Chapter 8.
General Problems in Herbicide Application for Rights-of-Way Vegetation Management

Table of Contents

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Chapter 8.
General Problems in Herbicide Application for Rights-of-Way Vegetation Management

IMPORTANT TERMS

adsorption
backflash
biological accumulation
brownout
drift
ecology
ecosystem
endangered species
erosion
food chain
groundwater
lateral movement
leaching
microbial breakdown
nonpersistent
persistent
photodecomposition
pollinators
residual life
runoff
surface water
volatilization

Herbicides are used to keep utility and pipeline rights-of-way, work areas, and storage sites clear of weeds in order to maintain safe and reliable service. They also play an important role in keeping railroad tracks and roadsides weed free to allow safe, unobstructed traffic flow. By choosing the right herbicides and applying them correctly, herbicides can achieve the intended goals without harming the environment.

ENVIRONMENTAL FATE

Environmental fate refers to what happens to the herbicide after it is applied to the right-of-way. When a herbicide leaves the application equipment, it is subject to some well-defined environmental processes. These processes are influenced by the chemical and physical properties of the herbicide and the spray solution. These processes move herbicides around in the environment or restrict their movement, and regulate the breakdown of the herbicides.

Transfer Processes

Herbicides in Air

Once a herbicide is released into the air, currents can move herbicide off target. Movement in the air can be reduced, but not completely eliminated. Movement of herbicides off target is an important concern to applicators. Uncontrolled movement in air can be from particle drift or volatilization. Both have the potential to cause damage to areas outside the treated site and to non-target organisms. Minimizing drift and volatilization are the applicator's prime responsibility.

Drift. Particle drift occurs when wind physically moves the herbicide and carrier from the target site during the spraying operation. Spray drift can damage susceptible plants adjacent to the

right-of-way or unintentionally expose animals or people to a chemical. An application should cease if the spray cannot be kept on the target area.

Drift potential increases:

- As the distance from the spray nozzle to the ground increases,
- As droplet or particle size decreases, and
- As wind speed increases.

Drift will be minimized if you:

- Spray at lower pressure,
- Use spray tips with narrow discharge angles,
- Use the largest practical nozzle openings to obtain large droplets,
- Reduce the distance between the nozzle and the weed,
- Reduce application speed,
- Use drift control additives that increase solution viscosity,
- Spray during the calmer times of the day, and
- Use attachments or modifications to spray equipment, such as shielded booms and drift-reducing nozzles.

The applicator should evaluate the wind speed and direction prior to spraying to determine the potential damage that could occur. If there are sensitive areas downwind (such as homes, water, and crops), try to make spray applications when the wind is calmest -- usually early morning or early evening, or when the wind is not blowing toward the sensitive area. If in doubt, the area should not be sprayed.

Volatilization. Volatilization can occur either during spraying or after application has occurred. Volatilization occurs when there is a physical change of the herbicide into gas. The resulting gas or vapor is readily moved by any wind. Herbicide vapors are created by the evaporation of the herbicide as the droplets falls from the sprayer or as the herbicide residue rests on surfaces, such as leaves, soil, asphalt, ballast, and gravel.

Volatility potential increases

- As air temperature increases,
- As surface temperatures increase, and
- As relative humidity decreases.

Volatility can occur hours after an area is treated, especially during a hot summer afternoon. Vapor losses are reduced or stopped when the herbicide becomes either bound or adsorbed to plant and soil surfaces or penetrates the foliage or soil. Volatilization is not as common as particle drift, but it has the potential for moving the herbicide a greater distance from the target.

Volatility varies greatly among herbicide products and is usually associated with emulsifiable concentrate formulations. Amine formulations of most herbicides are less volatile than their ester forms. Therefore, choosing nonvolatile herbicide formulations and avoiding application during periods of excessively high temperatures can reduce volatility. Some labels note temperature limits.

