APPLY PESTICIDES CORRECTLY
A GUIDE FOR COMMERCIAL APPLICATORS

RIGHT-OF-WAY PEST CONTROL

U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF PESTICIDE PROGRAMS
WASHINGTON, D.C. 20460

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ACKNOWLEDGMENTS

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PREFACE

Federal regulations establish general and specific standards that you must meet before you can use or supervise the use of certain pesticides. Your State will provide material which you may study to help you meet the *general* standards.

This guide contains basic information to help you meet the *specific* standards for applicators who are engaged in right-of-way weed control. Because the guide was prepared to cover the entire nation, some information important to your State may not be included. The State agency in charge of your training can provide the other materials you should study.

This guide will give you information about:
- types of weeds,
- methods of weed control,
- safe and effective use of herbicides, and
- application equipment.

INTRODUCTION

Rights-of-way are the areas involved in common transport. Included are:

- Federal, State, county, and township highways and roads,
- public airports,
- railroads,
- electric utilities (including transformer stations and substations),
- pipelines (including pumping stations),
- public surface drainage ways,
- public irrigation waterways,
- banks of public bargeways, and
- bicycle, bridle, snowmobile, and other public paths or trails (outside established recreational areas).

Plant growth along the right-of-way must be controlled to make sure that the right-of-way is:

- safe,
- usable,
- attractive,
- as inexpensive as possible to maintain, and
- not harmful to the environment of the surrounding area.

VEGETATION MANAGEMENT

Consider what vegetation already exists along the right-of-way and what may need to be added. Usually grasses should predominate, but some legumes may be desirable. For added beauty and variety, encourage some wildflowers. Also consider shrubs with colorful fruit and berries.

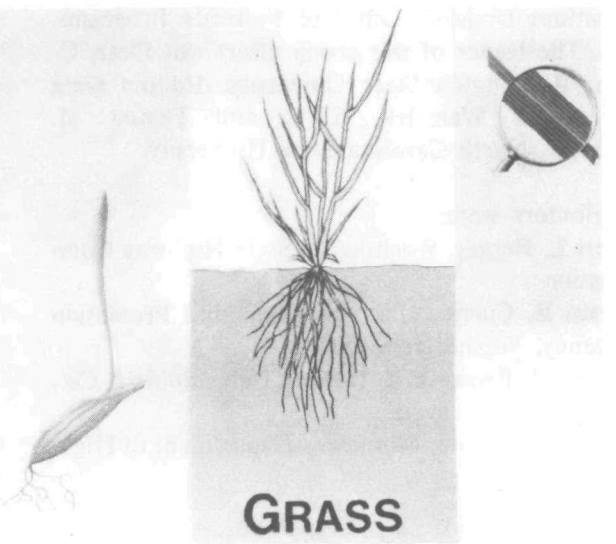
Plants along a right-of-way that can be considered weeds are those which:

- are a safety hazard,
- are a nuisance,
- are unsightly,
- impede the use and maintenance of the right-of-way,
- cause injury to man or animals,
- have been legally declared "noxious",
- crowd out desired plants,
- damage structures such as road surfaces and rail ballast, or
- could harm adjacent crops if allowed to spread.

For weed control purposes, plants may be classed as grasses, broadleafed, or woody plants.

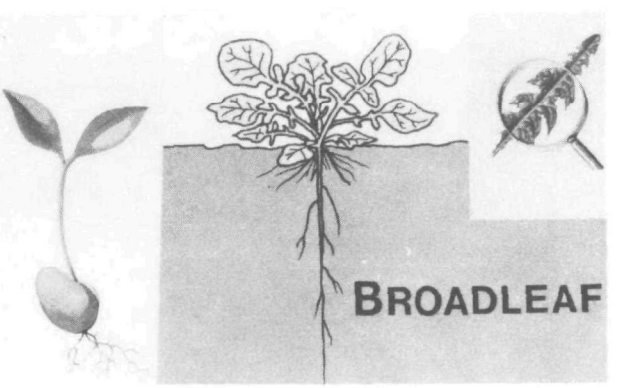
GRASSES

Young grass seedlings have one leaf coming from the seed. Grass leaves are generally narrow, upright, and have parallel veins. Many grasses have fibrous root systems.



BROADLEAF PLANTS

Broadleaf plants have two seed leaves. They generally have broad, net-veined leaves and tap roots or coarse root systems.

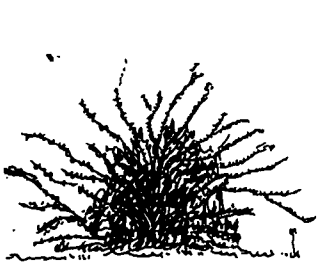


WOODY PLANTS

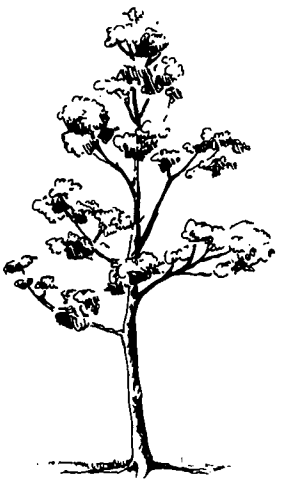
Woody plants are those that form wood. They include:

- Brush and Shrubs—woody plants that have several stems and are less than 10 feet tall. When

trees are present, brush or shrubs may be called understory.



- Trees—woody plants which usually have a single stem (trunk) and are over 10 feet tall.



A plan for controlling plant growth along a right-of-way may include both nonchemical and chemical aspects. All the control methods must be coordinated, since each has an effect on the others.

