Unit 2. Before You Chemigate

Learning Objectives

After studying this unit, you will be able to:

• Compare the benefits and drawbacks of chemigation.
• Decide whether a given location is suitable for chemigation.
• Understand what factors govern the suitability of chemigation.
• Know what to include in an operation plan.
• Distinguish between the different types of chemigation and their target pests.

This unit discusses some basic things to consider before chemigating. First, you should decide why you need to chemigate. Then, weigh the pros and cons of this method of pest control. You also need to make sure the land selected for treatment is suitable for chemigation. Hilly, rolling land, for example, often is not a good choice. The pesticide may be distributed unevenly on slopes or hills. Many other factors such as soil type may affect whether a certain area is suitable. This unit will help you understand the various types of chemigation specific to certain pests. Once you know what pest you want to target and what sort of area it has infested, you can form an operation plan and proceed with your treatment.
Terms to Know

Backflow—The movement of a liquid in reverse of the normal direction of flow in a piping system. In chemigation systems, backflow can also occur in the injection line, causing the pesticide supply tank to overflow.

Infiltration Rate—The rate at which irrigation water moves into the soil profile. It depends on soil structure, soil type, compaction, and other factors.

Backsiphonage—A vacuum caused by reduced pressure in a supply line of a piping system. This vacuum is one cause of backflow.

Compaction—A condition in which soil particles are packed too closely together. This can result from compression by heavy machinery, excessive soil tillage, dispersion of soil structure during wetting, and other factors. Compaction prevents water and pesticides from penetrating into the plant root zone.

Drift—The movement of a pesticide through the air as particles or vapors to nontarget areas.

Fungicide—A chemical that kills or otherwise inhibits fungi that cause disease in plants.

Herbicide—A chemical compound that kills or alters the growth and development of plants.

Insecticide—A pesticide used to control insect pests.

Irrigation Set—The area to be irrigated at any one time (using a drip/trickle system). The length of time an irrigation system operates (set time).

Lateral(s)—Irrigation pipelines that supply water to sprinklers or emitters. They are parallel to each other and are connected to a main line.

Nematicide—A chemical used to control nematodes.

Overspray—A spray application that overshoots the target area into a nontarget area.

Postemergent Herbicide—A pesticide applied after planting the crop but before the crop emerges. It kills weed seedlings that appear ahead of the crop.

Preemergent Herbicide—A pesticide applied before weed seeds germinate and begin to grow.

Prescription Application—An application made using the least amount of pesticide and water needed to incorporate the pesticide into the soil.

Runoff—Movement of water, possibly containing pesticides, away from the release site flowing across the soil surface or as subsurface drainage. Runoff liquid is neither intercepted by the crop canopy nor infiltrated into the soil.

Traveling Gun—A large, single-impact sprinkler that moves across the field on a wheeled cart connected by a hose to a reel. As the hose is reeled in, a swath is irrigated.

Uniformity Coefficient (UC)—A way to calculate the uniformity of an irrigation system, where 100 is “perfect uniformity.”
Why Chemigate?

When you chemigate, you have three main goals:

1. Apply the right amount of pesticide effectively and uniformly to the target area to control the target pest.
2. Protect the water supply from pollution.
3. Minimize human exposure to pesticides.

There are both benefits and drawbacks to chemigation. Weigh them carefully before you begin your treatment.

Advantages of Chemigation

There are many benefits in using an irrigation system to apply pesticide. These include:

• Effectiveness—Several years of field research and trials have proven the effectiveness of chemigation. These trials have tested many chemicals on a broad range of crops. The newer center pivots and other equipment allow you to apply exact amounts of foliar chemical with less water for best results.

• Application uniformity—You may achieve a more uniform application of pesticide than with other methods. This is especially true of center pivots with the new sprinkler devices.

• Prescription applications—You can use just the amount of water needed to move the pesticide to the desired soil depth. This helps to reduce the use of excess chemicals and water.

• Timing—Often, you can chemigate under a broad range of weather conditions. This gives you a wider window of opportunity in which to do the pesticide application.

