# Best Management Practices For Crop Pests

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# Best Management Practices for Crop Pests

Crop pests, including insects, weeds, nematodes, and plant disease organisms cause millions of dollars in damage to Colorado crops each year. Uncontrolled pests can outcompete crops for water, nutrients, and sunlight, causing producers economic losses. Pesticides often are used as the primary control method in agriculture 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 agriculturalists to look for alternative pest management methods.

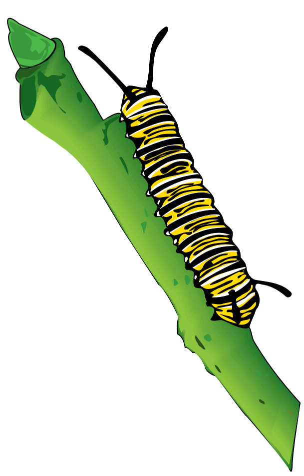
Farmers and other land managers can protect Colorado's water resources by implementing Best Management Practices (BMPs) that reduce excessive chemical use while controlling pests. A number of new and traditional management practices can help crops compete effectively against pests.

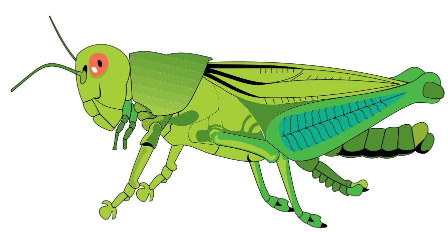
Pest management is a complex process because producers must contend with numerous pest species at any given time. The Integrated Pest Management (IPM) approach combines chemical control when necessary, with cultural and biological practices to form a comprehensive program for managing pests. IPM emphasizes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

**The BMP Approach**

**Rather than impose overly restrictive measures on farmers 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 the 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.**





## Integrated Pest Management

IPM offers growers an array of tools to help manage pest problems. At the foundation of this approach are good growing practices, preventive pest management measures, and a regular pest monitoring program that enables producers to accurately determine if a pest control measure is economically justified. IPM uses a common sense approach to find the weak link in a pest's life cycle. Sound pest programs do not attempt to eradicate pests, but rather to manage them so that economic crop losses are minimized.

IPM is the primary BMP for pest management. It involves combining practices such as:

- selecting crops and varieties which are resistant to pest pressures
- timing planting and harvest dates to minimize pest damage
- rotating crops
- monitoring pest and natural enemy populations
- employing beneficial insects and other biological controls.

The philosophy behind the IPM approach is to create unfavorable conditions for pest buildup by enhancing crop vigor and by protecting natural enemies that aid in controlling pest populations.

## Nonchemical Pest Control Practices

IPM may result in reduced pesticide use by employing preventive pest management and nonchemical pest controls. Nonchemical pest management methods include crop rotation, resistant varieties, cultural practices, and biological controls. These methods are basic to effective IPM and should be the first line of defense. However, producers must plan for their use in advance of pest outbreaks to successfully use nonchemical management tools.

### Crop Rotation

Crop rotation is a traditional production practice used to enhance soil fertility and tilth, increase crop vigor, and reduce the buildup of crop pests. Crop rotations cannot solve all weed, insect, and disease problems. However, without rotations, producers are essentially locked into pesticide-based control programs. Rotations are most likely to be effective on pests that tend to be crop specific and overwinter on site. By switching to another crop, pest cycles may be interrupted when they become active and find their food source is gone.

The key to a good rotation plan is to determine which pests are of most concern and then select crops accordingly. Obviously, market factors must be considered for producers to remain profitable. Continuous corn and alfalfa, as well as vegetable only and wheat-fallow cropping systems are common in Colorado. These systems have some production and marketing advantages, but usually result in weed and other pest problems. Rotating to different crops, such as from vegetables to small grains, provides the additional benefit of scavenging excess soil nitrate.

IPM programs are difficult to implement under cropping systems that do not include rotations. Where rotation is practiced, pesticide use can often be greatly reduced with no significant losses. For example, corn rootworm insecticide is used in the greatest volume of any agricultural insecticide in the United States. Rotating corn fields to any other crop generally eliminates the need for insecticide application, saving money and reducing potential environmental impacts.

