

Pesticide Management for Turfgrass and Ornamentals

Description

Pesticides are a family of chemicals used to manage pests. Common pesticides include herbicides, insecticides, and fungicides. This BMP offers guidance in the selection, use, storage and disposal of pesticides, with an emphasis on using integrated pest management principles. Much of the information included in this BMP is extracted from "Turfgrass Pest Management: A Training Manual for Commercial Pesticide Applicators", Michigan State University, Cooperative Extension Service, Bulletin E-2627.

Integrated pesticide management (IPM) is the use of all available strategies to manage pests so that an acceptable yield and quality can be achieved economically with the least disruption to the environment. The goal of IPM is to reduce and maintain pest populations at levels where aesthetic and economic losses are tolerable. The strategies used in IPM incorporate a wide range of pest controls, such as using resistant turf varieties, cultural controls, biological controls, mechanical controls, and the use of pesticides. IPM should not be considered "anti-pesticide." Pesticides are one of several management components within an IPM system. Knowledge of the pest and cultural requirements of the vegetation are keys to a successful IPM program.

This BMP addresses pesticide use in upland areas. It does not address pesticide use in aquatic resources, such as herbicides used to control nuisance aquatic weeds. Aquatic herbicides should be applied according to Act 368 of 1968 (Section 333.12561 - 333.12563, Public Health Code) and the rules promulgated thereunder. Permits for aquatic herbicide applications are not needed if the waterbody is a pond and is less than 10 acres **and** has one owner and no outlet. Contact the MDNR, Land and Water Management Division at (517)-373-1170 for information on aquatic herbicide use. The information contained in this BMP on pesticide storage, handling, transporting and record keeping are pertinent to aquatic pesticides.

Other Terms Used to Describe

Pest Management

Integrated Pest Management (IPM)

Integrated Turf Management (ITM)

Integrated Crop Management (ICM) See the Department of Natural Resource's Agricultural BMPs for ICM applications.

Pollutants Controlled and Impacts

The proper use of IPM principles will promote healthy vegetation, which require fewer inputs. (According to "Turfgrass Pest Management: A Training Manual for Commercial Pesticide Applicators", Michigan State University, Cooperative Extension Service, E-2327, some lawn care companies that implement IPM report a 40-60% reduction in pesticide usage). The proper storage, handling, application and disposal of pesticides will reduce the amount of pesticides available to contaminate surface waters and/or groundwater.

Application

Land Use

This practice is applicable to all land uses where pests are encountered or where pesticides are used or stored.

Soil/Topography/Climate

Soil adsorption, which is the tendency of the pesticide to be attached to soil, varies from one soil texture to the next. The higher the soil adsorption capacity, the greater the pesticide will attach to the soil and move off the land with soil erosion. This is discussed further in the "Specifications" Section, below.

It is particularly important to divert runoff from waterbodies and wetlands when pesticides are used on hilly terrain. Depending on the topography involved, certain application procedures may not be possible.

Climatic factors such as rainfall and temperature are discussed in the "Specifications" section, below.

When to Apply

For new development projects where pesticides will likely be used (such as parks/recreation areas, golf courses, etc.), a pesticide management program should be developed during the site planning process. On all existing sites where pesticides are applied, it may be appropriate to review the practices and adjust them based on specifications in this BMP.

Where to Apply

Apply this practice in all areas where pesticides are stored or applied.

Relationship With Other BMPs

Trees, Shrubs and Ground Covers should be used to select disease or insect-resistant varieties of trees, shrubs and ground covers, and to maintain healthy vegetation. To maintain healthy turf, use this BMP in conjunction with proper watering and mowing (see the Lawn Maintenance BMP), as well as Fertilizer Management and Soil Management.

Specifications

General Considerations:

Use Integrated Pest Management (IPM). IPM is a pest management system that uses all suitable techniques in a total management system to prevent pests from reaching unacceptable levels, or to reduce existing pest populations.

It is important to remember that vegetation cannot be both pest-free and benefit from biological control. For example, there are "good" insects which feed on pests. Accidentally killing these insects through indiscriminate pesticide applications may cause more problems than if the pesticide hadn't been applied. Do not attempt to wipe out a pest population; take time and care to use only the management practices which will prevent unacceptable injury to the plant.