NONCHEMICAL aspects of the plan might include:
- right-of-way location and design,
- erosion prevention and cover establishment,
- planting and encouraging desirable species,
- utilizing competitive characteristics of desirable plants,
- mowing,
- landscaping,
- equipment allocation, and
- controlled burning.

CHEMICAL methods include:
- fertilization, and
- use of herbicides.

TYPES OF HERBICIDES

SELECTIVE HERBICIDES

Selective herbicides kill certain kinds of plants but do not significantly injure others. Weeds must be correctly identified, and the right chemical must be correctly applied at the right time. Use spot treatments wherever possible instead of broadcast applications.

NONSELECTIVE HERBICIDES

Nonselective herbicides kill almost all plants in the area of application. They may leave the soil nonproductive (barren) for a year or more, depending on the chemical and the rate at which it is used. Not all plants react the same way to any one herbicide. Your choice of herbicide and application rate depends on what plant you need to control.

Use nonselective herbicides in areas where bare ground is needed. This type of control may be necessary around substations, pole yards, pumping stations, storage areas, guardrails, signposts, runway lights, parking areas, railroad yards, in railroad ballast, in pavement cracks, and on highway shoulders.

Plants in these areas could be a fire or safety hazard, restrict sight, damage structures, provide a breeding area for rodents and other pests, or reduce security.

The herbicide must be able to:
- kill existing exposed plants, and
- keep others from growing during the desired period of time.

The application should be in a uniform pattern at rates recommended on the label.

Wind, water, and soil erosion can cause herbicides to move sideways after application and before the chemical is fixed in the soil. Be careful to prevent surface movement which could cause damage to desirable plants in adjacent areas. Herbicides seldom move off target when applied to ballast and pavement cracks.

Nonselective herbicides usually should not be applied to slopes greater than 6:1, horizontal to vertical, without protecting the ground from erosion.

The area can be protected by:

- covering it with asphalt or crushed stone, or
- mixing the herbicides with a cut-asphalt and spraying it over the surface.

Nonselective soil-applied herbicides kill existing perennial plants slowly. To improve their effectiveness, combine them with contact and/or translocated herbicides. You can mow existing plants closely and remove them before treating the area. Remove plants from around guardrail posts with a shovel. Blading with a grader can also be used.

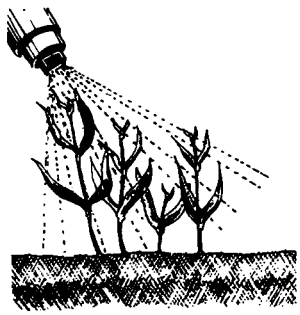
Weed growth above ground is eliminated. Some weeds will not come back. However, some weeds may regrow from roots. New weeds may grow from seeds in the soil.

PLANT GROWTH REGULATORS

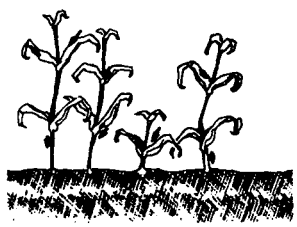
A vegetation cover is sometimes needed where mowing is not practical. In some of these places, you can use growth regulators to slow down plant growth. They act only on the leaves they contact, so they create no hazard from moving off target in the soil. Because they generally do not create bare ground, they help prevent erosion. Use of these chemicals may cause an increase in undesirable plants, however, because not all plants are equally susceptible to them.

CONTACT HERBICIDES

These are herbicides that control weeds by direct contact with plant parts. They must be applied to the leaves. They are sometimes referred to as chemical "mowers". Good coverage is necessary since only the plant area contacted is controlled. Most contact herbicides are nonselective.



Spraying of visible plant foliage starts the action of a contact herbicide. A sprayer is usually used to apply herbicide after growth has started.

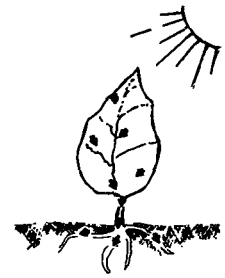


Herbicide is taken into the plant leaves where it interferes with growth. The plant begins to curl, wither, and then turn brown.

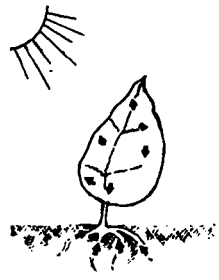
TRANSLOCATED HERBICIDES

These herbicides move through the entire plant system. They may build up in the plant's active growth centers. Most of these herbicides are selective. Some of them are most effective when applied to the plant foliage.

Spray growing vegetation until wet.



Chemical translocates to growing points and roots

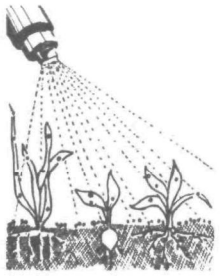


—and throughout the plant.

Susceptible plant gradually dies.

Other translocated herbicides must be applied to the soil. They are taken into the plant through the roots. These are called *soil residual* herbicides. The length of time the soil remains relatively weedfree depends upon the chemical used, amount applied,

rainfall, soil type, and the plant species in the treated area. Soil residual herbicides that are selective in some situations may be used nonselectively by increasing the rate of application.



Apply to soil and young plants in early spring.

Rain washes herbicide into the soil. It dissolves and is absorbed by the plant.

Herbicide is translocated to growing points. Plant yellows and gradually dies.

Plants die and ground may remain bare for a year or more.