Herbicides in Water

Flowing water (creeks, streams, ditches) is a means for herbicides to move in the environment. Herbicides can reach water as a result of direct application, drift, spills, incorrect filling, cleanup, disposal methods, erosion, runoff, and leaching. Water from treated ditches flowing into fields can cause crop damage and may also have the potential for contaminating water used for drinking, fishing, recreation, and irrigation. Keep herbicides out of water by turning off the sprayer when crossing water and leaving buffer strips.

Herbicides in Soil

Some or all of most herbicide applications eventually reach the soil. Herbicides deposited on foliage, for example, may be washed off onto the soil by rainfall or reach the soil with dead plant parts. High-volume liquid applications may drip onto the soil. Some herbicides are applied directly onto the soil. The impact a herbicide has on the environment depends greatly upon its fate in the soil.

Herbicides move in soil in two major ways: **leaching,** downward movement through the soil, and **lateral movement,** movement of the herbicide across the soil surface or within the soil profile, usually in connection with flowing water. The amount of herbicide lost through leaching depends on

- adsorption (the attraction between soil particles and herbicide molecules),
- soil texture (amount of sand, clay and silt particles),
- herbicide solubility,
- amount and intensity of rainfall, and
- degree of soil compaction

Usually, herbicides leach

- greatest through sandy soils and
- least through compacted soil or soils containing clays or organic matter.

Desirable trees can be injured if their roots absorb the herbicide. This can be a problem when soil active herbicides are used around roadside plantings or when they are used where the right-of-way passes through forests, along the edge of woodlots, near shade trees, or near orchards. Lateral movement becomes a concern when intense rainfall comes soon after application, or soil active herbicides have been applied to saturated soil and the rainfall cannot soak into the soil. Light showers are more likely to move the herbicide into the soil and reduce lateral movement. Use caution when applying herbicides on moderate to steep slopes, on saturated soils, on frozen soils, or on areas that may be subject to water erosion since all soil active herbicides can be move laterally. Movement down slope can be a problem after guide rail applications because the guide rails are often placed on fill slopes. The fingers of dead vegetation or scalloped edges will be visible throughout the growing season and perhaps visible into the next year. Compaction caused by construction, or hard dry soil during drought periods, encourages surface water flow. As water flows over the treated site, it picks up some of the herbicide and moves it laterally as runoff, which can be deposited where it is not wanted. Treated soil can injure plants if carried off the application site by water erosion. In sloping areas, use bare-ground treatments with caution. Downward leaching can move herbicides from inches to a couple of feet, whereas runoff or lateral movement can move herbicides much greater distances (Figure 1a and 1b).

Figure 1a. Surface movement of herbicide down slope on a roadside.

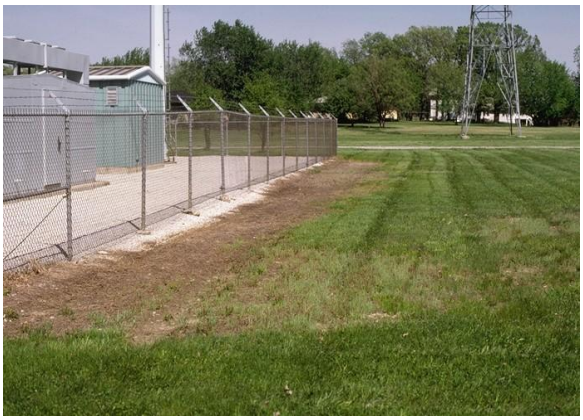

Figure 1b. Surface movement of herbicide down slope on a pumping station.

Removal Processes

Persistence in soils is an essential feature of herbicides used for residual weed control. Many of the uses of soil active herbicides require residual activity for several months. Herbicide residues must persist for several weeks for preemergence treatments to be effective because seed germination can occur throughout the growing season. Soil and herbicide characteristics as well as environmental factors influence degradation and breakdown of herbicides.

Adsorption

After application, herbicides may become adsorbed (attached to soil particles) to clay and organic matter particles much like iron is attracted to a magnet. The extent of this attachment increases as the percentage of organic matter and/or clay increases. This reduces the amount of chemical available to plants and slows both leaching and microbial breakdown. Increased soil moisture reduces herbicide adsorption.

