrate contamination of our groundwater resources. The most commonly found pesticide is atrazine. Consequently, Wisconsin implemented Chapter ATCP 30 to help minimize further contamination of our groundwater by atrazine. Under this rule, statewide rate restrictions have been implemented and, in some geographic areas, the use of atrazine is prohibited.

Mixing and loading pesticides. Mixing and loading pesticides pose a high risk of point source contamination of ground–and surface water because of the concentration, quantity, and type of pesticides that are usually handled at a mixing and loading site. To minimize this risk of environmental contamination, Wisconsin requires that certain mixing and loading sites have secondary containment.

Both private and commercial applicators are required to have a mixing and loading pad if more than 1,500 lb of pesticide active ingredient are mixed or loaded at any one site in a calendar year, or if mixing and loading occurs within 100 feet of a well or surface water. In–field mixing is exempt from the pad requirements provided mixing or loading at the site of application occurs 100 feet or more from a well or surface water.

Agricultural Chemical Cleanup program. Cleanup of contaminated soil or of contaminated groundwater itself is costly. The Agricultural Chemical Cleanup program helps ease the financial burden for facilities and farms by reimbursing them for eligible costs associated with the cleanup of sites contaminated with pesticides or fertilizers. For more information, contact the WDATCP at 608-224-4519.

Calibrating pesticide equipment

Accurate and uniform pesticide application is basic to satisfactory pest control. Too often a grower does not know exactly how much pesticide has been used until the application is completed. This leads to substantial monetary losses due to unnecessary pesticide and labor costs, unsatisfactory pest control resulting in reduced yields, and crop damage. Good pesticide application begins with accurate sprayer or granular applicator calibration. One method of calibration is described in the private pesticide applicator training manual *Pest Management Principles for the Private Applicator*. It also is found in the training manual *Pest Management Principles for the Commercial Applicator: Fruit Crop Pest Control*.

Planter granular applicators can be calibrated by adjusting the feed adjustment as suggested by the manufacturer and catching granules from one discharge tube or tube attachment. As rows are narrowed, the same rate per linear foot of row needs to be maintained.

Cleaning pesticide sprayers

Thorough sprayer cleaning is necessary when switching from one pesticide type to another. This is especially important when herbicides are applied with the same equipment as fungicides or insecticides. If you apply significant quantities of different types of pesticides, reserve one sprayer for herbicides only and another for insecticides and fungicides.

Follow these guidelines for cleaning spray equipment. Clean on a wash pad and apply rinsate to sites listed on label.

1. Flush the sprayer tank, lines, and booms thoroughly with clean water and apply the pesticide-contaminated rinsate to sites listed on label.
2. **Hormone-type herbicides (e.g., 2,4-D, Banvel):** Fill the sprayer with sufficient water to operate adding 1 quart household ammonia for every 25 gallons of water. Circulate the ammonia solution through the sprayer system for 15 to 20 minutes and then discharge a small amount through the boom and nozzles. Let the solution stand for several hours, preferably overnight. (Please note: household ammonia will corrode aluminum sprayer parts.)

   Insecticides, fungicides, and other herbicides: Fill the sprayer with sufficient water to operate adding 1/4 to 2 lb powder detergent (liquid detergent may be substituted for powder at a rate to make a sudsy solution) for every 25to 40 gallons of water. Circulate the detergent solution through the sprayer system for 5 to 10 minutes and then discharge a small amount through the boom and nozzles. Let the solution stand for several hours, preferably overnight.
3. Wash the tank and pump parts thoroughly by running the sprayer for about 5minutes with the nozzles closed.
4. If possible, let the cleaning solution stand in the sprayer overnight. (Please note: household ammonia will corrode aluminum sprayer parts.)
5. Discharge the liquid from the tank, spraying some through the nozzles.
6. Drain the sprayer completely and remove nozzles, screens, and strainers.
7. Scrub all accessible parts with a stiff bristle brush.
8. Rinse the sprayer thoroughly with clean water and reassemble.

Preparing pesticide sprayers for storage

Before storing the sprayer at the end of the season:

1. Clean the sprayer per label instructions or as specified above.
2. Fill the sprayer with sufficient water to operate adding 1 to 5 gallons of lightweight emulsifiable oil, depending upon the size of the tank. Circulate the oil/water solution through the sprayer system for 5 to 10 minutes.
3. Flush the solution out of the spray tank and through the boom; the oil will leave a protective coating on the inside of the tank, pump, and plumbing.
4. Remove the nozzles, screens, and strainers and place them in diesel fuel or kerosene to prevent corrosion. Cover the nozzle openings in the boom to prevent dirt from entering.
5. As an added precaution to protect pumps, pour 1 tablespoon of radiator rust–inhibitor antifreeze in each of the inlet and outlet ports. Rotate the pump several revolutions to completely coat the interior surfaces.

Pesticide disposal

It is the legal responsibility of all pesticide users to properly dispose of pesticide waste. Disposal is the final act of safe and judicious pesticide use. Follow established guidelines to ensure that human health and the environment are not subject to unreasonable risks. It is illegal to bury or burn any pesticide containers in Wisconsin.

Some pesticides are considered "hazardous" by the EPA. Disposing waste or excess resulting from use of these pesticides comes under stringent regulations of the Resource Conservation Recovery Act (RCRA). This federal law and the accompanying state law (NR 600) regulate generators of hazardous waste—those who need to dispose of hazardous pesticides.

The simplest way to avoid becoming a hazardous-waste generator is to triple rinse all pesticide containers and apply rinsates to labeled sites. If you must generate hazardous waste, disposal procedures may differ depending on the volume of waste generated and its characteristics. Regardless of the volume generated, you are responsible for disposing of it in an environmentally acceptable manner.

You can reduce the amount of pesticide waste (hazardous or not) by following these steps:

- Determine whether the pesticide you intend to use is considered hazardous by the EPA. A list of these pesticides is available from your county Extension office. If listed, check for alternative pesticides that are not hazardous and will provide equivalent pest control.
- Mix only the amount of pesticide needed and calibrate equipment so all solution is applied.
- Attach a clean water supply to the sprayer unit so the tank can be rinsed and the rinsate applied to the labeled site while still in the field.
- Triple rinse all pesticide containers. Even if the pesticides were hazardous, a triple-rinsed container is not hazardous waste and you can dispose of it in a sanitary landfill.
- Don't mix hazardous waste with other pesticide waste. This will result in the entire mixture being considered hazardous.

Wisconsin Clean Sweep program. The Wisconsin Clean Sweep program (formerly Pesticide Clean Sweep) offers a way to dispose of most kinds of pesticide waste including liquids, dry formulations, and hazardous pesticides. The program has two components to deal with agriculture and household pesticides. Wisconsin Clean Sweep is sponsored by WDATCP and individual counties. Check with your county Extension office or WDATCP (608-224-4545) for details on when a site will be held in your area.

