Pollution Prevention in Colorado Commercial Greenhouses

XCM-206

Colorado State University® Cooperative Extension

Authors: Karen L. Panter
Extension Agent, Commercial Greenhouse
Colorado State University Cooperative Extension
Adams County

Steven E. Newman
Greenhouse Crops Extension Specialist
Colorado State University Cooperative Extension

Reagan M. Waskom
Extension Water Quality Specialist
Colorado State University Cooperative Extension

The authors and Colorado State University Cooperative Extension gratefully acknowledge the funding support of the Colorado Pollution Prevention Program of the Colorado Department of Public Health and Environment.

With Cooperation from: Colorado Department of Public Health and Environment
Colorado State University Department of Horticulture and Landscape Architecture

BMP Review Team: Ronald F. Jepson, Agriculture Agent
David E. Whiting, Horticulture Specialist
James E. Klett, Professor of Horticulture

Published by Colorado State University Cooperative Extension in cooperation with the Colorado Department of Public Health and Environment.

SECTION 1

Introduction

Pollution prevention is the reduction or elimination of pollutants or wastes at the source, through the use of less hazardous materials or using more efficient practices or processes. By preventing pollution, a greenhouse enterprise can reduce production costs, eliminate or reduce waste management costs, lower risk and liability expenses, and free up resources by reducing regulatory burdens.

Nonpoint source pollution is an issue of which all agricultural chemical users are aware. Along with this awareness, there is a need for information specific to the greenhouse crop production industry for effective uses of biorational pesticides and biological controls of insect and mite pests, diseases, and alternatives to herbicide sprays in confined areas. Any reduction in the use of chemical pesticides will reduce the possibility of point or nonpoint source pollution from a greenhouse.

According to the Colorado Pollution Prevention Act of 1992, "the state policy of Colorado shall be that pollution prevention is the environmental management tool of first choice." Through the establishment of this act, The Colorado Department of Public Health and Environment developed the Colorado Pollution Prevention Program, which funded the development of this publication. The goal of this publication is to provide some Best Management Practices specific for greenhouse growers to reduce their risk related to pesticide use and potential nonpoint source pollution resulting from the use of pesticides.

SECTION 2

An Overview of Best Management Practices for Greenhouse Pesticide Use

Best Management Practices Defined

Greenhouse Best Management Practices (BMPs) are recommended methods, structures, and practices designed to prevent or reduce water pollution while maintaining economic returns. The BMPs concept deals specifically with nonpoint source pollution, such as runoff from greenhouse operations. Implicit within the BMPs concept is a voluntary, site-specific approach to water quality problems. Many of these methods are already standard practices, known to be both environmentally and economically sustainable.

The goal of BMPs is to protect water resources from degradation, while maintaining the economic viability of agriculture and related industries. Ideally, these practices will improve producer profitability. Best management practices are encouraged to be used by all Colorado citizens using pesticides and fertilizers. If BMPs are not used voluntarily as non-point source pollution prevention tools, they may become mandatory in the future.

Greenhouse BMPs are classified as either source, structural, cultural, or managerial controls.

- ***Source controls*** are considered the easiest to regulate and implement in greenhouses. They include restriction or removal of a particular pesticide. Such controls are generally accomplished by the Environmental Protection Agency (EPA) for pesticides through the labelling process.

Examples include: voluntary use restriction of a labeled pesticide by manufacturer; mandatory label restrictions by EPA.

- ***Structural controls*** usually require some capital outlay and maintenance, but are very effective in controlling pesticide, water, insect, and disease movement.

  Examples include: chemigation backsiphon devices; screening greenhouse openings; double doorways.

- ***Cultural controls*** are specific production practices that either minimize pest problems or maximize plant health thereby reducing the need for pesticides.

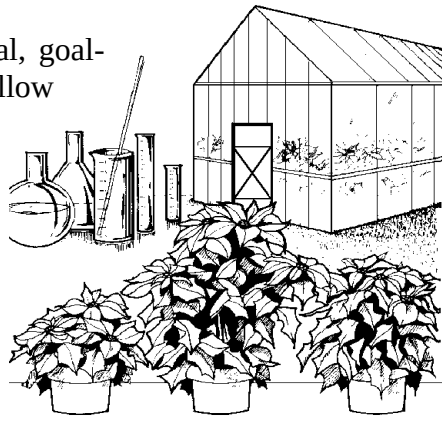
  Examples include: application techniques, such as split growth regulator applications; growing with proper temperature, humidity, and growing medium moisture levels to maintain plant health; scouting and monitoring for insect and disease pest on a routine basis; removal of plant materials and debris that favor disease or insect infestation.