### Resistant Varieties

Plant breeders have been selecting pest resistant varieties to improve crop productivity for many years. Now, host plant resistance is a cornerstone of many successful IPM programs.

Plants have many natural characteristics for keeping pests at bay: repellent or toxic chemicals, thorns, hairs, and resistant tissues. The greatest plant breeding successes have been in the selection of disease resistant varieties, but insect tolerant lines have also been developed. With some pests, such as plant viruses, the only effective control is the use of resistant varieties and clean planting material.

Resistant varieties will not interfere with other pest control measures and may reduce the need for pesticide treatment. However, resistance is not available for all problems. Potential drawbacks include decreased yields, increased susceptibility to other pests, and shifts in predominant pest biotypes as a result of over-exposure to the resistance genes. Examples of pest resistant Colorado crops include Russian wheat aphid tolerant winter wheat, curly top virus resistant sugarbeets, European corn borer resistant corn hybrids, sorghum unpalatable to birds, and dry beans with tolerance to white mold and halo blight. Check with your seed dealer to determine what sources of resistance are available in the crops you grow.

**Other Cultural Practices**

Pests have a more difficult time getting established when crop plants are thriving. For example, many late emerging annual weeds cannot compete successfully once the crop canopy shades the row. Insects such as spider mites thrive on drought stressed plants, but are much less competitive on vigorous crops. Producers should employ cultural practices to their advantage.

Optimum plant population, row spacing, fertility, and irrigation are practices that can improve crop vigor, thereby reducing pest competitiveness and impact. Growers should evaluate their production practices for areas where they can enhance crop health and vigor. Usually, these improvements will increase crop yield and economic return.

Adjusting planting, tillage, and harvest dates can sometimes help crops avoid pests. Early tillage destroys weeds where some insects lay their eggs. Tillage also is very important for destroying volunteer crops where pests such as Russian wheat aphid or wheat curl mite may overwinter or become established early. Early planting may help the shorter season corn varieties escape economic damage from second generation European corn borer.

Planting too early in the spring or too late in the fall has some drawbacks that producers should consider. Late frost and slowed emergence can make plants more susceptible to disease and insect pressure. A good technique for many growers is to plant a range of maturity dates, beginning as soon as the soil is at the proper temperature for germination. Producers may want to delay the planting of fields with problem weeds to allow for weed emergence and cultivation prior to crop establishment. Winter wheat growers can avoid wheat streak mosaic and Russian wheat aphid by delaying fall planting.

In some cases, crops can be harvested early instead of spraying. Harvesting alfalfa early may substitute for pesticide in reducing alfalfa weevil populations. An early first cutting can decrease the weevil population by mechanically damaging larvae and exposing them to predation and weather. Early harvesting is also a good way to manage foliar diseases in alfalfa. Harvesting corn for silage or high moisture grain may prevent losses caused by lodging due to stalk rot or corn borer.

**Biological Pest Control**

Beneficial organisms can help control weeds, diseases, and insects in crop fields when broad spectrum pesticides are avoided. These organisms may occur naturally or may be purposely introduced. Beneficials include predatory insects and mites, parasitic insects, and microbial organisms. Predators such as lady beetles and green lacewings feed on plant-eating pests. Insect parasites, like the tiny braconid wasp, lay eggs on or inside the developing pest. The single-celled protozoa, Nosema, is a microbial pathogen of grasshoppers. Additionally, grazing animals such as sheep can help control difficult weed species such as leafy spurge. Given favorable conditions, naturally occurring and introduced biological controls can do an excellent job of reducing some pests below economic injury levels.

Due to the cost of introducing biological controls, conserving the natural enemies already in your field is a useful IPM technique. Unfortunately, beneficial insects are often killed when broad spectrum pesticides are applied. To conserve beneficials in your fields:

- preserve habitat and alternate food sources for beneficials
- learn to distinguish beneficial insects from pests
- minimize broad spectrum pesticide applications
- use selective pesticides that are less toxic to beneficials
- treat only those portions of the field where pests cause economic levels of damage.

These natural controls often work more slowly than pesticides, but they can be effective, environmentally friendly, and economically sustainable.

