Extension Folder 212—Revised
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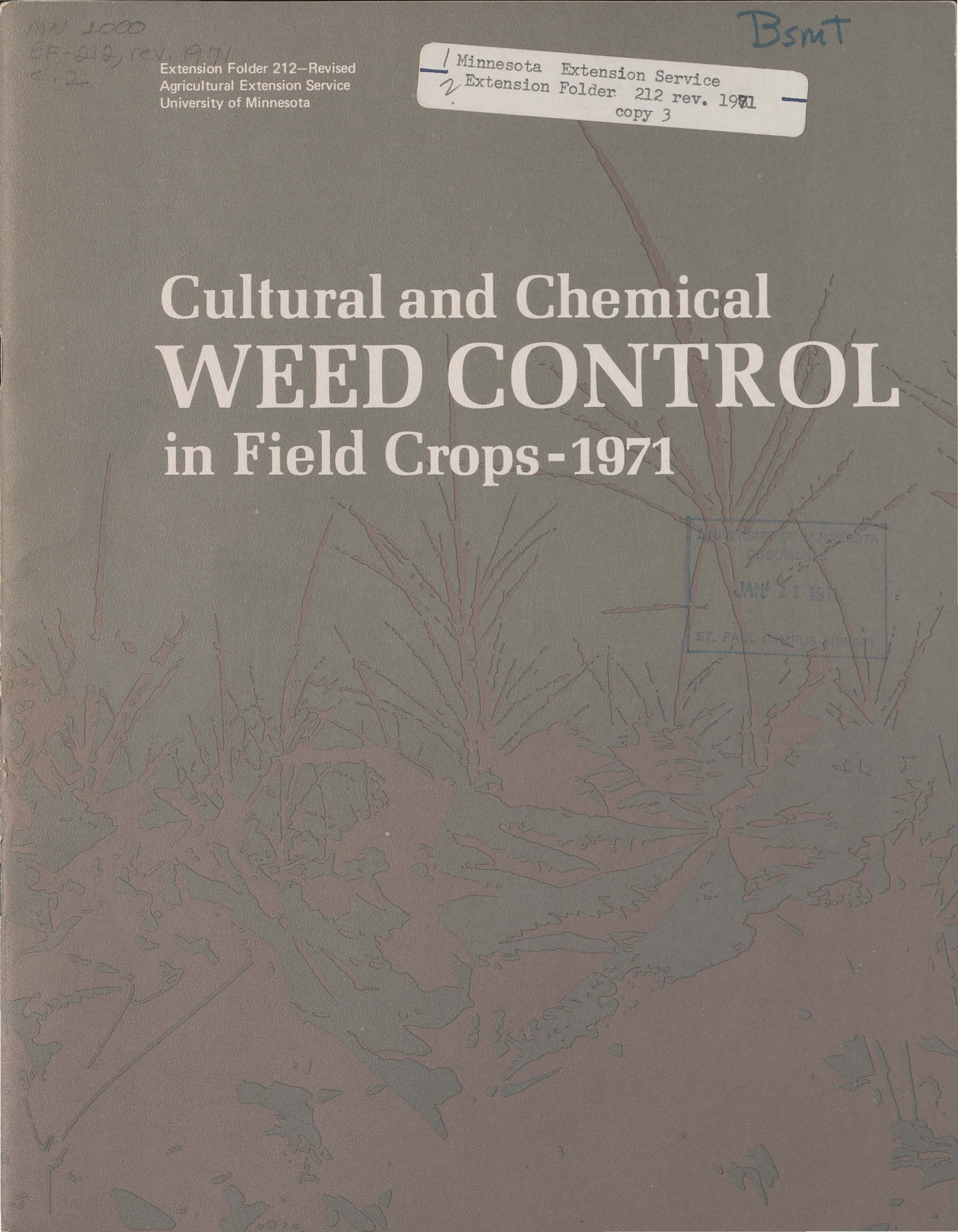
University of Minnesota

Cultural and Chemical WEED CONTROL in Field Crops - 1971



Cultural and Chemical Weed Control in Field Crops—1971

Information in this publication summarizes research at the Minnesota Agricultural Experiment Station and elsewhere on the effectiveness of using chemicals for controlling weeds. Application rates listed herein are broadcast rates and refer to acid equivalent or active ingredient rather than the amount of commercial product.

In general, the problems that might result from residues remaining on agricultural commodities from the use of these chemicals have not been investigated at this experiment station. Therefore, no claims or representations are made by the University of Minnesota or its officers or employees that the chemical pesticides discussed will or will not result in residues on agricultural commodities. However, all suggested uses herein are within clearances established by other agencies in compliance with federal regulations.

This position is necessary because of the enactment in July 1954 of Public Law 518, an amendment (commonly known as the Miller Amendment) to the Federal Food, Drug, and Cosmetic Act. This law makes liable for seizure any raw agricultural commodity moving in interstate commerce which carries a pesticide residue (1) for which no exemption or tolerance has been established or (2) which exceeds the tolerance established by the Food and Drug Administration. Similar state regulations cover intrastate shipments.

After December 31, 1967, registrations under the Federal Insecticide, Fungicide, and Rodenticide Act for pesticides previously registered for use in a manner involving food or feed on a "no residue" or "zero tolerance" basis were canceled unless: (1) finite tolerances or exemptions from the requirement of tolerances were established by the Food and Drug Administration or (2) progress reports were submitted to the Pesticides Regulation Division, U.S. Department of Agriculture, showing that studies are being conducted to obtain data to support finite tolerances. As of December 1970, herbicide registration will be a function of the Environmental Protection Agency (EPA). Registrations of some herbicides have been extended temporarily. *Therefore, registrations for some uses suggested in this bulletin could change by planting time.* New information will be available from county agents as changes occur.

Also observe label directions; they should be read and followed carefully. For information on specific problems contact your county agent.

Safety precautions — Always follow carefully the precautions on the label to help protect the operator, avoid crop injury, and prevent harmful residues in food and feed crops. Use herbicides only on crops for which they are specifically approved and recommended. Use only recommended amounts; applying too much of an herbicide may damage the crop, may be unwise if the crop is to be used for food or feed, and is costly. Apply herbicides only at times specified on the label; observe the recommended intervals between treatments and pasturing or harvesting of crops. Wear goggles, rubber gloves, and other protective clothing as recommended on the label. Guard against possible injury to nearby susceptible plants.

For aerial application, herbicides must have special registration. If the label does not indicate approval for aerial application, the chemical should not be applied from airplanes.

Contents

Revised for 1971 by G. R. Miller, professor and extension agronomist, O. E. Strand, assistant professor and extension agronomist, and R. Behrens, professor, Department of Agronomy and Plant Genetics. Other staff members concerned with field crop weed control include A. G. Dexter, assistant professor and extension sugar beet weed control specialist; R. G. Robinson, associate professor, Department of Agronomy and Plant Genetics; and R. N. Andersen, plant physiologist, Agricultural Research Service, United States Department of Agriculture.

Follow label instructions carefully when using agricultural chemicals.

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Trade names are sometimes used in this publication to clearly identify the herbicide under discussion. Omission of other trade names of similar herbicides is unintentional. The inclusion of a trade name does not imply endorsement and exclusion does not imply nonapproval.

Chemical Weed Control Practices

The terms listed below are used in this folder to describe herbicide applications:

Acid equivalent — A term used to express a rate or quantity of an acid herbicide.

Active ingredient — A term used to express a rate or quantity of a nonacid herbicide.

Band application — Herbicide applied to a narrow strip centered over the crop row.

Broadcast application — Herbicide applied over entire area.

Directed spray application — Herbicide applied to a band over the row that includes the base of crop plants and the weeds in the row. Spray is directed across the row from nozzles positioned near ground level on each side of the row. This type of application allows use of chemicals that will injure the crop plant if more than a small part of the plant is contacted by spray. Special units that guide from the ground or mount on cultivators must be used.