Plastic pesticide container recycling program. The best way to dispose of plastic containers is to recycle them. The Wisconsin Fertilizer and Chemical Association (WFCA) sponsors this program and sets up collection sites throughout the state. This program accepts triple-rinsed plastic pesticide containers dropped off at designated sites. Dirty containers will not be accepted. The containers are then transported to a granulation site where they are pelletized for recycling. Check with WFCA (608-249-4070) or your county Extension office to find out when a collection site will be in your area.

Please note that this recycling program is not a Wisconsin Clean Sweep program; waste pesticides will not be accepted at container collection or granulation sites.

Recycling mini-bulk tanks. In addition to recycling small containers, Wisconsin dealers and growers also may recycle mini-bulk tanks (60 gallons and larger). Only dealers are allowed to bring tanks to the collection site, although the program will accept farmers' tanks if they are brought to the site by a dealer. There is a nominal fee and tanks must have all metal removed. Note: a collection site is being planned for 2005, so please check with WFCA (608-249-4070) for details.

A final word

Chemical pesticides help make disease, insect, and weed management programs successful. However, pesticides present hazards to agricultural workers, the general public, and the environment. Therefore, they should be used wisely, safely, and only when needed. Proper crop management can lessen the need for pesticide use, because a well-maintained planting is less susceptible to disease, insect, and weed pests.

Note: When applying a pesticide, always follow the directions on the pesticide label. Label information changes from time to time. The current pesticide label is the final authority for safety and legality.

Table 3. Toxicity information, restricted-entry intervals and preharvest intervals of commonly used cranberry pesticides

Common name	Trade name	Cautionary signal word	Oral LD_{50}[a] (mg/kg)	Dermal LD_{50}[a] (mg/kg)	Restricted-entry interval (hours)	Preharvest interval[b] and limitations (days)
2,4-D	Weed-Rhap	caution	300–1,200	—	12	NA[c]
acephate	Orthene	caution	866–945	>10,250	24	75–90[d]
azinphos-methyl	Guthion	danger-poison	13	220	7 days	21
azoxystrobin	Abound	caution	>5,000	>4,000	4	3
carbaryl	Sevin	caution	307	2,000	12	7
chlorothalonil	Bravo	warning	9,000	>2,000	48	50
chlorpyrifos	Lorsban	warning	380	>2,000	24	60
clethodim	Select	warning	3,610	>5,000	12	30
clopyralid	Stinger	caution	>5,000	>5,000	12	50
copper ammonium carbonate	Copper-Count-N	caution	low toxicity	—	12	exempt[e]
copper hydroxide	Kocide, Champ, Champion	caution-danger	1,000	—	48	exempt[e]
diazinon	D•Z•N Diazinon, Spectracide	caution or warning	66	379	12–24[f]	7
dichlobenil	Casoron, Norosac	caution	3,160	—	12	NA
ferbam	Carbamate, Ferbam Granuflo	caution	>5,000	>4,000	24	Do not apply later than 28 days after mid-bloom
fluazifop-P-butyl	Fusilade 2000	caution	2,712–4,096	2,000	12	365
fosetyl-aluminum	Aliette	caution	2,860	>2,000[g]	12	3
glyphosate	Roundup, Roundup Ultra	warning caution	4,900 4,900	— —	12 4	30 30
imidacloprid	Admire	caution	>4,000	>2,000[g]	12	30
mancozeb	Dithane, Manex, Manzate, Penncozeb	caution	>5,000	>5,000	24	30
mancozeb + copper hydroxide	Mankocide	danger	2,535	>5,000	48	30
maneb	Maneb	caution	>5,000	>2,000	24	30
mefanoxam	Ridomil Gold	caution	1,172	>2,020	48	45
methoxychlor	Marlate	caution	6,000	2,800	12	14
napropamide	Devrinol	caution	5,000	—	12	NA
norflurazon	Evital	caution	8,000	20,000	12	NA
phosmet	Imidan	warning	126–681	>2,000	24	14
sethoxydim	Poast	caution	2,676–3,125	L	12	60
spinosad	Entrust, SpinTor	caution	>5,000	>2,000	4	21
sulfosate	Touchdown	caution	780	>2,000	12	365
tebufenozide	Confirm	caution	>5,000	>5,000	4	30

Abbreviations: L = little or no reaction; NA = not applicable; — = unknown.

[a] LD_{50} values are based on male rats except where noted.

[b] Days between final spray and harvest

[c] Not applicable.

[d] Maximum of one application per season. Valent products have a 75-day preharvest interval, products of other registrants have a 90-day preharvest interval.

[e] Exempt from tolerance—Fixed copper materials are exempt from the requirement of a tolerance when applied to growing crops in accordance with good agricultural practice. Under USDA labeling information, all fixed (basic) copper fungicides labeled for use on cranberries may be used on a "no time limitation" basis. But we suggest these copper materials not be used after the berries start to ripen.

[f] Varies with manufacturer; check the label.

[g] Dermal LD_{50} based on rabbits.

Disease management

At least 20 diseases have been described on cranberry in Wisconsin; all but two of these are caused by fungi. In Wisconsin, yield loss from most of the known diseases is minor and does not warrant the use of fungicides. Cottonball disease, however, can result in significant economic losses if left unchecked. The incidence of upright dieback varies from year to year but can be damaging, especially in young plantings. Although fruit rots in the field are usually not serious in Wisconsin, these can be significant at some sites and during warmer-than-average summers. Fruit rots that develop during storage—such as black rot and end rot—are important diseases of fresh-market fruit.

For effective disease management, you must identify the problem accurately before beginning treatment. The University of Wisconsin-Extension publications listed at the end of this booklet offer more complete information on many of the more important cranberry diseases. *Compendium of Blueberry and Cranberry Diseases* contains accurate descriptions and colored photographs of cranberry disease symptoms. It is available from APS Press (1-800-328-7560).

Fungicide update

Abound (azoxystrobin) was registered in 2003. In limited research, Abound was as effective as Orbit (propiconazole) in controlling cottonball. Its performance has been variable for other fruit rots.

Bravo WeatherStik, formerly Bravo 720 (chlorothalonil), has been available by a Special Local Needs registration (24c) for control of upright dieback. However, that registration has expired. Watch industry newsletters for the availability of Bravo for control of upright dieback.

Disease notes

Cottonball

On many Wisconsin marshes, cottonball generally occurs so infrequently that it does not require special control measures. However, on certain marshes the disease can cause economic damage. Losses result from fruit rot and costs of separating out rotten fruit. The most widely planted cultivars—including Ben Lear, McFarlin, Pilgrim, Searles, and Stevens—are all susceptible to cottonball.

