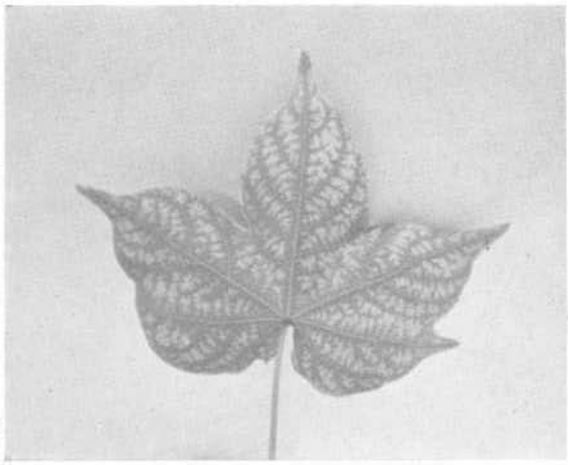
Chemical Control Of Annual Weeds In Cotton



At left, yellowed leaves of a dying morningglory plant in cotton treated with monuron; right, a cotton leaf showing the temporary yellowing (chlorosis) that sometimes develops when cotton is treated with urea herbicides.

Bulletin A-28

Cooperative Extension Service
And
Agricultural Experiment Station

The University of Arizona

NOMENCLATURE OF HERBICIDES

Trade names used in this publication are for identification only and do not endorse products named nor imply criticism of similar products not mentioned. All chemicals included in this report, especially when used on agricultural crops as defined under Public Law 518, should be applied to specific crops in accordance with the directions on the manufacturer's label as registered under the Federal Insecticide Fungicide and Rodenticide Act.

Designation	Chemical name	Trade name
dalapon	2,2-dichloropropionic acid	Dowpon
dicryl	3',4'-dichloro-2-methylacrylanilide	Dicryl
DCPA	dimethyl 2,3,5,6-tetrachloroterephthalate	Dacthal
diuron	3-(3,4-dichlorophenyl)-1,1-dimethylurea	Karmex
DMA	disodium monomethylarsonate	Several
monuron	3-(*p*-chlorophenyl)-1,1-dimethylurea	Telvar
—	petroleum oils	Several
prometryne	2,4-bis(isopropylamino)-6-methylmercapto-*s*-triazine	—
trifluralin	2,6-dinitro-*N*,*N*-di-*n*-propyl-a,a,a-trifluro-*p*-toluidine	Treflan

NOMENCLATURE OF WEEDS

Common name	Scientific name
barnyardgrass	*Echinochloa crusgalli* (L) Beauv.
Bermudagrass	*Cynodon dactylon* (L.) Pers.
browntop panicum	*Panicum fasciculatum* Swartz
Palmer amaranth (carelessweed)	*Amaranthus palmeri* S. Wats.
field bindweed	*Convolvulus arvensis* L.
hyssop spurge	*Euphorbia hyssopifolia* L.
Johnsongrass	*Sorghum halepense* (L.) Pers.
junglerice (watergrass)	*Echinochloa colonum* (L.) Link
morningglory	*Ipomoea* spp.
nutsedge (nutgrass)	*Cyperus rotundus* L.
puncturevine	*Tribulus terrestris* L.
red sprangletop	*Leptochloa filiformis* (Lam.) Beauv.
silverleaf nightshade (white horsenettle)	*Solanum elaeagnifolium* Cav.
Wright groundcherry	*Physalis wrightii* Gray

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Chemical Control Of Annual Weeds In Cotton

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Weeds occur in every cotton field. Although weed problems vary with past land use, annual weeds are the dominant weeds in Arizona cotton fields.

Winter annual weeds emerging after the preplanting irrigation are seldom serious. They usually are destroyed during seedbed preparation.

When cotton is planted in moist soil under a dry mulch, summer annual weeds usually do not germinate before the first postemergence irrigation. When cotton is planted in dry soil and irrigated-up, annual weeds emerge before or with the cotton.

The major annual weed problem in Arizona starts after the first irrigation. Broadleaved weeds, such as carelessweed, hyssop spurge, morningglory, puncturevine, and Wright groundcherry emerge throughout the growing season. Maximum emergence of annual grasses, such as barnyardgrass, browntop panicum, red sprangetop, and watergrass, begins after the second irrigation.

Emergence and growth of summer annuals may continue as long as moisture, temperature, and light are favorable. If cotton fails to cover the row middles, is defoliated by insects or disease after layby, or is irrigated or receives excessive rainfall in late fall, a severe weed problem may occur at harvest.