Drop-nozzle application — Herbicide applied by means of nozzles mounted on extensions below the spray boom to avoid spraying upper parts of the crop plant.

Postemergence application — Herbicide applied to the crop and weeds after they emerge.

Preemergence application — Herbicide applied after a crop is planted but before it or weeds emerge.

Preplanting application — Herbicide applied before the crop is planted.

Preplow application — Herbicide applied to soil and/or foliage of weeds before plowing.

Rate — The amount of active ingredient or acid equivalent of an herbicide applied to the area treated, that is, on a broadcast basis.

Soil incorporation — Mechanical mixing of the herbicide with the soil. Chemicals may be incorporated 3 to 4 inches with a disk or rotary tiller, 1 to 2 inches with a harrow or rotary hoe, or slightly covered with planter attachments. The desired depth of incorporation depends on characteristics of the chemical being used.

PREEMERGENCE APPLICATIONS

Several excellent herbicides are available for use in preemergence applications. These herbicides generally give good weed control. But results may vary depending on the kinds of weeds present, weather conditions, and soil type. Established perennials are usually not controlled with preemergence herbicides. Control of some deep-germinating and tolerant annual species may not be adequate with preemergence treatments. The surviving species vary with the herbicide used. Weed control may be poor if there is no rainfall soon after treatment. Or, if rainfall is very heavy, some herbicides will move downward in the soil, resulting in poor weed control and/or crop injury. Soil type can affect weed control. Use the rates given in instructions on the herbicide label for the soil type.

Numerous tests have been conducted in Minnesota to determine the overall effectiveness of herbicides. Table 1 shows the performance of herbicides on uncultivated corn plots in several years of county demonstrations. Table 3, page 10, gives similar information for herbicides in soybeans. Figures in Tables 1 and 3 are the percentage of trials in which weed control was rated good (more than 75 percent of the weeds controlled), fair (50 to 75 percent of the weeds controlled), or poor (less than 50 percent of the weeds controlled). Evaluations were made about 5 weeks after application. Herbicides not included in these tables have not been adequately tested or have performed poorly under Minnesota conditions.

GRANULAR VERSUS SPRAY FORMS OF HERBICIDES

Several herbicides are available in granular or spray forms. Approximately the same weed control can be expected from either form. Granular forms require no mix-

Table 1. Early evaluations of herbicides in weed control demonstrations in uncultivated corn

Chemical*	Pounds per acre active ingredient or acid equivalent broadcast	Years in trial	Number of trials		Percent of trials in each class					
					Grasses			Broad-leaved weeds		
			Grasses	Broad-leaved weeds	Good	Fair	Poor	Good	Fair	Poor
Alachlor (Lasso)	2½	1969-70	58	57	90	9	1	44	18	38
Atrazine (AAtrex)	3	1959-70	613	588	76	16	8	86	9	5
Atrazine (early postemergence)	3	1961-67	398	374	73	14	13	87	7	6
Atrazine + dalapon (Dowpon) + oil (early postemergence)	1 + ¾	1969-70	56	55	68	21	11	91	5	4
Atrazine + oil (early postemergence)	2	1966-70	222	221	88	8	4	94	4	2
Atrazine + surfactant (early postemergence)	2	1968-69	72	72	65	27	8	94	6	0
Atrazine + linuron	1½ + 1½	1965-70	271	270	78	16	6	84	11	5
Atrazine + propachlor	1½ + 3	1967-70	147	158	86	13	1	88	9	3
Linuron (Lorox)	2	1963-65	189	179	52	26	22	61	21	18
Linuron + propachlor (Londax)	1½ + 3	1968-70	99	98	87	8	5	76	14	10
Propachlor (Ramrod)	5	1965-70	283	278	81	12	6	40	28	32
SD 15418 (Bladex)	3	1969-70	58	57	83	14	3	72	18	10

* Applied preemergence unless specified early postemergence.

ing and they can be used directly from the package. The cost of granules is usually higher than the cost of an equal amount of the spray form. Distribution of chemicals with granule applicators is sometimes not as uniform as with sprayers, especially on rough ground. In some instances poor distribution has resulted in variable weed control. A wide, flat press wheel or similar attachment on the planter that leaves a level fine surface is desirable for uniform granule application. Chemicals that cause irritation are less irritating in the granular form than in the spray form.

HERBICIDE MIXTURES

Some herbicide mixtures are in use and several new herbicide mixtures show promise for overcoming limitations of single chemicals. Certain mixtures may (1) control more kinds of weeds, (2) give more consistent performance with different soils and weather conditions, (3) lessen soil residue problems, (4) increase persistence enough to give full-season weed control, or (5) reduce crop injury.

Only those mixtures that have been field tested under local conditions and registered for use by the U.S. Department of Agriculture should be used. Use of unregistered mixtures may result in poor weed control, crop injury, or accumulation of illegal chemical residues in the crop. Growers may be responsible for residues resulting from use of unregistered mixtures.

Weed Control in Field Crops

CORN

Weed control in corn is based on a combination of cultural practices and herbicide applications.

Cultural Practices — Cultural practices include seedbed preparation, establishment of an adequate stand, and timely, effective cultivations.

Early germinating weeds can be destroyed with a disk, field cultivator, or harrow before planting if conventional tillage is used. Minimum tillage methods that leave the space between the rows rough discourage weed growth.

Early cultivations are most effective for killing weeds. The rotary hoe or harrow works best if used after weed seeds have germinated and before or as soon as the weeds appear above the soil surface. Row cultivators should also be used while the weeds are still very small. Set the shovels for shallow cultivation to prevent root pruning and to bring fewer weed seeds to the surface. A rotary hoe or cultivator should be used as soon as weeds appear even if preemergence applications have been used.

Herbicides — Table 2 indicates corn tolerance to herbicides suggested for use in corn and relative efficiency of these herbicides in controlling common weeds. This is a general comparative control rating based on field observations. Under unfavorable conditions any of the herbicides may give unsatisfactory results. Under favorable conditions control may be better than indicated.

Preplanting applications of butylate (Sutan) incorporated into the soil at 4 pounds per acre have given good control of annual grasses, but butylate does not control annual broadleafs. Butylate controls nutsedge, but does not control other perennial weeds. Butylate should be applied before planting and incorporated immediately by disking. Disk twice, once in each direction, for best incorporation.

Preplanting and disked-in applications of atrazine (AAtrex) have resulted in weed control equal to or, under dry conditions, slightly better than preemergence applications without incorporation. Fall and early spring applications of atrazine have given adequate weed control, but if applied in the fall, higher rates are required to give control equal to spring application. Fall applications require fall disking and therefore leave the soil subject to erosion. Broadcast applications, necessary when preplanting treatments are used, may increase the potential of atrazine carryover compared to banded preemergence applications.

A mixture of butylate at 3 to 4 pounds per acre and atrazine at 1 to 1½ pounds per acre applied preplanting and disked-in has controlled both annual grasses and broadleafs. This mixture improves broadleaf control compared to butylate alone, and reduces atrazine carryover problems since lower rates of atrazine are applied.

Preplanting, disked-in applications of alachlor (Lasso) at 3 pounds per acre have effectively controlled nutsedge. Control of annual weeds has usually been better with preemergence than with preplanting application of alachlor, except under very dry conditions.

Preemergence applications of atrazine (AAtrex) at 1 to 4 pounds per acre have given good control of annual weeds with no injury to corn. A 4-pound per acre rate of atrazine should be used on fine textured soils or those high in organic matter. One to 2 pounds per acre of atrazine is adequate on sandy soils. Atrazine may remain in some soils for more than one season. Toxic residues are more likely to persist if soil moisture or temperatures are low.

Atrazine sometimes affects small grains, flax, sugar beets, soybeans, and other legumes planted the following spring. The label requires that small grains, flax, sugar beets, and small-seeded legumes not be planted in the year following atrazine application. Soybeans cannot be grown the year following atrazine use if the rate of atrazine application was more than 2 pounds per acre of active ingredient in western Minnesota or 3 pounds in eastern Minnesota. Residue can be minimized by using the lowest rate of chemical consistent with good weed control, use of band applications rather than broadcast applications, and plowing or thorough tillage of the soil prior to planting soybeans.