Plant Selection:

To **reduce pest problems**, the first step in any IPM program is to **select plants or materials that are resistant to pests and diseases**. Other considerations include selecting materials that provide food, moisture, or habitat to predators, parasitoids, and pathogens of pests. Selection should also be based on the soil characteristics, or with the intention of modifying that soil using the Soil Management BMP. Managers who choose well-adapted species are usually capable of minimizing management inputs while maintaining high quality vegetation.

Native plant species usually require fewer pest controls than introduced species. Choose adapted varieties based on environmental conditions, management level desired, and the intended use.

Species should also be selected based on where they will be planted. For example, most turf grasses generally do best in full to partial sun. The following lists turf performance in shady sites:

Satisfactory: rough bluegrass, fine fescue

Fair: tall fescue, perennial ryegrass

Poor: Kentucky bluegrass

Once the proper plant species is selected, **become knowledgeable in the management of that species**. Every species and every use of that species will involve different water requirements, mowing heights and frequency, and fertilizer rates. All of these factors can affect the health of that plant species.

Identify the Pest:

An organism should not be classified and treated as a pest until it is proven to be one. There are species of insects, fungi, nematodes, and bacteria that are harmless or beneficial to vegetation. Eliminating them with unnecessary pesticide applications often causes greater or additional pest problems. You cannot make appropriate management decisions until you identify the pest. Consider using reference books, the County Extension Service, and/or reliable consultants to help you identify pests.

Understanding pest life cycles and behavior allows applicators to effectively target pest control activities. Regular monitoring will allow you to determine when the pest is in the life stage that is susceptible to controls. See the attached exhibit for various monitoring techniques applicable to grasses.

Determine the Action Threshold:

The action threshold is the pest density at which action must be taken to prevent the pest from reaching the economic injury level. The economic injury level is defined as the density of pests at which the cost to manage the pest is equal to the losses that pest causes. This definition was developed for cash crops, where pest injury is easily converted into monetary losses. For turfgrass management, replacing damaged turf (for example) is an obvious cost of pest activity. However, damaged turf also reduces the aesthetic value of an area.

Action thresholds are usually set based on the judgement of the scout or applicator and reflect the level of treatment desired by the individual. Always take action before unacceptable injury occurs.

Select the Pest Control Strategy:

The best pest control strategy is one that most effectively controls the target pest and minimizes the potential for any adverse effect on the environment. This may include:

Cultural Controls. These include devising ways to change the conditions which are favorable to the pest to conditions that are not favorable to the pest, conditions which favor the pests' natural enemies, or conditions which encourage growth. Review the irrigation schedule, fertilizer rates, soil management, and, for turf, the mowing height and frequency, etc. All of these factors will affect the health of vegetation.

Consider modifying habitats, including components of the landscape and buildings, to enhance the environment required by the pests' predators. Crabgrass is a weed which out-competes turf in sunny, compacted areas. Aerating compacted soils will help desirable turf compete in this area.

Biological controls. Biological controls are living organisms which are used to control other living organisms. They include predators, bacteria, fungi and nematodes. Use of biological controls should only be done by professionals.

Mechanical controls. These include cultivating to control weeds, hand-picking weeds from turf and pests from plants, and screening living space to limit access by mosquitos and flies.

Traps/baits. If the pest is an insect, consider using pheromones (insect hormones) or other attractants to lure or confuse the pest; and use traps to capture pests.

Monitor pest populations using one or more of the following:

- detection kits
- computer models
- disease models
- traps
- knowledgeable (trained) scouts

Pest activity is predicted more accurately by monitoring weather conditions which influence pest development. Both plant and pest development depend on the amount of heat that surrounds the organisms. Turf pest development and their activity is best predicted with **degree days**. Degree days are figured in several ways, but are all based on a common principal: the development of plants and pests begins when the air temperature reaches a certain level, and usually continues until the temperature falls below that threshold. Degree days precisely measure the occurrence of above-threshold temperatures. The threshold is called the base temperature and is between 40-60 degrees F for most organisms.

The Crop Advisory Team (CAT) of Michigan State University (MSU) reports degree days with base temperatures of 42 degrees and 50 degrees F for several areas in Michigan. Pest management references, such as the CAT Alert, Landscape Edition (MSU, Cooperative Extension Service) identify what stage of pest development occurs at specific degree day totals. There are also many commercially-available weather monitoring devices and computer programs to help you predict pest development.