The Colorado Department of Agriculture has an aggressive biological pest control program headquartered in Palisade. The program monitors weed and insect pests in Colorado to determine the severity of new and established pest problems. It handles more than 40 different species of beneficial insects for the control of 19 weed and insect pests (Table 1).

**Table 1. Examples of insect biological control organisms released for pest control by the Colorado Department of Agriculture**

| Control Organism | Pest | Crop |
|---|---|---|
| Macrocentrus ancylivorus | Oriental fruit moth | Peach |
| Hippodamia variegata | Russian wheat aphid | Wheat |
| Tetrastichus incertus | Alfalfa weevil | Alfalfa |
| Phrydiuchus tau | Mediterranean sage | Range |
| Ceutorhynchus litura | Canada thistle | Range |
| Rhinocyllus conicus | Musk thistle | Range |
| Calophasia lunula | Toadflax | Range |
| Microlarinus lareynii | Puncturevine | Range |
| Aphthona flava | Leafy spurge | Range |
| Urophora affinis | Knapweed | Range |

Commercially available biological control organisms are being used successfully by some growers of high value crops. A number of suppliers throughout the United States provide beneficial organisms for release in gardens, greenhouses, and fields. The economic benefit of field releases of beneficial insects is uncertain in many crops because of limited knowledge about when and how to achieve establishment and control.

Biological pesticides, such as *Bacillus thuringiensis* (Bt), are commercially available and are effective against some pests. These products are extremely selective and of low toxicity to humans and nontarget organisms. Examples of biological pesticides include bacteria, fungi, viruses, or their toxins. The bacterial insecticide, Bt, is currently the most commonly used biological pesticide. Consider using these products in place of more toxic pesticides, especially when water supplies are vulnerable to contamination. Be sure to follow all label directions for application and storage of these products.

## Chemical Control in an IPM Program

Regular field scouting, coupled with forecasting pest problems and determining economic thresholds, is used to ensure that pesticides are only applied when pest populations warrant chemical control (Figure 1). The traditional approach of applying pesticides routinely or at the first sign of any crop pest is replaced with a philosophy that seeks to optimize crop growth and allow natural enemies of pests the opportunity to suppress the outbreak. Producers and consumers must understand, however, that there is no "silver bullet" in an IPM program and that some level of pests and diseases must be tolerated. Fortunately, most crops can tolerate a certain level of infestation before significant yield or quality losses occur.