SD 15418 (Bladex), chemically similar to atrazine, has given good control of annual grasses and most broadleafs when applied preemergence. There has been no apparent corn injury and no soil residue the following season. Weed control was not as good under dry conditions as under moderate to heavy rainfall. Within the suggested rates of 2 to 4 pounds per acre, the higher rates are required on soils higher in organic matter and finer textured. Do not apply SD 15418 after corn has emerged. **Caution:** As of December 1970, SD 15418 has not been cleared for use on corn.

Propachlor (Ramrod) has given good annual grass control on all soils when applied preemergence at 4 to 6 pounds per acre. Propachlor does not consistently control most broad-leaved or perennial weeds, but it may be used in mixtures with atrazine or linuron for annual grass and broadleaf control. Corn is very tolerant to propachlor.

Alachlor (Lasso), chemically related to propachlor controls annual grasses in corn. In addition, alachlor has given fair to good control of redroot pigweed, common ragweed, and common lambsquarters, but control of other broadleafs has been erratic. Corn has good tolerance to alachlor. Suggested rates are 2 to 3 pounds per acre.

C-6313 (Maloran), a recently developed preemergence herbicide for corn, shows promise for annual grass and broadleaf control on soils with less than 5 percent organic matter. Performance has been poor on soils with higher organic matter. C-6313 has usually given better control of broadleafs than of grasses at the suggested rates of 2 to 4 pounds per acre. Corn appears to have good tolerance to the chemical. **Caution:** As of December 1970, C-6313 has not been cleared for use on corn.

Preemergence applications of amiben, 2,4-D, dicamba (Banvel) or EPTC (Eptam) are not recommended because they have frequently caused corn injury and/or given erratic weed control.

Preemergence herbicide mixtures. Mixtures of atrazine with alachlor, linuron, prometryne or propachlor are registered for preemergence application on corn to control annual grasses and broadleafs. Soil residues of atrazine are reduced by using these mixtures since application rates are lower than if atrazine is used alone. These mixtures are less effective than atrazine alone on quackgrass. Do not apply the mixtures with linuron or prometryne after corn is up or severe corn injury will occur. These mixtures should not be incorporated into the soil.

A 1:1 ratio of active ingredients of an atrazine-linuron mixture has given weed control comparable to an equivalent rate of atrazine alone. Using linuron in combination with atrazine reduces the likelihood of corn injury and usually improves weed control compared with linuron alone. Rates vary from ½ to 1½ pounds per acre of each chemical according to soil type. In preemergence applications, corn tolerance to this mixture is not as great

Table 2. Effectiveness of herbicides on major weeds in corn

	Preplanting		Preemergence				Postemergence		
	Butylate	Atrazine	Alachlor	Atrazine	Propachlor	Linuron	2,4-D	Dicamba	Atrazine and oil
Corn tolerance	G	G	G	G	G	F	G	G	G
Grasses									
Giant foxtail	G	F	G	F	G	F	N	N	F
Green foxtail	G	G	G	G	G	F	N	N	G
Yellow foxtail	G	G	G	G	G	F	N	N	G
Barnyardgrass	G	F	G	F	F	F	N	N	F
Crabgrass	G	P	G	P	G	G	N	N	P
Panicum	G	P	G	P	F	G	N	N	P
Nutsedge	G	P	G	P	F	P	N	N	F
Quackgrass	N	G	N	G	N	N	N	N	G
Broadleafs									
Cocklebur	P	F	N	F	P	P	G	G	G
Lambsquarters	P	G	F	G	P	G	G	G	G
Mustard	P	G	P	G	P	G	G	F	G
Pigweed	F	G	G	G	F	G	G	G	G
Ragweed	P	G	P	G	P	G	G	G	G
Smartweed	P	G	P	G	P	F	P	G	G
Velvetleaf	F	F	P	F	P	F	G	G	F
Wild sunflower	P	P	P	P	P	P	F	G	G
Canada thistle	N	P	N	P	N	N	F	G	F

G — Good
F — Fair
P — Poor
N — None

as to atrazine alone. Corn injury may occur on low organic, coarse textured soils.

A mixture of atrazine and prometryne (Primaze) applied preemergence has given weed control comparable to atrazine alone, but corn has been injured under some soil and weather conditions. Suggested rates are 0.8 to 1.5 pounds per acre of each chemical. Label instructions specify this mixture *should not be used* under the following conditions: on sand, high organic clay, peat, or muck soils; on eroded hillsides; on alkaline calcareous soils of western Minnesota; where irrigation is used; nor on inbred lines of corn.

The mixtures of atrazine and propachlor or alachlor control broad-leaved weeds better than propachlor or alachlor alone and give more consistent control on high organic matter soils or with limited rain than atrazine alone. Corn has good tolerance to these mixtures. Suggested rates are 1 to 1½ pounds per acre of atrazine and 2 to 3¾ pounds per acre of propachlor or 1½ to 2½ pounds per acre of alachlor.

Using the mixture of linuron and propachlor (Londax) reduces the potential for corn injury compared to linuron alone since lower rates of linuron are used. This mixture controls broadleafs better than propachlor alone. Suggested rates are 1 to 1½ pounds per acre of linuron with 3 pounds per acre of propachlor. Do not use the mixture on sandy soils because of possible crop injury from linuron.

Early postemergence sprays of atrazine effectively control most annual weeds in corn. Broad-leaved weed control is especially good. Grass control is less consistent. It is important to apply early postemergence treatments at the proper time or results may be poor. Apply atrazine within 3 weeks of planting while the weeds are less than 1½ inches tall. The addition of 1 to 2 gallons per acre of special oils with an emulsifier or ¼ to ½ gallon per acre of special adjuvant-oil emulsions to the spray increases the effectiveness of early postemergence applications of atrazine. Labelled emulsions of either vegetable or petroleum oils are satisfactory. Suggested atrazine rates for postemergence application with oil are 1 to 3 pounds per acre. When atrazine is used, early postemergence treatments are preferred to preemergence if the soil is high in clay or organic matter and in western Minnesota where rainfall is less certain. These are the areas where preemergence applications of atrazine have given less satisfactory weed control. Severe corn injury has resulted from the addition of 2,4-D to this mixture.

A mixture of atrazine, dalapon and oil applied when corn is less than 6 inches tall has given promising results in research trials. Both grasses and broadleafs were controlled. Proper timing and rate of application appear critical to avoid corn injury. Some corn hybrids appear more sensitive than others to dalapon injury. Rates are ¾ to 1½ pounds per acre of atrazine and ⅜ to ½ pound per acre of dalapon. **Caution:** Do not use dalapon on corn grown for seed.

S-6115 (Outfox), a recently developed chemical has controlled annual grasses and broadleafs when applied as an early postemergence treatment at ¾ to 1 pound per acre in corn. Some corn stunting and leaf burn occurred; but the corn appeared to recover satisfactorily. **Caution:** As of December 1970, S-6115 has not been cleared for use on corn.

Postemergence — Annual broad-leaved weeds can be controlled with broadcast postemergence applications of ¼ to ½ pound per acre of 2,4-D amine when the corn is less than 8 inches tall. The ¼ pound rate has been adequate for susceptible weeds and is less dangerous to corn. The ½ pound rate has been satisfactory for moderately resistant weeds, but corn has usually been injured by this rate.

If 2,4-D esters are used, reduce application rates about 1/3. Since the ester forms are volatile, vapor injury to nearby susceptible crops is a possibility. The use of amines eliminates the danger of vapor injury because amines are not volatile. Spray drift from either amines or esters of 2,4-D will injure susceptible plants.