Plant Uptake

Herbicides absorbed by plant roots can be either accumulated or be deactivated in the plant. Generally, herbicide removal in plant residue accounts for a relatively small amount of herbicide loss. However, once herbicides are taken up, plants can degrade sizable amounts of the herbicides.

Degradation Processes

The environmental processes responsible for breaking down herbicides include microbial breakdown, chemical breakdown, and photodecomposition.

Microbial Breakdown. Microorganisms (microscopic living organisms in the soil such as fungi and bacteria) use all types of organic materials, including herbicides, as their food supply. Specific microorganisms readily attack some herbicides because of their chemical structure. Temperature and moisture affect microbial growth. Warm moist soils are ideal for microbial activity and promote rapid herbicide breakdown. Microbial breakdown is the major way herbicides are degraded in the environment. Persistent herbicides are usually not broken down easily by microorganisms and are only slightly soluble in water.

Chemical Breakdown. Reaction with water (hydrolysis), salts, acids, and other substances in the soil may deactivate herbicides. These reactions increase in warm, moist soils, which are the same environmental factors that accelerate microbial breakdown.

Photodecomposition. Most herbicides undergo some level of photodecomposition (breakdown by sunlight). Rainfall typically moves herbicides away from the soil surface and direct sunlight on rights-of-way.

ENVIRONMENTAL ISSUES

Non-Applicator Exposure

Be aware of crews, people, or equipment near the treatment area.

- Avoid spraying when spray drift can contact bystanders or work crews.
- Avoid spraying equipment or tools being used by others.
- When making a roadside application in traffic, space the trailing vehicle farther back from the sprayer to reduce the potential for the spray to be blown onto following motorists.
- Treat mailboxes at their base rather than spraying over the top.

Pollinators

Bees and other beneficial pollinators (insects that carry pollen from one flower to another) should be considered when making herbicide applications. Flower pollination by honeybees is necessary for many agricultural crops. In general, herbicides are not hazardous to pollinators. In the vicinity of apiaries it is best to apply herbicides in the early morning or in the evening when bees are not active. Whenever possible, warn the beekeeper so precautions can be taken to protect the hives.

Wildlife

Herbicides properly applied along the right-of-way are not hazardous to wildlife since actual exposure is very limited. But wildlife can be influenced by the plant response to the herbicide treatment. When diverse plant cover develops, such as on a utility right-of-way, habitat for certain species, including deer, rodents, songbirds, and butterflies, is enhanced with the improved protective cover and food.

A few herbicides have the potential to be toxic to fish. Concentrations used for aquatic weed control are carefully regulated to prevent injury to these and other aquatic organisms from the herbicide application. The greatest hazard to aquatic organisms occurs with the emulsifiable concentrate formulations because the organic solvents in the formulation are often toxic.

Endangered Species

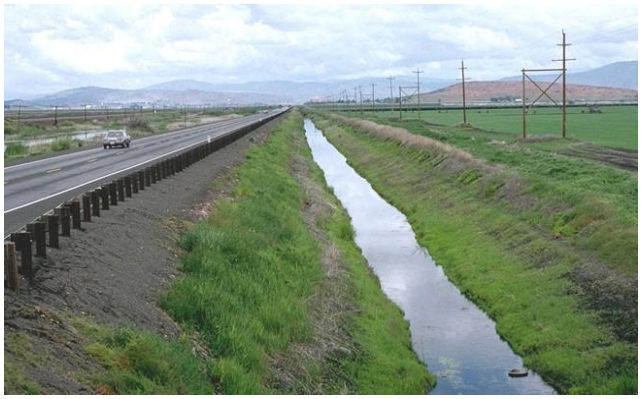

Figure 2. Wetlands and rights-of-way often co-exist

Rights-of-way may be ideal locations for threatened and endangered plant and animal species. In areas of intense agriculture or urbanization, rights-of-way may be the last remnant of undisturbed land. Wetlands containing endangered species may be adjacent to a right-of-way (Figure 2). Federal and state regulations may dictate management practices that prevent damage to endangered species.