Turf managers: When selecting monitoring equipment, keep in mind that climatic information that most accurately measures the conditions affecting turf is gathered at the crown level of turfgrass. Consider using one of the monitoring techniques listed in Exhibit 1.

Pesticides. Choose the most appropriate pesticide after considering pest resistance, human exposure, and environmental impact (including impact on surface and ground water). (See the next section for additional information). Follow the "Applications" section, below.

Educate all persons who will be involved in the use of pesticides. Inform them of potential pest problems (i.e. what to look for). Review irrigation and mowing schedules. Review pesticide and fertilizer management practices, including integrated pest management practices.

Selecting Pesticides:

Selection of the appropriate pesticide should first be based on the type of pest which needs to be controlled: either a plant (use a herbicide), insect (use an insecticide), rodent (use a rodenticide) or fungus (use a fungicide). If more than one pesticide can be used to control the pest, choose the pesticide that will yield the desired control results and have the lowest potential to cause any adverse environmental impacts. Choose the pesticide that fits into your pest management strategy and is the least toxic alternative. Ideally, you would want to choose a chemical with low leachability, low runoff potential, a low persistence value, low water solubility, and high soil adsorption capacity. (See the discussion below on the specific compound).

Where more than one formulation can be used (e.g. powder, gas, liquid, etc.), consult Exhibit 2.

Buy only the amount needed to give the desired results.

Selection of the specific compound should be based on the following considerations:

1. Persistence (Half-life). This is the term given to the days required for the pesticide in soil to degrade to one-half of its previous concentration. In general, the longer the half-life, the greater the likelihood the pesticide will be able to move into surface or ground waters and cause environmental impacts. **A pesticide with a half-life greater than 21 days may persist long enough to leach or move with surface runoff before degrading.**
2. Water solubility. The degree to which a pesticide can dissolve in water is given in parts per million (ppm). Solubility affects how easily a pesticide can runoff or leach. In general, pesticides with solubilities of 1 ppm or less tend to remain at the soil surface, tend not to leach, but may move off-site with soil. **Pesticides with solubilities greater than 30 ppm are more likely to leach.**
3. Soil adsorption capacity. Each soil type has a soil adsorption property, which is the tendency of the pesticide to become attached to soil. The higher the soil adsorption capacity, the greater the pesticide will attach to the soil and move off the land with soil erosion. The lower the adsorption capacity, the less likely the pesticide will bind with the soil, but the more likely the pesticide will have the potential to runoff or leach to groundwater. In general, soils with adsorption numbers greater than 1,000 strongly attach to soil, and those with number less than 300-500 are more readily available to run off or leach. See the

appendices to these BMPs for specific soil adsorption values.

4. Leaching and runoff potential. These characteristics are directly related to the soil adsorption and water solubility characteristics. Quite often a trade-off must be made between two pesticides, and the final selection of that pesticide should be based on the soil and groundwater conditions. If one pesticide has a low leachability and another a high leachability factor, then the low leachable one should be chosen to protect the groundwater.
5. Toxicity. After considering all other aspects of pest management, the applicator should choose the least toxic pesticide that is capable of producing the desired effect. Applicators need to remember that pesticides are inherently toxic by their nature, and utilize appropriate protective equipment to minimize their exposure.

In selecting the appropriate pesticides, applicators need to be aware of the potential for pest resistance. To reduce pest resistance potential, applicators should choose alternative control measures in their pest management strategies.

Pesticide labels contain the following information:

- a. Name of the chemical, including trade name, common name, chemical name and formulation
- b. EPA registration number
- c. Amount of active ingredient per unit, and net contents of the package
- d. Information on how to store, mix, apply and dispose of the product and container
- e. Manufacturer or formulator name, address and telephone number, and EPA establishment number
- f. Use classification. Certain chemicals have restricted use which requires applicator certification to purchase and use.
- g. Use recommendations, including timing and the minimum number of days between applications.
- h. Pest(s) controlled by the pesticides.
- i. Precautionary statements pertaining to physical and environmental hazards. Includes information such as keeping out of reach of children.
- j. Persistence (half-life), which is the duration it takes the pesticide to break down to one-half its previous concentration. See "Selecting Appropriate Pesticides," below.
- k. Statements regarding the toxicity of the pesticide. Pesticides are categorized based on toxicity:

Class I- Danger-Poison. Includes skull and crossbones; poisonous if swallowed. Do not

breathe vapor. Do not get in eyes, on skin, or on clothing.