To reduce the danger of 2,4-D injury when the corn is more than 8 inches tall, avoid spraying the upper leaves and leaf whorl of corn by using drop nozzles between the rows. However, adequate spray coverage of the tops of the weeds is necessary for maximum weed control. If nozzles are directed toward the row from both sides, the herbicide concentration must be reduced to compensate for the double coverage.

Some injury may result when corn is sprayed with 2,4-D. Brittleness followed by bending or breaking of stalks is the most serious type of injury, and it may result in severe stand losses when applications of 2,4-D are followed by a storm or careless cultivation.

Several factors influence the degree of injury resulting from 2,4-D. Hybrids vary in tolerance to 2,4-D. Corn growing rapidly is more susceptible than corn developing under less favorable growth conditions. When temperatures exceed 85° F. just before or at the time of 2,4-D application, the corn is more likely to be injured. At the rates of application commonly used, the stage of growth at which treatment is made during the period from emergence to tasseling is less critical than the effects of environmental factors.

If broad-leaved weed control is necessary after layby, 2,4-D ester at ½ pound per acre or 2,4-D amine at ¾ to 1 pound per acre may be applied using drop nozzles. Do not apply 2,4-D from tasseling to dough stage or poor kernel set may occur. 2,4-D can be applied after the early dough stage if necessary, but it is more beneficial to control weeds earlier.

Dicamba (Banvel) as a postemergence spray in corn has given better control of Canada thistle and smartweed than 2,4-D with less effect on the corn. But when used, dicamba drift has usually affected soybeans in the vicinity of treated cornfields. Dicamba also controls other broad-leaved weeds except mustard, but does not control grasses.

Dicamba can be used in corn at ⅛ to ¼ pound per acre either alone or in mixtures with 2,4-D amine at ¼ to ½ pound per acre. Applications can be made until

corn is 3 feet tall or until 15 days before tassel-emergence, whichever occurs first. Do not use on corn grown for seed. Later applications, especially when corn is tasseling, may result in poor kernel set. Use drops after corn is 8 inches tall.

Caution: Soybeans and other broad-leaved plants are very sensitive to dicamba. Dicamba effects have been observed on soybeans considerable distances from treated corn fields and in some cases soybean yield losses have occurred. Users of dicamba should take special precautions to avoid drift. Drift can be minimized by reducing sprayer pressure, increasing water volumes with larger nozzles and using drop nozzles to keep the spray release as low as possible and still give weed coverage. Drift potential is greater with windy or high temperature conditions. Do not graze or harvest for dairy feed prior to the milk stage of the grain if corn is treated with dicamba.

Atrazine and oil, discussed above, may be applied up to the layby stage of corn. However, results are not as good as from earlier applications when weeds are less than 1½ inches tall. Drop nozzles should be used to keep the spray out of the tops of the corn and to give better spray coverage on the weeds.

Flame weeding or directed sprays cannot be used on small corn. Therefore, early season weed growth must be controlled by some other means (use of rotary hoe, harrowing, herbicides, or cultivation) to prevent yield losses from early weed competition. Directed sprays and flame weeding are considered emergency measures to control heavy weed stands that have become established within corn rows.

Directed sprays — Specially designed equipment has been developed to make directed spray applications in corn. When applying directed sprays, the nozzles should be mounted so that wheels, skids, cultivator shanks, or similar devices control the nozzle height. To minimize spray contact with corn leaves, use attachments to lift the corn leaves and direct the spray to the base of corn plants and onto weeds in the row.

Directed sprays of dalapon-2,4-D mixtures at rates of 1½ pounds of dalapon and ½ pound of 2,4-D per acre can be used when corn height to the whorl is 8 to 16 inches. This mixture will stunt or kill most weeds in the row that are hard to control by cultivation. If excessive amounts of dalapon contact the corn leaves, plants become stunted and deformed. Twisted leaves and undeveloped ear husks are typical injury symptoms. **Caution:** Do not use dalapon on corn grown for seed.

Directed sprays of linuron at 1½ pounds per acre can be applied when the corn is not less than 15 inches tall. The addition of a wetting agent is necessary for effective weed control. Care must be taken in application to minimize spray on the corn leaves while covering most of the weed foliage with the linuron spray. Linuron will kill corn leaf tissue it contacts and, if leaf kill is extensive, corn yields may be reduced.

Flame weeding of corn is a practice that can be used in the same manner as directed sprays. Special equipment using LP-gas as fuel has been developed for flame weed control after corn is 8 inches tall. Flaming must be carried out carefully by experienced operators to avoid corn injury. Several flamings are usually required within 5 to 10 days to give adequate weed control with slight effect on the corn in most instances. Serious corn leaf burn can occur when the flame weeder is improperly adjusted or the operating speed is too slow. Searing of the bottom two or three leaves of corn commonly occurs and may slightly depress the corn height but has no apparent effect on corn yield. Corn yields in flame-weeded plots have often equalled those obtained using herbicides for weed control. A disadvantage of flame weeding is the necessity of flaming several times to obtain adequate weed control.

DRY EDIBLE BEANS

Before emergence, bean fields can be spike-tooth harrowed to kill emerging weeds. After beans emerge, use such implements as the weeder, rotary hoe, spike-tooth harrow, or coil spring harrow to kill weeds. Only small emerging weeds in the "white" stage can be uprooted and killed without injury to the larger beans. It may pay to harrow the field several times before the first cultivation if weeds emerge.

Beans are generally cultivated twice before the vines cover the middles. Hand hoeing is desirable when economically feasible.

Herbicides cleared for use on beans and tested by the University of Minnesota include EPTC (Eptam), trifluralin (Treflan), chloramben (Amiben), DCPA (Dacthal), dinoseb (DNBP) amine, and nitralin (Planavin).

EPTC at 3 pounds per acre or trifluralin at ¾ pound per acre on sandy soil to 1 pound per acre on finer textured soils are applied preplanting and incorporated into the soil. Incorporation should be accomplished within minutes after application to avoid loss of the herbicide. If a disk is used for incorporation, the field should be disked twice, once in each direction. The second disking need not be done the same day.

Chloramben, DCPA, or dinoseb amine are applied preemergence at 2, 10½, or 9 pounds per acre, respectively. Weed control at these rates may be less satisfactory than that obtained from the herbicides suggested for preplanting application. Nitralin has not given satisfactory weed control under Minnesota conditions.

Dinoseb amine may be applied when beans are emerging (not later than crook stage) at a rate of 3 to 4½ pounds per acre. This is primarily a contact killer for small and germinating weeds. Weather often makes treatment at this time impractical.

FLAX

Cultural practices — Weeds are generally more of a problem in flax than in small grain; therefore growers should sow flax on relatively clean land. To prepare land for flax, practice early afterharvest tillage of small grain stubble — except where such tillage results in serious

wind erosion — to control perennial weeds, prevent weed seed production, and stimulate annual weed seed germination in late summer and fall.

Another desirable weed control practice is to prevent weed seed production in the preceding corn, soybean, or other cultivated crop and prepare the seedbed for flax by shallow tillage. Delayed sowing of flax to permit spring tillage for wild oat control has been successful in some areas although the delay sometimes reduces flax yields. For delayed sowing, use early maturing varieties such as Linott, Summit, or Windom.

Herbicides — Time of application of herbicides is very important on flax. Flax is likely to be seriously hurt if sprayed during the period between bud stage and when 90 percent of the bolls have formed. Germination of the seed may be reduced by spraying between full bloom and the stage when seeds are colored. The preferred time to spray is when flax is 2 to 6 inches tall. MCPA is less likely to injure flax than 2,4-D. Flax injury is less likely with MCPA amine than MCPA ester. Weed control is most effective when spraying is done as soon as most of the weeds have emerged. MCPA may reduce yield of flax seed and straw unless weed competition is reduced sufficiently to offset injury from the chemical.