FACTORS AFFECTING CHEMICAL WEED CONTROL

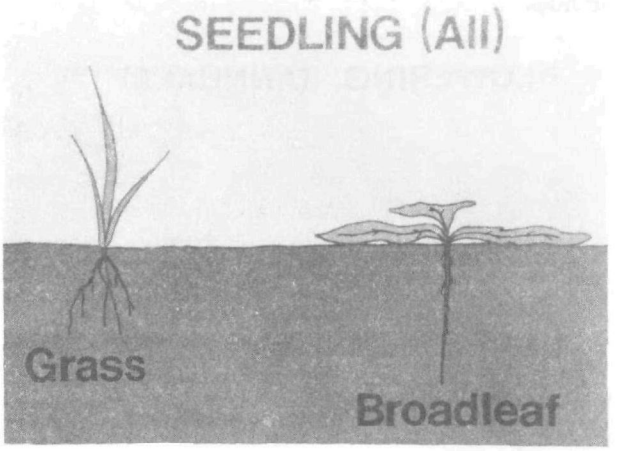
STAGES OF GROWTH

Grasses and broadleaf weeds go through four stages of growth:

- seedling,
- vegetative,
- bud and flowering, and
- maturity.

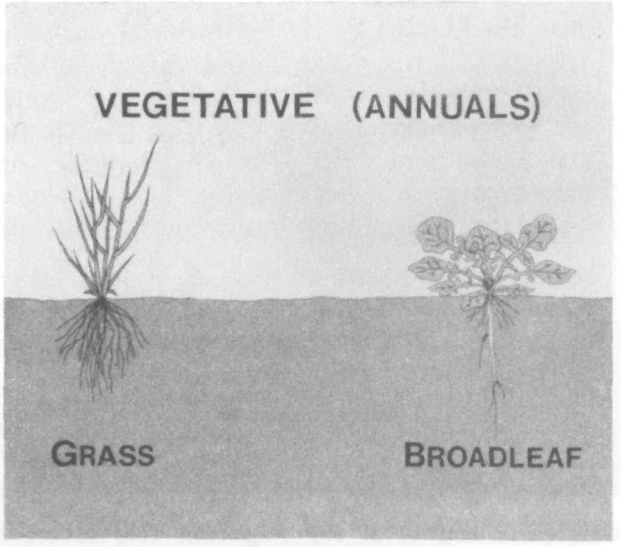
Seedling

The seedling stage of growth is the same for annual, biennial, and perennial weeds. They are all starting from seed. The weeds are small and tender, so less energy is required for control at this stage of growth than at any other stage. This is true whether mechanical or chemical control is used. Herbicides with foliar and/or soil activity are commonly used and usually effective at this stage.



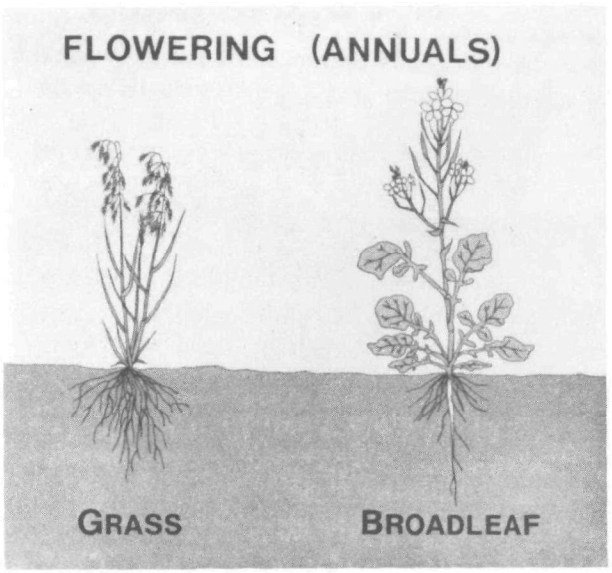
Vegetative (annuals)

During the vegetative stage of growth, energy produced by the plant goes into the production of stems, leaves, and roots. Control at this stage is still possible but sometimes more difficult than at the seedling stage of growth. Cultivation, mowing, and postemergence herbicides are effective controls.



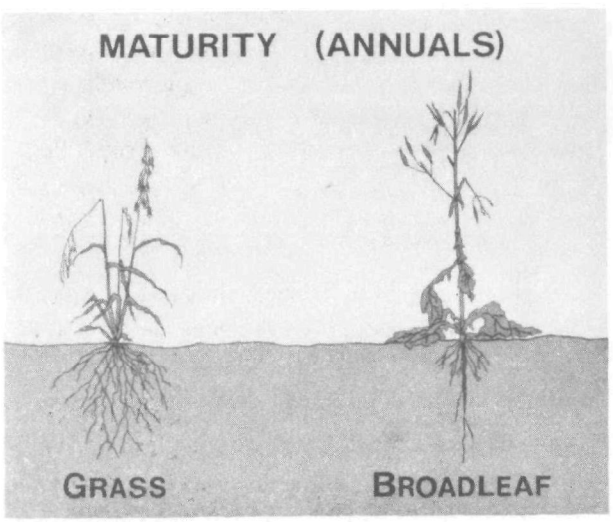
Bud and Flowering (annuals)

When a plant changes from the vegetative to the flowering stage of growth, most of its energy goes into the production of seed. As plants reach this more mature stage, they are usually much harder to control by either mechanical or chemical methods.

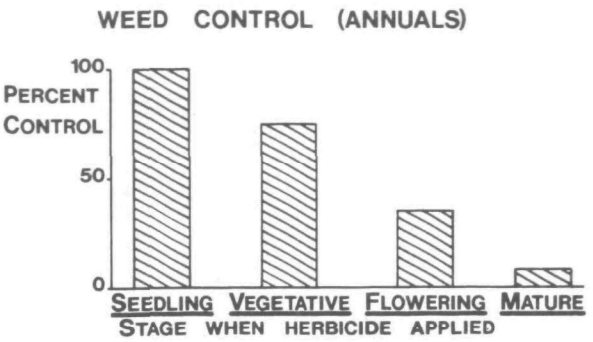


Maturity (annuals)

Maturity and seed set of annuals completes the life cycle. Chemical control is usually not effective at this stage since there is little or no movement of materials in the plant. Once the seeds are mature, neither mechanical nor chemical controls can harm them.



