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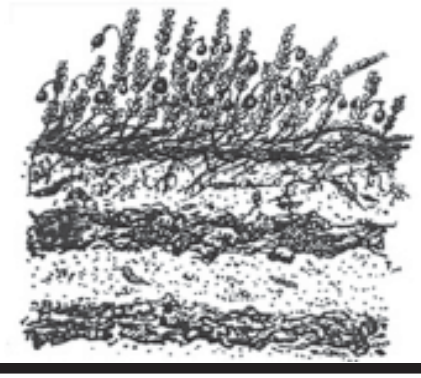
Chemigation

Carolyn DeMoranville
Cranberry Station, carolynd@umext.umass.edu

Hilary A. Sandler
Cranberry Station, hsandler@umass.edu

Steve Ward
Cranberry Growers Service



BEST MANAGEMENT PRACTICES GUIDE FOR MASSACHUSETTS CRANBERRY PRODUCTION

Chemigation

In addition to providing water to the cranberry vines, many cranberry growers use their irrigation system to deliver many of their pesticides and fertilizers. When an irrigation system is used to dispense chemicals, every effort should be made to maximize the performance of the system. Review the Irrigation, Mixing and Loading, Pesticide Application, and Pesticide Storage BMPs for additional information on pesticide use.

It is a violation of Federal law to introduce pesticides into an irrigation system through the suction side of the pump.

All pesticide applications must be made on the discharge side of the pump regardless of whether the water is from a well or surface water source. Only fertilizer applications can be made from the suction side of the pump.

WORKER PROTECTION STANDARDS (WPS) REGULATIONS REQUIRE:
All workers involved in any aspect of handling, mixing and/or loading pesticides must be trained as a HANDLER or have a pesticide license.

MA LAW REQUIRES THAT ALL PERSONS APPLYING PESTICIDES IN A COMMERCIAL CAPACITY MUST HAVE A VALID PESTICIDE LICENSE.

Several types of licenses are available:

Applicator License. If you intend to do pesticide work using general use (non-restricted) pesticide for hire, you must obtain an applicator license.

Private Certification. If you intend to do pesticide work using restricted use pesticides on property owned or rented by you or your employer for the purpose of raising agricultural commodities, you must obtain a private certification. This is the license usually obtained by individuals working as farmers.

Commercial Certification. If you intend to do pesticide work using restricted use pesticides for hire or not for hire (barter/volunteer) on someone else's property, you must obtain a commercial certification.

System requirements

To be in compliance, all irrigation systems that are used for chemigation applications must contain the following components:

- **Requirements for the irrigation system used for chemigation:**

  - Vacuum relief valve located at the highest point of the pipe system.
  - Interlocking pressure switch hookup.
  - Chemigation injection port positioned at least 6" lower than the bottom of the pipe (discharge pipe) on which the vacuum relief valve is located (i.e., the highest point of the pipe system).
  - 2' minimum elevation *differential* between the top of the highest sprinkler head and bottom of the discharge pipe. If the irrigation system does not meet the 2' requirement, the irrigation system must be equipped with a chemigation check valve, which includes a vacuum breaker and a low-pressure drain (and an injection port).
  - Positive displacement pump (non-impeller; e.g. a diaphragm or roller-type) or Venturi.
  - Interlocking pressure switch to shut down the chemigation pump at low pressure (if using displacement pump).
  - Back-flow prevention device (e.g., check valve or main line loop).

• Pump interlock, flow sensor and flow interrupter (if using positive displacement pump). Interlocks are not needed with Venturis.

Refer to Figures 1-3 for illustrations of chemigation equipment needed, atmospheric (barometric) loop and Venturi injector, and backflow valve when pump is not two feet higher than head, respectively.

System Recommendations

♦ **Chemical injection ports should be located at least 10 pipe diameters upstream from a 'T' fitting to insure proper mixing.**

For example, if the pipe diameter is 6", then the injection port should be at least 60" from the "T" fitting. Without sufficient travel distance before a 'T' fitting, proper mixing will not occur and the material will be applied nonuniformly across the treated area.

Install and orient injection port to permit proper water drainage and to minimize the risk of freezing (and damaging) the port.

Rinse out the injection port after chemigation to remove chemicals to prevent corrosion of the mechanism.

Injection port must extend halfway into the diameter of the pipe.

Recommended Practices

♦ **Timing your system**.