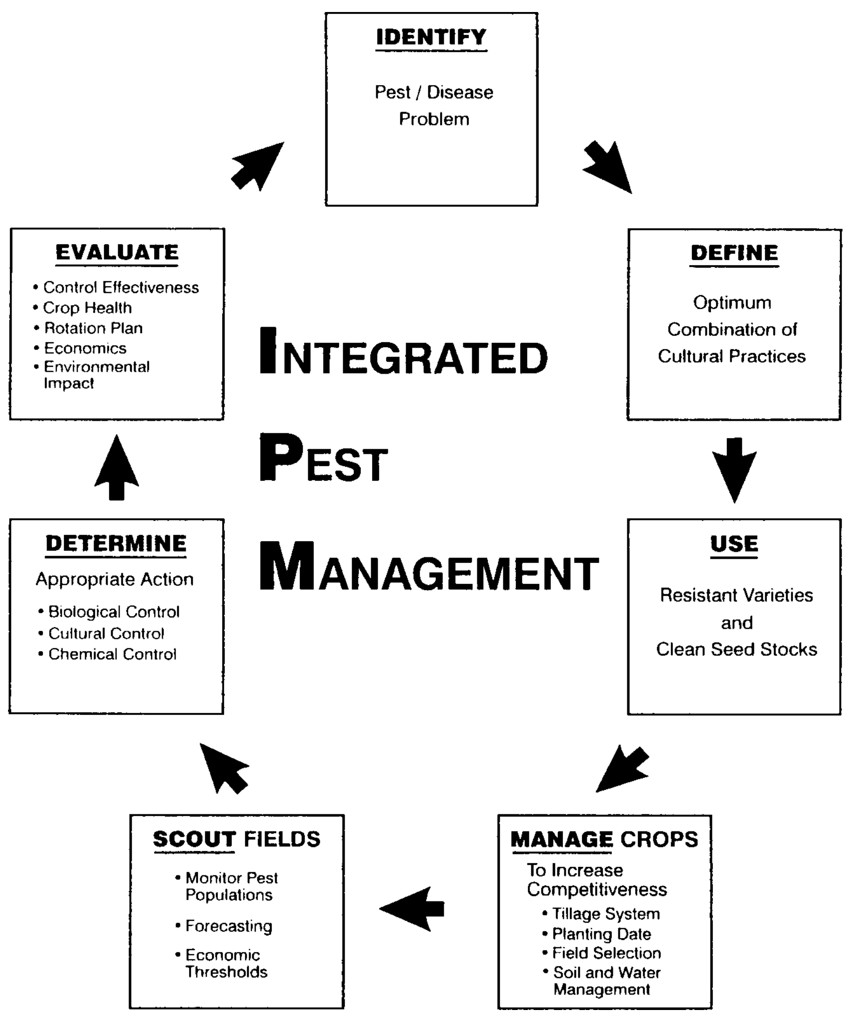



**Figure 1. Integrated Pest Management systems incorporate a number of tools to effectively manage weeds, insects, and diseases.**

### Field Scouting

Field scouting to assess pest and crop development is an essential BMP for any pest management program. Timely scouting can alert you to pest problems before they exceed economic thresholds. Some producers try to use the same pest control measures on all of their fields or watch their neighbors to know when it is time to spray. IPM makes no such assumptions. Rather, each field is individually monitored for potentially damaging pest outbreaks.

Proper scouting takes time and expert knowledge. Producers wishing to adopt an IPM strategy should ask themselves if they have the time, knowledge, and desire to scout their own fields. If not, a qualified consultant or crop adviser should be hired to monitor pest populations.

The tools used in a good scouting program include soil and tissue monitoring, pheromone traps, hand lenses, visual observations and a good system of field records and maps. Follow these steps to scout for pests.

- Make sure you have the proper equipment and knowledge.
- Record the crop stage and condition, pest populations and distribution, date and time of day, and any control recommendations.
- Sample each crop, variety, and field. Scout for pests by walking through the field – don't just check the field borders.
- Visit each field weekly. Some crops may require less frequent scouting, but others may require more during critical pest phases.
- Observe the proper re-entry periods for fields that have already been treated with pesticides.
- If you notice a problem that you cannot identify, take a sample of the pest, plant material, and soil (if appropriate) to the nearest Extension office or crop specialist as soon as possible.

### Economic Thresholds

The pest infestation level at which it pays to take remedial action is known as the economic threshold or action threshold. The economic threshold for most pests problems is just below the economic injury level – the level where the losses from pest damage equals the cost of control (Figure 2). Economic thresholds are set below the economic injury level to allow for the time lag between pest detection and the application of control measures.

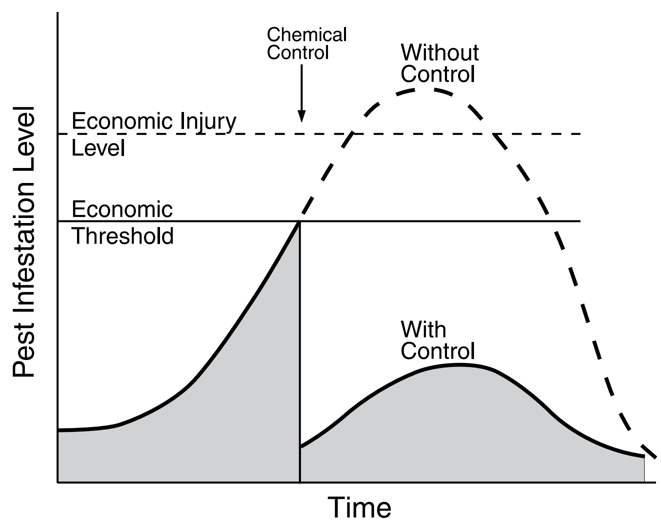



**Figure 2. Economic thresholds and pest population models help producers determine when pest control is warranted.**

Source: University of Idaho Current Information Series No. 938.

