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FARMERS' BULLETIN NO. 2183

USING PHENOXY HERBICIDES EFFECTIVELY

U. S. DEPARTMENT OF AGRICULTURE

COMMON AND CHEMICAL NAMES OF PHENOXY HERBICIDES

Common name	*Chemical name*
2,4-D	2,4-dichlorophenoxyacetic acid
2,4,5-T	2,4,5-trichlorophenoxyacetic acid
Silvex	2-(2,4,5-trichlorophenoxy)propionic acid
MCPA	2-methyl-4-chlorophenoxyacetic acid
4-(2,4-DB)	4-(2,4-dichlorophenoxy)butyric acid

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This bulletin supersedes Farmers' Bulletin 2005, "Using 2,4-D Safely."

Washington, D.C. *Issued May 1962*

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington 25, D.C. - Price 15 cents

USING PHENOXY HERBICIDES EFFECTIVELY

2,4-D, 2,4,5-T, MCPA, Silvex, 4-(2,4-DB)

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Phenoxy herbicides—chiefly 2,4-D, 2,4,5-T, silvex, MCPA, and 4-(2,4-DB)—are used widely. They are used for controlling weeds in many crops, on grazing lands, and on lawns, and for killing unwanted brush and trees. These herbicides are especially useful because—

- They are selective; they kill most broadleaf plants but do not kill grasses or grain crops.
- They are potent; many species of weeds are controlled by less than 1 pound of active ingredient per acre.
- They are easy to use.
- They are not poisonous to man, domestic animals, fish, or game when applied at the recommended rates.
- They do not accumulate in the soil and they have no unfavorable effects on soil organisms.
- They are not corrosive to spraying equipment.

HOW PLANTS REACT

When sprayed with phenoxy herbicides, leaves, green stems, twigs, flowers, and fruits usually absorb the herbicides. Roots absorb herbicides sprayed on the soil. When they are applied to growing plants or to the soil, herbicides rapidly become distributed in the leaves, stems, and roots and cause susceptible plants to die.

These herbicides are absorbed most readily by plants that are growing rapidly. Annual weeds are easiest to kill when they are young. Perennial weeds are easy to kill while they are seedlings; after they are established, most perennials are easiest to kill at the time flower buds appear.

Some broadleaf weeds are killed by very small amounts of phenoxy herbicides. Some are almost unaffected by very large applications.

The chart on pages 12 to 24 lists the susceptibility of many common weeds and woody plants to control by 2,4-D, 2,4,5-T, MCPA, silvex, and 4-(2,4-DB).

SALTS AND ESTERS

Phenoxy herbicides are usually formulated as acids, salts, and esters. Salt and ester formulations usually are supplied as liquid concentrates. The purchaser mixes them before use. The salt concentrates form solutions when mixed with water. The ester concentrates form solutions when mixed with oil; they form milky-white

emulsions when mixed with water.

Heat causes ester formulations to release vapors. Some esters release vapors rapidly at about 80°. These are the high-volatile esters. Others, the low-volatile esters, do not release vapors rapidly until the temperature is about 90° or higher.

Vapors from ester formulations can kill susceptible plants growing near the area to which the formulations are applied. Low-volatile esters are safer—that is, less likely to harm susceptible crops by toxic vapors—than high-volatile esters. Salt formulations are safest—they do not release enough vapors to cause damage.

High-volatile esters are less expensive than low-volatile esters and they can be used effectively and safely if no susceptible crops are growing nearby.

Ester formulations of the phenoxy herbicides are generally more potent, pound for pound, than salts. They penetrate leaves and other plant surfaces more readily than salts. When a range of rates is recommended for herbicide application, use the lower rate for esters and the higher rate for salts.

Esters are more effective than salts for killing weeds that are growing slowly because of drought or cold weather. Esters usually are best for treating weeds in areas of low humidity; esters are formulated in oils and remain in moist contact on foliage longer and penetrate better than salts, which are mixed with water. And, because

BN–13721–X

Weeds in this field of small grain (treated part at right) were controlled with 2,4-D, which cost 25 cents for each acre treated.

they are oily, esters are less likely than salts to be washed off foliage if rain falls soon after their application.