Timing your irrigation system is extremely important. It directly affects the level of pest control you can obtain by chemigation. Establishing a rinse time can be done by running a concentrated dye solution through your system. Dye tests should be run every 1-3 years. You should certainly run a dye test anytime significant modifications are made to your irrigation system. In general, the shorter the wash-off time (the time from first to last head), the better. You should target wash-off times to be 5 minutes or less. The efficacy of certain products (such as the Bts) will be higher with wash-off times around 2-3 minutes. Excessive wash-off times will adversely affect pesticide performance.

The goal of a dye test is to:

- Determine how long to operate the chemigation application, and
- Observe mixing and application performance.

Running a dye test:

1) Locate the first head in the system that applies water.

2) Mix a concentrated solution of tracer dye (e.g., 1 oz. per acre in a gallon of solution). Novice timers may want to use a darker solution since it is easier to see as the dye moves through the system.

3) Place the gallon of mixture in the spray tank and inject it through your chemigation system. It will be necessary to circulate the mixture for a few minutes to fill the injection hose.

4) Using a stopwatch or a watch with a second hand, start timing as soon as you start to inject the solution. Do this as quickly as possible. Try to inject the dye solution in 15 to 30 seconds. This will give you the maximum time to observe your system as well as give you a dark solution. Clean up and rinse out equipment later. You will be wasting excellent observation time by cleaning at this point.

5) Note the time it takes for you to first see dye reach the first head *and* last head. The last-head time minus the first-head time is the wash-off time (see below). This is the amount of time the system will be 'washing off' the applied material.

***Several terms are used to evaluate this process*:**

Injection port to first head (travel time). This is the time needed for the material to actually reach the bog. This is primarily affected by pipe length, diameter of the main line, number of elbows or 'T' connectors, and operating pressure. If this time is inconveniently long, consider moving the injection port closer to the area of application.

Injection port to last head (rinse time). This refers to the time, measured from the end of the injection,

that it takes a chemical to clear the last head in the system. This is the length of time you will run the irrigation system after the chemigation injection is completed.

First to last head (wash-off time or travel time on bed). This is the time that water (without any chemical) is being applied to the vines (traveling from first head to the last head). Long wash-off times will dilute and wash the material from the target area (leaves or fruit). You should try to get the wash-off time to be as short as possible (5 minutes or less).

Wash-off time = Rinse time – travel time

For most chemicals, you will want to have as short a rinse time and wash-off time as possible. However, there may be certain instances where the performance of a material will be improved with a slightly longer rinse time (assuming that your normal rinse time is fairly short). For instance, fungicide applications on bogs with very thick vines may benefit from an increased rinse time.

If you note differences in the dye concentration (i.e., some sprinklers are darker than others) as it moves through your system, the chemicals may not be mixing enough before they reach certain lateral lines.

Injection Issues. Injection time is the amount of time needed to inject the material into the irrigation system. This affects the dilution of the product that you are injecting. Typically, pumps run at 70 gal/minute/acre. Most labels indicate that chemicals should be applied in 400-600 gallons of water per acre. Thus, a 6-8 minute injection should be your target injection time. Smaller pump systems should err towards 6 minutes; larger bogs should err towards 8 minutes. Extra-large pump systems (25+ acres) should allow an additional minute (9 minutes total).

Note that an injection time that is too short (less than 6 minutes) risks injury to the vines, particularly around the heads. Injections times that are too long for a given pump system risk losing efficacy of the product.

- **Optimize the Coefficient of Uniformity for your system.**

  Your irrigation system should be operating at its optimal Coefficient of Uniformity. Even distribution of pesticides is important for efficacy and food safety concerns. Refer to Irrigation BMP for methods to improve uniformity.

- **Minimize rinse time.**

  Minimal rinse time generally improves the efficacy of materials delivered through the irrigation system. Keep in mind the physical limitations of your particular irrigation system. Follow all pesticide label recommendations, especially for new materials, as efficacy may be directly related to rinse time.

  General guidelines: For beds less than 3 acres, target a rinse time of 2-2.5 minutes. On large systems, try to limit rinse time to less than 10 minutes.

  Suggestions for minimizing rinse times:

  • Verify that pressure is good across the bog.

  • Verify that the pump is appropriate for the job.

  •Install satellite (lateral) shut-off valves.