Economic thresholds have been determined for a number of pests and pathogens and are usually expressed as a pest count or number of diseased plants per unit area (Table 2). Keep in mind that most thresholds are only guidelines; you must determine the economic and environmental variables of your production situation. As crop value increases, the economic threshold will decrease. Conversely, as the cost of control increases, economic thresholds increase. Newer thresholds have been developed to incorporate yield expectations and control costs into management decisions. When a pesticide application is justified, keep in mind that you can often save costs by using spot or banded pesticide treatments.

Including environmental costs, such as groundwater contamination or wildlife losses, when setting economic thresholds is still a developing concept and may not be reflected in many of the currently available figures. Factors such as site vulnerability, pesticide toxicity, and natural enemy presence and susceptibility to pesticides should be included in making a pesticide decision. For more information on pesticide selection, contact your crop adviser or see the bulletin *BMPs for Pesticide Use* available from Colorado State University Cooperative Extension.

**Table 2. Economic thresholds for selected insects and crops**

| Pest | Crop | Economic threshold* |
|---|---|---|
| Alfalfa weevil | Alfalfa | 20 larvae/180° sweep |
| European corn borer | Field corn | 1-3 larvae/plant |
| Grasshoppers | Dry beans | 8/sq yd |
| Russian wheat aphid | Small grains | 10-20% damaged and infested plants |

Source: 1993 Colorado Pesticide Guide, Field Crops.

* Actual threshold will depend upon expected crop value and control cost.

IPM also makes use of predictive programs to model the occurrence and development of pest problems. These programs can be used with pest monitoring and economic thresholds to aid growers in deciding when and if crops should be sprayed. Several successful pest models are in use in Colorado. The heat driven potato early blight model used in the San Luis Valley, the codling moth development model used by the apple industry on the West Slope, and the WEEDCAM model used for weed management decisions in irrigated corn are examples.

Changing your pest management strategy to an IPM program may involve modifying tillage, fertility, cropping sequence, and sanitation practices. There is no single recipe for a successful IPM program. Producers should evaluate the mix of control practices which are available and determine how they fit into their management regimes. This may require some experimentation and perhaps professional help. The potato and fruit programs are good examples of successful IPM in Colorado.

## Weed Management

Herbicides are important tools for weed control and presently account for approximately 65% of all pesticide use in Colorado. Rather than rely only on herbicides for weed control, farmers and other land managers can save money and minimize potential environmental impacts by selecting a weed management strategy that reduces pesticide use.

The IPM approach seeks to control weeds without unnecessary reliance on pesticides. It includes practices such as crop rotation, weed and weed seed scouting, weed mapping and modeling, crop competition, tillage, using certified seed stocks, and spot treatment or banding herbicides.

Weed management is complex because of the number of weed species in any given field. Some weed scientists prefer to use a “competitiveness index” which rates how weeds will affect a crop, rather than a single economic threshold for making herbicide decisions. Herbicide selection should be based on site and management variables to minimize potential ground or surface water contamination.

### Chemical Weed Control

Herbicide rates can be reduced by using a combination of cultural and mechanical practices. Furthermore, herbicide contamination of water resources can be reduced by good management practices. Probably the most important BMP for herbicide use is to keep these products separated from surface water and wells by observing a safe setback distance within which chemicals are not stored, handled, or applied. Install grass filter strips between fields and any water resource on sloping or erosive lands. Finally, select chemical controls carefully, considering their potential to impact water resources.

The use of postemergence herbicide is another BMP to consider. While preemergence and preplant treatments usually are very effective, it has been observed that most of the pesticides found in water supplies are those applied to soil. Postemergence chemicals often can be used at lower rates and plant foliage tends to intercept some of the herbicide before it reaches the soil surface. Another advantage of postemergence application is that treatments are made only if weed pressure is judged to exceed the economic threshold. Adjuvants, such as crop oils and methylated seed oils, can be used to improve the performance of postemergence herbicides.

Reduced tillage systems improve many soil erosion problems and save energy costs, but sometimes result in increased weed control problems. However, it is a common misconception that higher herbicide rates are needed in these systems to replace the reduction of tillage. Herbicide should still be applied at no more than the labeled rate. In some cases, combining preemergence with contact herbicides in a well-timed tank mix can provide the knockdown and residual activity to control weeds in reduced tillage systems.