Class II- Warning. May be fatal if swallowed. Do not breathe vapors. Do not get in eyes, on skin, or on clothing.

Class III- Caution. Harmful if swallowed. Avoid breathing vapors. Avoid contact with skin.

Class IV- Caution. No caution statement required.

Never purchase a pesticide that doesn't contain a label.

Review the pesticide label prior to mixing. **Follow label directions.**

Note that if you choose a **restricted use pesticide**, by law, you **MUST** have the credentials to use it. Restricted use pesticides are usually toxic or environmentally persistent chemicals which can cause significant health or environmental damage if misused. See the "Applicator Certification/Registration" section, below.

Pesticide Applications:

Read the label before application.

1. Application techniques include everything from hand-spraying to aerial spraying. Follow the application procedures on the label.
2. If the label lists more than one acceptable application procedure, use Exhibit 3 to apply the pesticide using the most target-specific method that effectively controls the pest. It is essential that the pesticide be applied in a manner to maximize the percentage of material on-target, and minimize any potential off-target effects.
3. Purchasers and applicators of restricted-use pesticides are required to pass an examination administered by the Michigan Department of Agriculture. See "Additional Considerations," below.
4. Equipment should be in sound mechanical condition, free of leaks and other defects or malfunctions which might cause a pesticide to be deposited off-site, or in a manner inconsistent with its label.
5. Application equipment should be **calibrated** frequently enough to ensure proper and safe application and comply with label directions. All pesticide applicators must follow label directions when using pesticides. Appendix 4 of these BMPs contains calibration procedures for the most common types of chemical application equipment. **Follow calibration procedures in the Appendix for all pesticide applications.**

Mixing and Loading:

Read the label before mixing and loading.

1. Always wear protective clothing when mixing and applying pesticides.

2. Mix the chemicals away from people and animals, on an impermeable surface, preferably a sealed concrete pad. Ideally, the pad should drain to a sump which can contain any spilled pesticides until they are pumped back into the sprayer and used according to label directions.
3. Never leave the filling operation unattended.
4. Have material available to contain any potential spill (see information on spills, below).
5. Fill the tank (or sprayer) approximately half full with water before adding pesticides.
6. Accurately measure chemicals in accordance with label directions. If measuring in teaspoons, use level spoonfuls, not heaping spoonfuls. Never use the same measuring device for food preparation.

Appendix 4, entitled "Supplemental Fertilizer and Pesticide Applications" includes a list of "Common Measuring Equivalents for Pesticides and Fertilizers." The equivalents allow users to mix only the amount of pesticide (or fertilizer) needed for a single, specific application.

7. If the tank is used to mix two or more chemicals, make sure the two chemicals are compatible with each other. When mixing two or more chemicals in a tank, be sure to mix them according to the sequence below:
 - a. Wettable powders
 - b. Flowables
 - c. Water solubles
 - d. Emulsifiable concentrates
8. Pesticide application equipment designed to draw water must have a properly functioning **anti-siphoning device**. Avoid back-siphoning by keeping the end of the fill hose above the water level, or by installing devices which prevent back-siphoning. For additional information, see Michigan State University, Cooperative Extension Service bulletin E-2349, "Protect Water Supplies from Back-Siphoning of Ag Chemicals."

Application Procedures:

1. Prior to an application of pesticides, the applicator should identify any sensitive areas (i.e. wetlands, lakes, streams, etc.) within and adjacent to the target area.
2. Pesticide applications should be made in a way which will prevent direct discharge of pesticides and reduce drift to the lowest extent possible. To do this:
 - Avoid applying pesticides prior to a rain storm, in heavy winds, or during any other weather conditions which may result in runoff. Do not apply on frozen ground.
 - When spraying pesticides, leave an unsprayed buffer strip around surface waters or near other sensitive areas (such as wetlands). Where possible, **leave a minimum 30-35-foot buffer between the edge of the spray area and the watercourse to avoid drift and/or runoff into surface waters.**

3. Where possible, apply pesticides only to those areas which are known to be impacted by the pest. Avoid applying to areas not affected by the pest.
4. **Always spray at the rate recommended on the label.** On the advice of experts, you may be able to apply less than the label recommended rate.
5. All applicators should apply pesticides during the most vulnerable or appropriate stage in the pests' life cycle. Insects, for example, have several life stages, some of which make them more vulnerable than others. The pesticide label may indicate the best time of year to apply the pesticide based on the type of pest being controlled.
6. Special precautions should be implemented in areas where the groundwater is high or where soils are coarse and groundwater could be easily impacted. Routine applications of pesticides that have the potential to impact groundwater should be avoided.
7. Pesticides should be applied in a manner which minimizes exposure to humans, livestock, domestic animals and non-target wildlife.
8. Use up excess pesticide mixtures according to label directions.