"ACID EQUIVALENT"

Phenoxy herbicide concentrates are available in various strengths. The amount of active ingredient in the concentrate is indicated on the container label as the number of pounds of "acid equivalent" in each gallon of concentrate.

Usually the strongest concentrates are the most economical to use; they usually cost less per pound of acid equivalent than weaker concentrates. For example, 1 gallon of a 2,4-D concentrate containing 4 pounds of acid equivalent per gallon usually will cost less than 4 gallons of concentrate containing 1 pound of acid equivalent per gallon, and it contains the same amount of active ingredient.

APPLICATION

General Principles

If herbicides are applied carefully they can save you money and labor. If they are applied carelessly, they can kill your crops.

Some crops and ornamental plants are extremely sensitive to phenoxy herbicides; they are severely injured or killed by small traces of the herbicides, such as spray drift or vapors.

The most sensitive of the crops and ornamental plants include cotton, grapes, tomatoes, cucumbers, tobacco, mimosa, roses, and dogwood. For more information about sensitivity of your crops to phenoxy herbicides, ask your county agricultural agent.

When using phenoxy herbicides near sensitive plants, observe all precautions regarding vapors, spray drift, and cleanliness of equipment.

For safe and effective control of weeds—

- Get professional advice before applying herbicides; ask your county agricultural agent, your State extension weed specialist, or other local agricultural authorities for weed-control recommendations.
- Use herbicides wisely: Follow label precautions.
- Avoid spraying on windy days.

Types of Phenoxy Herbicides Commonly Available

SALTS

Amine (triethanolamine, diethanolamine, trimethylamine, diethylamine, isopropanolamine, etc.)
Sodium
Potassium
Ammonium

ESTERS

High-Volatile

Methyl
Ethyl
Isopropyl
Butyl
Amyl
And others

Low-Volatile

Butoxyethanol
Butoxyethoxypropanol
Ethoxyethoxypropanol
Isooctyl
Propylene glycol butyl ether
And others

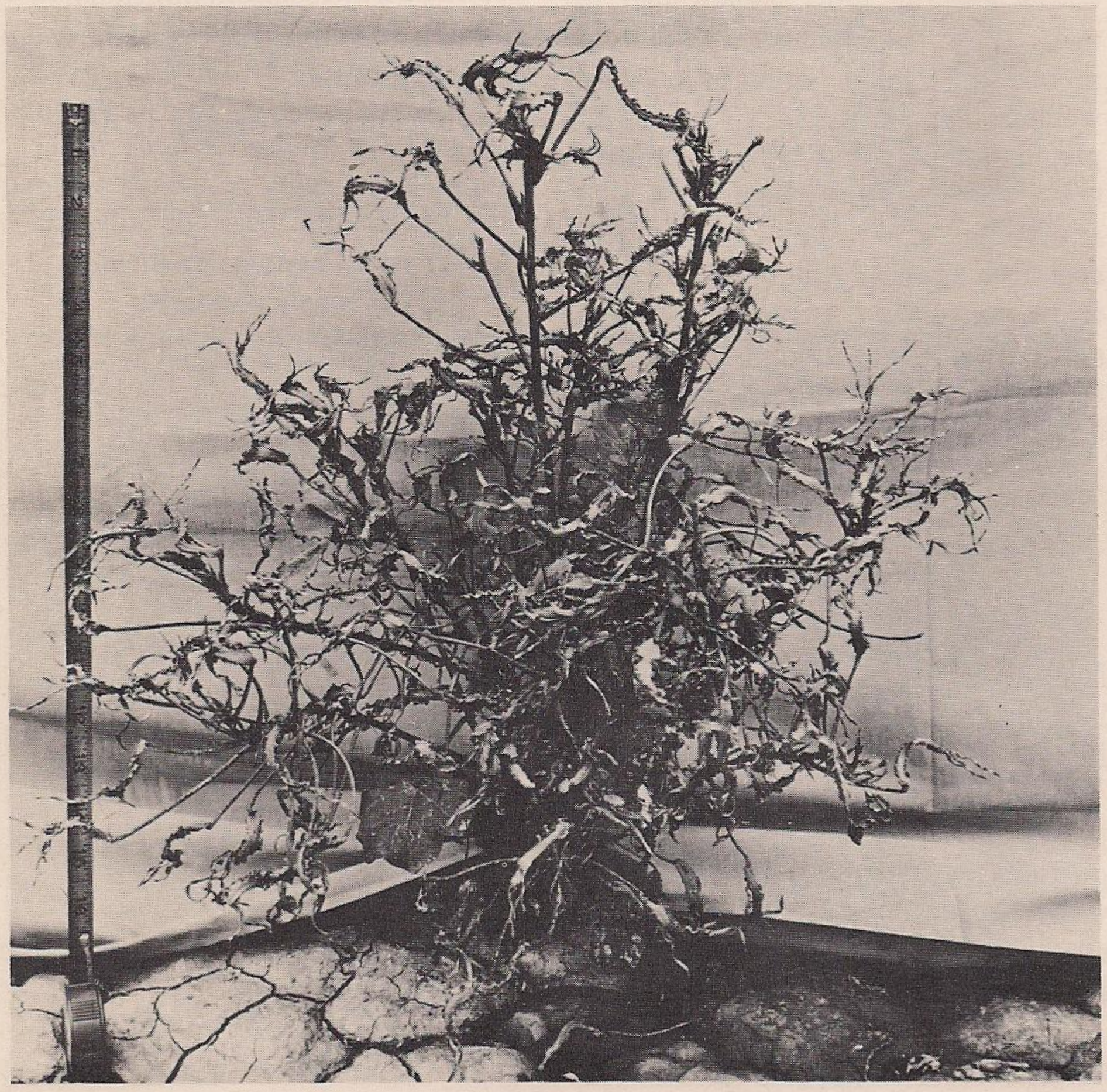
- Do not apply ester formulations when the temperature is above 90°.
- Check output of your sprayer frequently to prevent over application of herbicides.
- Avoid sprayer skips or overlapping swaths.
- Clean spray equipment immediately after use.
- Before using spray equipment for applying insecticides or fungicides to crops, test it for injurious traces of herbicides.