Susceptible weeds like wild mustard are killed by 2 to 3 ounces per acre of MCPA amine. Common lambsquarters, field pennycress, cocklebur, marshelder, and common ragweed require 4 ounces. From 5 to 8 ounces per acre of MCPA amine are required for control of wild buckwheat, thistles, smartweed, and redroot pigweed. At these rates flax may be injured and a good kill of these weeds seldom results, though their growth is usually checked and seed production reduced.

TCA at 5 pounds per acre or dalapon at ¾ pound per acre will kill green, yellow, and giant foxtail in young flax. Best results have followed application when the flax was 2 to 6 inches tall and the weeds less than 2 inches. TCA or dalapon can be applied in a mixture with MCPA amine to kill susceptible grass weeds and susceptible broad-leaved weeds with one application — but spraying must be done before early bud. Neither TCA nor dalapon should be used unless a serious annual grass population is present. Flax varieties recommended for use in Minnesota are approximately equal in tolerance to MCPA and TCA. However, varieties differ in their tolerance to dalapon. Most tolerant to least tolerant varieties are: Nored, Linott, Windom, Norstar, and Summit.

When flax is used as a companion crop to establish alfalfa, red clover, alsike clover, ladino clover, birdsfoot trefoil, timothy, meadow fescue, bromegrass, or crested wheatgrass, use MCPA amine as directed for susceptible weeds in flax except that legume seedlings should be at least 2 inches tall. Sweetclover seedlings are likely to be killed and other legumes injured by MCPA. Dalapon can be used on flax sown with alfalfa, sweetclover, or birdsfoot trefoil but will probably kill forage grasses and seriously injure red and alsike clovers.

Use 10 to 20 gallons per acre of spray solution when spraying with TCA, dalapon, or more than 4 ounces per acre of MCPA amine.

For chemical control of wild oats in flax see section on WILD OATS control on page 16.

FORAGES—ALFALFA, CLOVER, AND GRASSES

Legume Establishment

Seedling legumes generally are poor competitors with weeds. Management practices in preceding crops such as use of intertilled crops and afterharvest tillage to make the land as weed free as possible for the legume seedlings are desirable.

Clipping of seedling legumes (except sweetclover) when sown alone, mowing the stubble of companion crops, and patch mowing of perennial weeds aid in weed control.

Preplant incorporation treatments of 2 to 3 pounds of EPTC (Eptam) per acre have given effective control of annual broad-leaved and grass weeds in alfalfa, red clover, sweetclover, alsike clover, and birdsfoot trefoil when these legumes were sown without a grass in the mixture or a companion crop.

Benefin (Balan) has given effective control of annual grasses and fair control of common lambsquarters and pigweed when applied preplanting and incorporated into the soil just before seeding legumes. Benefin is cleared for use on alfalfa, birdsfoot trefoil, red, alsike, and ladino clovers at rates up to 1½ pounds per acre. On sandy soils a rate of 1⅛ pounds per acre should be used. Benefin controls weeds by affecting seed germination. It does not control established weeds.

Postemergence treatments with 2,4-DB at ½ to 1½ pounds per acre can be used to control broad-leaved weeds in seedling alfalfa, birdsfoot trefoil, red clover, alsike clover, and ladino clover when sown alone or with small grains. Spray when weeds are less than 3 inches tall, when the legumes are 2 to 3 inches tall, and small grains are 6 to 8 inches tall. Wild mustard is not effectively controlled by 2,4-DB. **Caution:** To avoid residues do not graze or harvest forage for livestock feed for 30 days after treatment.

Small grass weeds can be controlled in seedling alfalfa and birdsfoot trefoil (2 to 3 inches tall) with dalapon at 1 pound per acre. **Caution:** Do not feed first-year crop to dairy animals or animals being finished for slaughter. First-year crop should not be sold commercially or shipped interstate.

Dalapon-2,4-DB mixtures may be used to control weeds in alfalfa and birdsfoot trefoil sown without a forage grass or companion crop.

Seedling stands of ladino clover, alsike clover, red clover, and alfalfa sprayed with 2,4-D amine or MCPA at rates of ¼ pound per acre or less have been injured, but not seriously if a canopy of companion crops or weeds has been present. Reduced sprayer pressure helps minimize damage. MCPA is less injurious to legumes, but 2,4-D is more effective for controlling certain weeds.

Sweetclover has been severely injured and should not be sprayed with either 2,4-D or MCPA.

Mowing is the recommended practice for controlling many kinds of weeds if done at the right time and if repeated for 2, 3, or 4 years. In general, mow weeds in the early bud to blossom stage.

Established Legumes

In established legumes, the amine salt of 2,4-DB can be applied at ½ to 2 pounds per acre or the ester of 2,4-DB can be applied at ½ to 1 pound per acre in 15 to 30 gallons of water per acre. Do not use more than ¾ pound of the ester per acre on red clover. Apply when the annual broad-leaved weeds are 2 to 3 inches tall or when perennials are 6 to 8 inches tall. The same feeding restrictions apply that were mentioned previously.

Use of 2,4-D or MCPA is often hazardous to legumes. These chemicals should be used only when a serious weed problem exists. Either herbicide should be applied in the dormant stage of the legume — late fall or very early spring — to control susceptible broad-leaved weeds that are present at this time. MCPA or 2,4-D amine at 4 to 8 ounces per acre may be used during legume dormancy to control yellow rocket, a weed that is sometimes troublesome in legumes. White cockle is not controlled by 2,4-D or MCPA. Harvest of the legume before white cockle seed matures will reduce the rate of spread by seed.

Simazine (Princep) can be used on pure alfalfa stands established for a year or more to control seedling plants of wild mustard, yellow rocket, hoary alyssum, white cockle, shepherdspurse, and pennycress. Established plants except hoary alyssum are not consistently controlled. Application should be made after the last cutting in the fall and before the ground is frozen. Grasses in the alfalfa will be killed or injured. Some injury to alfalfa may occur. Recommended rates are 0.8 to 1.6 pounds per acre depending on soil type. Simazine should not be used on sands, loamy sands, or gravelly soils. **Caution:** Do not graze areas treated with simazine for 30 days or cut hay for 60 days after treatment.

All chemicals suggested for legume establishment or established legumes can be used in legume fields intended for seed production. Two additional chemicals can also be used in seed production fields. TCA at 5 to 7 pounds per acre can be used for control of many annual grasses (not wild oats) in established alfalfa, sweetclover, and birdsfoot trefoil grown for seed without permanent injury to the legumes. Do not treat ladino clover, alsike clover, and red clover with TCA. Dalapon at 2 pounds per acre will suppress quackgrass in birdsfoot trefoil seed fields during the growing season if applied early in the spring soon after quackgrass growth starts. (Note feeding restrictions previously mentioned.)

Perennial Grasses

Dicamba (Banvel), 2,4-D, MCPA, or silvex will control broad-leaved weeds in established perennial grasses such as timothy, bluegrass, and bromegrass. Combinations of dicamba with MCPA or 2,4-D give better control of mustards and other weeds resistant to dicamba. If Canada thistle or sowthistle is a problem, repeated applications of dicamba, 2,4-D, or MCPA may be required.

In timothy grown for seed, early spring applications of dicamba at ¼ to ½ pound per acre have controlled young nightflowering catchfly and white cockle. The chemical should be applied after weeds start to grow and when timothy is 2 to 4 inches tall. Timothy injury is more likely if dicamba is applied late or at the higher rate. When applied in the spring, silvex at 1 to 2 pounds per acre gave good control of nightflowering catchfly and white cockle with little injury to the timothy.

Established Grass Pastures

In established pastures good management and controlled grazing are most important in any attempt at weed control.

In very weedy pastures where good perennial grasses are thin, reseeding may be the most important practice. To be successful, prepare a firm seedbed for any reseeding and add lime and fertilizer by soil test. Protect new seedlings from grazing until they are established and graze moderately thereafter. Plowing (or intensive surface tillage) and seeding to adapted grasses, where practicable, will usually eliminate many of the perennial pasture weeds.