(Degree of control at any stage will vary according to the species of weed and the herbicide used.)

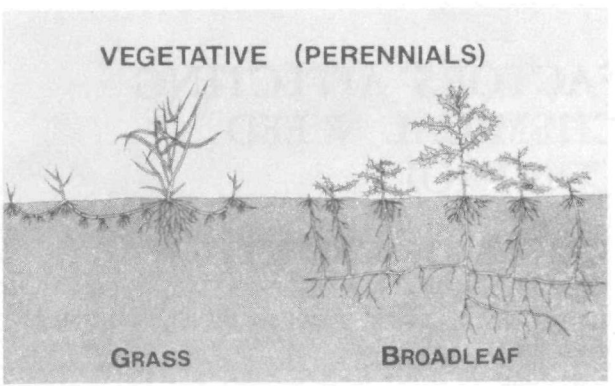


Biennials

Biennals, in two years, go through the same stages as annuals. Control is usually easiest during the seedling stage or when the weeds are still quite small.

Vegetative (perennials)

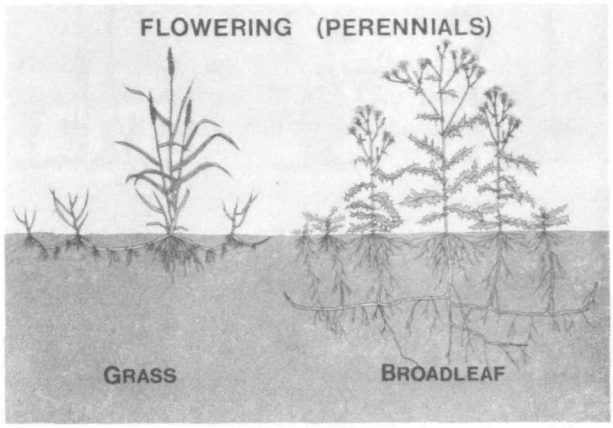
When the plant is small, part of the energy used to produce stems and leaves comes from energy stored in the underground roots and stems. As the plant grows, more energy is produced in the plant leaves. Some of this is moved to the underground parts for growth and storage. Herbicides provide some control at this stage.



Bud and Flowering (perennials)

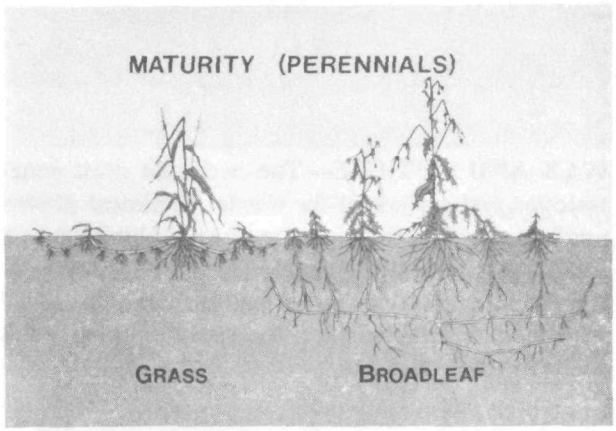
At this stage the plant's energy goes into the production of flowers and seeds. Food storage in the roots begins during these stages and continues

through maturity. Chemical control is more effective at the bud stage (just before flowering).

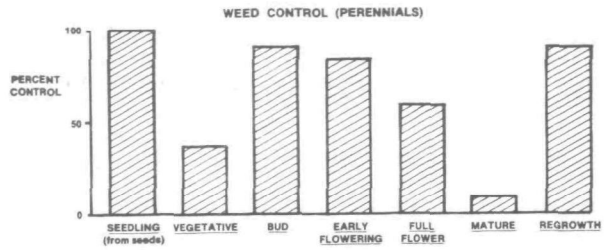


Maturity (perennials)

Only the above-ground portions of these plants die each year. The underground roots and stems remain alive through the winter and send up new plant growth the next spring. Chemical control is usually ineffective at this stage.



(Degree of control at any stage will vary according to the species of weed and the herbicide use.)



Woody Plants

Woody plants go through the same four growth stages as other perennial plants. They do not die back to the ground during the winter, but many kinds lose their foliage. Woody plants can be controlled with herbicides at any time, but control is easiest when the plants are small. Foliar treatments can be used at any time when the woody plants have actively growing leaves. They usually work best when the leaves are young.

TIME OF YEAR

With a fall application of an herbicide, the target plant must survive three stresses:

- the effects of the herbicide,
- the effects of winter, and
- the heavy demand for nutrients caused by the rapid growth period in the spring.

Fall treatments also may be safer for the environment, because many crops and other desirable plants have completed their growth.

Perennial weeds that have regrown after being controlled by chemical or mechanical methods should be treated in the fall. At that time, herbicides reach underground plant parts through the natural translocation activity of the plant. Before the first killing frost, nutrients move from the above-ground parts of the plants to be stored over winter in the underground parts. Underground parts must be killed to control these weeds.