The fungus that causes cottonball, *Monilinia oxycocci*, overwinters as sclerotia (mummies) in previous seasons' infected berries. In the spring, at the same time as budbreak, sclerotia germinate to produce small cup-like apothecia that release ascospores. The airborne ascospores infect tender young uprights that have recently emerged and cause the tip blight stage of the cottonball disease. Infected uprights turn tan and wilt from the tip back shortly before bloom. At the base of newly infected leaves is an inverted "V" pattern of tan diseased tissue characteristic of tip blight. In severely infested beds, ascospores of *M. oxycocci* also may infect and kill unopened flowers, causing a flower blight symptom. Eventually, wilted shoots become covered with a white mantle of fungal spores. These spores invade flowers through stigmata (pollen-receptive surfaces of flowers). The fungus does not kill the flower but grows inside the developing berry. These infected berries or "cottonballs" do not become noticeable until late in the season when they fail to turn red; instead, they turn yellowish and sometimes are marked with brown stripes. Removing "trash" after harvest may reduce the number of diseased fruit that remain in the bed and thereby reduce disease the following season. Cottonball can be managed with well-timed fungicide treatments applied properly.

Upright dieback

Upright dieback is characterized by yellow mottling and chlorosis of leaves, followed by bronzing and death of the entire upright. In young plantings (1–3 years old), large patches of uprights can be affected; in older plantings affected uprights are generally scattered among healthy uprights. Upright dieback seems to be worse under hot, dry conditions that are stressful to the cranberry plant. The exact cause of upright dieback is not well understood, but the fungus *Phomopsis vaccinii* has been isolated from affected plants. Several other fungi can also be isolated from plants with symptoms, but their roles in the upright dieback syndrome are not understood. Conditions that favor vigorous, but not excessive,

vine growth should help vines tolerate or resist fungal infections. To help prevent upright dieback, provide adequate moisture and cool beds by sprinkling with water during hot, dry periods. Infection probably occurs during the spring as shoots are elongating, so fungicide application at this time is likely more effective than applications made later after the fungus has invaded the plant tissue.

Fruit rots

Under Wisconsin growing conditions, fruit rots before harvest (field rot) are rarely a problem. Therefore, fruit destined for processing soon after harvest normally does not need to be protected by fungicides during the growing season. However, berries to be stored for sale at a later date as fresh fruit should be protected from storage rots, such as end rot and viscid rot, by timely applications of fungicides during the growing season.

Of the fungicides registered for use on cranberries, chlorothalonil (Bravo) is the most effective product for field rot and storage rot management. Bravo should be applied between midbloom and early fruit set. However, Bravo can be phytotoxic and may reduce yields if sprayed during midbloom, especially if applied in low spray volume (less than 50 gal/a). If spray volume is low, consider using Abound during midbloom, followed by Bravo during late bloom to early fruit set. Mancozeb is ineffective on a 10- to 14-day schedule. Ferbam has not been tested in Wisconsin, but in Massachusetts and New Jersey, it has been less effective than Bravo. Copper hydroxide was not effective in controlling storage rot in recent research in Wisconsin. Other forms of copper have not been tested.

Fungicides have been relatively ineffective at controlling blackrot, a storage rot disease . Fruit infection apparently occurs late in the season or at harvest, when little or no fungicide residues remain to protect fruit. Black rot spores may be abundant in flood waters while water-raking fruit. Fruit then become infected through wounds. Therefore, try to minimize fruit injury before and during harvest. To reduce the chance of infection, dry-rake fruit that will be stored for fresh market sale, or dry fruit immediately after water-raking.

Refrigerate cranberries immediately after harvest and during storage to delay development of storage rots. Be aware, however, that these diseases can develop at low temperatures and eventually cause rotting even at near-freezing temperatures. Store fruit at 38–40°F; infected berries break down rapidly at temperatures above 55°F.

Phytophthora root and runner rot

Several species of the soil-inhabiting fungus-like organism *Phytophthora* have been found in Wisconsin. The species causing root rot of cranberry in Massachusetts and New Jersey, *Phytophthora cinnamomi*, has ***not*** been isolated in Wisconsin during surveys taken in the late 1980s and in 1997 and in sporadic sampling since then. On affected plants, typical symptoms above ground include small leaves, stunted uprights, reduced flower and fruit production, and premature reddening of the foliage. Below ground, small feeder roots frequently are lacking, and runners may exhibit bluish-gray discoloration under the bark.

These symptoms occur most often on plants located in areas of a bed that are poorly drained and occasionally have standing water. Often, affected plants die and leave large areas of the bed devoid of cranberry vines. Replanting in these void areas usually is unsuccessful; instead, weeds rapidly become established and proliferate.

Although mefenoxam (Ridomil) is registered for control of Phytophthora root and runner rot, use of Ridomil in Wisconsin has not been successful in research trials. This is probably because the types of *Phytophthora* found in Wisconsin are not sensitive to Ridomil. However, practices aimed at soil water management, such as avoiding over-irrigation and improving soil drainage (e.g., by installing drainage tile, digging center ditches, and deepening side ditches) appear to be effective at reducing disease severity. Sanding affected areas to fill in low spots and improve drainage, and making additional fertilizer applications also may be beneficial.

Leaf and stem diseases

Three leaf diseases occasionally cause significant damage to cranberry plants in Wisconsin. Two are Protoventuria (Gibbera) leaf spot and Cladosporium leaf spot. Characteristic gray to white centers of Cladosporium leaf spots distinguish them from Protoventuria spots, which are small and red. Although no fungicide is registered specifically for controlling these two diseases, the same fungicides used for storage rots ordinarily control them.

The third leaf disease—red leaf spot—is marked by large, circular, bright red spots on the upper surface of leaves and paler red spots on the undersurface. In severe infestations, shoot tips may become infected and killed. Young plantings of 'Ben Lear' and 'Stevens' appear most susceptible, but any cultivar may develop the disease if vine growth is luxuriant. Red leaf spot is usually so sporadic and unpredictable that we do not recommend routine spraying to control it. If it does occur, the spray program for storage rots should adequately control red leaf spot.

In recent years, several growers have reported stem gall or "canker" which girdles and kills uprights. Large portions of beds can be damaged and put out of normal production for 2–3 years. The cause of stem gall is probably bacteria that produce a plant growth hormone. Stem gall seems to be worst in areas where plants have been damaged by beaters, tires, or cold injury. The pathogenic bacteria infect through wounds. There are no chemical controls for these bacteria. Until more is known about stem gall, the best strategy is to minimize plant injury at harvest, during the winter, and in early spring.