- ***Managerial controls*** are strategies and tools that minimize pollutant losses in ground or surface water. These methods are much more site specific than source or structural controls. An increased level of awareness through management enables producers to consider both environmental and economic impacts when choosing production or control methods.

  Examples include: Integrated Pest Management; irrigation scheduling; record keeping of pest infestations and pesticide use.

General Guidance Principles

The following guidance principles are intended as general, goal-oriented guidelines for selecting BMPs. They are intended to allow operators significant managerial flexibility achieving the goal of protecting our water resources while maintaining economic returns. Under each guidance principle, site-specific BMPs should be selected, which are tailored to specific greenhouse crops and management constraints. BMPs listed after each of the following guidance principles are examples intended to illustrate possible practices.



To select BMPs that achieve the environmental quality goals of your operation, consider:

- The environmental sensitivity of the greenhouse location;
- Overall costs and benefits of the new practice;
- Short-term and long-term effects on water quality; and
- The most suitable practices for your site and your greenhouse management plan.

Guidance Principle 1: Manage irrigation to minimize transport of chemicals from the soil surface or immediate crop root zone.

Irrigation water is the major transport mechanism for greenhouse chemicals. Beneficial use of irrigation water implies keeping it free from pollutants that might affect quality. Methods to help minimize groundwater contamination due to deep percolation of water include:

- Scheduling irrigation according to crop needs and growing medium water depletion;
- Upgrading irrigation equipment to improve application efficiency; and
- Reducing water application rates to ensure no runoff or deep percolation occurs during chemigation application.

Guidance Principle 2: Use an integrated pest management approach in pest control decisions.

Crop pests, such as insects, weeds, and plant diseases, cause millions of dollars in damage to Colorado greenhouse crops each year. Pesticides often are used as the primary control method. Greenhouse crop producers can save money and protect water quality by selecting a pest management strategy that reduces chemical use. Integrated Pest Management (IPM) combines chemical control with cultural and biological practices to form a single program for managing pests. It emphasizes maintaining pests below an economic threshold and using the minimum amount of pesticide necessary for control. Also, using a proper pesticide at the time of maximum pest susceptibility is critical to an effective IPM program.

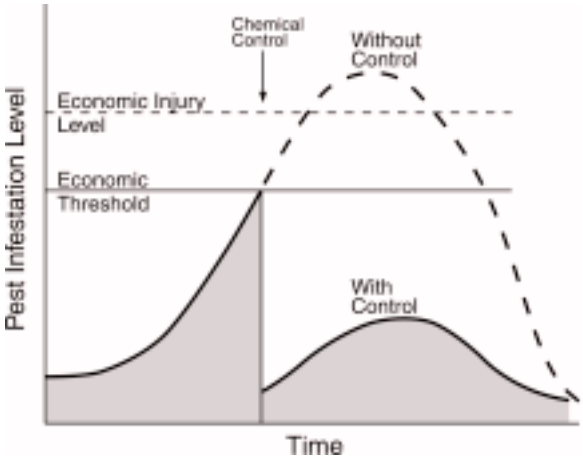


FIGURE 1. Economic thresholds and pest population models help growers determine when pest control is warranted. (Source: University of Idaho Current Information Series No. 938.)

Reducing dependence upon chemical controls also decreases the probability of occupational health risks, reduces the chance of pest resistance, and increases consumer confidence in greenhouse-grown crops.

The foundation of an IPM approach is a regular pest-monitoring program that enables producers to accurately determine when a pest control measure is economically justified. Other practices include:

- Selecting crops and varieties with few insect and disease problems;
- Timing pesticide applications to minimize host plant damage and maximize pest control;
- Rotating crops in the greenhouse;
- Spot treating problem areas instead of the whole greenhouse; and
- Employing beneficial insects and other biological controls.

Guidance Principle 3: Apply pesticides only when needed and use in a manner that will minimize off-target effects.

Pesticide use is often necessary to achieve high levels of crop productivity and quality. Scientific data indicate that these products can be used safely if applicators follow the appropriate BMPs. For example:

- All chemical applicators must receive thorough training and EPA certification prior to any use.
- Know the characteristics of the application site, including soil type and depth to groundwater under the greenhouse. Be aware of any drinking water wells down gradient of your operation.
- Compare chemical leaching hazard, persistence, and toxicity to site-specific conditions to determine suitability of the pesticide at that location, i.e. each specific greenhouse.
- Inspect, calibrate, and maintain application equipment on a regular basis.
- Minimize pesticide waste and storage by purchasing and mixing only enough chemical to meet application needs. Use the smallest available package size wherever possible to minimize container disposal problems.