Pesticide Storage:

Read the label to determine appropriate storage procedures

1. Store all pesticides away from food products, seeds, fertilizer, and protective equipment.
2. Store all pesticides in a cool dry location, out of direct sunlight. Ideally, pesticides should be stored in a secure room/building. Buildings should be located no closer than 150 feet from a well and no closer than 200 feet from surface water (i.e. lake, river, stream, wetland). Where these restrictions are not being adhered to, additional water source protection methods should be used.

The following applies to the room/building where pesticides are stored:

*Post the room/building with highly visible warning and "NO SMOKING" signs.

*The room/building should be properly ventilated with an exhaust fan.

*The room/building should contain a sealed cement floor that will prevent spilled pesticides from leaking through cracks.

*Where possible, the room/building should be fireproof and explosion proof.

*The room/building should be locked when not in use. Keep all pesticides out of the reach of children, pets and unauthorized persons.

*If pesticides are stored in a separate building, there should be a containment dike around the building to prevent potential runoff.

*The pesticide storage room/building should contain metal shelves for smaller containers and pallets on the floor for large drums.

3. Store pesticides in their original container. **Secondary containment should be provided for all pesticide containers.**
4. Store all pesticides by classification (herbicide, fungicide, etc.) to prevent misuse or contamination.
5. Mark the date of purchase on each container so older material can be used first.
6. Have supplies for the clean-up of pesticide spills readily available. These include kitty litter, sawdust, and buckets. A fire extinguisher approved for chemical fires should also be readily accessible.
7. Have emergency telephone numbers visibly posted, and first aid equipment readily available.
8. Store protective clothing in a location separate from the pesticides.
9. Store equipment for measuring and mixing pesticides in the pesticide storage room/building.
10. Do not store pesticides in underground tanks.
11. MSU Cooperative Extension Service bulletin E-2335, "On-Farm Agri-Chemical Storage and Handling," contains additional information on pesticide storage.

Pesticide Disposal:

Read the label for specific disposal instructions.

1. Do not discard partially-filled pesticide containers in the trash.
2. Before disposing of empty pesticide containers, triple rinse or power rinse the container. If conducted at a common site, the rinsing operation should be performed over an impervious pad, otherwise the operation should occur in the field at the time of application. To triple rinse, follow the steps below:
 - a. Allow concentrate to drain into the tank for 30 seconds.
 - b. Add water to the container (10% of the tank volume), replace lid and rotate container.
 - c. Dump rinse water into tank and drain for 30 seconds.
 - d. Repeat twice more.
 - e. Use the rinseate according to label directions.

It is critical that pesticide containers are rinsed immediately after they are emptied. Once pesticide residues become dry in the containers, they are difficult to remove.

3. Puncture the container so it is not used for other purposes.
4. Where possible, recycle plastic containers.
5. Dispose of glass containers in a sanitary landfill.
6. Never reuse a pesticide container.
7. Open burning of pesticide containers is prohibited by law.
8. For additional information on pesticide disposal, contact the Michigan Department of Natural Resources, Waste Management Division at (517)-373-2730, or the Michigan Department of Agriculture, Pesticide and Plant Pest Management Division, (517)-373-1087.

Spill Cleanup:

Develop a spill response plan to identify the procedures which will be followed to contain and clean up spills.

Below are guidelines for spill cleanup if a pesticide is spilled indoors and if the area drains to a sanitary sewer. For all outdoor spills, and indoor spills with areas which drain to storm sewers, contact the Michigan Department of Natural Resources at the Pollution Emergency Alert System (PEAS) number: 1-800-292-4706.