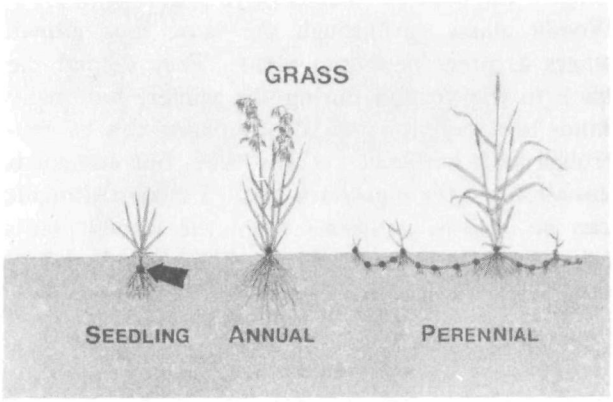
Winter annuals also can be more easily controlled by a fall application of herbicide, because they are seedlings at that time.

Spring treatments will control summer annuals and perennials while they are in the seedling stage. Fall and spring are ideal times to control biennials in the rosette stage. In the fall, translocation is occurring, and in the spring active growth begins again.

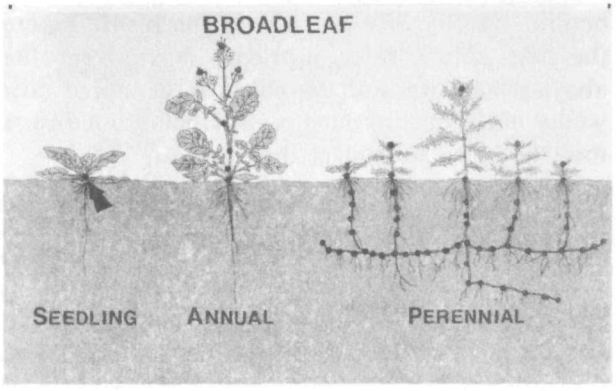
FACTORS AFFECTING FOLIAGE APPLICATION

Location of Growth Points

GRASS—The growing point of a seedling grass is protected below the soil surface. The plant will grow back if the herbicide or cultivation does not reach the growing point. Creeping perennial grasses have buds below the soil surface.



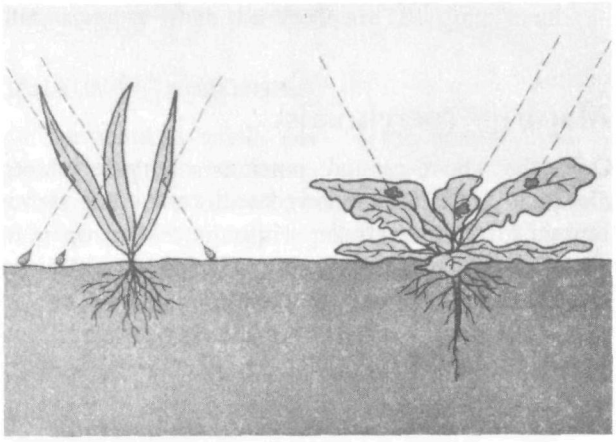
BROADLEAF—Seedling broadleaf weeds have an exposed growing point at the top of the young plant. They also have growing points in the leaf axils. Herbicides and cultivation can reach these points easily. The established perennial broadleaf plant is hard to control because of the many buds on the creeping roots and stems.



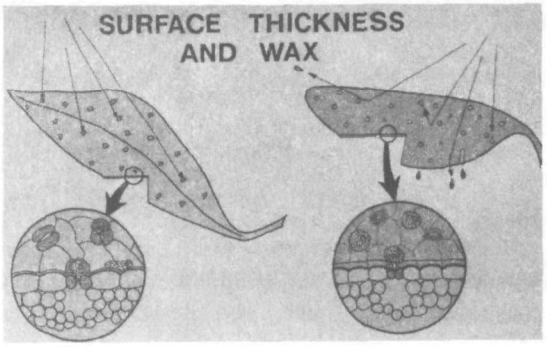
WOODY—Many woody plants, either cut or uncut, will sprout from the base or roots.

Herbicide Entrance Into the Weed

LEAF SHAPE—Herbicide sprays tend to bounce or run off of plants with narrow vertical leaves. Broadleaf plants tend to hold the spray. If recommended on the label, add an adjuvant to increase spray retention.

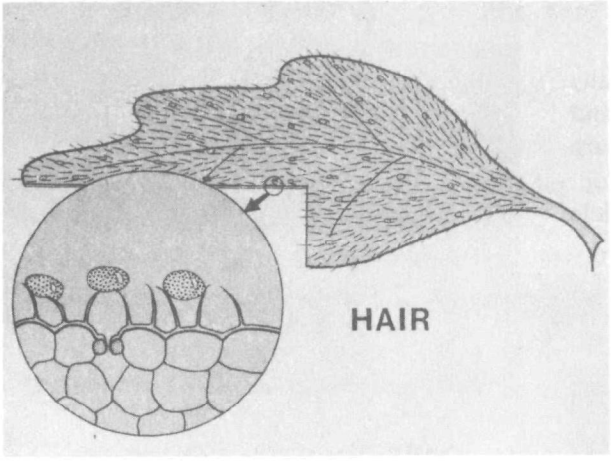


WAX AND CUTICLE—The herbicide must penetrate the leaf surface of the weeds. Thickness of wax and cuticle affect the entrance of an herbicide into a leaf. A leaf with a thin cuticle allows the spray solution good contact with the leaf surface. On a leaf with a thick waxy surface, the spray solution tends to stand up in droplets.



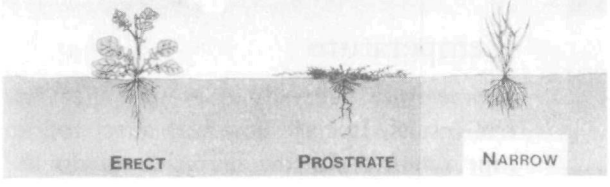
The wax and cuticle are thinner on young weeds. This is another reason for applying herbicides at the early growth stage.

