No cultivation - no chemical.

No cultivation - 2 pounds per acre of simazine, pre-emergence.

Recommendations for

WEED CONTROL

in Field Crops 1961
Federal laws and regulations pertaining to use of herbicides are in an unsettled state. The authors have endeavored to make recommendations in this bulletin conform to restrictions under the laws and regulations. Research has shown these recommendations to be sound from the performance standpoint, but it is probable that future developments will require some modifications. Labels on herbicide containers give information on application restrictions.

Herbicide rates recommended here are on the basis of acid equivalent (for chemicals derived from acids) or active ingredient (for chemicals not derived from acids). The rates are for the areas on which the herbicides are actually applied. When an herbicide is applied as a band over the row, the crop area is much greater than the area actually treated. Band applications commonly cover about one-third of the total area of the crop.

CORN

2,4-D Post-emergence Treatment: From ½ to 2 pounds per acre, acid equivalent, of 2,4-D ester is recommended. One and one half pounds per acre is the proper rate for the average weed problem. Two pounds per acre are required on heavy soils or where heavy giant foxtail infestations are expected. Regulations limit the rate of sweet corn to ½ pound per acre. There is no clearance for use on popcorn. The 2,4-D post-emergence treatment should not be used on sandy soils.

In addition to controlling broadleaved weeds, 2,4-D will control annual weed grasses for a period of three to five weeks after application. By the time the weeds start to grow, the corn will usually be 12 to 15 inches tall; and the early, slow, tedious cultivation will be eliminated. An over-all application will normally delay the need for cultivation for a longer period of time than a band application.

DNBP (“Premerge”) Early Post-emergence: Only alkanol amine salts of DNBP should be used. Three pounds per acre should be applied just after the weeds come up. The corn should not be larger than the 4-leaf stage. Best results are obtained if the temperature is between 60° and 85° F. This herbicide is recommended where situations are unfavorable for the use of 2,4-D (near cotton, where weed grasses are a problem on sandy soil, and for 2,4-D susceptible inbred lines of corn). Burning of tips of corn leaves is normal, but this generally does not measurably affect corn yields. Duration of weed control is about the same as for the 2,4-D pre-emergence treatment. Where it can be used, 2,4-D is more practical.

CDAA (“Randox”) Pre-emergence: Use 4 pounds per acre. This treatment usually gives good control of annual weed grasses and fair control of annual broadleaved weeds. Its duration of weed control is similar to that of 2,4-D pre-emergence, but the cost requires that it be applied as bands over the rows. Thus, weed growth in the middles determines the amount of cultivation required. Where it can be used, 2,4-D is more practical.

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A new product sold as "Randox T" has recently been put on the market. It is a mixture of CDAA and TCBC (trichlorobenzyl chloride). This product is still in the experimental stage, but research so far indicates that the addition of TCBC improves the control of broad-leaved weeds considerably over that of CDAA alone. It is used as a pre-emergence treatment. For those who would like to try this material, a per-acre rate of about 3 pounds of CDAA carrying about 7 3/4 pounds of TCBC is suggested. Mixtures containing TCBC are injurious to soybeans.

Simazine Pre-emergence: The recommended rate is 2 pounds per acre. The spray mixture forms a suspension of fine, solid particles in water. Care should be taken to insure that there is sufficient agitation of the material in the spray tank to prevent the simazine from settling out. Over-all application usually gives control of annual weeds for the entire season. Band application usually requires as many cultivations to control the weeds in the middles as are required to control weeds following the over-all pre-emergence treatment with 2,4-D. Treatment with simazine is not fully effective if the soil surface remains quite dry for two to three weeks after application. Simazine residue in the soil may injure wheat or oats seeded in the fall or spring following a simazine-treated corn crop. It appears safe to follow a simazine-treated corn crop with corn, soybeans, sorghum, or cotton. Information is not available on the effects of simazine soil residues on the different forage grasses and legumes seeded the spring following a simazine-treated corn crop.