1. If the pesticide is a liquid, surround the area with an absorbent material to keep the pesticide from moving.
2. If the pesticide is a liquid, sprinkle sawdust, kitty litter or other absorbent materials over the spill. Wear gloves and rubber boots.
3. Collect the absorbent material and read label directions for the proper disposal of the waste. If in doubt as to the proper disposal of the waste material, contact the MDNR, Waste Management Division at (517)-373-2730, or your local Cooperative Extension Service office.
4. After removing the waste material, contact the wastewater treatment plant operator. Upon their approval, wash the area down with water, again, only **if the area drains to a sanitary sewer. Do not wash into a storm sewer.**

Record Keeping:

The Michigan Pesticide Control Act (Act 171) requires that all commercial applications of pesticides be recorded by the applicator. Records are useful when runoff, drift or leaching occurs. Records should include:

- Date of application
- Chemical applied (trade name and formulation)

- Rate per acre (acres or square feet)
- Method of application
- Area treated with pesticides
- Purpose of application (target pest(s))
- Weather and soil conditions at time of application
- Most recent date of calibration
- Name of applicator

Exhibit 4 is a Pesticide Use Record form which can be used for each pesticide application.

Maintenance

Proper pesticide management is an ongoing practice, beginning on or before the first pesticide is brought onto the site, and ending only when pesticides are no longer stored or used on the site. Ongoing maintenance should include a minimum annual check to ensure that:

1. Applicators are applying pesticides according to label directions.
2. Equipment is calibrated so that pesticides are applied at the appropriate rate.
3. Labels on the pesticide containers are legible.
4. Pesticides are being stored according to the label directions, and that there is secondary containment for all pesticides.
5. Records are being kept which accurately document the use and application of the pesticide.

Transporting Pesticides:

Proper transporting of pesticides should include:

- Securing containers to avoid breakage and leakage
- Packaging containers to avoid contamination with other chemicals, seed, fertilizer, animal feed and human food

Additional Considerations

Wildlife:

Bees and amphibians such as toads, frogs and salamanders, are sensitive to pesticides. Avoid spraying near wetlands used by breeding amphibians, especially during the breeding season of April, May and June.

Applicator Certification/Registration:

Anyone purchasing and applying restricted use pesticides in Michigan must be certified by the Michigan Department of Agriculture via a testing procedure. Recertification is required every three years.

For persons employed by **commercial certified applicators**: The Pesticide Control Act of 1976 was

amended in 1988 to create a new classification of pesticide applicators called "registered technicians." Under this amendment all commercial applicators must be either "certified" or "registered" in order to apply any pesticide.

Notification and Posting:

Commercial applications on golf courses, lawns, community rights-of-way, as well as all indoor applications, should be indicated on a placard visible to employees and visitors, stating that pesticide applications do occur from time to time. On golf courses, signs should also be placed on the first and tenth tees at the time of application, noting the date and time of application and product information, until label reentry requirements have been fulfilled.

Right-of-way applications will likely only be posted at multiple use areas. Persons that want notification should be aware that notification may occur via newspaper advertisement in the legal section of a community paper.

Exhibits

- Exhibit 1: Monitoring Techniques for Turf. "Turfgrass Pest Management: A Training Manual for Commercial Pesticide Applicators", Bulletin E-2627.
- Exhibit 2: Pesticide Formulations. USDA, Soil Conservation Service (Michigan), 1992.
- Exhibit 3: Pesticide Application Equipment and Methods. USDA, Soil Conservation Service (Michigan), 1992.
- Exhibit 4: Pesticide Use Record. "Turfgrass Pest Management: A Training Manual for Commercial Pesticide Applicators", Bulletin E-2627.

Exhibit 1

Monitoring Techniques for Turf

There are a number of ways to monitor turfgrass for information used in a pest management program. One of the most common detection methods is the actual sighting of pests and their damage. The following describes turf pest detection methods.

1. Visual inspection. Get down on your hands and knees and part the grass with your fingers. Concentrate on the edge of the damaged area where fungal disease and insects are likely to be abundant. Watch for insect movement and check grass blades and thatch for insect cases or excrement (grass), or for fungal fruiting bodies.
2. Coffee can technique. Use this technique to flush turf insects out of grass crowns and thatch. First cut both ends out of a 2-pound coffee can. Drive one end a couple of inches into the turf, then fill the can with water. Wait a few minutes for insects to float to the surface.
3. White paper test. Use a sod lifter, cup cutter, sturdy knife, or a trowel to remove a small piece of sod. Slowly peel the sample including soil, thatch, and grass plants apart over a sheet of white paper. Against the white background, living organisms will be easily detected.
4. Turf roll-back. Cut a section of turf one foot square and roll it back to expose root-feeding grubs.