Cranberry disease management recommendations

1. Always read the label before using any pesticide even if you have used the product before. Information on labels changes. The information presented in table 4 is only a guide and should be used in conjunction with specific label recommendations.
2. Fungicides are listed by their common (or generic) names. See table 3 for a cross-reference to trade names.
3. Apply fungicides in sufficient water to provide adequate coverage. Most can be applied as either dilute (usually 100–300 gal/a water) or concentrate (usually 20–50 gal/a water) spray mixtures by ground equipment, by aircraft (at least 5 gal/a water), or through sprinkler irrigation systems, if permitted. Concentrate applications initially do not cover fruit and foliage as thoroughly as dilute applications, but dew, rain, or sprinkler water redistribute the fungicide so that coverage becomes comparable to that of dilute applications. The risk of phytotoxicity is greater with concentrate applications.
4. Most cranberry fungicides are toxic to fish. Exercise caution!

Table 4. Fungicide application schedule for cranberry diseases

Disease	Application timing	Fungicide, rate/acre[a]	Comments and restrictions
Cottonball	10–15% bloom, then again at full bloom	Abound 2.08F, 6.2–15.4 fl oz	Applications of Abound are not permitted before bloom. See the label for specific use restrictions.
Fruit rots	Mid- to late bloom, then at 10- to 14-day intervals	Bravo WeatherStik, 4.0–5.5 pt	The lower rate is sufficient in most years. All chlorothalonil products have a 48-hour restricted entry interval and a 50-day preharvest interval.
		Ferbam 76WDG, 6.0 lb	Do not apply more than five times per year. Do not apply later than 28 days after mid-bloom.
	Mid- to late bloom, then at 7- to 10-day intervals	Abound 2.08F, 6.2–15.4 fl oz	See the label for specific use restrictions, especially related to aquatic wildlife. Do not apply more than two sprays of Abound before alternating with an unrelated fungicide.
		Penncozeb 80WP, 3.0–6.0 lb; or Penncozeb 75DF, 3.0–6.0 lb; or Penncozeb 4FL, 2.4–4.8 qt; or Dithane DF, 3.0–6.0 lb; or Dithane F-45, 2.4–4.8 qt; or Dithane M45, 3.0–6.0 lb	Many formulations of mancozeb are sold under various trade names. Be sure that cranberries are on the label. All mancozeb products have a 24-hour reentry period and a 30-day preharvest interval. Do not exceed 14.2 lb/a active ingredient per season. Addition of a spreader-sticker may be necessary. May cause some delay in coloring of fruit in the fall.

[a]Pesticide active ingredients are listed in table 3.

Insect management

Blackheaded fireworm and cranberry fruitworm are the most important insect pests of cranberries in Wisconsin. Virtually every marsh is susceptible to attack, and economic damage can occur if controls are not adequate. Of secondary importance are spanworms and cranberry girdler. These normally occur at low levels, but if environmental conditions favor an outbreak and you don't take appropriate controls, losses can be serious. Cranberry tipworm, cranberry weevil, sparganothis fruitworm, flea beetle, and dearness scale are more spotty in distribution but can also be damaging. Other insects occasionally cause problems.

Insect monitoring and identification

The benefits of a pest monitoring program include more rapid and dependable detection of major and minor pests, improved timing of controls, greater flexibility in choice of control approaches, and reduced usage of pesticides when pests are not present. Delays in chemical applications will often result in increased damage. Do not rely on calendar timing of sprays—this approach may work four years out of five, but unusual weather patterns or abnormally heavy pest pressures will occasionally produce unexpected damage. Be especially vigilant early in spring for hatch of first-generation blackheaded fireworm larvae. Early warm spring weather can lead to early hatch. Sex pheromone traps are commercially available to monitor adult flight periods of blackheaded fireworm, cranberry girdler, and sparganothis fruitworm. Several companies manufacture and market the baits and traps.

Proper pest identification also plays a role in achieving control. Although cranberry fruitworm and blackheaded fireworm are still our most serious fruit pests, we occasionally see significant damage from sparganothis fruitworm. Sparganothis fruitworm feeds on the foliage and surface of the fruit (like blackheaded fireworm), and also within the fruit (like cranberry fruitworm). Although similar in appearance to the blackheaded fireworm, sparganothis fruitworm is identified by its yellow head. Paired pale spots along the body and a more ragged chewing hole in fruit further distinguish sparganothis fruitworm from cranberry fruitworm. Sparganothis fruitworm may also cause damage to adjacent leaves, and its feeding activity can continue into the early harvest period.

Occasional pests

In addition to our most serious pests, several less-common insects can feed on cranberry plants and fruit. Although natural environmental factors often control these "occasional pests," they can occur in sufficient numbers to cause injury. Crop consultants, IPM scouts, and growers have increasingly reported cases of unusual insects causing damage. This does not necessarily indicate an increased number of actual cases. Rather, as more people are trained in pest management and as routine IPM scouting becomes common, pest situations that were previously overlooked or misdiagnosed are recognized as caused by occasional pests. IPM practices also have led to the overall reduction in pesticide use, which sometimes allows these normally uncommon insects to increase to damaging numbers.

The occurrence of such insects is often spotty, even being confined to part of an individual bed. This emphasizes the need for monitoring all beds. Although intensive monitoring such as trapping and sweep-sampling is **not** necessary for all beds, they all should at least be routinely inspected visually. Further, the spotty distribution of occasional pests makes large-scale pesticide applications unnecessary and probably disruptive to natural controls. Instead, localized outbreaks should be controlled with spot treatments of the areas affected.

Insecticide update

In response to EPA's continued reassessment of older pesticides, the use pattern for acephate insecticide has been reduced to a single application per year. Note that the preharvest interval may vary with manufacturer. The standard preharvest interval is 90 days. However, Valent, the producer of Orthene formulations, has received a section 24(c) (state) registration for a preharvest interval of 75 days. Other registrants of acephate may not have such labeling, therefore requiring the 90-day preharvest interval. If you are uncertain about your product, check with your pesticide supplier.

2005 restriction on Orthene tank mixes. Because of some residue problems associated with Orthene use in 2003, Valent has been reevaluating its usage on cranberry. Valent will continue its registration of Orthene on cranberry, but in 2005 will prohibit tank-mixing Orthene with diazinon or any other organophosphate insecticide including chlorpyrifos (Lorsban), azinphos-methyl (Guthion), and phosmet (Imidan). Valent will conduct further studies to attempt to explain the unexpected high residue levels and to evaluate the future status of tank mixes with other products.