Although perennial weeds are serious problems in some fields, they are less widespread than annual weeds. The growth of established perennial weeds starts with cotton seedling emergence and continues until harvest. Bermudagrass, Johnsongrass, field bindweed, white horsenettle, and nutgrass are the most troublesome perennial weeds in Arizona cotton. The growth and control of seedlings of perennial weeds are similar to those of annual weeds.

Losses caused by annual weeds in cotton vary with the number and type of weeds, and the effectiveness of the control program. Weeds developing early in the season can reduce production by competition for light, nutrients, and water. Weeds growing after layby may hinder harvest and reduce lint quality.

Successful machine-harvest depends on control of weeds throughout the season. In assigning costs in cotton production, much of the hoeing and mechanical cultivation must be assessed to weed control.

Cultural Practices

Proper cultural practices are essential to produce a crop which can compete with weeds and maintain control achieved with cultivation and herbicides. Start cultural practices with adequate preplanting irrigation, proper seedbed preparation, and planting methods which favor rapid cotton seedling growth and minimize weed seed germination. Planting in moist soil under a dry mulch is an excellent planting method where practical.

Vigorous and uniform stands of cotton shading the soil surface usually suppress weeds after midsummer. Ideal cotton stands have one to four plants per foot of row. These spacings generally are most productive and reduce weed problems.

During the early part of the growing season, cultivate fields when necessary to control weeds. Flame cultivation, properly used, is an effective method of controlling annual weeds in the drill row until layby.

A good crop rotation should be maintained on fields intended for cotton production. Crops included in the rotation should have competitive growth habits, or a cultivation schedule that interferes with the normal development of most weeds. When cotton is grown for several years on the same field, mechanical cultivation may not control certain weeds and they become increasingly troublesome.

Other important weed control measures include: (1) the use of high-quality planting seed containing no weed seeds, (2) a program to prevent any weed seed being introduced or spread in cotton fields, and (3) sound fertilization, irrigation, and insect-control programs which encourage the growth of cotton plants and increase their ability to compete with weeds.

Urea Herbicides

Two urea herbicides, monuron and diuron, are extensively used to control annual weeds in cotton. In 1962, more than 100,000 acres of cotton in Arizona were treated with these herbicides.

Monuron was the first herbicide used for layby applications in cotton. During recent years, use of diuron has increased for layby and early-season applications.

LAYBY APPLICATIONS

The last cultivation in cotton is often called "layby". Where only mechanical cultivation is used to control weeds, layby usually is before the fourth or fifth irrigation. Layby ap-

plications of urea herbicides usually are made after the last cultivation.

Until cotton layby, weeds are usually controlled by cultivation. The use of urea herbicides usually permits an earlier layby than is possible where mechanical cultivation alone is used to control weeds.

Layby applications usually are made before the third, fourth, or fifth irrigation, but sometimes earlier. The later applications are safest because cotton is larger and has more tolerance of urea herbicides. Cotton should be 15 inches high before diuron is applied; 20 inches high before monuron is applied.

When applications are made prior to the first or second irrigation, weed control may not be satisfactory. At this time, when cotton provides little shade, the soil surface drys rapidly and frequently cracks. This allows weed seeds to germinate below the treated area. After emerging through the cracks, weeds may not be controlled by the herbicide.

Weed Control

Diuron or monuron applied to the soil at layby often controls annual weeds and the seedlings of perennial weeds until harvest. If cotton stands are thin when the field is treated, or if cotton is later defoliated by insects or diseases, weeds may become established within two months after treatment. A vigorous cotton crop shading the row middles maintains the weed control achieved by layby applications of herbicides.

Rainfall also influences the effectiveness of urea herbicides. Weed control has been better when herbicide applications were followed by rainfall.

Rate of Application

The recommended rate of application varies from .80 to 1.60 pounds per acre. Urea herbicides are absorbed near the surface of fine-textured or clay soils. In sandy soils, these herbicides may leach from the surface into the root zone of cotton. Thus, the proper rate of application varies with soil type.

Suggested Rates
For Layby Application

Soil Types	Pounds per acre	
	Diuron	**Monuron**
Sands	None	None
Sandy loams	.80-1.00	.80-1.00
Loams and silt loams	1.00-1.60	1.00-1.20
Clay loams and clays	1.60	1.20

Since the effectiveness of layby applications is influenced by soil type and cultural practices, determine the best rates for specific fields by observing the results of previous treatments.