Atrazine Pre-emergence or Post-emergence: Atrazine can be used at the same rate with, for all practical purposes, the same performance and the same residue precautions as simazine. This material may require somewhat less moisture than simazine to make it effective. Atrazine spray will kill weeds up to 1 1/2 inches high and still give all-season weed control. Label restrictions limit post-emergence applications to not later than three weeks following planting. The wider range in time of application (from planting until the weeds are about 1 1/2 inches tall) is the major advantage of atrazine over simazine.

SORGHUMS

2,4-D Post-emergence: Pre-emergence spraying with 2,4-D is not recommended because of likelihood of injury to the crop. Post-emergence spraying with 2,4-D (same rate as for field corn) gives about the same performance on sorghums as on corn. Likelihood of injury is a little greater on sorghum than on corn. Sorghum is most resistant to 2,4-D injury when it is between 8 and 18 inches tall. Under conditions of an early broad-leaved weed infestation, it is better to spray early, however, than wait until the sorghum is 8 inches tall. The weed com-
petition may be expected to injure the sorghum more than the 2,4-D.

Propazine Pre-emergence: The use of propazine for weed control in sorghum is still in the experimental stage. This herbicide is chemically related to simazine and the properties are similar. Experimental results so far indicate that 2 pounds per acre result in good control of annual weeds without injury to the sorghum. This treatment is not cleared for use at this writing but it is possible that it will be cleared by sorghum planting time in 1961.

SMALL GRAINS

Wheat, Rye, Barley, Oats: Use from 1/2 to 3/4 pound per acre of 2,4-D acid equivalent. The amine form is safer than the ester form from the standpoint of crop injury. The time of application is preferably from the tillering to the joint stage, but spraying can be done until the boot stage if necessary. This treatment usually kills interseeded legumes. Label clearance is given for as much as 1 pound per acre, but only until 50 days before harvest (for rye only up to the joint stage). Fall-seeded small grains should be sprayed only in the spring.

A joint statement of the Secretaries of Agriculture and of Health, Education, and Welfare has indicated that spraying of wheat later than 50 days before harvest is not contrary to regulations.

Rice: Label clearance has been given for post-emergence applications of 2,4-D up to 1 1/2 pounds per acre, at least 80 days pre-harvest. Research information is not available on the performance of 2,4-D for weed control in rice under Missouri conditions, but farmers have used it with satisfactory results.

The use of CIPC at 6 to 8 pounds per acre for barnyard grass control is cleared and is recommended by some states. The rice is drilled 1 to 2 inches deep. The chemical should be applied when the grass begins to emerge, before it is beyond the 1-leaf stage. At this time the development of the rice may range from well sprouted to well emerged. If the soil becomes dry (to the point of crust) within two to four days after treatment, the rice should be irrigated. The rice should be flooded 10 to 14 days after treatment. The performance of this treatment under Missouri conditions is not known.

SOYBEANS

CDAA ("Randox") Pre-emergence: This herbicide has not injured soybeans during six years of testing in Missouri. It generally controls annual grasses but often is poor for controlling broad-leaved weeds. It is rather expensive. The cost of spraying can be reduced by band applications over the row. It may be profitable where grass weeds are a serious problem. A minimum rate of 4
pounds per acre is needed. CDAA is extremely irritating to the skin. When spraying, start on the down-wind side of the field so that, as successive swaths are sprayed, you will not drive through the extremely fine particles in the air. If the wind direction is parallel to the rows, spray only while traveling into the wind.

**CIPC Pre-emergence:** Injury to soybeans occurs frequently with CIPC and the risk is considered too great to make its use practical. Weed control has generally been good with rates of 6 to 8 pounds per acre.

**NPA ("Alonap 3") Pre-emergence:** NPA has controlled weeds well when moisture was adequate, but severe stunting of soybeans has frequently occurred. Stunting has been especially severe when treatment has been followed by heavy rainfall. A minimum rate of 4 pounds per acre is needed. The risk of injury is considered too great to make the use of this material practical.