Methods

Cropland

You can apply herbicides on cropland as preemergence sprays (after the crop is planted but before it or the weeds come up) or as postemergence sprays (after the crop and weeds come up).

Most modern spray equipment is designed for low-volume application—from about 5 to about 20 gallons of spray per acre. With the



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Cotton is extremely susceptible to phenoxy herbicides. This plant was killed when it was accidentally sprayed with 2,4-D.

proper attachments, low-volume equipment can be used for broadcast spraying, band treatments, or directed spraying.

Apply a broadcast spray if the crop plants are not sensitive to the herbicide.

For broadcast application, the spray rig is equipped with a multiple-nozzle boom or a single boomless nozzle.

Apply a directed spray if the crop plants are somewhat sensitive to the herbicide.

For directed application, the rig is equipped with a boom and drop nozzles, which are adjusted to spray the weeds but no more than the bases of the crop plants.

Noncropland

Apply low-volume broadcast spray with boom sprayer to control weeds, brush, and trees on grazing land and along irrigation canals.

Airplanes often are used for applying low-volume broadcast sprays. Airplanes are especially useful for spraying nonrow crops, such as small grains and rice, and noncropland areas that are too large, too rough, or have too many obstructions for ground equipment.

Apply high-volume directed spray to kill brush and trees along roads, utility lines, and fencerows, and aquatic weeds and brush along irrigation and drainage canals.

Equipment for high-volume spraying usually has a large-capacity spray tank (over 100 gallons per acre of spray may be used) and operates at relatively high pressure (about 60 to 100 pounds per square inch). The rig usually is equipped with a spray hose and adjustable nozzle. The spray often is applied as a drench that thoroughly wets the leaves and stems of the plants that are to be killed.

Apply sprays of ester formulations in diesel oil or kerosene to the bark at the base of small trees or to cuts in the bark at the base of large trees.