If the soil type varies in a given field, it may be impossible to determine the one best rate of diuron or monuron. The entire field may be treated at the rate best for the major portion of the field or only part of the field may be treated.

For best results, treat various soil types at different rates of application. The tractor speed can be varied to adjust the rate of application for different soil types.

The final decision on amount of herbicide to apply on a particular field must be made by the user, but it should be within the recommended rates.

Diuron or Monuron

The choice between the two herbicides will depend on several factors:

1. Weeds. Monuron has been more effective in controlling morningglories and carelessweed. Diuron has been more effective on groundcherry and the annual grasses.

2. Soil type. On sandy soils, diuron is the safer herbicide. On clay soils, monuron is more effective.

3. *Size of crop.* In small cotton, diuron is the safer herbicide.

4. Rainfall. As rainfall decreases, monuron has been the more dependable herbicide.

After layby, weeds often grow in cotton not treated with herbicides.

No annual weeds are present at harvest in this row treated at layby with monuron.

In tests to date, combinations of monuron and diuron have not given better weed control than the same rate of either herbicide applied alone. However, reducing the amount of monuron in combinations of the two herbicides has reduced the yellowing of cotton foliage caused by layby applications.

Effect on Cotton

Following application of urea herbicides, cotton foliage sometimes becomes chlorotic (yellow) within a few days after the next irrigation or rainfall. This type of chlorosis is shown in the photograph on the front cover.

Chlorosis, if it occurs, usually is temporary and cotton foliage regains normal color within a few weeks. Monuron induces more severe chlorosis than diuron. Chlorosis increases as the sand content of the soil increases and the clay content decreases. Heavy rainfall following treatment increases this chlorosis.

If high rates of diuron or monuron are applied, cotton foliage may turn brown and cotton plants may be stunted.

Cotton varieties respond differently to applications of urea herbicides. Deltapine Smooth Leaf and Acala 44 develop more intense chlorosis than Acala 4-42. Young Pima S-2 plants are somewhat susceptible to urea herbicides and develop intense chlorosis after treatment.

Diuron and monuron applied as recommended do not reduce cotton yields. Applications of these herbicides have had no effect on fiber properties, boll characteristics, and spinning quality of cotton.

Cultivation and Irrigation

Proper cultivation prior to treatment is necessary for the success of layby applications. This cultivation must destroy all clods which would cause uneven distribution of the spray. It must also shape the beds to allow uniform application of the herbicide and complete moistening of the bed by the following irrigations.

Whenever possible, destroy all annual weeds by cultivation prior to the application of urea herbicides. Although monuron frequently kills weeds which have reached an advanced stage of growth, it is desirable to have fields free of established weeds when the herbicide is applied. The photograph on the cover shows morningglory, several feet long, controlled by monuron without affecting cotton.

After diuron or monuron is applied to the soil, it is necessary to irrigate to activate the herbicide. Irrigation moves the herbicide into the soil where weed seeds germinate. Best weed control results when the beds are completely wet by irrigation water. Irrigating only alternate rows usually results in poor weed control.

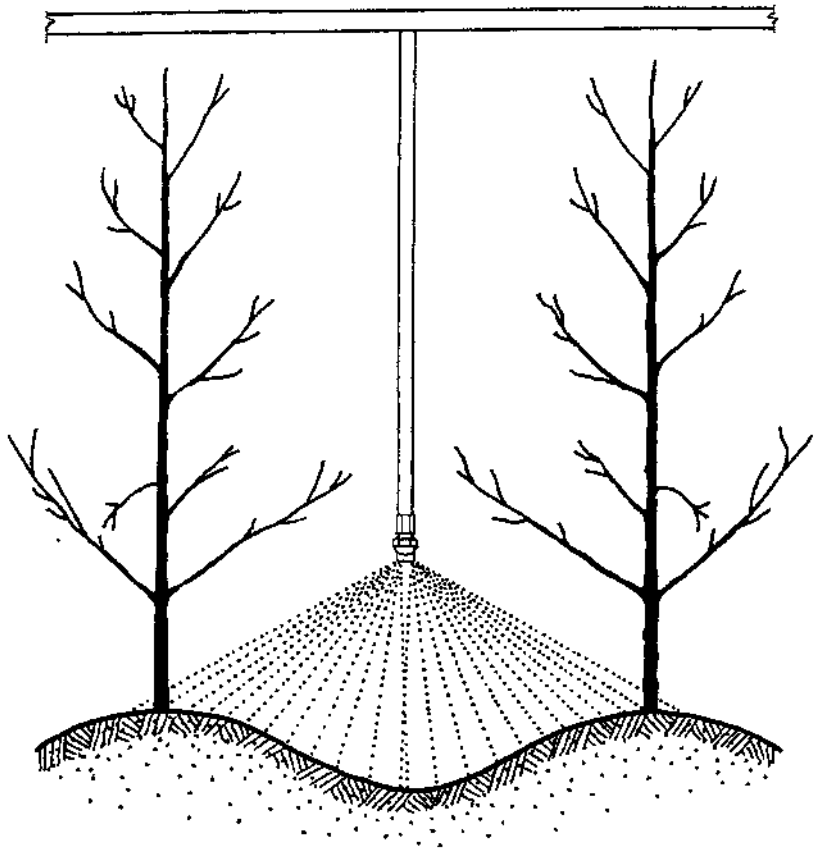
In fields having considerable slope, layby applications may be followed with a shallow cultivation prior to irrigation. This cultivation mixes the herbicide into the surface layer of soil minimizing its movement down the furrow by the irrigation.