The active ingredient spinosad, manufactured by Dow AgroSciences, has recently been registered for use on cranberries. In university trials, spinosad has provided moderate control of various Lepidoptera species. Spinosad labels clearly indicate that the products are for "insect suppression" on cranberries. You should interpret this to mean that control can be achieved when pest populations are at relatively low levels, but may not be adequate at higher populations. Spinosad may be applied through approved irrigation systems, including solid set. Spinosad is a natural product, derived from the fermentation of a bacterium. It is a selective insecticide, and relatively safe to many beneficial insects. It has a very low mammalian toxicity. Important target pests on cranberry include armyworms, loopers (spanworms), fireworms, and sparganothis. It is not registered for use against cranberry fruitworm. Results will be best when used against hatching eggs or young larvae, so routine pest scouting will be helpful for timing applications. SpinTor is the trade name of the formulation used in conventional agricultural systems. Because of the solvents involved in this formulation, it is not acceptable for certified organic production. However, the formulation Entrust does not include the same solvents and has been approved for use according to USDA standards for organic agriculture. In summary, spinosad will fit well into IPM systems because it conserves beneficial natural enemies, although it may not provide adequate control of high pest populations. Still, the Entrust formulation should prove useful for organic cranberry growers.

Imidacloprid recently received registration for use on cranberry. This insecticide is in a new chemical group, the chloronicotinyls (also known as the neonicotinoids). These are synthetic chemicals related to natural nicotine. Imidacloprid kills a narrower spectrum of insects than organophosphate insecticides, but is still hazardous to bees and other beneficial insects. Imidacloprid is produced by Bayer Crop Science and sold for use on cranberry as Admire 2F, a 2 lb/gal flowable formulation. Currently, Admire is registered on cranberry only for soil insects, specifically "root grubs" (white grubs) and "rootworms" (leaf beetle larvae). This registration is primarily for soil insects in the eastern United States that do not occur in Wisconsin. Imidacloprid is not particularly effective against the white grubs of June beetles that are the predominant grub problem in Wisconsin. Further, we know of no data showing imidacloprid to be effective against the larvae of redheaded flea beetle, the predominant leaf beetle pest of Wisconsin cranberries. Therefore, we are not recommending its use in Wisconsin, pending further research. If growers wish to evaluate this product independently, it is labeled at the rate of 16–32 oz/a per application, with a maximum annual usage of 32 oz/a. It can be chemigated or applied by ground equipment, but not by air. There is a 30-day phi. Refer to the label for other instructions and restrictions.

Table 5 reviews the major insecticide registrations on cranberry. The labels for each product contain additional important, specific information. Carefully read the pesticide labels to choose materials that best fit your needs and to fully understand application procedures and precautions.

Table 5. Currently registered insecticides for cranberries[a]

Insecticide and formulation	Labeled insects	Remarks
acephate (Orthene): 75S, 97	fireworms, fruitworm, spanworms, sparganothis	Maximum of 1 application per year. Water soluble; should not be used with more than the recommended amount of water or wash-off may occur, particularly with sprinkler application.
azinphos-methyl (Guthion): 50W	fireworms, fruitworm, sparganothis, tipworm	Maximum of 3 applications per year and a minimum period between applications of 14 days.
Bacillus thuringiensis (Bt) Dipel: ES, 2X Biobit: 1.6% F, 3.2% WP	spanworms	The percent active ingredient in Biobit is about half that of Dipel; check labels for specific rates. Must have good coverage of leaf surfaces; a spreader/sticker may improve effectiveness. Most effective against young larvae. Two to three successive applications at 3- to 5-day intervals may be necessary.
carbaryl (Sevin): XLR, 4F, 80WSP	fireworms, fruitworm, sparganothis	Maximum of 10 quarts or 12.5 lb (80WSP) per acre per year.
chlorpyrifos (Lorsban): 4E	cranberry weevil, fireworms, fruitworm, spanworms, sparganothis	Maximum of 2 applications per year.
diazinon (D•Z•N): 50W, AG500, AG600WBC	blackheaded fireworm, fruitworm, tipworm	Current labels of some products require a minimum of 400 gal/a of finished spray, which precludes usage of low-volume spray equipment. Maximum of 6 applications per year and a minimum period between applications of 14 days. All formulations are very hazardous to birds.
phosmet (Imidan): 70W	blossomworm, cranberry tipworm midge, cranberry weevil, cutworms, false armyworm, fireworms, fruitworm, gypsy moth, spanworms, sparganothis	Maximum of 15.6 lb per season. Minimum of 10 days between successive applications. Reduced activity in alkaline spray waters, which should be buffered. Available in water-soluble bags.
spinosad (SpinTor 2SC, Entrust)	armyworms, fireworms, leafrollers, loopers (spanworms), sparganothis	For pest suppression; may not provide acceptable results against high population numbers. Best timed against hatching eggs and young larvae. The Entrust formulation is USDA-approved for the National Organic Program.
tebufenozide (Confirm): 2F	blossomworm, false armyworm, fireworms, fruitworms, gypsy moth, sparganothis, spanworms	Maximum of 64 fl oz (4 applications) per acre per year.

[a]Refer to table 3 for restricted entry intervals and preharvest intervals; refer to table 7 for insecticide rates.

Pheromone-mediated mating disruption

Mating disruption uses a synthetic version of the insect's own sex attractant (pheromone) to block the ability of the male moth from finding the female. This disrupts the mating process, resulting in a significant reduction in the number of eggs laid.

Mating disruption of blackheaded fireworm has been evaluated for 5 years now in Wisconsin. Sprayable pheromone is designed to be mixed with water and sprayed through conventional insecticide delivery equipment; it can be applied by air or ground equipment as well as through irrigation systems. The second delivery system that we have evaluated are point-source emitters called MSTRS that are spaced around the perimeter of the cranberry planting. Both application methods resulted in the same degree of "trap shutdown" which is a measure of mating disruption. Formulations of both application methods continue to change so contact suppliers or pest management personnel for updated information on deployment rates.

In 1999 and 2000 we also evaluated both application methods for mating disruption of sparganothis fruitworm. The results have been somewhat questionable in Wisconsin and New Jersey, but research in Massachusetts resulted in good fruit protection. More sparganothis research is necessary before we can recommend full scale adoption of mating disruption for this insect.

Mating disruption can be a viable component of integrated pest management. However, under current economic conditions it may be more expensive than conventional insecticides, especially if multiple pest types are present simultaneously. We encourage growers to evaluate this new technology under their own conditions, but suggest using caution in doing so; be prepared for followup insecticide applications to control larvae if necessary. If you wish to evaluate mating disruption, Extension Entomologist Dan Mahr is available to offer suggestions.

Insecticides and pollination

Insects are important for cranberry pollination. Active pollinators improve fruit set. Honey bees are not the only pollinators; bumble bees and other wild insects may be just as important. Whenever possible, do not apply insecticides when 2% or more of the flower buds are open or you may kill a significant number of pollinators. Similarly, do not introduce honey bees to a marsh until 10% of the flowers have opened. Remove bees immediately after pollination.