  • Install satellite ports (especially on larger systems) if rinse time is greater than 10 minutes. This assumes that overall performance is adequate for chemigation.

  • As a last resort, consider significant re-design of the system.

- **Consider innovative high performance irrigation systems for new plantings or renovations.**

  While you may not be able to replace an existing system, install the best possible design in new plantings or renovations. Consult your local Natural Resource Conservation Service or a local irrigation system specialist for advice on system designs.

- **Consider alternatives to help shorten travel times.**

  Install satellite injection ports or shutoffs at each bed. You can inject chemical from a single injection port and shut off water to individual beds when the travel time to that bed is complete or you can install an injection port along the main at each bed and chemigate each bed separately. These options will increase your workload. However, the system will perform more efficiently and your production should be enhanced.

- **If possible, install the injection port so you have an unobstructed view of the application area.**

  This will allow you to view the area during the application to insure that the system is working properly and that people have not inadvertently wandered into the application area. If the injection site is remote from the application area, consider stationing another person or vehicle near the application area.

- **The area around the injection port(s) should have secondary containment to facilitate containment and clean up of spills or leaks.**

  Consider having a bucket placed below the injection port to catch any spilled material. See Pesticide Storage and Mixing, and Loading BMPs.

- **It is preferable to calibrate your own system rather than rely on the manufacturer's specifications.**

  Output values of pumps are normally measured at the factory based on specific drive shaft speeds that may vary from the actual speed of your drive shaft. Calibrate with the irrigation system under normal conditions. Using a stopwatch with either a calibration tube or a tank with volume units printed or embossed on the side, measure the amount of solution removed from the supply tank. Make adjustments to the injection pump on 30-second or one-minute time checks.

  Calibrate the Venturi or injection pump to insure that it can deliver the required chemical volume in the appropriate injection time.

- **Proper dilution and mixing of chemicals is important for efficient chemigation.**

  It is recommended to mix the ingredients in the following priority: 1) water, 2) pesticide, 3) adjuvants, 4) the rest of the water. However, if you are using a suspending agent, put it in the water and agitate for 15 minutes prior to adding anything else. Check to make sure that the various chemicals are compatible.

  Mixing Order for Liquids. Add 25-35% of total water first, and then add the pesticide. Add the rinse water from the containers. Add the rest of the water.

  Mixing Order for Dry Formulations. Add 50% of the total water first, and then add the pesticide. Mix in the rest of the water.

  Determining Your Total Mix. Generally, figure between 1-2 gallons per acre for liquids and 2-3 gallons per acre for dry formulations. For most liquids, the total amount of liquid (pesticide + water) needed will be a 1:1 mix. For example, if you applying 4 pt/A of Sevin to a 10-acre bog, you will need a total of 5 gallons of the pesticide. Therefore, mix it with 5 gallons of water.

  Mix on site. Keep chemicals in original containers. DOT-approved containers are needed for over-the-road transport with containers that are not the originals.

  Keep in mind the limitations of your injection system. It is important that your injection system have the capacity to provide the output needed for the size of the bog that is to be treated.

- **Be sure that the material you are applying is labeled for use through chemigation apparatus.**

  Even though many liquid formulations are labeled for chemigation, not all liquid formulations can be applied through the irrigation system. Read the pesticide label for each product thoroughly.

- **Nontarget application should be minimized with the use of screens and part-circle heads.**

  Sprinkler heads should not spray across open water unless water can be held for the appropriate holding time. Sprinklers should also not spray across dikes. The water stream should not contact areas where pedestrian or vehicular traffic might occur or contact open water. Make sure nozzles are sized to give matched precipitation when using part-circle heads. They should deliver one-half the water output of a full-circle head.

- **Late night through pre-dawn is the optimal time for chemigating.**

  Atmospheric conditions are typically most stable during this time period. Injury to pollinators and drift to nontarget areas is also minimized. In addition, it is less likely that someone will accidentally wander into the application area during these times. Early applications should be completed prior to dawn since research indicates that atmospheric conditions are usually most unstable at dawn and usually thereafter.

  The timing of a particular application may also be chosen to maximize efficacy of control for a particular pest.

- **Avoid applications when wind speeds exceed 5 mph.**

  Excessive wind increases the likelihood of off-target and nonuniform applications. Bear in mind application during still conditions retards dissipation and increases the likelihood of drift of odorous compounds.