After treated fields are irrigated, or if enough rain occurs, avoid any deep cultivation or cultivation which forms large clods. Shallow cultivation after the irrigation following treatment does not decrease the effectiveness of layby applications.

Application

Spray the herbicide directly on the soil using 25 to 50 gallons of water per acre. Varying the amount of water between 20 and 80 gallons per acre has not altered the effectiveness of diuron or monuron, provided uniform coverage was obtained.

Layby applications require spray equipment similar to that used for bottom defoliation of cotton. Nozzles are attached to a single drop located between adjacent rows and directed to obtain complete coverage of the soil between the rows.



Layby applications are made with drop nozzles directing the spray to cover the soil between cotton rows, but contacting as little cotton foliage as possible.

Double-outlet tips or flooding nozzle tips producing a 150° to 160° flat spray or double-swivel nozzles with 80° flat spray tips can be used. It is advisable to have a check-valve strainer in each nozzle to prevent the spray solution from "dribbling" while turning at the row ends.

Direct the spray to contact as little cotton foliage as possible. Cotton plants are not injured when the lower foliage is covered by diuron or monuron, although these leaves may become chlorotic within a few days.

Any herbicide sticking to cotton leaves is wasted unless washed to the soil by rain. Therefore, the nozzles should be set as close to the soil surface as possible and still give complete soil coverage.

Diuron and monuron are slightly soluble in water. Because of their low solubility, *vigorous agitation must be maintained* in the sprayer tank to keep the herbicide in suspension. If agitation is not provided, the herbicide will gradually settle to the tank bottom and applications will not be uniform. Mechanical agitation is most effective and is preferred to hydraulic agitation.

Wettable powders tend to clog the line and nozzle screens. Screens should never be finer than 50 mesh. In

some cases, it may be necessary to remove line strainers and nozzle screens to avoid clogging. A pressure guage placed in the line at the shutoff valve allows the operator to detect increases in pressure caused by clogged nozzles.

Unless a cotton grower has high-clearance spraying equipment with mechanical agitation, it may be desirable to have a competent custom applicator make layby treatments.

Diuron and Wetting Agent

When small weeds are present, addition of a wetting agent (surfactant) to the spray solution may increase the effectiveness of diuron as a layby application in cotton. Wetting agents, such as "Surfactant WK" and "X-77", added to the spray solution at the rate of .5 percent increase diuron's effectiveness as a contact herbicide applied to the foliage of weeds.

Although layby applications of urea herbicides may kill seedling or established weeds it is preferable to remove all weeds by cultivation prior to treatment.

Skip-Row Cotton

Use mechanical cultivation to control annual weeds on the fallow rows of "skip-row" cotton. Mechanical cultivation of fallow rows may be impossible after layby and late-season weed growth may interfere with mechanical pickers. Application of monuron or diuron to the fallow rows will reduce this weed problem.

Treat fallow rows with the same rate of herbicide used in the planted rows. If urea herbicides are applied to fallow rows, *every row must be irrigated in all subsequent irrigations.* If the fallow rows are not irrigated, the herbicide residue may affect the next crop.

EARLIER APPLICATION

Urea herbicides are also used to control annual weeds in cotton early in the growing season. Diuron is used in preplanted and early post-emergence applications. Both diuron and monuron are used as preemergence applications on certain soil types.

Preplant

Preplant applications of diuron control most annual weeds for much of the growing season. Preplant applications are possible at several stages of seedbed preparation.