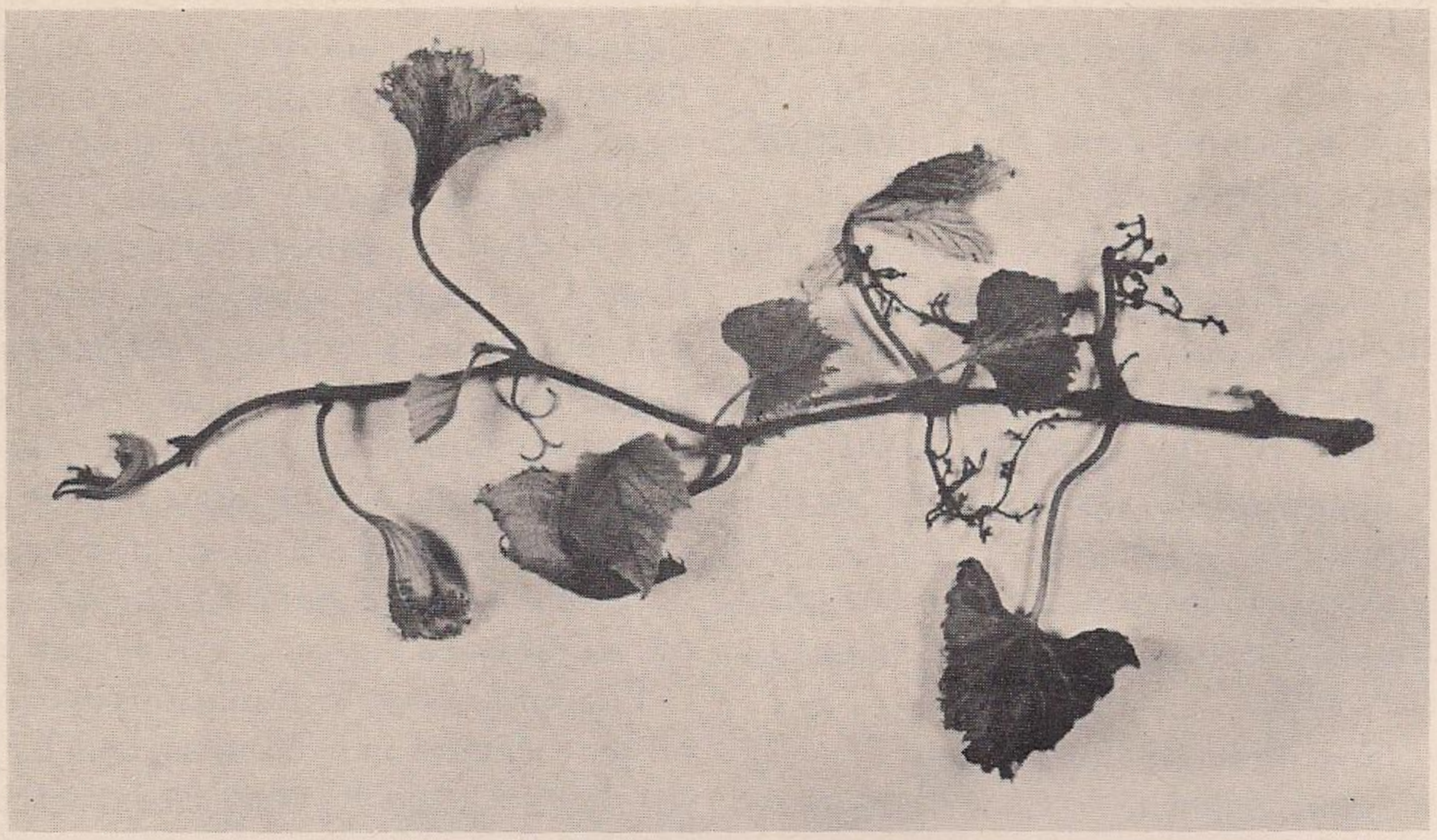
Phenoxy ester formulations with oil as a carrier can be absorbed by the bark at the base of trees with trunk diameters up to about 4 inches. The spray usually is applied with a small hand-operated sprayer and the lower 6 to 12 inches of bark on the trunk is thoroughly wetted with the solution.

Spray Drift

Wind-carried droplets of phenoxy herbicides may kill susceptible crops near the area that is being treated.