- **Periodically attend workshops on chemigation procedures whenever possible.**

Additional Chemigation Guidelines

- Do a chemigation practice run with dye or water at the start of each season to insure all parts are working correctly.

- Prior to every application, make sure irrigation pump and injection pump (or Venturi) are operational before mixing pesticide solutions.

- Rinse out spray tank and pump after each application but do not include this rinse water in rinse time calculations. Avoid making up spray applications well ahead of time. Pesticide solutions may be corrosive and can cause pump components to fail prematurely. In addition, pesticide solutions may settle and form a sludge that may physically impede your machinery.

- Use secondary containment to capture all leakage from injection ports and consider using dry disconnect fittings on all chemical supply hoses. Secondary containment can be as simple as a 5-gallon bucket placed under the injection port or as sophisticated as a treated concrete pad with a berm.

- Rinse out injection ports on the irrigation water supply after each application. Concentrated residue left in the port may foul the mechanism.

- Make sure the chemical feed hose is de-pressurized before disconnecting from the injection port on injection systems utilizing positive displacement pumps. Failure to do so may result in you being sprayed with pesticide.

- Always use caution when working around the last head of any irrigation system as some pesticide residue may be present if rinse time was inadequate.

- New chemicals applied at low rate will most likely require short wash-off times.

Significant portions of this BMP were excerpted from:

Bicki, T. 1998. **Best management practices to optimize chemigation applications**. Environmental Bulletin Series, No. 5. Ocean Spray Cranberries, Inc., Lakeville-Middleboro, MA.

Cranberry Chart Book-Management Guide for Massachusetts, 2000. H.A. Sandler, C.J, DeMoranville, and D. Cannon, eds. UMass Ext. Publ., E. Wareham, MA. 51 pp.