### Herbicides and Groundwater Contamination

Herbicides have been the most commonly detected class of pesticide found in groundwater in agricultural regions of the United States. For example, the herbicide atrazine has been detected in numerous water quality monitoring programs (Table 3). In light of this, crop advisers in Colorado need to consider replacements and BMPs for chemicals such as atrazine. Although there are other preemergence products available for broadleaf control in corn, few are as versatile or provide as broad a spectrum of weed control as cheaply as atrazine. Atrazine is also used on fallow ground in Colorado, but good residue management can help minimize losses due to runoff.

A number of currently available alternative chemicals and weed control methods should be considered, especially if there is significant risk of contaminating water supplies with atrazine.

**Examples of preplant, burndown, or preemergence herbicide options for weed control in corn include:**

Banvel (dicamba)
Bladex (cyanazine)
Cycle (metolachlor + cyanazine)
Dual (metolachlor)
Frontier (dimenthenamid)
Lasso (alachlor)
Modown (bifenox)
Roundup (glyphosate)

**Postemergence herbicide options include:**

Accent (nicosulfuron)
2,4-D
Banvel (dicamba)
Basagran (bentazone)
Beacon (primisulfuron)
Bladex (cyanazine)
Buctril (bromoxynil)
Pursuit (imazethapyr) - use only with tolerant corn hybrids

For specific herbicide recommendations, see Colorado Pesticide Guide for Field Crops, XCM-45.

Here are some of the BMPs recommended to protect water from herbicide contamination.

- Apply the lowest effective labeled rate.
- Combine band application with tillage.
- Reduce triazine herbicide application rates by tank mixing with other compatible products.
- Calibrate sprayer precisely to ensure uniform application, avoiding drift.
- Incorporate strip cropping into planting strategy.
- Utilize filter strips and setbacks around surface water.
- Practice crop rotation.
- Avoid application immediately prior to any rainfall or irrigation.
- Reduce tillage to increase surface residues.

Farmers who use atrazine on coarse soils, erosive soils, or near surface water need to take the appropriate precautions and consider using alternative weed control measures.

**Table 3. Common herbicide products containing atrazine**

| Common name | Trade name |
|---|---|
| Aatrazine | AAtrex, Atrazine |
| Atrazine + metolachlor | Bicep |
| Atrazine + cyanazine | Conquest, Extrazine |
| Atrazine + bentazon | Laddok |
| Atrazine + dicamba | Marksman |
| Atrazine + pendimethalin | Prozine |
| Atrazine + butylate | Rhino, Sutazine+ |
| Atrazine + alachlor | Bullet, Lariat |

### Nonchemical Weed Control Measures

Tillage is the primary nonchemical weed management tool used by crop growers. Combining tillage with band or spot herbicide treatment is often a viable approach. Crop production without the use of herbicides is difficult because of the expense and lack of labor for hand weeding. Nonetheless, producers can reduce reliance on herbicides by incorporating crop rotations with other cultural practices, such as delayed planting dates, narrow row spacing, and good crop management to improve crop competitiveness against weeds.

Occasionally, the best weed control strategy is to rotate weedy fields to a crop especially competitive against your major weed problem. For example, going from corn to a solid-seeded forage legume such as alfalfa can effectively reduce wild proso millet. Rotating small grains to corn can help reduce wild oat problems. Additionally, rotating vegetable crop fields to almost any agronomic crop can break the pest cycle and reduce chemical impacts.

There are currently no commercially feasible means of using insects or disease organisms to control weeds in Colorado crop fields. However, the Colorado Department of Agriculture is working to initiate biological control programs for some of the noxious weed problems in the state.

## Insect Management

The IPM approach was originally conceived for insect control and offers growers a number of potential tools to manage insects. Among other benefits, this approach increases consumer confidence in the food supply, decreases possibility of occupational health risks, and reduces the possibility of insect resistance to insecticides.

A sound insect management program does not attempt to eradicate insects, but to manage them to minimize economic crop losses. IPM techniques for insect control include: 1) selecting crops and varieties which are resistant to insect pressures, 2) timing planting and harvest dates to minimize insect damage, 3) monitoring pest and natural enemy populations, and 4) employing beneficial insects and nontoxic biological pesticides. Well-timed insecticide application can also be an important component of an IPM program.