To reduce the danger of damaging crops with spray drift—

- Use nozzles that apply a coarse spray.
- Use low pressures—no more than 35 pounds per square inch for boom sprayers, 100 pounds for spray guns.
- Avoid spraying on windy days; do not spray with ground equipment when the wind velocity is more than 10 miles an hour, or from airplanes when the wind velocity is more than 6 miles an hour.
- Spray when wind is blowing away from susceptible crops and toward the area being sprayed.



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Spray drift from a nearby application of phenoxy herbicide severely injured this Concord grape vine.

The bark of many trees that are over 4 inches in diameter is too thick for the spray to penetrate. To kill these larger trees, it is necessary to ring the base of the tree with ax cuts and spray the ester solution into the cuts. The ax cuts must go through the bark and into the sapwood.

TESTING OUTPUT OF SPRAYER

Before mixing or applying herbicides on cropland, check the output of your spray equipment. If you apply too little herbicide, it is ineffective. If you apply too much, it may kill your crops.

In the test, the tractor speed and the pump pressure should be the same as they will be when you apply herbicide. If your tractor is not equipped with a speedometer, it is a good idea to make the test on the same type of terrain that you plan to spray and to mark the throttle setting that you use.

To test the output—

- Fill the spray tank with water.
- Spray a strip exactly 220 yards long.
- At the end of 220 yards, stop spraying and measure, in quarts, the amount of water needed to refill the spray tank.

To determine the spray output in gallons per acre, multiply the number of quarts by 16.5 and divide the answer by the width, in feet, of the spray strip.

Example: Your spray rig treats a strip 20 feet wide. At operating speed and pressure, the rig uses 6 quarts of water in 220 yards:

$6 \times 16.5 = 99$.

$99 \div 20 = 4.95$, or about 5 gallons of spray per acre.

The output of the sprayer is for the area treated. If your sprayer

BN-13681-X

The equipment used to apply insecticide to this tobacco plant had been used previously for applying phenoxy herbicide. The tobacco was injured by herbicide traces that remained in the sprayer.

is adjusted to apply spray in bands to row crops, calculate the total width of the spray pattern. To do this, multiply the number of nozzles by the width that each nozzle treats.

If you are using 6 drop nozzles and each treats a 20-inch width, then the total width of the spray pattern is 10 feet, regardless of the nozzle spacing.

Output of the spray equipment may change because of enlarged nozzle orifices or worn parts in the pump. Check the output periodically to prevent application at the wrong rate.

After you know the output of your sprayer, you can mix the spray accurately. To calculate the total amount of spray needed, multiply the area to be sprayed, in acres, by the output per acre. Add the recommended amount of acid equivalent—in the form of herbicide concentrate—to enough carrier (water or oil) to equal the total amount of spray needed.

For example: The calculated output is 5 gallons per acre and you plan to spray 10 acres at a recommended rate of 1 pound of acid equivalent per acre. Therefore