Guidance Principle 4: Maintain records of all pesticides applied.

Keep accurate records of all agricultural chemicals as a BMP that can save money and help you make informed management decisions. By federal law, records of all restricted-use pesticide (RUP) applications must be maintained by operators for at least two years. Records of non-restricted pesticides can be maintained on the same form as the RUP records, with minimal additional effort. Keep records on all pesticides applied, including brand name; formulation; EPA registration number; amount and date applied; exact location of application; name, address, and certification number of applicator. Use this information together with other information for use with crop and pest modeling programs and economic analyses.

- Irrigation water analysis;
- Crop growth records;
- Amount of water applied; and

- Effectiveness of alternative pest control measures.

Guidance Principle 5: Facilities for pesticide storage, mixing, and loading should protect groundwater from contamination due to spills or leaks.

Spills, leaks, and backsiphoning into wells during chemical handling operations are though to be responsible for most of the significant incidents of drinking water contamination by pesticides. Colorado Senate Bill 90-126 requires bulk storage facilities that annually handle more than 3,000 pounds (or 500 gallons) of bulk formulated pesticide to meet specified requirements. These rules provide guidelines for bulk chemical storage, mixing/loading equipment, and mixing/loading pads. Even though very few greenhouse chemical facilities fall under these regulations, the guidelines are BMPs for anyone who routinely handles pesticides or commercial fertilizers.

BMPs for storage and mixing facilities include:

- Store all pesticides in a locked building with cement floors, located at least 100 feet from any water supply;
- Equip storage facilities with secondary containment dikes designed to contain liquid spills or leaks;
- Use impermeable mixing/loading pads at pesticide loading sites;
- Provide worker safety features such as showers, protective clothing, and spill cleanup kits; and
- Make Material Safety Data Sheets available at the mixing station.

Guidance Principle 6: Protect wellheads from potential sources of contamination.

Wellheads are very vulnerable sites for groundwater contamination because they are direct conduits to groundwater. Activities around the well, such as pesticide mixing and loading, represent a serious threat to drinking water supplies.

BMPs for wellhead protection include:

- Regular inspection and maintenance of well construction as needed;
- Installation of backflow prevention devices;
- Stay at least 100 feet from the well when mixing, loading, and storing agricultural chemicals; and
- Monitor well water quality periodically and know site-specific variables affecting aquifer vulnerability.

SECTION 3

Best Management Practices for Greenhouse Crop Pests

Overview

Crop pests, including insects, weeds, and plant disease organisms cause millions of dollars in damage to Colorado greenhouse crops each year. Uncontrolled pests can out-compete crops for water and nutrients, causing producers economic losses. Pesticides often are used as the primary control method in agriculture and horticulture because of their convenience and cost effectiveness. However, along with these benefits have come some drawbacks. Concerns about potential environmental problems, such as groundwater contamination and problems with pest resistance, have caused many greenhouse crop producers to look for alternative pest management methods.

Greenhouse crop producers can protect Colorado water resources by implementing Best Management Practices (BMPs) that reduce excessive chemical use while controlling pests. A number of new and traditional management practices can help crops compete effectively against pests.

Greenhouse pest management is a complex process because growers must contend with numerous pest species at any given time. The Integrated Pest Management (IPM) approach combines chemical control when necessary, with cultural and biological practices to form a comprehensive program for managing pests. IPM emphasizes maintaining pests below an economic threshold while applying the minimum amount of chemical necessary for control.