Careful monitoring of pest populations early in the season will help you plan insecticide applications to avoid the period when plants have blossoms. If you don't monitor populations, pest outbreaks that should have been controlled may occur during blossom. In this situation, growers must decide if losses from the pest or from the lack of pollinators will be greater. If you must use an insecticide during blossom time, use those that are least toxic to bees and apply them in the evening after bees stop foraging. The next morning use sprinkler irrigation to wash off the pesticide and discourage bee foraging. Table 6 lists the relative bee toxicity of commonly used cranberry insecticides.

Wisconsin law allows beekeepers the right to request notification of pesticide application if their hives are within 1.5 miles of an application site. If someone makes such a request, you must notify them at least 24 hours prior to application. For more information on honey bees and pesticides, refer to Extension publication *Protecting Honey Bees in Wisconsin from Pesticides and Other Toxic Chemicals* (A3086).

Table 6. Relative toxicity of certain cranberry insecticides to honey bees

Toxicity to bees	Insecticide	Comments
Highly toxic	acephate, azinphos-methyl, carbaryl, chlorpyrifos, diazinon, phosmet	Use of these pesticides at any time of day or night during blossom may result in severe bee losses. For maximum bee protection, do not use them within 7 days of blossom.
Moderately toxic	malathion	This pesticide should not be applied while bees are actively foraging, but it is relatively safe if dosage, timing, and method of application are correct.
Relatively nontoxic	*Bacillus thuringiensis*, methoxychlor, tebufenozide	These products will cause a minimum amount of injury to bees.

Cranberry insect management recommendations

Table 7 is a guide to insecticide usage on cranberries. Insecticides and rates listed reflect labeling that was accurate when this publication went to press. The grower/applicator is responsible for confirming that the intended use of a pesticide is legal. People who use information in this publication assume all responsibility for personal injury or property damage.

Table 7. Spray schedules for cranberry insects

(Where several pesticides and formulations are listed for the control of a pest, apply only one pesticide.)

Timing of spray	Insect	Pesticide, rate/acre[a]	Comments and restrictions
Delayed dormant (1/2 inch new growth)	cranberry weevil	chlorpyrifos 4E, 3.0 pt	Fireworm treatments normally also control weevils.
	fireworm, sparganothis fruitworm	acephate 75S, 1.33 lb; or 97, 1.0 lb *azinphos-methyl 50WP, 2 lb carbaryl 4 lb/gal, 4.0 pt; or 50WP, 6.0 lb; or 80WSP, 2.5 lb chlorpyrifos 4E, 3.0 pt *diazinon 50WP, 4.0 lb; or 4E or AG500, 4.0 pt; or AG600WBC, 54.5 fl oz phosmet 70W, 1.3–4.0 lb tebufenozide 2F, 16.0 fl oz	Acephate is now restricted to a single application per year. The preharvest interval varies with manufacturer; see note in Insecticide Update, page 16.
	tipworm	*azinphos-methyl 50WP, 2 lb *diazinon 50WP, 4.0 lb; or 4E or AG500, 6.0 pt; or AG600WBC, 54.5 fl oz	Diazinon has a maximum of 6 applications per year; allow at least 14 days between treatments.
	spanworm	acephate 75S, 1.33 lb; or 97, 1.0 lb *Bacillus thuringiensis* (see product labels for rates) chlorpyrifos 4E, 3.0 pt phosmet 70W, 1.3–4.0 lb tebufenozide 2F, 16.0 fl oz	You can control spanworms with fireworm treatments if the treatments coincide with the youngest larval stages of spanworms. Acephate is now restricted to a single application per year. The preharvest interval varies with manufacturer; see note in Insecticide Update, page 16.
June 7–21	dearness scale (crawler stage)	No materials registered	Applying azinphos-methyl or chlorpyrifos for fireworm or tipworm control during this period may control scale.
Hook stage to start of blossom	cranberry weevil, fireworm, spanworm, sparganothis fruitworm, tipworm		Use materials, formulations, and rates listed above that are labeled for your target pests. Do not apply broad-spectrum insecticides once flowers have started to open.
Blossom	**Protect pollinating insects. Do not use insecticides during blossom period.**		
After blossom (mid- to late July)	fireworm, sparganothis fruitworm, tipworm		Use materials and rates as listed above.
	cranberry fruitworm	acephate 75S, 1.33 lb *azinphos-methyl 50WP, 2 lb carbaryl 4 lb/gal, 4.0 pt; or 50WP, 6.0 lb; or 80WSP, 2.5 lb chlorpyrifos 4E, 3.0 pt *diazinon 50WP, 6.0 lb; or 4E or AG500, 6.0 pt; or AG600WBC, 54.5–82.0 fl oz phosmet 70W, 1.3–4.0 lb	Acephate is now restricted to a single application per year. The preharvest interval varies with manufacturer; see note in Insecticide Update, page 16. Note: Rate of diazinon is higher than for other insects. Two to four applications at 7- to 10-day intervals may be needed for serious infestations. Chlorpyrifos has a 60-day preharvest interval. The phosmet label recommends using higher label rates for cranberry fruitworm.
August 1–15	cranberry girdler	*diazinon 14G, 21.0 lb	Application must immediately be followed by sprinkler irrigation to be effective.

* Restricted-use pesticide.

[a]Pesticide trade names are listed in table 3.

Weed management

Weeds compete with cranberry vines for light, water, and nutrients. Tall weeds shade vines, reduce cranberry photosynthesis and nitrogen uptake, discourage pollinating insects, and slow the drying of rainfall, irrigation, and dew from vines. The slow drying of cranberry vines favors disease development and may impede pollen shedding. Heavy stands of weeds slow harvesting and can cause damage to fruit skin during harvest. In short, weeds reduce cranberry yield and quality. An effective cranberry weed management program uses both cultural and chemical controls.

Cultural control

Improving drainage of wet areas helps control wiregrass sedge, arrowhead, and other weeds. Increasing soil moisture reduces ragweed and goldenrod. Heavy nitrogen fertilization in June encourages barnyard grass and other annual weeds. Too little fertilization may produce weak vines and open areas for weed invasion. Fertilization, water management, and other cultural practices that maximize cranberry growth encourage a solid canopy of cranberry vines, which will compete with weeds and reduce their density.

Soil pH. If soil pH is above 5.5, growth of some upland weeds may be reduced by lowering soil pH. Elemental sulfur is the most efficient way to reduce soil pH. Apply the sulfur in split applications of 50–100 pounds each per acre during the year when beds are dry and water is not puddled. Do not apply over 500 pounds of sulfur per acre per year. Sulfur pellets are preferred. Change in pH takes time, don't expect immediate results. No direct pH response results from application of sulfate salts such as ammonium sulfate or potassium sulfate.