### Chemical Insect Control

While insecticides have the potential to seriously contaminate groundwater quality, there have been very few reports of insecticide found in Colorado groundwater. Nonetheless, eliminating unnecessary insecticide application is a basic step in reducing unwanted environmental impacts.

IPM procedures for insect management and insecticide use are very similar to the principles discussed above. The main difference is the need to conserve natural insect enemies by careful pesticide use and selection. Additionally, insect pest populations can shift predominant biotypes and rapidly become pesticide resistant under the right conditions. Ask your crop adviser which chemicals are available for pest control on your crops and rotate their use. Try to use the least toxic chemical when beneficial insects are present.

### Nonchemical Insect Control

Cultural control of insect pests is achieved by targeting the weak link in the insect's life cycle. In some situations, crop rotation can significantly reduce insect problems. For an effective crop rotation, the alternate crop must be an unacceptable host to the insect pest. In any case, continuous or prolonged monocropping should be avoided. The reliance of these systems upon pesticides makes them difficult to adapt to an IPM program.

Altering planting, tillage, and harvest dates can sometimes be used to disrupt insect life cycles. Tillage, by itself, is usually inadequate to control insects. However, it can be used to reduce some insect populations by exposing them to predation or weather. Tillage is an important component of an insect management program if insects overwinter in the soil, on weeds, or in field trash.

Naturally occurring and introduced biological controls can also be used for insect management. The complexity of the relationship between crop pests and their biological enemies is a subject of intense research, but is largely unexploited in commercial agriculture. Currently, the most feasible way to exploit these systems is to conserve the naturally occurring predators and parasites found in crop fields. Biological insecticides, cultural control methods, and the use of resistant varieties can help producers reduce the need for chemicals toxic to beneficial organisms. Additionally, cultural and management practices that increase crop health and vigor, such as good irrigation management, tend to decrease plant susceptibility to pests.

## Disease Management

Plant pathogens such as fungi, bacteria, viruses, mycoplasms, and nematodes often can be managed by employing good sanitation and cultural practices with occasional chemical controls. Using clean seed and propagation stock and planting disease resistant varieties can greatly reduce disease incidence. Other IPM techniques for disease management include: 1) destroying alternate host plants, 2) rotating crops, and 3) managing soil and water for optimum crop growth.

Disease resistant crops continue to be a cornerstone of plant breeding efforts. Resistance does not, however, mean immunity from disease. Growers must still provide conditions that enable crops to thrive and ensure that they use clean planting materials. Additionally, more virulent microbial pests can be selected by continuously using only one disease management strategy, such as host plant resistance.

Repeated planting of fields with crops susceptible to soil-borne pathogens, such as Verticillium or Rhizoctonia, favors the buildup of these organisms. Selection of fields with reduced disease risk should be made for planting these crops. Rotation of crops and crop varieties and using clean seed stock are basic BMPs for disease management.

Pathogens often overwinter in crop residue or on alternate hosts near the field. Producers need to know and understand the life cycles of their pest problems in order to manage them. Weeds that serve as reservoirs of disease inoculum should be controlled. Volunteer crops can also be a significant problem if they are not destroyed. Be sure to scout your fields for disease and vectors, not only during the growing season, but also during the off-season.

Chemicals for disease control are not applied as commonly as herbicides or insecticides in Colorado. However, they are extremely important tools for managing severe disease outbreaks and seedling diseases. Fungicides are the most effective disease control chemical. Chemical control tends to be less effective against bacteria and is unavailable for plant viruses, although disease vectors can be controlled in some cases. Many of the commonly used fungicides act as plant protectants to reduce disease infection, rather than as eradicants. They must be applied to crops on a preventive basis to be effective. However, producers should base these applications on forecasting tools such as temperature models or effective scouting.

Fungicides have been found in groundwater in agricultural regions, but usually at very low levels. Producers should follow all of the appropriate BMPs for the proper use of these chemicals to protect water resources.

## Summary

Pest management decisions affect producer profitability, as well as the environment. Preventing pest problems by a sound crop management program is often an economic alternative to pesticide use. The IPM approach applies preventive measures first and then follows a decision-making process designed to help producers arrive at the best answer to their individual pest problems. Producers are advised to consider the following questions before a pest management decision is reached.