Livestock

If the right-of-way crosses pastures or areas where livestock are confined, applicators should be aware of potential hazards. These are often addressed on the product label. For example, some plants, such as wild cherry or Johnsongrass, may become more attractive to livestock after spraying. As these treated plants respond to the herbicide, they produce prussic acid or cyanide that can kill animals. Also, as animals graze on a recently treated right-of-way, they can also ingest herbicide residue from treated plants. The herbicide could be an illegal residue in the meat or milk, thus restricting the sale of these products.

Biological Accumulation

Accumulation of some pesticides in the food chain raised public concern in the early 1960s. At each higher level in the food chain, non-degraded pesticides accumulated in the predator as the predator consumed its prey. This phenomenon **(biological accumulation**) had a serious impact on wildlife, especially predatory birds. Biological accumulation was associated with the organochlorine insecticides. These materials were oil soluble and not easily degraded in the environment so they accumulated in the fat of animals. All pesticides are tested today for their ability to accumulate in living organisms. No herbicides used for rights-of-way vegetation control accumulate in the food chain.

Brownout

Brownout is the discoloration of plant foliage after a herbicide application. In highly visible areas, brownout can become a serious public relations problem because its occurrence is an unsightly contrast to the surrounding green vegetation (Figure 3). Brownout can occur as dead foliage resulting from brush and broadleaf weed control or yellow (chlorotic) grass treated with a growth regulator. Several herbicide treatments methods can reduce the potential of brownout including late-season foliage treatments, dormant basal treatments, cutting tall stems and treating the stumps, or using products that do not cause rapid foliage discoloration. Treating weeds when they are small reduces the visual effect and eliminates the need for cutting. Applying herbicides to brush late in the growing season reduces the visual impact because the leaves blend with the developing fall colors.

Figure 3. Brownout occurring from a broadcast, high-volume application of phenoxy herbicides.

Backflash

Backflash is the uptake of herbicide by untreated trees adjacent to treated trees. This uptake occurs through root grafts, which can be a problem with trees that originate from root sprouts, such as aspen, oaks or sassafras. It can occasionally occur between unrelated species. This is not a common occurrence, but if it happens, it would usually be noticed along the edge of a right-of-way where affected trees are located out of the treated area but show effects similar to the treated trees. With some herbicides, treated trees or shrubs can release herbicide into the soil following their death. Occasionally a neighboring susceptible non-target plant can subsequently take up the released herbicide and show signs of injury.

Spills

Inform your supervisor immediately if a spill occurs so they can contact the state agency responsible for spills. In the event of a serious spill,

- Confine it to the site and keep it out of water. Keep a shovel and stiff broom or other clean up materials on the truck.
- Work carefully and do not hurry.
- Do not let unauthorized people enter the area until the spill is completely cleaned up.

- If the product was spilled on a person, wash it off immediately.
- Do not leave a spill until it is cleaned up or responsible help arrives.
- Keep labels and MSDS sheets available to assist emergency personnel.
- Control, Contain, Call, and Clean up.

Adjacent Water, Wells, and Groundwater

The occurrence of herbicides in water and wells adjacent to rights-of-way is more likely to occur in limestone areas, sandy soils, and areas having high-water tables. As the limestone dissolves, sinkholes develop. Herbicides can be washed directly into the underground water system by way of sinkholes. Sandy soils are conducive to herbicide movement into underground water supplies since herbicides that have the potential to leach move readily through these soils. High water tables pose a problem because herbicides do not have to leach far to reach groundwater systems. In these instances, the herbicides move so quickly through the soil there is limited opportunity for soil adsorption and microbial degradation.

Factors that enhance the potential for herbicides to contaminate groundwater include:

- Herbicides with long soil persistence,
- Herbicides with high soil mobility,
- Application to soils with little adsorptive capacity, and
- Soils with water table close to the surface.