HAIRS—Hairs on the leaf surface tend to keep the spray solution from entering. The droplets stand up on the hair and do not contact the leaf surface.

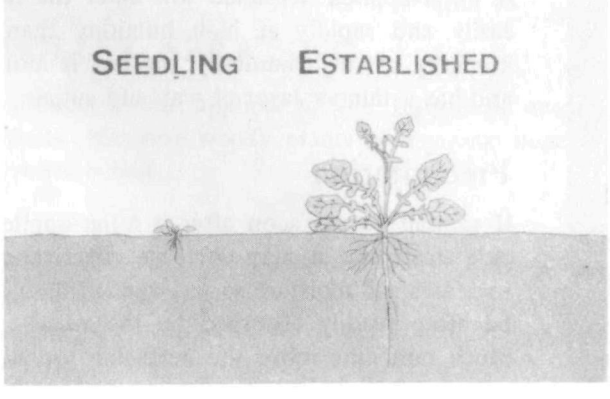


Seedling weeds usually have fewer and shorter hairs. This is another reason for early control.

SPECIES—Species vary in growth habits and susceptibility to herbicides.



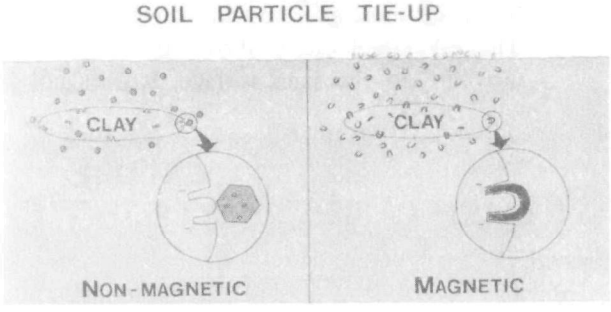
SIZE—Seedling weeds are easier to control than established weeds. Smaller plants, regardless of their stage of growth, are usually easier to control than larger plants.



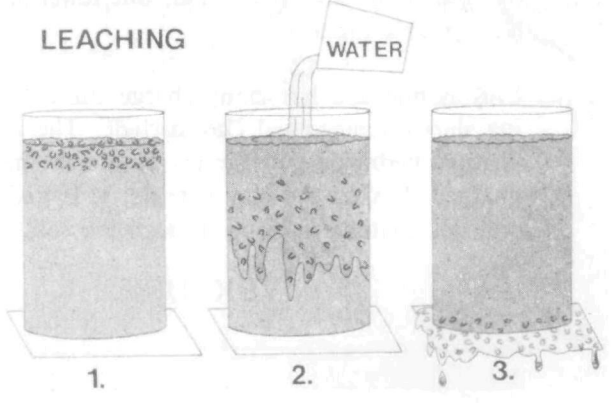
FACTORS AFFECTING SOIL-APPLIED HERBICIDES

Herbicide Characteristics

SOIL PARTICLE TIE-UP—One of the properties of herbicides is magnetism. Some are not magnetic at all; others have strong magnetism. Those without a magnetic charge move down through the soil quickly. Others, with positive magnetic charges, tend to tie-up on the negative charge sites of soil particles.



LEACHING—Leaching is related to herbicide characteristics and soil factors. Herbicides and soils vary from nonleachable to completely leachable.



PERSISTENCE—Persistence of an herbicide in the soil depends on herbicide characteristics, rate of application, soil texture, organic matter, precipitation, temperature, and surface flow. Herbicides can:

- remain concentrated at the soil surface,
- partially leach (diluting effect), or

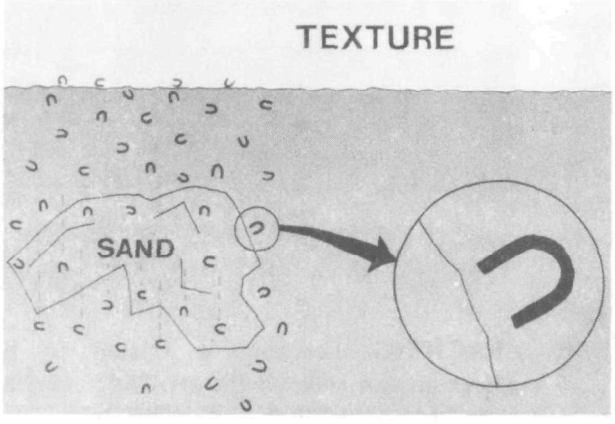
- move through the soil in a front, allowing new weeds to grow above.

Soil Type

Two factors affect the movement of herbicides that are applied to the soil:

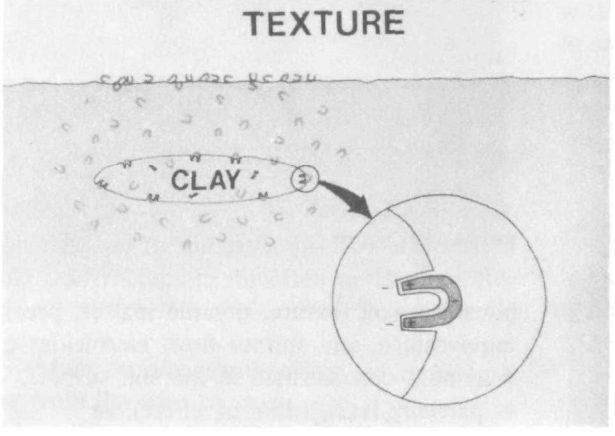
- the texture of the soil—how much sand, silt, and clay the soil contains, and
- organic matter in the soil.