**Sodium PCP Pre-emergence:** Sodium PCP has given good weed control most of the time. Be sure to use the sodium salt of pentachlorophenol and not pentachlorophenol itself. Sodium PCP has injured soybeans only when they were planted shallowly. Use 20 pounds of actual sodium pentachlorophenol (excluding sodium salts of other chlorophenols that may be present) per acre. This material is not as soluble in water as most herbicides so it is necessary to use 15 to 20 gallons of water per acre to have enough water to dissolve it. Considerable stirring is required to get sodium PCP into solution. Breathing the dust or fine spray particles causes severe sneezing. The material is somewhat irritating to the skin. When spraying, follow the same precautions as for CDAA.

At this writing sodium PCP is not approved for use in soybeans, other than those planted for seed. An attempt is being made to have the treatment approved for general use on soybeans before planting time for the 1961 soybean crop. Unless clearance is obtained, the treatment should not be used on soybeans for food or animal feed.

**Amiben Pre-emergence:** Amiben is still in the experimental stage. It has been somewhat superior to sodium PCP and considerably better than CDAA in controlling weeds during the two years it has been in experiments at the Missouri Agricultural Experiment Station. About 3 pounds per acre are required for good weed control. Some injury to soybeans has been encountered at this station and in other states. Amiben can be used for soybeans raised for seed only. Approval has not been obtained for use on soybeans for other uses.

**COTTON**

**Diuron ("Karmex") Pre-emergence:** This treatment has label clearance up to 1.5 pounds per acre. Diuron is recommended at the rate of 1 pound per acre on light soils and 1.5 pounds per acre on heavy soils. Because of the high cost, a band treatment is more practical than an over-all treatment.

**CIPC Pre-emergence:** CIPC has label clearance up to 9 pounds per acre. It is recommended at the rate of 6 pounds per acre on light soils and up to 9 pounds per acre on heavy soils. CIPC should be applied as a band treatment because of the high cost.

**Non-fortified herbicidal Oils Post-emergence:** Oils are recommended for use on cotton seedlings 2 inches or more in height, but before cracks occur in the stem covering during true bark formation. These oils should be used at the rate of 5 to 7 gallons per acre. They should be applied soon after weed emergence and should not be applied at less than five-day intervals or total more than three applications.

**Flame Cultivation Post-emergence:** Flaming is a recommended practice for mid- and late-season control of perennial weeds and vines in cotton. It is most effective when used in combination with pre- and post-emergence chemical applications. Flaming should not be started before the cotton is 8 to 10 inches tall or 3/16 inch in diameter at the base. Flaming can be repeated as often as is necessary to control the weeds.

**Diuron Lay-by:** A lay-by application of diuron is recommended for cotton subject to high infestations of annual weeds. Normally, such infestations occur only in wet seasons and in fields given summer irrigation. Diuron should be used on such fields at 0.5 to 1.0 pounds active ingredient per acre on sandy loam soil and 1.0 to 1.5 pounds per acre on heavy clay soil. The spray application should be made on weed-free soil following the last normal cultivation. The spray should be applied in such a manner as to result in complete coverage of the row middles while directing the herbicide away from the cotton plants. Irrigation to activate the herbicide is recommended if rain does not fall within 10 days following treatment. Soil residues following a Diuron lay-by treatment may injure fall seeded cover crops. It appears safe to follow lay-by diuron treatments with spring-seeded crops.