The herbicide label may restrict the use of a product in certain geographic areas of the country. Always refer to the product label for geographic restrictions.

APPLICATION ISSUES

Obstructions and Physical Barriers

Fixed obstructions, such as switch stands, whistle boards, delineator posts, light posts, telephone poles, and guide rails can interrupt the spray pattern. Narrow county roads have obstructions such as fences, trees, ornamental plants, and mailboxes. Skips occur where the sprayer is turned off and on to avoid these obstacles. Spraying around obstructions is accomplished by adapting the sprayer to miss or clear the most common ones, or by using booms with drop nozzles, or nozzles which require no boom such as Boom Busters or off-center nozzles. Occasional obstructions (parked cars, workers) are sometimes left untreated and spot

applications may be necessary. However, these interruptions are a small percentage of the total spray operation.

Ditches, Culverts, and Bridges

Ditches are important avenues for removing surface water, which makes them a particular problem when adjacent to the right-of-way. Because moisture conditions differ, the weeds in the ditch may differ from those on the adjacent right-of-way in both size and species, and may not be controlled with the same herbicide. Be aware that when the ditch has water, it could transport the herbicide off the right-of-way. It could go into a field, an irrigation ditch, or into a drinking water source.

Check the herbicide label for guidance when treating in or around ditches. Turn the sprayer off when crossing water, regardless of size. Treat the area around culverts and drainage inlets carefully. Leave a buffer zone around the water's edge. Strips of green vegetation serve as natural filters, catch eroded soil, and reduce the possibility of the herbicide entering the water source.

Highway Traffic

Highway traffic interferes with chemical application. Traffic density may require the use of slow-speed hazard signing and trailing or escort vehicles. These are important to your safety as well as to the motorists. Passing and on-coming traffic, especially trucks, create air currents around the application equipment. These currents distort the spray pattern and can blow the spray droplets off the right-of-way, thus increasing off-site drift. Drift is more of a problem on small, narrow sites or medians than on larger areas such as interchanges.

Traffic or pedestrians at intersections or highway rail crossing may not realize that you are spraying as you approach. Motorists or pedestrians may not be able to move to avoid the sprayer. Be prepared to turn the sprayer off. If possible, schedule the application to avoid peak traffic periods.

Accessibility and Terrain

Accessibility can restrict equipment or the method of application. Sites may be fenced off, or behind guide rails, hedgerows, and sound barrier walls. Wet ditches can cut off a section of the right-of-way. Steep slopes limit the type of equipment normally used to treat the site.

Inaccessible areas should be spot treated by handguns or backpack sprayers. Cut slopes may need to be treated more often than fill slopes because weeds are more visible.

Over-Application

Over-application can result in injury to both desirable and undesirable plants, loss of selectivity, bare ground, and soil erosion. It is often the result of incorrect calibration or over-lapping spray swaths. Both are avoidable if the applicator pays attention to application details. Be aware of these potential problems particularly when treating irregularly shaped areas with broadcast application methods, such as a boom. Over-application often occurs when following the edges of a treated area to narrow points or when leaving the sprayer on while making turns in the treated area. Colorants can be added to the spray solution to make the treated areas more visible.

Invasion by Other Weeds and Resistance

Weeds not controlled by the herbicide mixture will be released, and new species can invade the treated site. This can occur with perennial plants recovering from vegetative reproductive tissues or with annuals germinating from new seeds. Biotypes of some weeds, such as kochia, annual ryegrass, and Russian thistle, can develop resistance to herbicides previously used on the site. Applicators should be aware of resistant weeds and integrate different control methods or herbicides with different modes of action to prevent resistant weeds from becoming established.

Loading and Mixing

Loading and mixing along the right-of-way can inadvertently contaminate water sources when water is taken from creeks, ditches, and fire hydrants. Most states require equipment to have devices to avoid **back siphoning** (water flowing from the spray equipment back into the water source). Using an air gap in the filling line is the simplest way to prevent back siphoning (Figure 4). The water line is never inserted into the spray tank. A nurse tank used only to carry water is a way to avoid any herbicide contamination to

Figure 4. An air gap prevents herbicide solution from contaminating water sources.