Chemical control

Before using an herbicide, read and follow the label directions! Use only registered materials. Table8 lists herbicides that are registered for use on cranberries in Wisconsin. Products are listed alphabetically and represent treatment options for each period covered. The inclusion of product names in these tables is not an endorsement of a particular manufacturer's brand.

Preemergence herbicides are only effective before weeds germinate or produce significant growth. Make applications as early as the label allows. Poor performance and vine damage caused by some preemergence herbicides can be traced to making applications too late. Where this type of control is not possible, use postemergence herbicide or wiper applications.

When more than one herbicide is available to control a problem weed, rotate among available materials to prevent weed resistance and potential build-up of residues in the soil. Herbicides must be applied evenly for effective weed control. Calibrate application equipment frequently and avoid overlap where possible.

Preemergence herbicides

Casoron is widely used to control germinating weeds in Wisconsin cranberry beds. While Casoron is effective, at high rates it can damage vines and reduce yields. Use the lowest effective rate possible. In the past, only a single application per year was allowed. The new label allows for multiple applications. Allow 3–6 weeks between applications. Do not apply more than 100 lb/a (4 lb ai) per year.

Oldfield cinquefoil can be controlled by applying 100 lb/a Casoron in mid-May, before May 20. Timing is critical. Control is best when the cinquefoil has just emerged. This is a spot treatment recommendation. At this high treatment rate, vine growth was seriously reduced.

Grass control

Three herbicides designed specifically for grass control are now labeled for cranberry: Fusilade, Poast, and Select. Poast and Select are labeled for bearing beds. To reduce the chance of developing resistant grasses, use Select on non-bearing beds where grasses are a problem. All of the grass herbicides require addition of crop oil concentrate or surfactant according to the label for adequate control. Timing is critical; read the product label carefully and be sure to apply when grasses are at the correct stage for maximum effect. Multiple applications may be necessary for control. Vine injury may result when applied during the heat of the day. For better results, spray in the evening when air temperatures are cool. These herbicides do not control sedges. To distinguish between grasses and sedges, roll a stem between your thumb and fingers. A grass will roll smoothly, a sedge will not.

2,4-D Only granular applications of 2,4-D are allowed preemergence in Wisconsin. Granular 2,4-D must be applied before bud break to avoid herbicide injury. Liquid sprays are not legal; however, a single wiper application per year of 2,4-D (Weedar 64) is legal. See table 8 for details. You must have the supplemental label in your possession before making the application.

Roundup (glyphosate) Roundup is a nonselective herbicide without residual action. Plants absorb the chemical through leaves and stems, and transport it throughout the plant through the vascular system. Roundup acts through the root system, so treated weeds may take several weeks to die. Be patient and wait for results.

During the production period, Roundup is registered for wiper application only, which is effective when weeds are taller than the canopy. Weeds may be wiped with Roundup anytime during the season up to 30 days before harvest.

After the initial treatment, spot treatment with the wiper will eliminate weeds missed or those requiring a repeat application. A repeat application may be necessary where weeds were initially dense. Addition of a surfactant or ammonium sulfate will enhance the activity of Roundup. Including a spray dye in the mix allows you to see what has been wiped.

During renovation or planting, Roundup can be applied as a spray to reduce perennial weeds. Any green plant tissue readily absorbs Roundup. It may kill some weed species at application rates as low as 0.25 lb/a. To prevent contact with desirable vegetation, use Roundup very carefully according to label directions.

Roundup Ultra. This formulation of glyphosate is registered for cranberry. This formulation requires no additional surfactants or additives and will be rainfast 1–2 hours after application. It has a reduced restricted entry interval (4 hours as opposed to 12 hours for regular Roundup). The percent active ingredient and application methods are the same.

Wiper application. Wipers should deposit herbicide on as much foliage as possible while not contacting or dripping onto the vines. The degree of control is proportional to the amount of foliage wiped. Using a food-safe dye in your wiping equipment will make it easier to see where you have and have not wiped. See the label for details.

Timing is important for wiper applications. Annual weeds that are about to flower are most susceptible to control with Roundup. Applications to young, rapidly growing plants will kill tops before the herbicide has had time to move throughout the plant for a complete kill. For most perennial weeds, July and August treatments are most effective. *Note, Roundup cannot be applied within 30 days before harvest.* If weeds are still actively growing after harvest, a post-harvest wiping may help. Don't clip weeds prior to wiping. Clipping removes foliage that could be wiped with Roundup. Woody perennial weeds may require two to three applications per year for 2 years for complete control.

Precautions: Do not allow Roundup to contact or drip on cranberry plants or the vines will die. Wear non-permeable rubber or plastic boots when applying Roundup. If footwear becomes contaminated with herbicide, wash them thoroughly before walking on lawns or other desirable foliage. Mixing Roundup with hard water that is high in calcium, iron, manganese or zinc, or with dirty water containing organic matter will reduce activity. Be sure to clean equipment thoroughly both before and after treatment.

Cut stump applications. Woody perennial weeds such as brambles (dewberries), bog rosemary, and willows can be controlled by cutting the tops off the plants and then treating the cut stumps with Roundup at 20 to 50% of full strength. Mixing dilute Roundup with lanolin and then treating the stumps is also effective.

Stinger (clopyralid) Stinger is a postemergence phenoxy-type herbicide. It is very active and will damage any vines it comes in contact with. Stinger may be applied as a spot treatment spray or wiped on weeds. Multiple applications of a low-concentration solution have given good results. Early summer and post-harvest applications are both effective. The phi is 50 days. Don't apply more than 16 oz/a of product per year. The 24(c) label expires December 31, 2007.