Spraying with 1 to 2 pounds per acre of 2,4-D, 2,4,5-T, or a mixture of the two gives better control of many weeds with a single application than is obtained with a single mowing treatment. The weeds should be sprayed when growing actively. Repeated treatment for 2 or more years is usually necessary. In general, these chemicals have been used at rates necessary for weed or brush control without appreciable injury to grasses, but legumes will be eliminated. **Caution:** Do not graze dairy cattle on pastures treated with 2,4-D for 7 days after treatments.

MCPA can be used at low rates of about ¼ pound per acre where legumes are present. Some 2,4-D resistant weeds such as buttercup are controlled better with MCPA.

Dicamba (Banvel) is cleared for broad-leaved weed control in grass pastures. The suggested rate of application ranges from ¼ pound per acre for susceptible annuals to 4 to 8 pounds per acre for eradication of resistant perennials. Mixtures of ½ to 1 pound per acre with 2,4-D will give better control of 2,4-D-resistant species. The higher rates of dicamba may be practical for spot treatment of perennial broad-leaved weeds. Do not apply on or near desirable trees or plants or in locations where the chemical may be washed or moved into contact with the roots of desirable plants. Prevent drift of dicamba to desirable plants, particularly soybeans. **Caution:** After treatment of pastures with dicamba, do not graze dairy animals for 7 to 60 days nor harvest for hay for 37 to 90 days depending on the rate of application. See label for details. There is no waiting period between treatment and grazing for animals other than dairy animals; except, do not graze meat animals in treated fields within 30 days of slaughter.

SMALL GRAINS—SPRING WHEAT, OATS, AND BARLEY

Wheat and barley are less sensitive than oats to 2,4-D applications made during the growing season. All three crops are sensitive as seedlings. Wheat and barley are relatively tolerant from the time five full leaves appear until the early-boot stage. During this period 1/6 to ½ pounds of 2,4-D ester or ¼ to ⅔ pound of 2,4-D amine will control most broad-leaved weeds without serious injury to crops. Some injury to oats should be expected, but weed control generally will more than offset losses resulting from 2,4-D injury. Oat injury can be reduced by using no more than ½ pound per acre of 2,4-D amine. MCPA is less likely to injure oats than 2,4-D. **Caution:** Do not cut for forage or graze treated grain fields for 2 weeks after treatment with 2-4,D.

Avoid spraying wheat and barley in the boot stage of development. Varietal differences in wheat and barley have been unimportant. Oat varieties differ in their response to 2,4-D.

Small grains are more tolerant to MCPA than to 2,4-D. Using MCPA permits spraying in the 2- to 5-leaf stage of the small grains, whereas using 2,4-D in this early stage would usually result in excessive crop injury. MCPA rates of ¼ pound per acre of amine or 1/6 pound per acre of ester will control small mustard plants. For other broad-leaved weeds or larger mustard, up to ⅔ pound per acre of amine and ½ pound per acre of ester may be required.

Weeds more easily controlled by MCPA than 2,4-D are hemp nettle, horsetail, buttercup, tartary buckwheat, corn spurry, and perennial peppergrass. Those more easily controlled by 2,4-D than MCPA are Russian thistle, falseflax, velvetleaf, jimsonweed, smartweed, redroot pigweed, ball mustard, tansy-mustard, and hemp.

Bromoxynil controls most annual broad-leaved weeds, including some 2,4-D resistant weeds, in wheat and barley when applied at ⅜ to ½ pound per acre as an early postemergence treatment. Some injury to small grains has occurred at the higher rate. Bromoxynil has also been used in combination with MCPA ester at ¼ pound of each material per acre applied early postemergence. The combination has injured underseeded legumes more than either material used alone. Bromoxynil does not control annual grasses or perennials.

Dicamba at ⅛ pound per acre controls hard-to-kill broad-leaved weeds such as wild buckwheat and smartweed in oats and wheat when used alone or in mixtures with ¼ pound per acre MCPA. The combination of dicamba and MCPA gives better control of mustard than dicamba alone. Oats are most tolerant to dicamba, followed by wheat, with barley being least tolerant. Applications made at the two- to five-leaf stage of small grain growth are the least injurious to the grains. **Caution:** Dicamba is cleared for use on wheat and oats, but not for spring barley. Do not graze or feed to livestock forage or threshings from small grains treated with dicamba.

Applications of 2,4-DB at ½ to 1½ pounds per acre made when small grains are 6 to 8 inches tall will control many broad-leaved weeds with no injury to legumes, except sweetclover. Mustard is not usually controlled by 2,4-DB, and other weeds require higher rates than used for MCPA or 2,4-D. **Caution:** Grain should not be harvested for 30 days after treatment.

For control of wild oats in small grains see section on WILD OATS control (page 16).

SMALL GRAINS—WINTER WHEAT AND RYE

Many annual broad-leaved weeds can be controlled in winter wheat and rye by spraying with 2,4-D — using the ester at ¼ to ½ pound per acre or the amine at ½ to ¾ pounds per acre in the spring, after the grain is fully tillered but before it is in the boot. Do not spray winter wheat or rye in fall. **Caution:** Do not graze or feed forage from treated fields within 2 weeks after treatment.

GRAIN SORGHUM

Sorghum will not germinate or grow in cold soil. Therefore, late planting in warmer soil, May 25 to June 10, is necessary if sorghum is to grow rapidly enough so that weeds can be controlled by cultivation. Later planting would be still more desirable but the short Minnesota growing season will not allow later planting if maximum grain production is desired.

Treatment with CDAA (Randox), propachlor (Ramrod), norea (Herban), propazine (Milogard), or atrazine (AAtrex) is usually necessary to prevent drastic reduction in sorghum yield due to weed competition. These herbicides control annual grasses (not wild oats) in sorghum. Propazine, atrazine, and norea also kill broad-leaved annual weeds. CDAA or propachlor at 4 pounds per acre, norea at 2.4 pounds per acre, or propazine at 2 pounds per acre are applied preemergence. Propachlor (Ramrod) is chemically related to CDAA and usually preferred.

Atrazine at 2 pounds per acre should be applied after the sorghum has emerged and as soon as a few annual grass weeds have started to emerge. Atrazine kills both emerged and nonemerged susceptible weeds, if grasses are less than 1½ inches tall when treated. A mixture of atrazine at 1 to 2 pounds per acre plus either special emulsifiable oil at 1 gallon per acre or special adjuvant-oil emulsion at ¼ to ½ gallon per acre gives better weed control than atrazine alone at the same rates. Approved emulsions of either vegetable or petroleum oils are satisfactory.

Mixtures approved for preemergence application are norea at 2 pounds per acre plus either atrazine or propazine at 1 pound per acre and propachlor at 2 to 3¾ pounds per acre plus atrazine at 1 to 1⅞ pounds per acre. **Caution:** Do not graze or feed forage within 21 days after application of atrazine or propachlor-atrazine. Do not graze or feed forage within 90 days after treatment with norea, norea-propazine, or norea-atrazine. Do not graze or feed forage from propachlor-treated sorghum to dairy cattle.

These herbicides have not seriously injured adapted grain sorghum varieties in Minnesota. Occasionally CDAA has caused injury, but the sorghum has recovered and outyielded unsprayed sorghum. Atrazine, propazine, or mixtures containing them should not be used on sandy soils, as injury to sorghum may occur.

For the control of broad-leaved weeds, 2,4-D may be used at ¼ to ½ pound per acre. However, injuries similar to those of corn may occur. Sorghum is most susceptible to 2,4-D in seedling, early boot, and pollination stages of growth. It is most tolerant when 4 to 12 inches tall, but injury may occur at this stage of growth also.

Dicamba (Banvel) at ⅛ to ¼ pound per acre is also approved for control of broad-leaved weeds in sorghum 4 to 12 inches tall and within 25 days after sorghum emergence. **Caution:** Do not graze or feed forage from dicamba-treated sorghum prior to the mature grain stage.