• Activation of pesticide—Many pesticides (especially some herbicides) work only in moist soil. Even a light irrigation will activate these chemicals.

• Reduced soil compaction—Tractors and other heavy equipment used in conventional pesticide application can cause soil compaction. Chemigation greatly reduces compaction by reducing field traffic. A center pivot system, for example, causes compaction only in the tower wheel tracks.

• Reduced crop damage—Irrigation systems generally cause much less crop damage than tractors and regular sprayers. Most crop damage from chemigation systems comes from tower wheel tracks of a center pivot.

• Reduced hazard to applicator/operator—Unlike with other pesticide application methods, chemigators do not need to “ride the system.” Their main role is to calibrate the equipment and check at intervals to make sure everything is running smoothly. Also, chemigation often requires less mixing and loading than other methods.

NOTE: Check the pesticide label for instructions on how often you must monitor the system during the treatment.

• Reduced environmental hazards—Chemigation, if done properly, may be less harmful to the environment than regular pesticide application. First, the chemicals are much more dilute in the irrigation water: 1/100 to 1/1,000 as much. Also, wind drift may be less of a problem. The pesticide travels in larger water droplets than in other methods, reducing the chance of drift.

• Reduced cost—When you compare the cost of chemigation to the cost of regular ground or aerial application of pesticides, you must weigh several factors. Although the initial cost of chemigation equipment may be high, in the end it may be cheaper than other methods. This is especially true if you apply the same chemical more than once.

Disadvantages of Chemigation

Unfortunately, there are some drawbacks to chemigation. These include:

• High cost of equipment—Besides an irrigation system, you will need special equipment to inject pesticides into the irrigation water. You will also need to install safety equipment to protect the water source from pollution. There may be
other costs if you need to modify your equipment (ex. converting from a high-pressure to a low-pressure system).

- Increased environmental hazards—By definition, a chemigation system connects to a water supply. Therefore, it may cause water pollution unless you install a backflow prevention device. There is also a risk of runoff because of the relatively large amounts of water needed to irrigate. In addition, overspray and wind drift may be a problem if you are using end guns on center pivot systems. Many people consider chemigation a greater risk to the environment for two reasons:
  - the volume of the product, and
  - the complexity of the injection equipment.
- Hazards to applicator/operator—Although pesticides used in chemigation are greatly diluted, the application rate remains the same. There is a risk of an inhalation hazard and dermal exposure for chemigators.
- Increased application time—It may take hours longer to chemigate a field than it would to treat it by conventional means, either on the ground or from the air. This could mean a greater chance of facing bad weather—such as high wind and freezing temperatures—while chemigating.
- Unnecessary water application—At times, you may want to apply a pesticide without adding more water to the field, crop, or turf. This is especially true early in the growing season and during rainy periods. You can reduce overwatering by using the lowest water application rate. You could also use a high-speed sprinkler system.
- Management concerns—Chemigation demands a high degree of training and skill in handling chemicals and in setting up and calibrating equipment. Calibration may be more complex than for other application methods. Also, as an applicator, you must understand the irrigation system and the required safety equipment. Finally, your equipment might malfunction while it is unattended. This could cause a misapplication of the chemical, resulting in an environmental hazard or human exposure.
- High cost of chemicals—The choice of pesticides may be limited for chemigation. A lower-cost pesticide, for example, may be labeled only for other application methods.

### Considerations before Chemigating

There are many factors to take into account before you chemigate. These include:

- pesticide label requirements;
- water supply;
- location;
- soil type;
- topography;
- irrigation system features;
- irrigation system uniformity;
- drift, overspray, and runoff potential; and
- economic/management issues.

### Pesticide Label Requirements

Your FIRST step before chemigating is to check the pesticide label. You can apply a pesticide through an irrigation system only if the label states that you may do so - and through what kind of system. In other words, the pesticide must be labeled for application in water through an irrigation system. The label will also tell you in what areas, such as greenhouses and turf farms, you may chemigate. See Unit 1 (Introduction) for a more detailed discussion of label requirements and related laws.