**LEGUMES**

**4-(2,4-DB) Post-emergence:** This material has been cleared for use in seed production only. It has given good results on broadleaved weeds in mature or seedling alfalfa, red clover, birdsfoot trefoil, alsike clover and ladino clover. The best results are obtained when weeds are from 2 to 8 inches tall. Large weeds may need heavier applications. Rates of from ½ to 1⅛ pounds per acre of the amine formulation can be used safely on legumes.
Dalapon ("Dowpon") Post-emergence: This chemical may be used for seed production only. It is used as a post-emergence spray to control weed grasses before the grasses have more than two leaves. Dalapon injures alfalfa more easily than birdsfoot trefoil; no more than 2 pounds per acre should be used on alfalfa. Birdsfoot trefoil will tolerate 3 pounds per acre. Red clover, ladino clover, and alsike clover are injured by dalapon. Dalapon and 4-(2,4-DB) can be mixed and sprayed together to kill a mixed stand of broadleaved weeds and weed grasses.

DNBP: From 1 to 2 pounds per acre may be used to control winter annual weeds in legumes. Apply DNBP in late fall when legumes are dormant and the weeds are small. A second application may be made in late winter if necessary when legumes are still dormant. It can be used on alfalfa, red clover, ladino clover, alsike clover, and birdsfoot trefoil.

EPTC ("Eptam"): This material may be used to establish small-seeded legumes. It can be used pre-emergence at 15 pounds per acre. Good results at lower cost have been obtained by pre-planting treatments of from 1 to 3 pounds per acre. The treatment is made by preparing the seedbed and then spraying the herbicide on the soil surface. The herbicide should then be disked into the soil to a depth of about 2 inches. Both weed grasses and broadleaved weeds are controlled with this material, although it controls grasses better than the broadleaved weeds. With rapid growing legumes such as alfalfa, satisfactory weed control may be obtained throughout the season. Slow-growing birdsfoot trefoil may become weedy in mid-summer after spring treatment. Some injury to Kenland red clover has been observed, so it is not certain that the material may be safely used on all varieties of red clover.

PASTURES

2,4-D: No information is available at present on label restrictions. Restrictions may be applied at any time. Evidence indicates that lespedeza may tolerate rates up to 1/2 pound per acre. This rate is effective on many annual broadleaved weeds. Rates up to 1 or 2 pounds per acre may be used to control perennial weeds such as ironweed. A 1- to 2-pound per acre rate, repeated every year for four to five years, is necessary for good control.

Dalapon: Eight pounds per acre may be used in fall or spring to kill grasses in preparation for the renovation of pasture sod. This material will reduce the number of diskings necessary to prepare a seedbed. Residues generally disappear in about six weeks and seedings can then be made. This practice probably is not practical, except in special cases, because of high cost.

BRUSH

Foliage Applications

2,4-D: Black locust, box elder, buckbrush, cottonwood, hawthorn, sassafras, and sumac are susceptible to 2,4-D. It is effective in foliage applications of 2 1/2 pounds of ester in 100 gallons of water. The foliage should be wet thoroughly.

2,4,5-T: Oak and hickory species may be controlled with 2 1/2 pounds per 100 gallons of water. Spray to thoroughly wet the foliage.

2,4-D and 2,4,5-T: These materials may be mixed in approximately equal amounts and use at the rate of 2 1/2 pounds in 100 gal. of water to control mixed stands of brush.

2,3,6-TBA: Formulations containing high amounts of trichlorobenzoic acids have given excellent control of persimmon at rates of 4 pounds per 100 gal. of water. The foliage should be thoroughly wet. The cost is high for treatment of more than spotted stands.

Aerial Foliage Application: Apply 2 pounds of the ester of 2,4,5-T or of silvex in enough diesel oil to make 5 gallons per acre. An emulsion of 1 gallon of oil plus chemical and 4 gallons of water per acre may be used to increase droplet size to reduce drift. These treatments are effective on black oak, blackjack oak, white oak, post oak, hickory, and others. On areas where there is a mixture of many brush species, equal parts of 2,4-D and 2,4,5-T may be used at 3 pounds per acre. Application should be made as soon as leaves reach full size and while weather conditions favor active growth. One application will not give a complete kill, so retreatment the second or third year with 1 to 2 pounds per acre will improve results. It may be more economical to delay the retreatment for several years until the leaf canopy rebuilds sufficiently to start to suppress grass production, then the full application rate should be used again.