The drawing on page 10 outlines the soil surface at several stages during cotton seedbed preparation.

Preplant applications after furrowing are safer for cotton than applications before furrowing. If diuron is applied before furrowing, cotton must be planted below the herbicide or stands may be severely reduced. Rates of diuron used in preplant applications are the same as layby treatments for a specific soil type.

Preplant applications of diuron should be used only where cotton is preirrigated and planted in moist soil. Treated cotton should not be irrigated-up. Preplant treatments should be used only on soils having a moderate to high clay content.

Treated fields must be furrowed before the first and sometimes later irrigations to shape and maintain beds and furrows. Mechanical cultivation should be used as needed to control perennial weeds and annual weeds escaping or surviving the preplant application of diuron.

Preemergence

When cotton is planted in dry soil and irrigated-up, the early-season weed problem can be severe. Band applications of urea herbicides over the drill row after planting but prior to the germination irrigation can reduce this weed problem.

Rates required to control weeds with preemergence applications are similar to rates used in layby applications for a given soil.

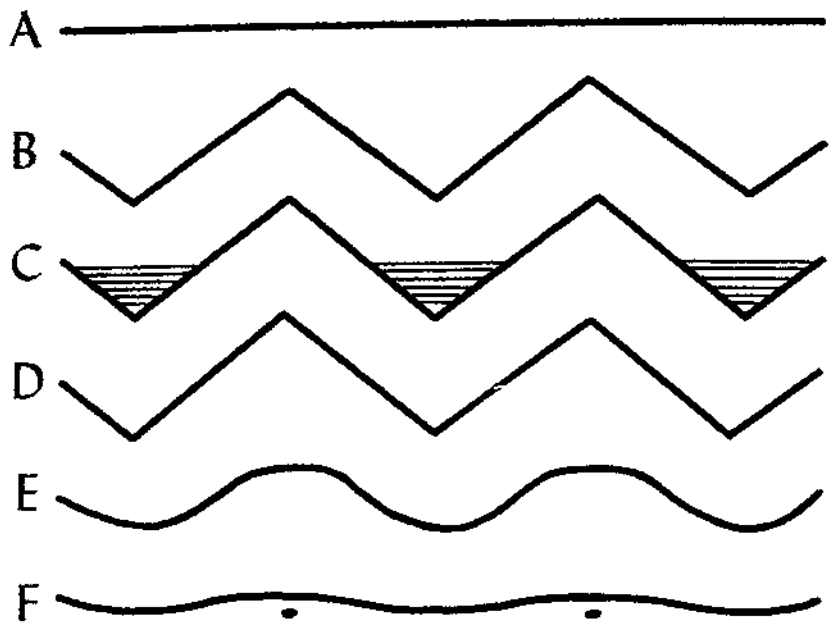


Diagram of soil surface during seedbed preparation for cotton.

A — The land is flat three to six weeks before planting. "Prefurrowing" preplant applications can be made at this time.

B — The land is furrowed; "preirrigation" preplant applications are made at this stage.

C — The preplanting irrigation is made.

D — After the soil dries a "preharrowing" preplant treatment is possible.

E — The tops of the beds are harrowed.

F — Cotton is planted slightly below the original surface of the soil.

SPLIT APPLICATION

It is possible to achieve season-long control of annual weeds combining mechanical cultivation with more than one application of urea herbicides. Early-season control can be achieved with a preplant or preemergence herbicide application.

Mechanical cultivation shapes beds and helps control annual weeds until layby. The layby treatment and crop competition control annual weeds until harvest.

If split applications of urea herbicides are used, the total application in one season should not exceed the amount registered for use in cotton.

HERBICIDE RESIDUES IN THE SOIL

Diuron and monuron applied to control annual weeds in cotton may persist in the soil for several months, so the effects of their residue on subsequent crops must be considered. Small areas at row ends are commonly affected where the sprayer stops, turns and starts. Occasionally the crop on an entire field is affected by herbicide residues.

Injury from herbicide residue is most severe on the sandy soils and "hot spots" in a field. Severe injury to alfalfa, barley, safflower, vegetables, and wheat has sometimes oc-

curred when these crops were planted after cotton treated with diuron or monuron. A residue of only a few ounces per acre of urea herbicides may affect these crops.