SOYBEANS

Cultural practices—Cool soil temperatures slow the germination and growth of soybeans considerably so that weeds may gain a competitive advantage. However, in warm soils, soybeans are good competitors of weeds because germination and growth are rapid.

Several cultural practices control annual weeds in soybeans. Preparing the seedbed immediately prior to sowing of the crop kills many weeds. Postemergence cultivation with the rotary hoe, harrow, or shovel cultivator is effective if done when the weeds are small and soil conditions are favorable.

Herbicides—Table 3 shows the performance of some preemergence herbicides in uncultivated soybeans during several years of county demonstrations. Figures show the percentage of trials in which weed control was rated good (more than 75 percent of the weeds controlled), fair (50 to 75 percent of the weeds controlled), or poor

Table 3. Early evaluations of herbicides in weed control demonstrations in uncultivated soybeans

Chemical	Pounds per acre active ingredient or acid equivalent broadcast	Years in trial	Number of trials		Percent of trials in each class					
					Grasses			Broad-leaved weeds		
			Grasses	Broad-leaved weeds	Good	Fair	Poor	Good	Fair	Poor
Alachlor (Lasso)	2½	1969-70	43	42	91	2	7	55	26	19
C-6989 (Preforan)	4½	1968-70	67	63	76	21	3	75	11	14
Chloramben (Amiben)	2	1963-66	149	137	54	27	19	56	25	19
Chloramben (Amiben)	3	1959-70	387	374	74	16	10	74	18	8
Linuron (Lorox)	2	1962-70	298	289	51	26	23	64	21	15
Propachlor (Ramrod)	5	1965-69	145	138	81	13	6	39	36	25
Trifluralin (Treflan)	1	1965-70	129	122	87	12	1	61	23	16

Table 4. Effectiveness of herbicides on major weeds in soybeans

	Preemergence						Preplanting		Post-emergence	
	Alachlor	C-6989	Chloramben	Chloramben and Norea	Chlorpropham	Linuron	Trifluralin	Vernolate	Chloroxuron	2,4-DB
Soybean tolerance	G	G	G	F	G	F	F	F	F	P
Grasses										
Giant foxtail	G	G	G	G	P	F	G	G	P	N
Green foxtail	G	G	G	G	P	F	G	G	P	N
Yellow foxtail	G	G	G	G	P	F	G	G	P	N
Barnyardgrass	G	F	G	G	P	F	G	G	P	N
Crabgrass	G	G	G	G	P	G	G	G	P	N
Nutsedge	G	P	P	P	N	P	P	F	N	N
Broadleafs										
Cocklebur	P	P	P	P	P	P	P	P	P	F
Lambsquarters	F	F	G	G	P	G	G	G	F	P
Mustard	P	F	F	F	F	G	P	F	G	P
Pigweed	G	G	G	G	P	G	G	G	F	P
Common ragweed	P	F	G	G	P	G	N	P	P	P
Smartweed	P	G	F	F	G	F	P	F	P	P
Velvetleaf	P	N	F	F	P	F	P	F	P	P
Wild sunflower	P	—	P	P	P	P	N	P	F	P

G — Good
F — Fair
P — Poor
N — No control
— Inadequate information

(less than 50 percent of the weeds controlled). Evaluations were made about 5 weeks after application.

Table 4 indicates soybeans tolerance to herbicides suggested for use in soybeans and efficiency of these herbicides in controlling common weeds. This is a general comparative control rating based on field observations. Under unfavorable conditions any of the herbicides may give unsatisfactory results. With favorable conditions control may be better than indicated.

Preplanting applications — In soybeans, trifluralin (Treflan) applied at ½ to 1 pound per acre preplanting and incorporated has given good control of annual grasses, pigweed, and common lambsquarters, but has given little control of most other broad-leaved weeds. Proper incorporation can be accomplished by double disking twice in opposite directions or by other methods which thoroughly mix the chemical with the top 3 inches of soil. The chemical should be incorporated while applying or within a few minutes after applying. Incorporation with a spike-tooth harrow after planting has caused trifluralin injury to soybeans in some trials.

Applications of trifluralin 2 to 3 weeks before planting have given equal weed control and less soybean injury compared with applications at planting time. With early application one disking can be done at application time, followed by an additional disking at planting.

Fall applications of trifluralin are feasible if the full rate for the soil type is applied after October 15 on a relatively level surface and disked in. Weed control has not been quite as good from fall applications as from spring applications, but with cultivation weed control should be satisfactory. Fall applications should not be attempted on fields subject to serious wind or water erosion or flooding nor on rough, cloddy fields.

Vernolate (Vernam) at 3 pounds per acre disked in preplanting has given good control of annual grasses, fair to good control of nutsedge, redroot pigweed, common lambsquarters, and velvetleaf, but inconsistent control of other broad-leaved weeds. Occasionally vernolate has caused some early soybean injury, but the soybeans have recovered without apparent yield reduction. Vernolate should be incorporated into the soil immediately after application to avoid loss of the chemical. Application on wet soils may result in poor weed control. The soil surface should be dry and the soil dry enough to permit good soil mixing.

Preemergence applications — Preemergence applications of chloramben (Amiben) at 3 pounds per acre control most annual broad-leaved and grass weeds. Performance has been consistent on all soil types where sufficient rain occurred before weeds emerged. In a few instances stand reductions and slight stunting of soybeans treated with chloramben have been noted. However, yields did not appear to be reduced.

Propachlor (Ramrod) has given good annual grass control but it is not effective against most broad-leaved weeds. Suggested rates are 4 to 5 pounds per acre. Soybeans have good tolerance to propachlor. **Caution:** As of December 1970 propachlor has received clearance for use on soybeans grown for seed for planting only. Do not use seed for food, feed or oil.

Alachlor (Lasso), chemically related to propachlor has given good annual grass control in soybeans. Alachlor has given fair to good control of redroot pigweed, and common lambsquarters, but control of other broadleafs has been erratic. Soybeans have good tolerance to alachlor. Suggested rates are 2 to 3 pounds per acre. Alachlor has usually controlled annual weeds better when applied preemergence than preplanting, but preplanting incorporated treatments controlled nutsedge better than preemergence applications.

C-6989 (Preforan) is a recently developed preemergence herbicide that has controlled annual grasses and some broadleafs. Soybeans have good tolerance to the chemical. Rates are 3¾ to 4½ pounds per acre. **Caution:** As of December 1970, C-6989 is cleared only for soybeans grown for seed for planting.

Preemergence applications of Linuron (Lorox) at ½ to 2½ pounds per acre control most annual broad-leaved weeds and grasses in soybeans. Linuron is best suited for medium textured soils with less than 4 percent organic matter. Weed control has been inconsistent on soils higher in organic matter and clay. Soybean injury has sometimes occurred on sandy soils. It is extremely important to use the rates recommended on the label for your soil type. Linuron may be used as a preemergence treatment for broadleaf control after trifluralin has been applied preplanting.

A mixture of chloramben and norea (Noraben) applied preemergence on soybeans has given good annual broadleaf and grass control. Rates for the chloramben-norea mixture are 1 to 1½ pounds per acre of chloramben and 0.8 to 1.2 pounds per acre of norea. There is some soybean injury potential with the chloramben-norea mixture. Do not use on sands or sandy loams with low organic matter.

Chlorpropham (Chloro IPC) applied preemergence at 2 to 3 pounds per acre has given good control of smartweed and fair mustard control. Other weeds are usually not controlled. Soybeans have good tolerance to chlorpropham. Chlorpropham may be applied preemergence to fields treated preplanting with trifluralin or in mixtures with some other preemergence herbicides.

The chemicals DCPA (Dacthal), dinoseb (DNBP), naptalam and chlorpropham mixture (Alanap plus, Solo), nitralin (Planavin), and PCP have occasionally caused injury to soybeans and/or have given erratic weed control under Minnesota conditions.