Basal, Frill, and Stump Spray

The recommended mixture consists of 16 pounds of 2,4,5-T in enough diesel oil to make 100 gallons of spray mixture. The same concentration of 2,4-D may be used on species susceptible to this material.

Poison Ivy

Amitrole (amino triazole) at 4 pounds active ingredient per 100 gallons of water and 2,4-D or 2,4,5-T at 2 1/2 pounds per 100 gallons of water (1 to 2 tablespoons per gallon of water when using 4 pounds per gallon material) are good foliage sprays. A 2,4,5-T dormant spray that thoroughly wets the stems can be used, although it is not always as effective as a foliage spray. Amittol is slightly more effective, but is more expensive than 2,4-D.
Amitrole usually causes less injury to near-by desirable plants from drift or volatilization than 2,4-D or 2,4,5-T.

WILD ONION AND GARLIC

Both wild onion and wild garlic can be controlled in established grass with 2 to 4 pounds per acre of 2,4-D ester applied in spring (early) or in fall (about November 1). The 2-pound rate is more practical for large areas of infestation. At least 3 treatments are usually required. Annual spring treatments are probably most effective. Annual fall treatments can be used. Eradication can be achieved more rapidly by applying 2,4-D in both spring and fall (starting in either spring or fall).

Wheat can usually be kept from grading garlicky by spraying with 1 pound of ester of 2,4-D between tillering and jointing (can spray as late as the boot stage if necessary). This may occasionally cause slight damage to the wheat. It does not eradicate the onions or garlic.

JOHNSONGRASS

See Missouri Agricultural Experiment Station Bulletin 729.

SOIL STERILANTS

Sodium Chlorate: From 3 to 5 pounds per square rod are required for sterilization. The fire hazard should be considered around buildings. This treatment produces sterility for one to two years. (See CAUTION below.)

Chlorate Mixtures: Most of these materials have chemicals added to eliminate or reduce the fire hazard or to give faster or more general killing action.

Monuron ("Telvar"): Use 40 to 80 pounds per acre. This material gives long-time sterility action. It may remain in the soil several years. Monuron and other substituted urea herbicides are also used in mixtures as soil sterilants.

Other Soil Sterilants: Numerous other good soil sterilants are on the market. A complete discussion of them is beyond the scope of this bulletin.

GENERAL GRASS KILLERS

Dalapon ("Dowpon"): Twenty to 40 pounds per acre give 30 to 60 days sterility. Seedlings, especially Johnsongrass, may be a problem.

TCA: Use 60 to 100 pounds per acre. TCA soil residues last 60 to 90 days. Seedlings of such weeds as Johnsongrass may become a problem after the effects of the TCA have disappeared.

GRANULAR FORMS OF HERBICIDES

Granular formulations of herbicides currently are attracting much interest. Use of granules for pre-emergence applications shows promise, but the method is still in the experimental stage. For those who would like to use granular herbicides as pre-emergence treatments on a trial basis, application at the same rates as recommended for sprays is suggested. Preliminary research indicates that some of the newer herbicides do not have the same amount of activity on plants in the granular form as in liquid sprays so it will likely be necessary to state separate rates of liquid sprays and for granular applications after further testing. Granular herbicides are relatively ineffective for weeds that have emerged.

Great care is required in calibrating and adjusting granule applicators so that proper rates of application and even distribution of chemicals are obtained.

CAUTION

Sodium chlorate in contact with any flammable material is a fire hazard. Pure sodium chlorate will not burn, but clothing, dry vegetation, wood, or any other flammable material can produce a flash fire when mixed with sodium chlorate. Avoid, as nearly as possible, contamination of clothing, floors of buildings, wagon boxes, etc. with sodium chlorate. As soon as a spraying job is finished, contaminated clothing or equipment should be thoroughly washed. Sodium chlorate should not be used on vegetation near buildings. Do not walk or drive over freshly treated areas. Sodium chlorate is probably no more poisonous to livestock than ordinary salt, but they can get too much. Livestock should be kept away from treated areas until there has been a rain following treatment. Keeping the livestock well supplied with salt reduces the hazard of the animals consuming the sodium chlorate.