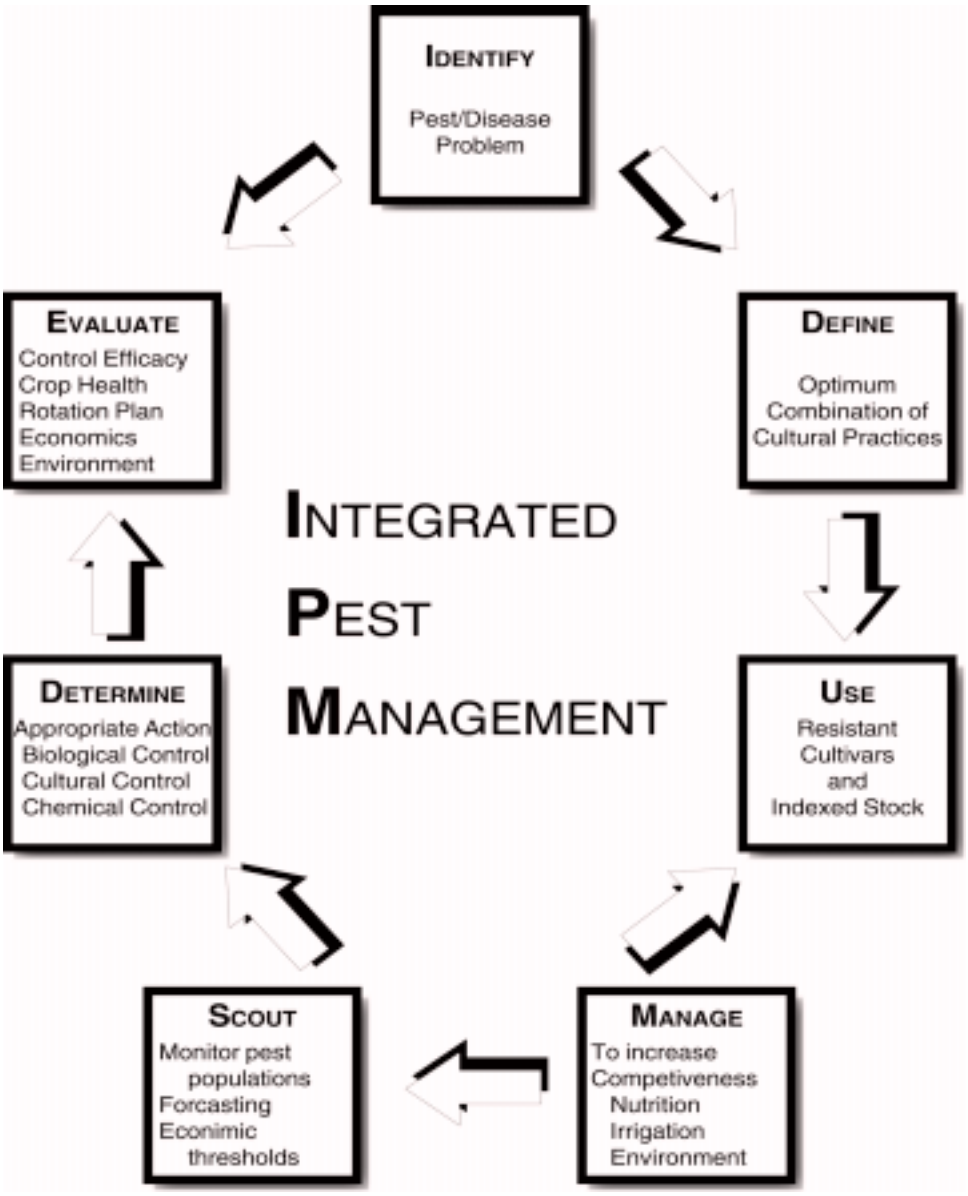


FIGURE 2. Integrated Pest Management systems incorporate a number of tools to effectively manage insects, diseases, and weeds.

The BMP Approach

Rather than impose overly restrictive measures on greenhouse crop producers and related industries, the Colorado Legislature passed the Agricultural Chemicals and Groundwater Protection Act (SB 90-126) to promote the voluntary adoption of Best Management Practices. The act

calls for education and training of all producers and agricultural chemical applicators in the proper use of pesticides and fertilizers. Voluntary adoption of BMPs by agricultural chemical users will help prevent contamination of water resources, improve public perception of our industry, and perhaps eliminate the need for further regulation and mandatory controls.

BMPs are recommended methods, structures, or practices designed to prevent or reduce water pollution. Implicit within the BMP concept is a voluntary, site-specific approach to water quality problems. Development of BMPs in Colorado is being accomplished largely at the local level, with significant input from growers, crop advisors, and other professionals. Many of these methods are already standard practices, known to be both environmentally and economically beneficial.

Best Management Practices for Greenhouse Crop Pests

To select crop pest BMPs that achieve water quality goals for your operation, consider:

- Overall costs and benefits of pest management;
- Short-term and long-term effects on water quality; and
- The most suitable practices for your site and crop production plan.