To be useful in turf management, detection information should include detailed information such as the specific area of turf showing injury, level of injury, or number of pests present per sample area. To keep detection information uniform, develop a system to rank turf condition. Use a standardized monitoring sheet.

Source: "Turfgrass Pest Management: A Training Manual for Commercial Pesticide Applicators", Michigan State University, Cooperative Extension Service, Bulletin E-2627.

Exhibit 2

Pesticide Formulations

| Pesticide Formulations | Water Quality Hazard | | Potential Environmental Hazard |
|--|----------------------|-----|--------------------------------|
| | Med | Low | |
| Aerosol | | X | Drift |
| Aqueous suspension | X | | Runoff, Drift, Leach |
| Bait | | X | Runoff, Leach |
| Controlled release formulation | | X | Runoff, Leach |
| Dry flowable (water dispersable granule) | X | | Drift, Runoff, Leach |
| Dry soluble | X | | Drift, Runoff, Leach |
| Emulsifiable concentrate | X | | Drift, Runoff, Leach |
| Emulsifiable solution | X | | Drift, Runoff, Leach |
| Encapsulated | X | | Runoff, Leach |
| Flowable | X | | Drift, Runoff, Leach |
| Gas | | X | Drift |
| Granule | | X | Runoff, Leach |
| Liquid | X | | Drift, Runoff, Leach |
| Pellet | | X | Runoff, Leach |
| Soluble powder | | X | Drift, Runoff, Leach |
| Ultra low volume | | X | Drift |
| Wettable powder | X | | Drift, Runoff, Leach |

The pesticide formulation is a product of the pesticide's active ingredient and the inert carrier. The inert carrier and any additives--such as surfactants, stickers, defoaming agents, etc.--determine how easily and effectively the active ingredient is applied to the target pest. The formulation strongly influences the pesticide's potential for drift during application.

The runoff and leaching potentials of pesticides are strongly influenced by the pesticide's chemistry. The pesticide chemistry (i.e. the composition, structure and properties of the active ingredient and transformations it undergoes) becomes a potential environmental hazard after the pesticide is applied.

Exhibit 3

Pesticide Application Equipment and Methods

| Pesticide Application Method | Potential Drift Hazard To Surface Water Quality | | |
|--|---|-----|-----|
| | High | Med | Low |
| Airplane and helicopter (aerial spraying) | X | | |
| Air assisted applicator (band application) | | | X |
| Airblast sprayer (broadcast application) | X | | |
| Backpack sprayer, duster | | X | |
| Controlled droplet applicator | | | X |
| Dips and drenches | | | X |
| Fogger | X | | |
| Fumigation equipment | | | X |
| Granular application | | | X |
| Hand gun | | | X |
| Hand sprayer | | | X |
| Hopper box application | | | X |
| Impregnated fertilizer | | X | |
| Incorporation into asphalt | | | X |
| Injector | | | X |
| Irrigation equipment (chemigation) | | X | |
| Low volume applicator | | X | |
| Mister | | X | |
| Recycling sprayer | | | X |
| Roller | | | X |
| Seed treatment | | | X |
| Spreader | | X | |
| Transplanter and seeder | | | X |
| Wick | | | X |
| Wiper | | | X |

This Exhibit provides the user a comparison of pesticide application methods. Each method is ranked as having a high, medium, or low potential to drift from the target pest and affect surface water quality.

Exhibit 4

| Pesticide Use Record | |
|---|---|
| <p>Name of applicator:</p> <p>Certification or Registered Technician number:</p> | <p>Date of application:</p> <p>Time of application:</p> |
| <p>Name of client and address of target area:</p> <p>Specific area(s) treated:</p> | <p>Target pest or purpose:</p> <p>Life stage of pest:</p> |
| <p>Air temperature:</p> <p>Windspeed and direction:</p> | <p>Soil moisture and texture:</p> <p>Sunny/cloudy:</p> <p>Rain before/after application? When?</p> |
| <p>Pesticide product name:</p> <p>Pesticide EPA registration number:</p> | <p>Pesticide rate:</p> <p>Amount applied:</p> |
| <p>Sprayer or spreader used:</p> <p>Date of last calibration:</p> | <p>Nozzle or gun size:</p> <p>Spray pressure or spreader setting:</p> |

Source: "Turfgrass Pest Management: A Training Manual for Commercial Pesticide Applicators", Michigan State University, Cooperative Extension Service, Bulletin E-2627.