1) Is control economically justified?
2) Are nonchemical control methods available and practical?
3) If pesticide application is the only method available, are there choices of products to consider?
4) Does the label of the product selected contain groundwater advisories or other environmental caution statements?
5) Can the pesticide be applied in a way that reduces rate, maximizes effectiveness, and minimizes harm to natural beneficial organisms?

IPM is a Best Management Practice that can help protect water resources while improving your crop production program. Contact your local crop adviser for more specific information on implementing an IPM program for your operation.

*Note:* The pesticide label always supersedes any educational material such as this publication. Always read and follow label instructions precisely. Data presented in this publication on commercial products are for educational purposes only. Reference to commercial products does not imply endorsement, nor is criticism implied of products not mentioned.

# Best Management Practices for Crop Pests

*Guidance Principle:* Use an Integrated Pest Management approach in pest control decisions.

To select the 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
- most suitable practices for your site and crop rotation plan.

## General Crop Pest BMPs

5.1 Use an Integrated Pest Management (IPM) approach that selects the most appropriate means of pest control, including cultural, biological, mechanical, and chemical methods.

5.2 Rotate crops and select crop varieties resistant to the primary pests. Adjust planting, tillage, and harvest dates to help minimize weed, insect, and disease problems.

5.3 Improve plant vigor and pest tolerance by supplying adequate plant nutrients and soil moisture, and by adjusting growing conditions as needed for optimum crop growth.

5.4 Scout fields 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. (See *BMPs for Agricultural Pesticide Use*, XCM-177, for further information.)

## Weed Management BMPs

5.5 Evaluate site-specific weed management alternatives and develop a plan that includes cultural, mechanical, and chemical control as appropriate.

5.6 Scout and map weed infestations at least twice during the crop season. Early scouting is needed for weed detection and selection of control measures. Late season scouting is needed for evaluating control and future weed problems. Maintain good records of weed populations and control measures used.

5.7 Treat the problem, not the field. Consider use of hand weeding for small, isolated areas, or on larger areas where labor costs are not prohibitive. Spot spray and band herbicides, rather than broadcast, where appropriate.

5.8 Select herbicides after analyzing the vulnerability of water resources at the site. Consider alternatives to herbicides known to be a water quality hazard.

5.9 Establish setbacks a safe distance from surface water and wells where herbicides known to cause water quality problems are not applied.

## Insect Management BMPs

5.10 Destroy alternate pest breeding sites and hosts during the off-season to interrupt life cycles so that potential recurrences are reduced.

5.11 Scout crop fields at least weekly after insect infestations are first predicted or observed. Be sure pests are properly identified before control measures are employed.

5.12 Select biological and least toxic insecticides when feasible. Incorporate insect resistant varieties and crop rotations into your farm plan.

5.13 Protect naturally occurring biological control organisms by using insecticides that are less toxic to natural enemies.

5.14 Handle insecticides carefully around the wellhead and be sure chemigation backflow prevention devices are operating correctly.

## Disease Management BMPs

5.15 Select disease resistant cultivars when possible. Use disease free seed and propagation materials.

5.16 Rotate crops and manage residues to decrease pathogen survival. Avoid planting susceptible crops on fields with a history of disease problems.

5.17 Control insect and other disease vectors both during the crop season and during the off-season.

5.18 Keep harvest and tillage equipment clean, especially when moving from fields with diseased crops.

**For more information about pest management or specific inquiries about BMPs, contact Colorado State University Cooperative Extension. They have publications, programs, and specialists available to help you answer questions about water quality.**

**Related source material from Colorado State University Cooperative Extension:**

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| | **Crop Production and Pest Management Field Record** |
| **XCM-45** | **Colorado Pesticide Guide for Field Crops** |
| **XCM-43** | **Colorado Pesticide Guide for Vegetable Crops** |
| **556A** | **High Plains Sunflower Production and IPM** |
| **548A** | **Colorado Dry Bean Production and IPM** |
| **XCM-177** | **Best Management Practices for Agricultural Pesticide Use** |
| **XCM-41** | **Colorado Tree Fruits, Pest and Crop Management Guide** |