General Greenhouse Crop Pest BMP categories include:

- Use an Integrated Pest Management (IPM) approach that selects the most appropriate means of pest control, including cultural, biological, structural, mechanical, and chemical methods.
- Rotate crops, if possible, in the greenhouse and select varieties with few insect and disease problems. Know the particular insects and diseases to which particular crop mix is susceptible.
- Improve plant vigor and pest tolerance by supplying adequate light, nutrients and water, and by adjusting the greenhouse environment as needed for optimum crop growth.

- Scout greenhouses and surrounding areas for pests and use economic thresholds to determine when and if control measures are justified. Maintain precise records of pest infestations and management methods employed.

Insect Management BMP categories include:

- Destroy alternate pest breeding sites and hosts, if possible, to interrupt life cycles so that potential recurrences are reduced.

- Scout greenhouse crops at least weekly. Be sure pests are properly identified before control measures are employed.

- Select biological and least toxic insecticides when feasible. Incorporate crops with few insect pests into your greenhouse crop rotation.

- Protect naturally occurring biological control organisms by using insecticides that are less toxic to them.

- Handle insecticides carefully around wellheads and be sure chemigation backflow prevention devices are operating correctly.

Disease Management BMP categories include:

- Select crop varieties with disease resistance when possible. Use disease free seed, plugs, cuttings, and other propagation materials.

- Rotate different crops through the greenhouse if possible. Clean up dead and decaying plant material and growing media from benches and floors to decrease pathogen survival.

- Control insect and other disease vectors both inside the greenhouse and out.

- Keep greenhouse tools and equipment clean, especially when moving from house to house and crop to crop. Keep chlorine bleach or other greenhouse labeled disinfectants available to disinfect cutting tools, bench surfaces, underneath benches, and other work areas.

- Use new or thoroughly cleaned growing containers and sterile, pre-bagged or steamed growing media.

Weed Management BMP categories include:

- Evaluate site-specific weed management alternatives and develop a plan that includes cultural and mechanical control both inside the greenhouse and out.

- Scout and monitor weed infestations just as you would insect and disease problems. Maintain good records of weed populations, control measures used, and their effectiveness.

- Use sterile, pre-bagged growing media or thoroughly steam pasteurize your own growing mix for container-grown crops. Thoroughly steam beds for fresh cut flower production between crops. Steam to 180°F and maintain that temperature for 30 minutes.

- Treat the problem, not the greenhouse. Use hand weeding for most areas in the greenhouse.

- Several herbicides are labeled for greenhouse, but all have strict requirements for greenhouse use. Herbicide use in the greenhouse should be discouraged, unless the house is completely empty.

- Spray herbicides sparingly around the outside of the greenhouse. Establish setbacks a safe distance from surface water and wells where herbicides known to cause water quality problems are not applied. Mow weeds around the perimeter of the greenhouse instead of spraying herbicides.

SECTION 4

Best Management Practices for Greenhouse Pesticide Storage and Handling

Overview

Storage and handling of pesticides in their concentrated forms pose the highest potential risk to ground or surface water from agricultural chemicals. For this reason, it is essential that facilities for the storage and handling of these products be properly placed, designed, constructed, and operated. Colorado law (SB 90-126) requires operations handling large volumes of bulk agricultural chemicals to comply with containment regulations. Operators who handle amounts of pesticides that fall below the thresholds for mandatory containment (most Colorado greenhouses are in this category) should observe Best Management Practices (BMPs) for handling these concentrated products in the interest of protecting water quality.

Economic considerations, including liability, risk, and property transfer problems, as well as fire and environmental hazards constitute a strong inducement for operators to evaluate current greenhouse pesticide practices and facilities. This section contains suggestions for operators to consider for their enterprise.

Greenhouse pesticide facilities include storage and the mixing and loading site. The size of these facilities will vary from small greenhouse enterprises to large commercial dealers. However, all operators need properly designed facilities that promote worker safety and environmental protection.

Proper management of the containment facility and the mixing and loading area is an important aspect of responsible pesticide use. Use of poor practices at these sites can lead to water contamination, serious liability problems, and a poor public image for greenhouse pesticide applicators and dealers.

Storage Facilities for Pesticides

Plan storage facilities as a secured, single-use area, separate from other activities and storage. Design the storage area to protect pesticides from possible theft, unauthorized use by untrained personnel, and temperature extremes. Federal law requires that concentrated pesticides be stored in a secured area. Be sure to post warning signs near each entrance to the storage facility.

Greenhouse pesticide storage and handling facilities should provide:

- Separate storage areas for pesticides and fertilizers that are secured and keep the products out of the weather;
- Secondary containment of the stored products;
- Safe mixing and loading area away from water resources; and
- Worker protection features such as showers, first aid, and spill clean-up kits.