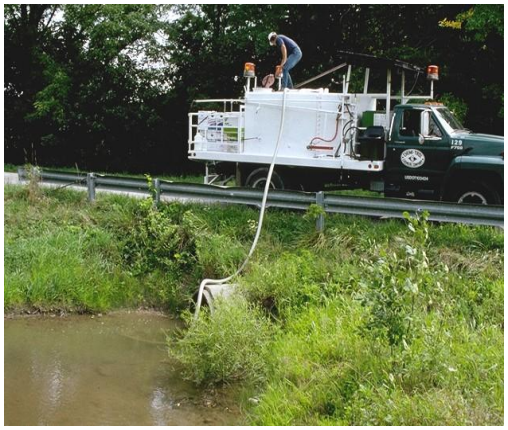

Figure 5. Chemical mixing should not occur adjacent to streams and creeks.

streams, lakes, or ponds when filling with water. Make certain the correct valves are opened and closed on sprayers that have separate tanks for concentrates and water (Figure 5).

Some states have regulations regarding using open water sources for mixing herbicide tanks, and strict distance requirements when mixing chemicals near open water sources. Avoid mixing chemicals next to an open water source. After loading water, move the vehicle away from the creek or ditch prior to mixing to reduce the potential for a spill getting into the water. Load the chemical concentrates carefully. Mixing at an untreated area on the right-of-way helps reduce applicator exposure. Some states require spill containment equipment when mixing herbicide tanks. Avoid using muddy water because the soil particles can tie-up some herbicides. Diquat and glyphosate may be rendered completely ineffective by soil particles suspended in the water.

Empty containers should not be discarded on the right-of-way. Secure them so they will not blow off the equipment, and return them to the operations base for proper disposal. Close chemical containers after each use to prevent spills. Do not use empty herbicide containers for any other purpose.

SUMMARY

Herbicides help maintain safe, reliable rights-of-way. With proper selection and correct application of chemicals, they can be used to improve worker and public safety with no harm to the environment. There are a variety of potential problems and hazards associated with the changing conditions on a right-of-way that the applicator must consider during application. Following the label will prevent most environmental problems.

Chapter 8 Example Test Questions

1. Physical problems encountered when spraying on roadsides include:
   A. All of the following
   B. Highway traffic
   C. Guide rails
   D. Steep slopes

2. The discoloration of plant foliage after herbicide treatment is:
   A. Volatilization
   B. Brownout
   C. Drift
   D. Backflash

3. The movement of herbicide down through the soil is termed:
   A. Brownout
   B. Drift
   C. Photodecomposition
   D. Leaching

4. Leaching:
   A. All of the following
   B. Is necessary to move the herbicide into the root zone
   C. Can be a problem when off-site trees pick up the herbicide through their roots
   D. Is accentuated in sandy soil

5. Lateral movement:
   A. All of the following
   B. Can be encouraged by soil compaction
   C. Can occur on steep slopes
   D. Can occur when soil active herbicides are applied on saturated soil

6. Potential well contamination is of particular concern in:
   A. All of the following
   B. Soils overlying limestone
   C. Sandy soils
   D. Areas with high water tables

7. Water flowing from the spray equipment to the water source is termed:
   A. Drift
   B. Lateral movement
   C. Back siphoning
   D. Backflash

8. When wind carries the chemical and its carrier off the target area, this is called:
   A. Lateral movement
   B. Leaching
   C. Drift
   D. None of the above

9. Drift can be reduced by:
   A. All of the following
   B. Using low pressure
   C. Using the smallest nozzle possible
   D. Using nozzles with large fan angles

10. Winds are usually calmest during:
   A. Early morning
   B. Mid-day
   C. Early evening
   D. Both A and C

Answers:

1.	A	3.	D	5.	A	7.	C	9.	A
2.	B	4.	A	6.	A	8.	C	10.	D

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