The problem of residues of herbicides used in cotton affecting the following crop can be minimized by the following precautions:

1. Use the lowest rate of herbicide required to control weeds.
2. Follow normal grower practices in treated cotton. Do not skip any irrigations. Irrigate every row after treatment.
3. Use a moldboard plow when preparing the seedbed for the next crop.
4. Preirrigate before planting the next crop.
5. Plant the next crop on the flat rather than on beds.
6. If possible, avoid placing the drill row directly over the drill row of the previous cotton crop.
7. Plant a resistant crop. Cotton and sorghum are more tolerant of diuron and monuron residues than are other major crops. Residues of these herbicides, however, will increase the susceptibility of cotton seedlings to the seedling disease organisms.

When heavy rainfall occurs after application of herbicides the problem of residues in the soil is reduced. Residues of herbicides in the soil will not be reduced during a fallow period without rainfall or irrigation.

When susceptible crops are planted in soil containing a residue of monuron or diuron, they usually appear normal at emergence. After several days or after the first irrigation, seedlings become yellow and the tip of their leaves may turn brown.

These symptoms are not always indications of permanent injury or reduced yield. Affected plants may recover and produce normal yields. Sometimes no foliage symptoms appear yet yields are reduced.

Residues from diuron and monuron sometimes persist after the treated crop is harvested. There has been no accumulation of these herbicides after several annual applications when normal growing practices are followed.

Each grower must determine if herbicide residues persist with his soils and cultural practices. Under certain conditions no herbicides will remain in the soil and many of the precautions are unnecessary. If injurious amounts of herbicide remain in the soil susceptible crops should never be planted following treated cotton.

Other Herbicides

Herbicide evaluation for weed control in cotton is a continuous program. The development and use of new herbicides will be reflected in "Chemical Weed Control Recommendations for Irrigated Areas of Arizona," published as Bulletin A-1, available from your local County Extension Agent.

DCPA has controlled annual weeds for extended periods when applied to the soil before weeds germinate. It is most effective in controlling grasses and less effective on morningglories and groundcherry. Cotton has tolerated DCPA applied preplant, preemergence, or at layby at rates which controlled most annual weeds.

Trifluralin has controlled annual weeds for extended periods when applied to the soil before weeds germinate. It is most effective on grassy weeds. Soil incorporation increases the effectiveness of trifluralin. Preplant applications of one pound per acre have caused slight stunting of cotton seedlings, but higher rates are tolerated as layby applications.

Prometryne has controlled annual weeds for several weeks when applied to the soil before weeds germi-

nate. It is most effective on broadleaved weeds and less effective on grasses.

Dalapon has controlled annual grasses when applied as a directed spray to weed foliage at layby. However, such applications have delayed cotton maturity, and sometimes reduced yields.

DMA with wetting agent, dicryl, and selective petroleum oils have controlled small annual weeds early in the season when applied as a directed spray to their foliage. However, repeated applications are needed if weeds emerge after the initial application.

Calibration of the Sprayer

Unless the operator is thoroughly familiar with the sprayer it should be calibrated in each field. The following steps can be followed in calibrating a sprayer:

1. Fill the sprayer tank to a predetermined level with water. This may be a full tank or a height on a measuring stick.

2. Select the speed to be used. Sprayer speed must be constant to allow uniform spray application.

3. Spray an area in the field at the selected throttle setting, using the pressure recommended for the most efficient use of nozzles.

4. Determine the number of square feet in the sprayed area.

5. Determine the number of gallons applied by measuring the amount of water required to refill the tank to the predetermined mark.

6. Compute the gallons applied per acre: divide 43,560 by the area sprayed (in square feet) and then multiply the number of gallons used.

$$\text{Gallons per acre} = \frac{43{,}560}{\text{Area Sprayed}} \times \text{Gallons.}$$

If the gallonage applied per acre is too high or low, it can be corected by:

a. Altering the speed of the sprayer.

b. Altering the pressure at which the spray is applied.

c. Changing to different size spray tips.

7. Sprayer calibration should be checked frequently in the field because wettable powders cause rapid wear on spray nozzle tips and most pumps.

Field Records

Where many fields will be treated with herbicides each year, it is desirable to keep permanent records of the application and the control achieved in each field. These records are invaluable in determining what type and rate of herbicide should be used in future years. Each field record should include:

- Field identification.
- Soil type.
- Weeds present.
  - Stage of weeds.
- Herbicide used.
  - Rate.
  - Date.
  - Method.
    - Nozzle size and arrangement.
    - Pressure.
    - Tractor speed.
    - Gallons of spray per acre.
- Posttreatment cultivation.
- Rainfall.
- Crops treated.
  - Stage.
- Weed control and crop condition four weeks after treatment.
- Weed control at harvest.