### Water Supply

No chemigation system can draw water from any water supply unless that supply is protected from contamination. You must either:

- use a reduced pressure principle backflow prevention device or
• create a vertical air gap between the water supply and the irrigation system.

Safety devices are discussed in more detail in Unit 5 (Backflow Prevention).

Location of Treatment Area

How close is your irrigation system, pesticide storage and mixing areas to occupied buildings, neighboring crops, lakes and ponds, roadways, and public water supplies? The farther away you are from all nontarget areas, the better. Be especially careful with surface-water bodies. Rivers, streams, ponds, lakes, and drainage channels are at particular risk. Also consider wellheads and other groundwater sources. You must not endanger people, wild or domestic animals, or any sensitive areas when you chemigate. Federal court decisions and pesticide labels may require buffer zones between a target site and surrounding area. (A major pesticide contamination of groundwater occurred in Hawaii when a pesticide storage site was located uphill from a drinking water well. A spill allowed the pesticide to flow to the well and seep down the well into the groundwater.)

Soil Type

You may have several different soil types in your field. It is important to know your soil types because the rate at which water and chemicals enter the soil often differs with soil type. This is called the infiltration rate. Coarse-textured sandy soils can have high infiltration rates. This means that runoff is less of a problem in this type of soil than in fine-textured clayey soils. However, if you apply too much water to sandy soil, the pesticide may leach below the crop root zone. For clayey soils, the reverse is true. The risk of leaching (deep percolation) is lower, but the risk of runoff is higher. (This assumes that other factors such as slope, surface roughness, and compaction are equal.)

Topography

The topography, or the type of terrain, affects how well your irrigation system will disperse chemicals and water. Important variables are slope and landforms. On hilly, rolling terrain, the pesticide may be distributed unevenly. If the terrain varies along the length of the system, the pressure will vary. This may also cause uneven dispersal of the pesticide. To correct this problem, use pressure regulators or “dammerdikers” on each sprinkler device. Otherwise, your irrigation system may not work for chemigation.

Features of the Irrigation System

Irrigation systems differ in many ways. Choose a system based on the type of chemigation you need to do. For foliar application, you will need a sprinkler system. For soil applications, you can use any type of irrigation system. Also, make sure your system:

• has the right injection equipment,
• has effective safety devices,
• is properly designed, and
• is well maintained.

The entire system should be in good working order.

Distribution Uniformity of the Irrigation System

“Perfect uniformity” is the goal of every irrigator. It means that each point along the distribution lateral receives the same amount of water. Poor uniformity causes uneven application. Some areas may receive too much water while other areas receive too little.

The type of irrigation system you have often determines how evenly it will apply water and pesticide to the target area. Center pivot systems, for example, usually give uniform applications. Traveling gun systems, in contrast, often do not. You need to ensure some degree of uniformity before you can use your irrigation system for chemigation.

One of the most important factors affecting uniformity is pressure. Closely linked to this is system configuration or design. Well-designed low-pressure systems
(35 to 50 psi or less at the pivot point) can give excellent uniformity. They are also less prone to drift. There must be adequate overlap in the wetting pattern for the given sprinkler height and nozzle pressure. Highpressure systems (80 to 85 psi or greater at the pivot point) often give good uniformity, also. But applications made with highpressure systems are more prone to drift.

Your irrigation equipment dealer can instruct you on how to measure the uniformity coefficient (UC) of your system. It applies mostly to sprinkler systems. In theory, the UC of a “perfectly” uniform application is 100. If the UC of your system is less than 85, you may want to adjust it to a higher level.

Potential for Drift, Overspray, and Runoff

Drift, overspray, and runoff are the main causes of loss from chemical applications. They can also lead to pollution, human exposure, and even lawsuits. Assess these conditions before chemigating:

- environmental and human safety concerns,
- weather (especially wind),
- type of sprinklers or emitters,
- system pressure,
- soil type,
- topography, and
- type and formulation of chemical(s).

If weather or other conditions worsen during your application, shut down your system until things improve.