Greenhouse pesticide storage and handling facilities should enable one to:

- Minimize the amount of agricultural chemicals stored and handled;
- Reduce waste such as rinsate, containers, and partially used product
- Maintain good records of all chemical use; and
- Provide preparation and training to respond to emergencies.

In most cases, pesticides and fertilizers should be stored separately to minimize the possibility of cross contamination or creation of hazardous waste in the case of fire or other disaster. Small operations can avoid the need for multiple storage areas by constructing separate containments for

pesticides and fertilizers within the same structure. Whenever possible, minimize storage of chemicals to avoid the associated risks. Purchasing only the amount of chemical needed, keeping tight inventory control, and using returnable container systems can help small operators minimize storage. However, even small operations need the insurance of a well designed and managed facility. The cost of these preventive measures is far less than the potential costs of a cleanup or lawsuit.

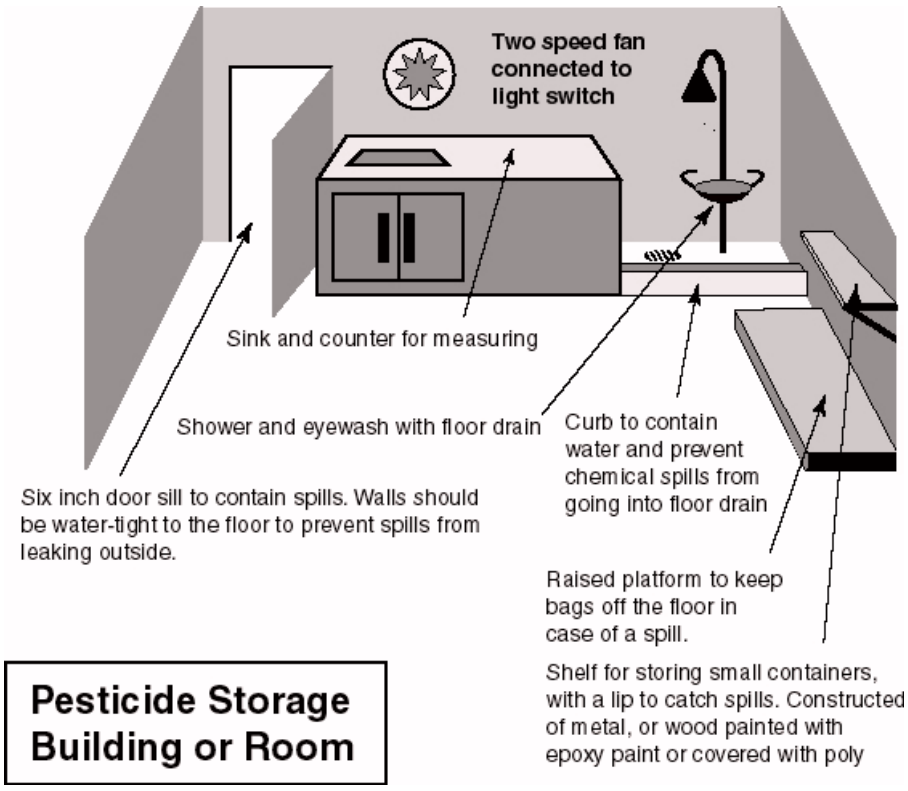
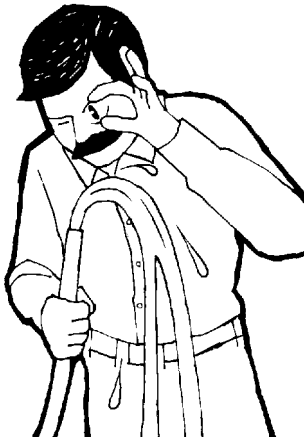


FIGURE 3. Suggested ideas for a greenhouse pesticide storage facility. (adapted from *Tips on Managing Floriculture Crop Problems* with permission of The Ohio Florists' Association and Florists' Mutual Insurance Co.)

Liquid Pesticides

Always store pesticide by container size and product in locked buildings with impermeable floors and ventilation. Herbicides, fungicides, and insecticides should be separated to prevent cross contamination. Never store liquids below grade or in a basement. Small boxes and jugs should be kept on shelves, while drums and mini-bulks should be kept on floor pallets. Small volume returnables or mini-bulks in Department of

Transportation (DOT) approved containers will help small operations reduce the problems of storing unused product and minimize container disposal problems. Additionally, pesticides stored in these containers are exempted from requirements for secondary containment under SB 90-126.