If 2,4-D or 2,4,5-T is used in the vicinity of growing cotton or tobacco, or near gardens, truck crops, or orchards, great care should be exercised in the selection and application of the chemicals. Chemicals having a low volatility should be used. Amine forms are least volatile. Low volatility esters are usually safe. High volatility esters are hazardous.

In any herbicide application, care should be taken not to allow the material to drift to useful, sensitive plants.
## Glossary of Chemical Names

<table>
<thead>
<tr>
<th>Short Name or Abbreviation</th>
<th>Complete Chemical Names</th>
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<tbody>
<tr>
<td>amiben</td>
<td>3-amino-2,5-dichlorobenzoic acid</td>
</tr>
<tr>
<td>amitrole</td>
<td>3-amino-1,2,4-triazole</td>
</tr>
<tr>
<td>atrazine</td>
<td>2-chloro-4-ethylamino-6-isopropylamino-s-triazine</td>
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<tr>
<td>CDAA</td>
<td>2-chloro-N,N-diallylacetamide</td>
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<tr>
<td>CIPC</td>
<td>isopropyl N-(3-chlorophenyl) carbamate</td>
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<tr>
<td>2,4-D</td>
<td>2,4-dichlorophenoxyacetic acid</td>
</tr>
<tr>
<td>dalapon</td>
<td>2,2-dichloropropionic acid</td>
</tr>
<tr>
<td>4-(2,4-DB)</td>
<td>4-(2,4-dichlorophenoxy)butyric acid</td>
</tr>
<tr>
<td>diuron</td>
<td>3-(2,4-dichlorophenyl)-1,1-dimethylurea</td>
</tr>
<tr>
<td>DNBP</td>
<td>4,6-dinitro-o-sec-butylphenol</td>
</tr>
<tr>
<td>EPTC</td>
<td>ethyl N,N-di-n-propylthiolcarbamate</td>
</tr>
<tr>
<td>Herbicidal oils</td>
<td>(a complex mixture of petroleum products)</td>
</tr>
<tr>
<td>monuron</td>
<td>3-((p-chlorophenyl)-1,1-dimethylurea</td>
</tr>
<tr>
<td>NPA</td>
<td>N-1-naphthylphthalamic acid</td>
</tr>
<tr>
<td>silvex</td>
<td>2-(2,4,5-trichlorophenoxy)propionic acid</td>
</tr>
<tr>
<td>simazine</td>
<td>2-chloro-4,6-bis(ethylamino)-s-triazine</td>
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<tr>
<td>sodium chlorate</td>
<td>sodium chlorate</td>
</tr>
<tr>
<td>sodium PCP</td>
<td>Sodium pentachlorophenate</td>
</tr>
<tr>
<td>2,4,5-T</td>
<td>2,4,5-trichlorophenoxyacetic acid</td>
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<tr>
<td>2,3,6-TBA</td>
<td>2,3,6-trichlorobenzoic acid</td>
</tr>
<tr>
<td>TCA</td>
<td>trichloroacetic acid</td>
</tr>
<tr>
<td>TBC</td>
<td>trichlorobenzyl chloride</td>
</tr>
</tbody>
</table>

1 An ester or a salt of this compound is the form used in the field.

The mention of commercial products does not imply that they are endorsed or recommended over others of a similar nature not mentioned.

## Acknowledgment

This bulletin has been prepared as a result of cooperative research conducted by the University of Missouri Field Crops Department and the Crops Research Division, Agricultural Research Service, United States Department of Agriculture. The bulletin reports on University of Missouri Agricultural Experiment Station research project 156, Weed Control.