Economics and Management

Compare the cost of chemigation to that of other application methods. As discussed above, you may find that over time, chemigation is less costly than conventional methods.

We have already seen that chemigation demands a high degree of skill, training, and management ability. If you decide to chemigate, make sure you or another responsible person is qualified to run a chemigation system safely and effectively. For more information on management, see Unit 4 (Application Systems and Equipment).

Operation Plan

After weighing all of the above factors, you have decided to chemigate. Now, you should prepare a written observation and operation plan. Include the following:

- A list or drawing of sensitive areas that may be subject to drift, overspray, or runoff. These may include—but are not limited to—wetlands, hospitals, schoolyards, parks, and public roads.
- A description of the methods you will use to prevent drift, overspray, and runoff. This includes monitoring wind speed and disabling end guns or sprinkler heads.
- A description of backflow prevention equipment or other devices to prevent backflow and backsiphonage.
- A description of how you will calibrate your system and recalibrate, if necessary.
- A description of how you plan to monitor your system to make sure that it is working properly.
- A statement that gives the flush time (fill time) for the chemigation system.
- A description of the required safety procedures for anyone who enters the treated area. This includes use of personal protective equipment (PPE), worker notification, and restricted-entry intervals (REIs).
- A description of emergency response procedures.

Follow this plan whenever you chemigate. Keep one copy of the plan with you at the site and another copy at your home or office.

Target Applications

Chemigation can be broken down into different types depending on your target pest(s).
These include the application of
- fungicides,
- insecticides,
- herbicides, and
- nematicides.

**Fungicides**
Many farmers apply fungicides through an irrigation system to control fungal diseases. You can apply the chemical(s) either to the foliage (leaves) or to the soil. To treat foliage, use one of these sprinkler systems:
- center pivot,
- side-roll lateral, or
- hand-move lateral.
   Traveling guns are less effective because they often give less uniform coverage.
   A crucial factor to consider is the formulation of the fungicide. Be wary of copper-based fungicides. They can corrode aluminum pipes very quickly. For a foliar application, use a product that will not easily wash off. For a soil application, pick a formulation that will remain in the soil root zone. This type of chemigation works because you apply the fungicide when the leaf is wettest. This is also when the fungus is most active.

**Insecticides**
You may want to apply insecticides through an irrigation system to control insect pests. This seems to work best with center pivot systems. Here, too, it is important to choose the insecticide based on its formulation. For foliar application, the formulations best suited for chemigation are those that will adhere to plant tissues and are not highly water soluble. Choose products formulated to stick to the leaves of the plants sprayed. Certain adjuvants (ex. stickers or spreaders) will also help you achieve this result.

**Herbicides**
You can also apply herbicides through an irrigation system to control pest plants. This works especially well with center pivot systems. You can apply both preemergent and postemergent herbicides in this manner. You can also use preplant herbicides.

There are several important rules to follow when you apply herbicides through your irrigation system:
- Apply preemergent herbicides with enough water to distribute them in the top 2-1/2 inches of soil. The exact amount of water depends on:
  - soil type,
  - the amount of water in the soil when chemigation begins, and
  - the solubility of the product.
- Apply herbicides within five days after the last tillage. Otherwise, some weed seeds may have already started to germinate.
- Inject the herbicides continuously while irrigating or at the beginning of the irrigation set. Do not wait to apply the product at the end of the set.
  Some postemergent herbicides need only a small amount of water (1/2 inch or less). Too much water will cause the product to be washed off the leaf surface. The label will tell you how much water to use.

**Nematicides**
Applying nematicides through an irrigation system is an effective way to control nematodes. Some soil fumigants labeled for chemigation are particularly effective. They may be applied through sprinkler and drip/trickle irrigation systems. The product label will tell you how and where you may apply the pesticide.

If the label permits, you may apply these chemicals through the drench method using sprinklers or emitters.

Unit 3 explores the safety requirements for successful chemigation. You will learn how to protect the environment, workers, and yourself when you apply pesticides through an irrigation system.