Dry Pesticides

Stored dry products pose little threat to groundwater as long as they are kept dry. Always keep dry products on pallets to reduce the possibility of water damage.

Best Management Practices for Greenhouse Pesticide Storage and Handling

General BMPs

- Assess the storage site and the loading areas to determine appropriateness of the site in terms of human safety and ground and surface water vulnerability.

- Follow all state and federal regulations regarding label directions for storing and mixing of chemicals and for disposing of empty containers.

- Keep accurate pesticide use records as well as storage and handling. Maintain a log book to document storage facility inspection and maintenance.

Chemical Storage BMPs

- Store all agricultural chemicals in a locked, well marked building or area with impermeable floors, located a safe distance from any water source.

- Store pesticides in their original containers with labels intact, visible, and legible.

- Store products by type and size. Keep fertilizers and pesticides in separate containments. Store small volume containers on metal shelving with a retainer lip at the front of each shelf.

- Participate in Chemsweep or any statewide pesticide recovery program to eliminate any banned or unidentified chemicals on the property.

Secondary Containment for Liquids BMPs

- Equip pesticide and fertilizer storage facilities with secondary containment dikes designed to contain liquid spills or leaks. Recover any spill in the storage area immediately and reuse or dispose of appropriately.

- Separate containment of pesticides and fertilizers.

- Construct secondary containment systems out of chemical-resistant, impermeable material. Do not use exposed earthen berms for secondary containment of pesticides.

- Inexpensive, portable secondary containment devices, which are made of plastics, are commercially available.

Mixing and Loading BMPs

- Construct impermeable mixing/loading pads at permanent pesticide loading sites. Design pads to handle the volume of the largest sprayer, plus an additional 25%.

- Site permanent mixing areas a minimum of 100 feet, or the necessary safe distance, from any water source or well.

- Install backflow prevention devices on supply lines or be sure an air gap is established when using hoses connected to a water supply. Using nurse tanks for water supplies ensures protection from backflow.

- Recover any spill at the mixing site immediately and reuse. Do not allow spilled chemical soak into the soil. Keep granular absorbent material, such as cat litter, available at the mixing site to clean up small spills.

- Clean loading pads and sumps after daily use. Do not allow accumulation of pesticides in the sump. Keep the sump covered when not in use to keep out trash, dirt, and debris.

Waste Management BMPs

- Mix only the amount of pesticide that will be used for the current job.

- Use products by age so that older product gets used first. If containers are deteriorating, use the product as soon as possible.

- Dispose of unwanted or outdated materials properly. Participate in state-sponsored pesticide collection programs when available.

- Purchase the correct amount of product needed and return unopened containers for credit. Whenever available, use mini-bulks, small-volume refillable containers, or dissolving packets to avoid container waste.

- Recover rinsates and wash water from the mixing pad for reuse as make-up water or apply to the crop as a dilute solution in accordance with the label directions.

- Clean spray tanks and spray equipment at the application site. Take care to rinse equipment in areas where water will not run off toward wells or surface water.

- Triple-rinse or pressure-rinse one-way pesticide containers immediately after emptying. Rinse container caps and the outside of containers to remove pesticide residues. Puncture containers prior to disposal.

- Recycle empty pesticide containers whenever possible. Do not burn or dispose of containers on-site.

Worker Safety BMPs

- Provide worker safety features such as gloves, showers, protective clothing, fire extinguishers, and spill clean-up kits. Keep Material Safety Data Sheets available at the mixing station.

- Train all employees in proper pesticide handling and safety procedures. Employees should have a clear understanding of your operation's emergency response plan in case of any spill or fire. Emergency response plans should include records of products stored and provisions for notification of the proper local authorities.

SECTION 5

Best Management Practices for Greenhouse Pesticide Use

Overview

Pesticides are widely used to protect crops and livestock from losses due to insects weeds, and diseases. Colorado uses about 1% of the 1.2 billion pounds of pesticide applied annually in the United States. The Environmental Protection Agency (EPA) has estimated that 70% of the total pesticide use is for agricultural production, with the remaining used in the urban, industrial, forest, and public sector. These chemicals have helped to increase agricultural production with reduced labor. However, problems associated with improper pesticide use have led to human illness, wildlife losses, and water quality degradation.