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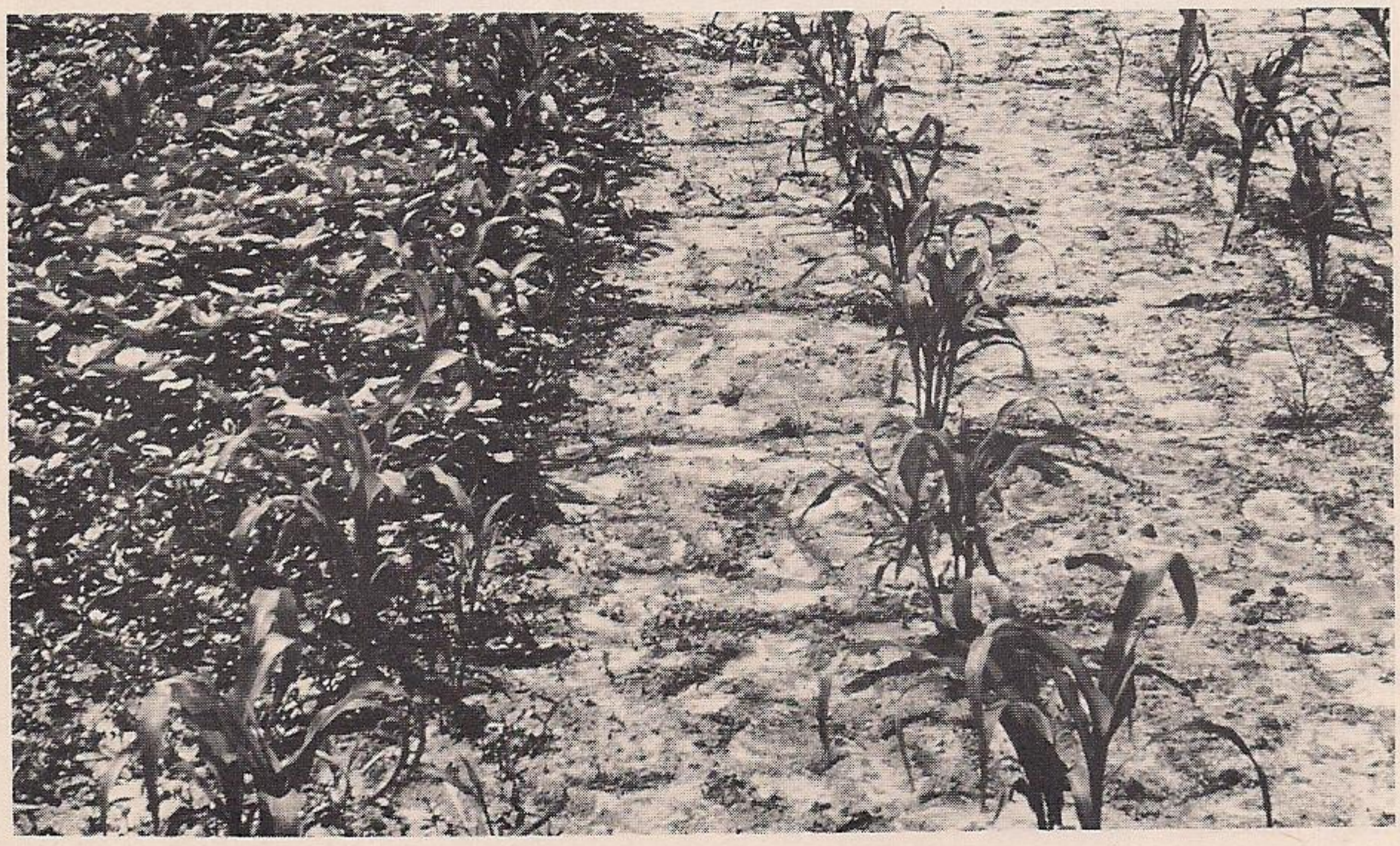
High-volume applications of phenoxy herbicides are effective for controlling brush along irrigation canals, utility rights-of-way, roads, and fence rows.



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The right half of this field was sprayed with 2,4-D before the corn or weeds emerged. The left half of the field was not treated.

you will need a total of 50 gallons of spray containing 10 pounds of acid equivalent.

The herbicide concentrate contains 4 pounds of acid equivalent per gallon. Add 2½ gallons of concentrate (10 pounds total acid equivalent) to 47½ gallons of water.

CLEANING SPRAY EQUIPMENT

Clean your spray equipment immediately after using it for applying herbicides.

Some crops can be damaged or killed by traces of phenoxy herbicides that are left in the sprayer after cleaning. Before applying fungicides or insecticides to crops with equipment that has been used for herbicides, test the equipment for herbicide traces.

Fill the tank with water and spray a few of the crop plants. Sensitive plants such as tomato, cotton and tobacco are good test plants. Wait a day or two after spraying. If the crop plants show no distorted growth after this period, the equipment can be used safely for spraying the crop. If the plants are distorted, then clean the spray equipment again. Retest the equipment for cleanliness before using it on crops.

For greatest safety with sensitive crops, apply fungicides or herbicides with equipment that has not been used for applying herbicides.

You can clean spray equipment quickly with a suspension of activated charcoal in water. Use at least one-third of a tank of water. For each 10 gallons of water add ¼ pound of activated charcoal and ⅛ to ¼ pound of laundry detergent. Agitate this mixture vigorously to distribute the charcoal through the water.

Wash the equipment for 2 minutes by swirling the liquid around in the tank so that it reaches all parts of the tank. Pump some of the liquid through the hose and nozzles. Then drain the tank and rinse the equipment with clean water.