TEXTURE—Sand is coarse and does not have many charge sites. The drawing shows a magnified sand particle in the soil. The magnet-shaped particles are herbicide molecules moving down through the soil. The magnified circle shows the herbicide particle moving past the sand surface. It does not tie-up.

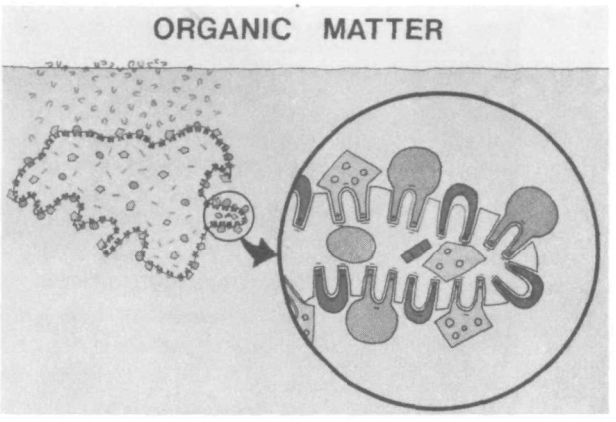


Silt has more sites than sand, but fewer than clay and organic matter.

Clay is fine and has many charge sites. The drawing shows a magnified clay particle. The positively charged herbicide particle has fit into the negatively charged slots on the clay particle. It is tied up and will not continue moving through the soil.



ORGANIC MATTER—Organic matter has many more negative charge sites than even the finest soil particles. The magnified circle in the illustration below shows not only herbicide particles tied up on the organic matter, but also particles of other materials such as water, sodium, calcium, and ammonia.



OTHER FACTORS

Soil Moisture

Soil-applied herbicides must be in moist soil to be taken up by plant roots. This requires water in the form of precipitation or irrigation.

Temperature

Temperature generally does not affect weed control results. It may, however, affect the amount of time required for the herbicide to do its job. As temperature increases, the herbicide may work more quickly. In very cold weather, action of the herbicide may be slowed.

Humidity

A foliar-applied herbicide will enter the leaf more easily and rapidly at high humidity than at low humidity. At high humidity, the leaf is more tender and has a thinner layer of wax and cuticle.

Precipitation

If rainfall occurs soon after a foliar-applied herbicide treatment, it may decrease effectiveness. Rain increases soil moisture so soil-applied herbicides can be more readily absorbed by the weeds. But too much rain may move the herbicide too deep, past

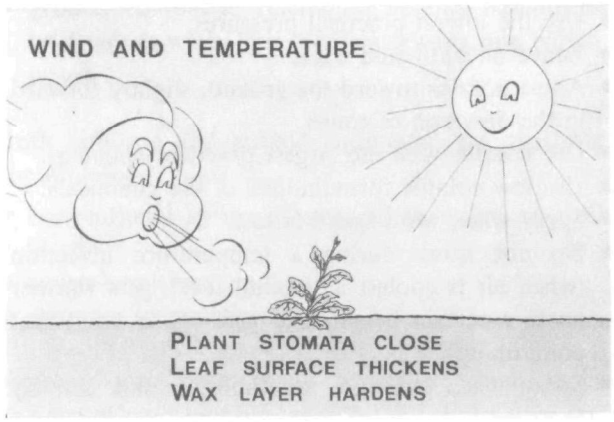
the zone where the weeds are. A hard rain may move surface-applied herbicides out of the target area. This is especially true if the soil surface is packed or sloping.

Wind and Temperature

Wind and temperature can also affect the weed. A hot, dry wind will cause:

- the openings on the plant surface to close,
- the leaf surface to become thicker, and
- the wax layer to harden.

These factors make it harder for herbicides to penetrate the leaves.



WOODY PLANT CONTROL

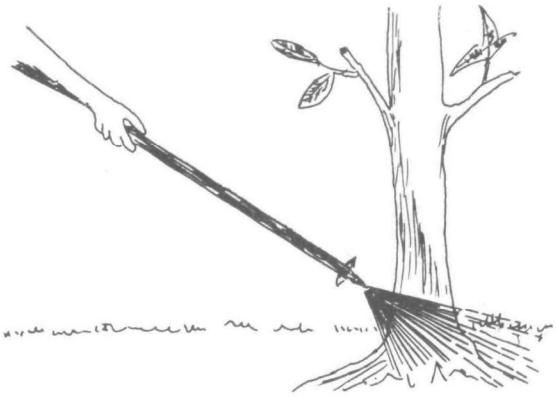
Woody plants may be controlled mechanically or chemically.

FOLIAR SPRAYING

Herbicides are applied to the foliage of woody plants. Spraying woody plants at a young stage of growth is best.

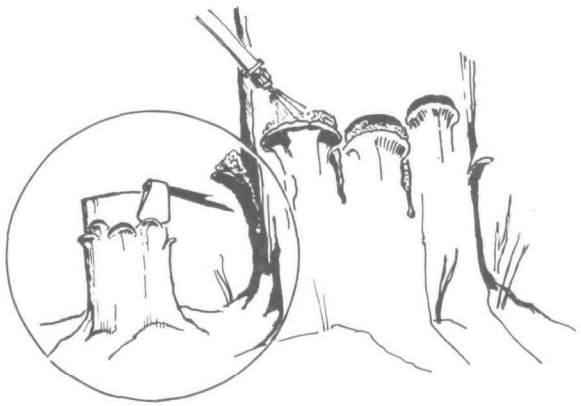
BASAL SPRAYING

Herbicides are applied in oil to lower parts of stems and exposed roots. It is best to fell large trees and then treat the stumps.