The major groups of pesticides include insecticides, herbicides, and fungicides. Herbicides are the most widely used class of agricultural pesticides and subsequently have been the most frequently found in ground and surface water. Until recently, it was thought that pesticides applied to agricultural fields were broken down or tied up before they could reach groundwater. However, the development of extremely sensitive detection methods has led to the discovery that commonly used management practices may lead to small amounts of pesticide contaminating ground and surface water supplies. Since rural residents depend on these water supplies, agricultural producers need to exercise a high level of management to avoid contamination.

This section addresses Best Management Practices (BMPs) for preventing nonpoint source contamination of water resources by

greenhouse pesticide applicators. Contamination from normal pesticide application is called non-point source contamination, since a single point of contamination cannot be identified. Point source contamination would include spills of concentrated chemicals at storage, mixing, or loading sites.

Since pesticides are an important tool for most greenhouse operations, and cleaning up contaminated groundwater is extremely difficult, producers need to adopt BMPs for pesticide use, which are appropriate for their crops and site. A number of pesticide application practices are available that can be used to reduce potential non-point source contamination of water supplies.

Best Management Practices for Greenhouse Pesticide Use

General BMPs

- Obtain thorough training and the appropriate certification prior to any pesticide use.

- Read all label instructions prior to chemical mixing. All pesticide applications must follow label specifications and must be applied only to the crops for which the product is registered for use in Colorado.

- Keep precise pest and pesticide records.

- Consider the effects of pest control measures on the environment and nontarget organisms. Minimize chemical reliance by rotating different crops through the greenhouse and by using mechanical, cultural, or biological pest management measures whenever feasible.

Pesticide Selection BMPs

- Avoid the overuse of preventive pesticide treatments. Base pesticide application on site-specific pest scouting and indicators of economic return.

- Select least toxic and less persistent pesticides when feasible.

- Consider pesticide and target site characteristics to determine suitability of the pesticide at that location. Include knowledge of pesticide persistence, mobility, and adsorption in pesticide selection. Chemical applicators should know the characteristics of the application site, including soil texture under the greenhouse, organic matter content, local topography, and proximity to ground and surface water.

Pesticide Application BMPs

- Maintain application equipment in good working condition and calibrate equipment frequently to ensure recommended rates are applied. Replace all worn components of pesticide application equipment prior to application.

- Ensure that the pesticide applicator knows the exact location to be treated in the greenhouse. Post warning signs on doors to greenhouses that have been treated, in accordance with local, state, and federal laws. Follow the established re-entry time as stated on the label.

- Employ application techniques that increase efficiency and allow the lowest effective labeled application rate. Use spot applications of pesticides where appropriate to reduce environmental hazards and treatment costs.

- Avoid unnecessary and poorly timed application of pesticides. Optimize pesticide rate, timing, and placement to avoid the need for re-treatment.

- Avoid overspray and drift.

- Time pesticide application in relation to growing medium moisture, anticipated weather conditions, and watering schedules to achieve the greatest efficiency and reduce the potential for off-site transport. Avoid pesticide application when growing medium moisture status or scheduled irrigation increases the possibility of runoff or deep percolation. After application, manage irrigation to reduce the possibility of leaching which may transport pesticide from the target site.

- Establish buffer zones where pesticides are not applied within a safe distance from wells and surface water.

- Avoid repetitive use of the same pesticide, or pesticides of similar chemistry, to reduce the potential for pesticide resistance development and shifts in the pest spectrum. Rotate mode-of-action pesticide chemistries.

- Ensure that backflow prevention devices are installed and operating properly on irrigation systems used for applying pesticides.

Pesticide Safety BMPs

- Read and follow label safety directions, maintain appropriate Material Safety Data Sheets (MSDS), and become certified prior to applying restricted use pesticides.

- Wear the appropriate protective equipment specified on the chemical label to minimize unnecessary exposure to pesticide. Be sure to clean protective gear after each day's use.

- Provide emergency hand and eye wash facilities for personnel who might be accidentally exposed to chemicals, and formulate a safety plan complete with information about locations of emergency treatment centers for personnel exposed to chemicals.

- Know what to do in case of accidental pesticide poisoning. Have a pesticide first aid kit available when handling pesticides. Check the produce label for instruction and call the nearest poison center in the event a pesticide is swallowed. Produce labels often contain a telephone number where expert information is also available. Take the pesticide label to the attending physician if you need treatment.

- Establish a plan of action in the event of a pesticide spill.

COLORADO Pollution Prevention PROGRAM

Colorado Department of Public Health and Environment

Colorado State University Cooperative Extension