SUSCEPTIBILITY CHART

The chart that follows lists the effects of phenoxy herbicides when applied as foliage sprays on a number of common weeds. Normal rate of application for 2,4-D, 2,4,5-T, MCPA, or silvex is 1 pound per acre; normal rate of application for 4-(2,4-DB) is 2 pounds per acre.

The control ratings for the herbicides are interpreted as follows:

Excellent.—One application at normal rate kills the weed.

Good.—Several applications at normal rate needed to kill the weed.

Fair.—Repeated applications at normal rate or application at higher rates needed to kill the weed.

Poor.—Weed kill is erratic, even at high rates of application.

Blackeyed susan (*Rudbeckia serotina*)	Perennial	Good		do	Excellent	
Bloodweed (*Ambrosia aptera*)	Annual	Excellent		Excellent		
Blueweed, Texas (*Helianthus ciliaris*)	Perennial	Fair				
Bouncingbet (*Saponaria officinalis*)	do	Poor	None	Poor	Poor	Do.
Boxelder (*Acer negundo*)	Woody	Good		Good	Good	
Bracken (*Pteridium aquilinum*)	Perennial	None	None	None	None	Do.
Broomweed, common (*Gutierrezia dracunculoides*).	Annual	Good		Good	Good	
Broom, Scotch (*Cytisus scoparius*)	Woody	do		do		
Buckeye, California (*Aesculus californica*)	do	Fair		Poor	None	
Buckwheat:						
Tartary (*Fagopyrum tataricum*)	Annual	Poor	Excellent	Fair		
Wild (*F. convolvulus*)	do	Fair	Fair	Good	Fair	Good.
Buffalobur (*Solanum rostratum*)	do	None	None	None		
Bulrush (*Scirpus* spp.)	Perennial	Fair	Fair	Fair	Fair	None.
Burdock, common (*Arctium minus*)	Biennial	Excellent	Excellent	Excellent	Excellent	Excellent.
Bur-head (*Echinodorus cordifolius*)	Annual	do	do	do	do	
Buckbrush (*Symphoricarpos orbiculatus*)	Woody	Good		Fair	None	
Western (*S. occidentalis*)	do	Fair	None	Poor		
Bullnettle (*Cnidoscolus stimulosus*)	Perennial	Good	Fair	Good		
Burroweed (*Haplopappus tenuisectus*)	do	do		Excellent		
Buttercup:						
Celery leaf (*Ranunculus sceleratus*)	Annual	Fair				
Corn (*R. arvensis*)	do	Good	Excellent	Excellent	Excellent	Excellent.
Creeping (*R. repens*)	Perennial	do	do	do	do	Good.
Tall (*R. acris*)	do	do	do	do	do	Excellent.
Campion, bladder (*Silene cucubalus*)	do	None	None	None	None	None.
Carpetweed (*Mollugo verticillata*)	Annual	Excellent		do	do	Excellent.
Carrot, wild (*Daucus carota*)	Biennial	Fair	Fair	Fair	Fair	Fair.
Catchfly, night flowering (*Silene noctiflora*)	Annual	None	None	None	None	None.
Catsear, spotted (*Hypochoeris radicata*)	Perennial	Good	Excellent	Excellent	Excellent	Excellent.
Catnip (*Nepeta cataria*)	do	do		do		
Cattail:						
Broadleaf (*Typha latifolia*)	do	Fair	Poor	Fair	Fair	Poor.
Narrowleaf (*T. angustifolia*)	do	do	do	do	do	Do.
Ceanothus (*Ceanothus* spp.)	Woody	do	Fair	Good		Fair.
Wedgeleaf (*C. cuneatus*)	do	Good	do	Excellent		
Chamise (*Adenostoma fasciculatum*)	do	Fair	Poor	Fair	Poor	Poor.
Chickweed:						
Common (*Stellaria media*)	Annual	do	do	Good	Excellent	Fair.
Field (*Cerastium arvense*)	Perennial	do	do	do	do	Poor.
Mouseear (*C. vulgatum*)	do	do	do	do	do	Do.

See footnotes at end of table.