CUT-SURFACE TREATMENT

The herbicide can be applied to the sapwood through frill or notches. Another alternative is injection.



STUMP TREATMENT

Close-cut stumps and exposed roots also may be treated with herbicides in oil. It is best to treat immediately after cutting. All sprouts must be treated.

SOIL TREATMENT

Applications are made to the soil around the base of plants. Generally, granular herbicides are used. These must be in moist soil for results to occur.

DRIFT

Be sure that the herbicides you use do not drift to nontarget areas, either within the right-of-way or outside of it.

There are two kinds of drift:

PARTICLE DRIFT—spray droplets which are carried away from the application area by air movement. The distance a particle of herbicide spray can drift is determined by:

- the force of the wind,
- the distance from the spray nozzle to the ground, and
- the size of the particle. The smallest particles, such as those in fog or mist, present the greatest drift hazard.

VAPORIZATION—evaporation of an active ingredient during or after application. The movement of such vapor with wind currents may injure sensitive vegetation. Vaporization is not as common as particle drift, but it has more potential for moving a greater distance.

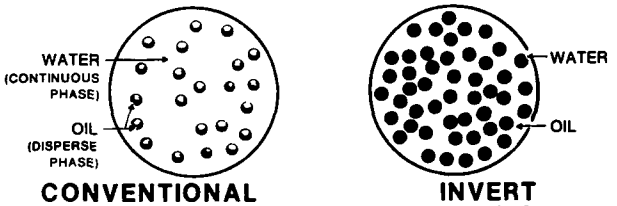
To reduce the chances for drift:

- Use the lowest practical pressures.
- Leave an untreated edge.
- Angle nozzles toward the ground, slightly forward in the direction of travel.
- Use nozzles with the largest practical openings.
- Use low-volatile formulations of the chemicals.
- Spray when wind speed is low.
- Do not spray during a temperature inversion (when air is coolest at ground level, gets warmer up to a certain height, and gets cooler from that point on up).
- Spray when sensitive vegetation is not actively growing.

DRIFT CONTROL AGENT

Special adjuvants and application systems have been developed to help overcome some drift problems. Three of these are:

- foams (tank mixed, conventional formulation with an additive),
- invert emulsions (three systems; mixed at nozzle, mixed at pump, or tank mixed), and



CONVENTIONAL EMULSION **INVERT EMULSION**

- spray additive stabilizers (thickeners in dry form mixed with conventional formulation in tank with agitation).

Though they differ in method, all three have similar advantages:

- better control of both particle drift and vaporization, and
- more highly visible spray, which allows you to see where you are placing it.

HERBICIDE APPLICATION EQUIPMENT

The equipment used is of two general types:

- airborne equipment, carried either by fixed wing aircraft or by helicopter, and
- ground equipment (including floating equipment on drainage ways, irrigation waterways, and bargeways).

Both airborne and ground equipment are available for applying:

- conventional sprays (water, oil in water, and oil in oil),
- invert emulsions, and
- granular formulations.

Rights-of-way have many obstacles which make the use of conventional spray booms difficult or impossible. The "manifold" sprayer (usually six nozzles with individual on-off valves, each set for different distances but with adjacent swath patterns) and the "handgun" sprayer nozzle are widely used. You also can get special equipment for applying herbicides to rights-of-way from aircraft.

Much special equipment has been developed for specific right-of-way jobs. It includes equipment for mounting on trucks, trailers, barges, rail vehicles, and all-terrain vehicles. The lack of a full range of well-adapted, readily available equipment for right-of-way spraying is a problem. Another difficulty in right-of-way application is the maintenance of a supply base. Because most rights-of-way are long and narrow, the operation continually moves away from its supply base. Return travel time is often excessive. Low application rates with minimum amounts of water or oil carrier make the job faster and more efficient since it reduces the supply runs. Mobile supply units are often needed. One unit, spray and supply combined, may be more efficient.

MANAGING AQUATIC PLANTS

Aquatic weeds are plants which interfere with the use or performance of water areas. They may:

- make the area less attractive,
- interfere with recreation,
- obstruct the flow of water in ditches or canals, and
- harbor insects or rodents.

The first step in control is to identify the general problem. Then you must identify the specific species to be controlled. Cooperative Extension Service personnel, written material, and herbicide manufacturers' representatives can help you.

The basic approaches to aquatic weed control are:

- design and construction of the water area,
- operation and maintenance,
- mechanical control, and
- chemical control.

The best control method is that which gives safe, effective weed control while causing the least harm to other parts of the environment.

CHEMICAL CONTROL

The use of herbicides to control weeds in water areas is often very effective. Use the herbicides as the label directs.

As you analyze any aquatic weed problem, consider the following:

BIOLOGICAL ASPECTS:

- Identify the problem species.
- Identify other species present.
- Determine the density and stage of growth of the weeds, and how much area they cover.
- Determine what species of fish are present.

WATER USE ASPECTS:

- Know the uses of the water in the treatment area.
- Find out how long the water can be quarantined from each use.
- Know how much water leaves the treatment area and what it will be used for.

PHYSICAL ASPECTS:

- Determine the size of the area to be treated.
- Determine the depth and movement of the water.
- Note the clarity of the water.
- Determine the water temperature.
- Determine the water quality.

RECORDKEEPING

Keep detailed records of control measures so that evaluations can be made of previous activity in order to improve future control and to be able to have accurate information in case of outside liability actions.

Such records may include:

- areas treated and date,
- material and rate applied,
- environmental conditions,
- equipment and crew,
- evaluation of effectiveness,
- problems encountered, and
- damage claims.

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