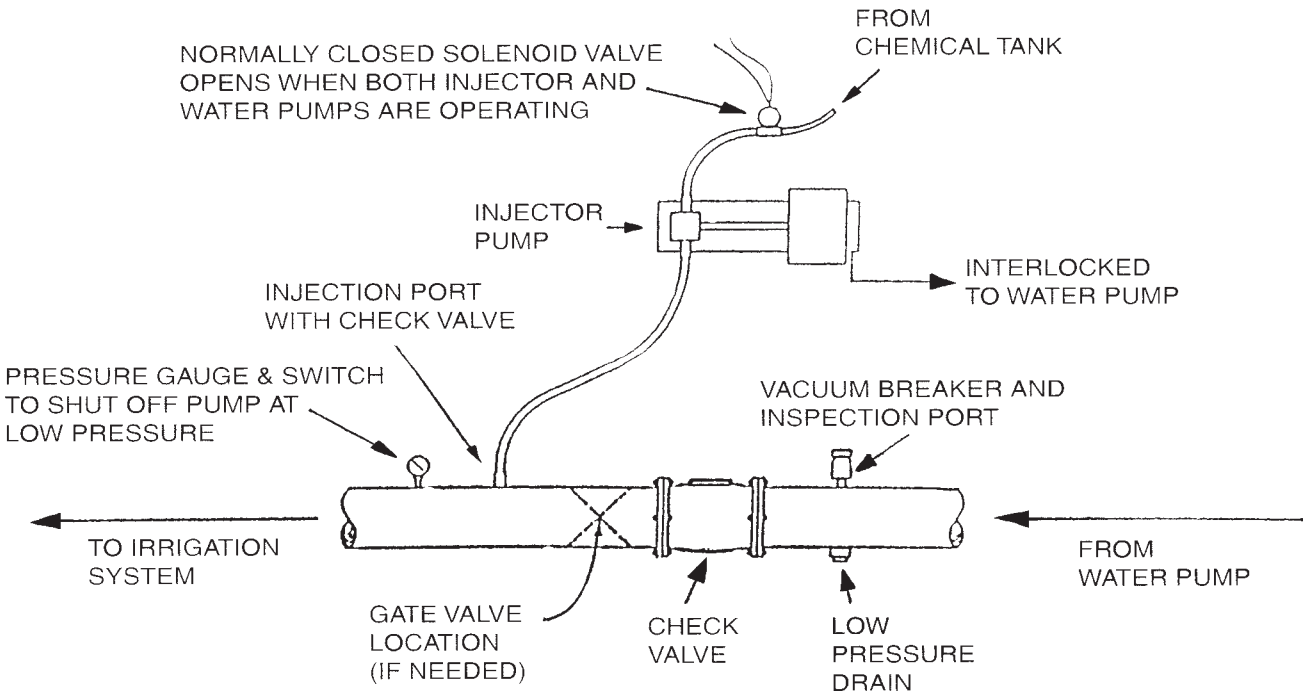
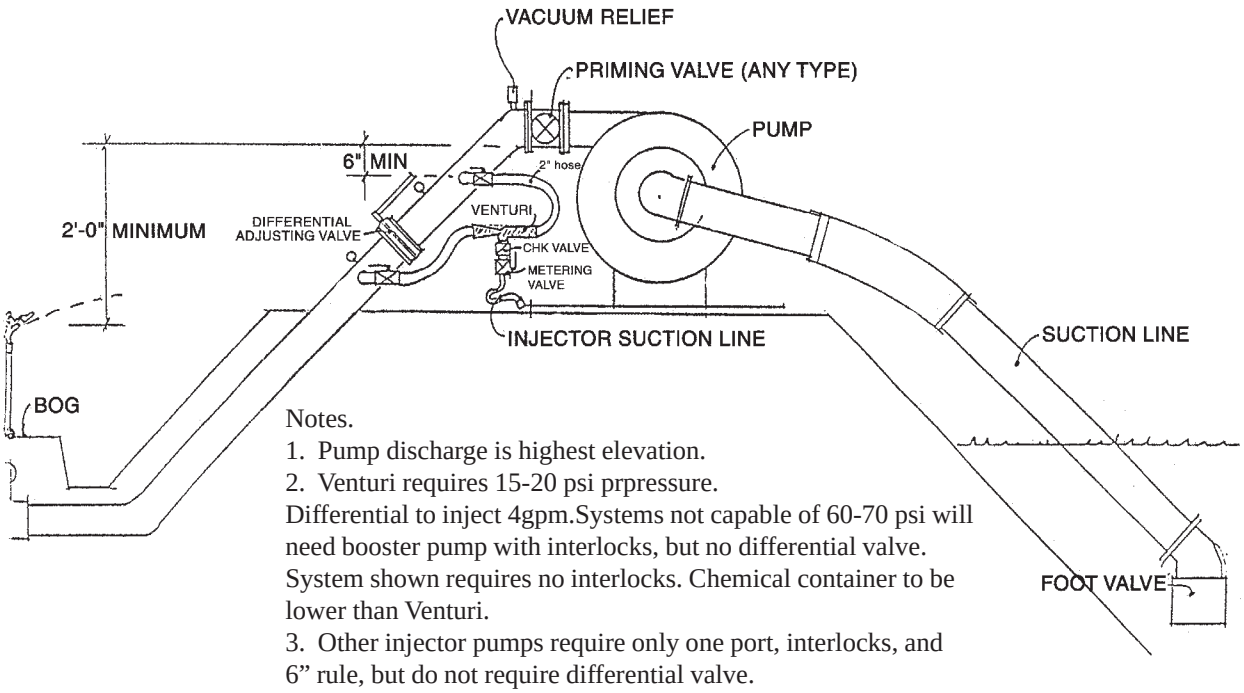
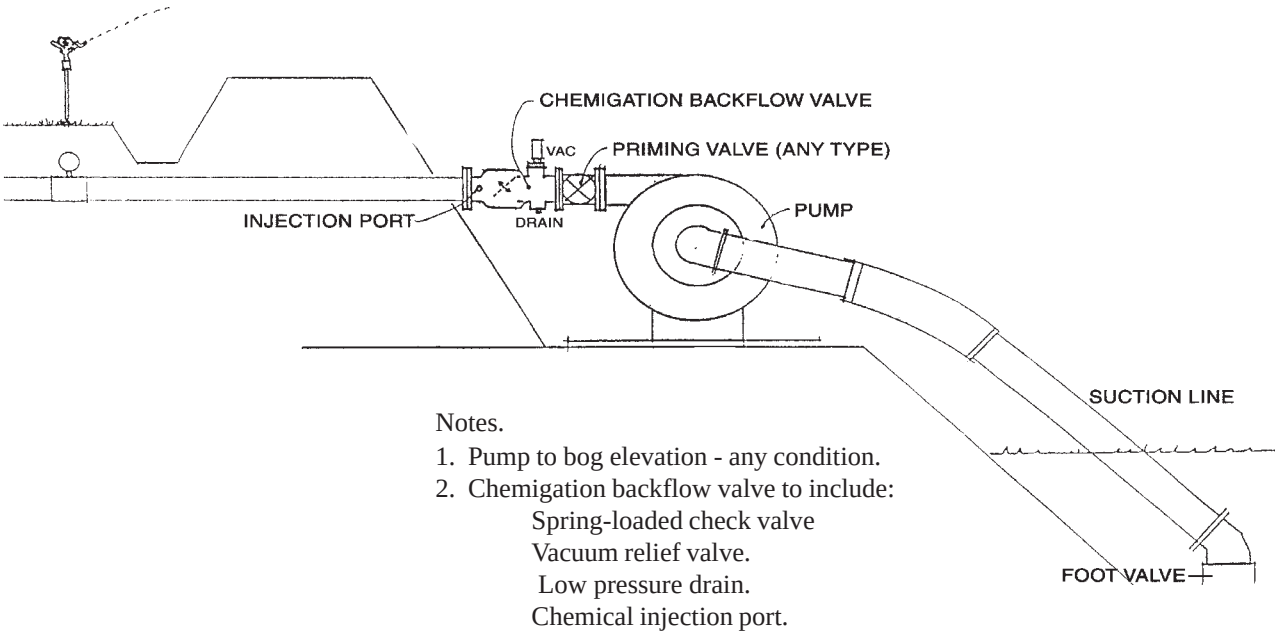