Table 8. Cranberry weed control

Application timing	Weeds	Commercial product, rate/acre	Active ingredient, rate/acre	Comments and restrictions
BEARING VINES				
After harvest and before winter	wiregrass sedge	Casoron or Norosac 4G, 100.0 lb	dichlobenil, 4.0 lb	Some injury may develop on vines. Use granular formulation. If bed is to be sanded after application, reduce rate to 75 lb/a.
	clover, goldenrod	Stinger 3EC, 4.0–10.6 oz	clopyralid, 0.09375–0.25 lb	Apply when vines are dormant but weeds are still green. Use the lowest rate to avoid vine injury.
Spring—before May 10	ditch stonecrop, loosestrife, ragweeds, sticktites, tearthumb smartweed	Weed-Rhap 20G, 10.0 lb	2,4-D, 2.0 lb	Apply before weed seeds germinate. Irrigate after application. Apply as early as possible to control ditch stonecrop, which germinates in early April. Devrinol is a safer material for use when sticktites are the main problem. Store 2,4-D away from other pesticides and fertilizers. The volatile 2,4-D can be absorbed by other products and may result in plant injury when these products are used.
Spring—before May 20	annual broadleaf weeds, cinquefoil, perennial grasses, sedges	Casoron or Norosac 4G, 35.0–100.0 lb	dichlobenil, 1.4–4.0 lb	Some injury may develop on vines. Irrigate soon after application. Supplemental ammonia nitrogen fertilization in early June will reduce cranberry vine injury Split application may be made; allow 3 to 6 weeks between applications. Do not apply more than 100 lb/a per year.
	annual grasses, bluejoint, creeping sedge, sicklegrass, turkeyfoot	Evital 4G, 40.0–80.0 lb	norflurazon, 1.6–2.0 lb	Use lower rates on sandy soils, weak vines, and 'Stevens' and 'McFarlin' cultivars. Expect some vine injury.
May 10–20	sticktites	Devrinol 10G, 40.0–60.0 lb	napropamide, 4.0–6.0 lb	Apply as sticktites germinate, usually in early May. Irrigate within 24 hours after application or product will decompose with ultraviolet light. Soil bacteria degrade napropamide. Repeated applications will reduce the length of its effectiveness as soil bacteria populations increase. Napropamide controls a narrow range of weeds and is quite expensive.
May 15–25	ditch stonecrop, dodder	Casoron or Norosac 4G, 25.0 lb	dichlobenil, 1.0 lb	Must be watered into the soil immediately after application. Split application may be made; allow 3–6 weeks between applications. Do not apply more than 100 lb/a per year.
	grasses	Poast EC, 0.5–2.0 pt/a	sethoxydim, 0.10–0.416 lb	Apply 10–20 gal/a of solution to actively growing grass weeds before extensive tillering or seedhead formation. Must be used with crop oil concentrate or spray adjuvant to allow thorough wetting. Use no closer than 60 days before harvest.

(continued)

Table 8. Cranberry weed control *(continued)*

Application timing	Weeds	Commercial product, rate/acre	Active ingredient, rate/acre	Comments and restrictions
BEARING VINES *(continued)*				
May 15–25 *(cont.)*	grasses	Select 2EC, 6.0–8.0 fl oz	clethodim, 0.095–0.126 lb	Apply in 5–40 gal/a of solution to actively growing weeds. Always include crop oil concentrate at 1% v/v. The 6 oz rate is effective for small annual grasses. Use the 8 oz rate for larger or perennial grasses. Do not exceed 8 oz per application. If needed, wait at least 14 days before second application. Do not apply between hook and fruit set. Treat at least 30 days before harvest.
Spring through August 15	broadleaf weeds, brush, grasses, sedges	Roundup or Roundup Ultra, 4.0 lb/gal EC (1 part Roundup or Roundup Ultra, 4 parts water)	glyphosate	**Wiper application only.** Wipe weeds above the cranberries with appropriate equipment. Do not apply glyphosate within 30 days of harvest. Do not mix, store, or apply glyphosate in galvanized metal containers, because the herbicide reacts chemically with the metal. Use stainless steel, plastic, or aluminum. Read and follow label directions carefully. Surfactants will improve the action of Roundup and should be added; do not add surfactant to Roundup Ultra as it already contains surfactant. Cut stump applications to woody weeds are allowed. Be sure the herbicide contacts only the cut stump and not vines.
Late June through July	tall broadleaf weeds	Weedar 64, 33% solution (1 part Weedar 64, 2 parts water)	2,4-D	**Wiper application only.** Wipe weeds above the cranberries with appropriate equipment. Do not apply more than once per year. Do not allow the solution to touch or drip onto vines. You must have the supplemental label in your possession at application.
	clover, goldenrod	Stinger 3EC, 4.0–10.6 oz	clopyralid, 0.09375–0.25 lb	Avoid herbicide contact with cranberry vines. Cover weed foliage as thoroughly as possible using low concentrations of active ingredient. Multiple applications may be necessary to control perennial weeds. Expect some vine injury. Wiper application is also effective.
NONBEARING VINES				
After planting	germinating grasses, sedges, etc.	Devrinol 10G, 30.0 lb	napropamide, 3.0 lb	Must be watered into the soil within 24 hours or it decomposes with ultraviolet light.
		Evital 4G, 20.0–30.0 lb	norflurazon, 0.8–1.2 lb	Irrigate immediately after application. Some vine injury may occur.
		Select 2EC, 6.0–8.0 fl oz	clethodim, 0.095–0.126 lb	Apply in 5–40 gal/a of solution to actively growing weeds. Always include crop oil concentrate at 1% v/v. The 6 oz rate is effective for small annual grasses. Use the 8 oz rate for larger or perennial grasses. Do not exceed 8 oz per application. If needed, wait at least 14 days before second application. Do not apply between hook and fruit set.

Table 8. Cranberry weed control *(continued)*

Application timing	Weeds	Commercial product, rate/acre	Active ingredient, rate/acre	Comments and restrictions
NONBEARING VINES *(continued)*				
At least 1 year before harvest	grasses	Fusilade 2000 EC, 2.0–3.0 pt	fluazifop-P-butyl, 0.25–0.375 lb	Spray 4–40 gal/a of solution to actively growing grass weeds. Best if applied before seed set. Must be used with crop oil or nonionic wetting agent. May not be used closer than 1 year before harvest.
	broadleaf weeds, brush, grasses, sedges	Touchdown LC, 6.0 lb/gal, mix 1.0 qt Touchdown plus 1.0 gal water (20% solution)	sulfosate	**Wiper application on nonbearing vines only.** Wipe weeds above cranberry vines with appropriate equipment. Do not contact vines. Selective only through selective contact. Do not mix or store in galvanized containers. Use no closer than 1 year before harvest.

More information

For detailed information about cranberry disorders, see the following Extension publications:

Black Rot of Cranberry (A3197)
Botryosphaeria Fruit Rot and Leaf Drop (A3351)
Cottonball Disease of Cranberry (A3194)
Cranberry Fruit Rot Diseases in Wisconsin (A3745)
Early Rot (Scald) of Cranberry and Blast of Blossoms and Young Fruit (A3352)
End Rot of Cranberry (A3196)
Fungal Leaf Spot Diseases of Cranberry in Wisconsin (A3711)
Red Leaf Spot (A3343)
Viscid Rot and Upright Dieback of Cranberry (A3195)
Yellow Rot of Cranberry (A3350)

Abbreviations used in this publication

D=dust, G=granules
DF=dry flowable
E or EC=emulsifiable concentrate
F=flowable
LC=liquid concentrate
S=solution or sprayable
SC= soluble concentrate
WBC=water-based concentrate
WP=wettable powder

References to pesticide products in this publication are for your convenience and are not an endorsement of one product over other similar products. You are responsible for using pesticides according to the manufacturer's current label directions. Follow directions exactly to protect the environment and people from pesticide exposure. Failure to do so violates the law.

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