Figure 1. Required equipment for conducting chemigation on commercial cranberry farms.



Notes.
1. Pump discharge is highest elevation.
2. Venturi requires 15-20 psi prpressure.
Differential to inject 4gpm.Systems not capable of 60-70 psi will need booster pump with interlocks, but no differential valve. System shown requires no interlocks. Chemical container to be lower than Venturi.
3. Other injector pumps require only one port, interlocks, and 6" rule, but do not require differential valve.

Figure 2. Cranberry bog backflow prevention and chemigation. Example of atmospheric loop and venturi injector.



Notes.

1. Pump to bog elevation - any condition.
2. Chemigation backflow valve to include:
   - Spring-loaded check valve
   - Vacuum relief valve.
   - Low pressure drain.
   - Chemical injection port.

Figure 3. Cranberry Bog backflow prevention and chemigation. Example of chemigation backflow valve, pump not 2 feet higher than head.

PESTICIDE APPLICATION CHECKLIST

IMPORTANT PHONE NUMBERS

Massachusetts Poison Control System. 1-800-682-9211 **Chemtrec. 1-800-424-9300**

Prior to the Application

Worker Protection:

Have all appropriate Personal Protection Equipment (PPE) ready to use.
Have labels and MSDS on-hand
Have decontamination kit stocked and ready for use.

Appropriate notification:

Neighbor relations.
Sign-posting.
WPS and REI notification.

Environmental concerns:

Address any public drinking water recharge area restrictions.
Check to see that the planks are in place.
Check the weather forecast.

Transport the pesticide in a legal manner.

Applicator must have the appropriate license for application.

Verify that all equipment is working properly.

Observe pre-harvest intervals.

Have your Emergency Action Plan on-site.

Equipment that may be helpful to have on hand:

- 5-gallon bucket
- Knife
- Measuring cup
- Duct tape
- Injection port rinse device
- Stopwatch
- Mixing stick
- Portable communication devices (e.g., cellular phones)
- Bungee cords (to hold hose, etc.)
- Assorted tools (pliers, screwdriver, wrench etc.)
- Clean water in jugs
- Pesticide clean-up kit (5 gallon is good)
- WPS decontamination kit

After the Application

Record keeping done?

Containers rinsed and disposed of appropriately?

Are excess pesticides properly stored?

Clothes properly washed after application?

Prepared by Carolyn DeMoranville (Project Leader), Hilary Sandler, and Steve Ward. Figures provided by Jack Heywood, Stearns Irrigation. Production of this Management Guide was supported by Massachusetts Department of Food and Agriculture as part of the Agro-Environmental Technology Grants Program. Matching funds were provided by University of Massachusetts Extension (USDA Cooperating) and Cape Cod Cranberry Growers Association. UMass Extension offers equal opportunity in programs and employment.

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