Postemergence applications: Cocklebur can be controlled by applying 2,4-DB at 0.2 pounds per acre to soybeans from 10 days before bloom up to midbloom or as a directed spray when soybeans are 8 to 12 inches tall. Cockleburs may develop regrowth and produce burs after a good initial dieback. The burs produced will germinate. Stunting of the soybeans may occur and appears to

be more severe under hot, dry conditions. Because of potential soybean injury, 2,4-DB should be used only in cases of severe cocklebur infestation. **Caution:** Do not harvest within 60 days after application.

Chloroxuron (Tenoran) can be used as an early postemergence spray on soybeans for control of certain broad-leaved weeds. The chemical gives excellent control of wild mustard, and fair to good control of common lambsquarters and redroot pigweed. Other broadleafs are only partially controlled and grasses are usually not controlled. One of the preplanting or preemergence chemicals discussed above should be used for grass control. Chloroxuron should be applied over the top of soybeans when the soybeans have the first trifoliolate leaf. Soybeans are susceptible to injury in the unifoliolate leaf stage. Broad-leaved weeds should be no more than 2 inches tall when sprayed. Chloroxuron will not effectively control larger weeds. The spray must contact the weeds to be effective. Some soybean leaf burn and delayed growth usually occurs following chloroxuron treatment. A few days delay in maturity has sometimes resulted. Suggested rates are 1 to 1½ pounds per acre applied with a special wetting agent. Do not apply more than these rates. **Caution:** Do not graze treated fields. Do not apply within 90 days of harvest.

SUGAR BEETS

Herbicides may be used in sugar beets to supplement conventional cultivation practices. Hand labor, mostly hoeing, is still needed but can be reduced by timely cultivations and herbicide applications. More than one herbicide application may be practical in some fields. Chemicals such as dalapon, endothall, phenmedipham, or pyrazon may be applied postemergence following preemergence or preplanting herbicide applications. However, the sugar beet injury potential is greater where these combination treatments are used than if only one application is involved. To minimize injury from combination treatments, the lower suggested rates should be used and postemergence treatments should not be applied at high temperatures.

Table 5 indicates sugar beet tolerance to herbicides suggested for use in sugar beets and relative effectiveness of these herbicides in controlling common weeds. This is a general control rating based on field observations. Under unfavorable conditions any of the herbicides may give unsatisfactory results. With favorable conditions control may be better than indicated.

Annual grasses, except wild oats, may be controlled by TCA at 6 to 8 pounds per acre applied preemergence. **Caution:** TCA is not cleared for use on sugar beets if the tops are to be fed.

EPTC (Eptam) at 2 to 3 pounds per acre incorporated into the soil before planting usually gives excellent annual grass control and often good annual broad-leaved weed control. The higher rates should be used only on fine-textured, high organic matter soils. Some stand reduction and temporary stunting may occur, especially from the higher rates. If postemergence treatments of other herbicides are planned, the lower rate of EPTC should be used to reduce sugar beet injury.

Cycloate (Ro-neet), chemically related to EPTC, controls annual grasses and some broadleafs when applied at 3 to 4 pounds per acre preplanting and incorporated. Use the higher rate except on coarse-textured, low organic soils. Cycloate has resulted in less sugar beet injury than EPTC, but cycloate has given more variable weed control. Less sugar beet injury has resulted from postemergence treatments following cycloate than following EPTC.

Both EPTC and cycloate give better results if applied when the soil surface is dry and the chemicals are thoroughly mixed into the soil immediately.

A combination of EPTC at 2 pounds per acre incorporated into the soil before planting plus TCA at 6 pounds per acre preemergence has given excellent control of annual grasses, particularly foxtail, and some broadleaf control in several years of testing. The combination has given satisfactory control under climatic conditions in which the single chemicals gave poor results. The treatment has at times given stand reduction and temporary stunting of beets. This combination treatment has given more severe injury in some years than in others.

Dalapon at 2 to 3 pounds per acre will control most emerged annual grasses. Higher rates or repeated treatments are usualy required to control wild oats and some sugar beet injury may occur. For best control, grasses should be sprayed before they are 3 inches tall. Late-emerging grasses can be controlled with directed sprays of dalapon at 2 to 3½ pounds per acre until sugar beets are 14 inches tall. If repeated applications are used, no more than 6 pounds per acre can be applied in any single growing season.

Pyrazon (Pyramin) controls most annual broadleaved weeds when applied at 3.8 pounds per acre preemergence on medium- to coarse-textured soils with less than 5 percent organic matter. Pyrazon should be used with TCA as a preemergence treatment for both annual grass and broadleaf control. Pyrazon has usually performed more consistently when applied as a postemergence treatment on most Minnesota soils, and addition of dalapon has improved weed control.

The mixture of dalapon and pyrazon (Pyramin Plus) has given good annual grass and broadleaf control if applied when broadleafs have two true leaves. The suggested rate is 3.8 pounds per acre of pyrazon and 2.2 pounds per acre of dalapon. Best results occurred when the mixture was applied postemergence following use of a preplanting or preemergence herbicide.

Diallate (Avadex) at 1½ to 2 pounds per acre as a preplanting soil-incorporated treatment may be used to control wild oats in sugar beets. Barban (Carbyne) at ¾ to 1 pound per acre may be used to control emerged wild oats. Wild oats should be sprayed in the two-leaf stage.

Certain broad-leaved weeds — annual smartweed, wild buckwheat, and marshelder — may be controlled by a postemergence application of endothall at ¾ to 1½

pounds per acre. Sugar beets should have 4 to 6 true leaves when endothall is applied. Do not apply endothall later than 40 days after sugar beet emergence.

Application of endothall at temperatures below 60°F. may give poor results. Temperatures in excess of 80°F. at time of treatment may cause excessive injury, particularly in very small beets. Endothall may cause leaf burn on the beets but recovery is usually rapid. Endothall will generally give disappointing results on most broad-leaved weeds not mentioned above.

Phenmedipham (Betanal) at 1 to 1½ pounds per acre as an early postemergence treatment controls most annual grasses and broad-leaved weeds except redroot pigweed. To avoid injury, the sugar beets should have two true leaves before treatment and the weeds should have no more than four leaves for best control. To reduce sugar beet injury do not apply when temperatures are over 85°F. and if a preemergence or preplanting herbicide has been used, use the lower rate of phenmedipham.

Trifluralin (Treflan) is cleared for use at ¾ pound per acre applied postemergence when sugar beets are 2 to 6 inches tall for annual grass control. The chemical must be incorporated immediately with cultivators or tillers adjusted to mix the chemical with soil in the row without damaging the sugar beets. Application is usually made immediately after blocking or thinning. The crop should be clean cultivated before application since trifluralin does not control established weeds.

SUNFLOWERS

Sunflowers are often a weedy crop. They compete well with weeds, but do not develop ground cover quickly enough to prevent weeds from establishing.

Weeds frequently emerge before sunflowers. Thus many weeds can be killed by spike-tooth or coil spring harrowing about 1 week after planting but before sunflowers germinate.

After sunflowers emerge such implements as the weeder, rotary hoe, spike-tooth or coil spring harrow may be used to kill weeds. Sunflower seedlings are strongly rooted so small emerging weeds in the "white" stage can be uprooted and killed without injury to the larger sunflowers. Setting of the harrow or weighting of the rotary hoe to do most damage to the weeds and least to the sunflowers can be accomplished on a "try-and-adjust" basis. It might pay to harrow the field several times if weed emergence warrants it.

Cultivation to kill weeds between the rows is the major method of weed control. Sunflowers are more easily damaged or broken by the cultivator than is corn.

EPTC (Eptam) at 3 pounds per acre or trifluralin (Treflan) at ½ to ¾ pound per acre on sandy soil to 1 pound per acre on finer textured soils are applied preplanting and incorporated into the soil while applying or within a few minutes after applying. If a disk is used for incorporation, the field should be disked twice, once in each direction. The second disking need not be done the same day. Both herbicides kill many grasses and some broad-leaved annual weeds but are not usually effective on wild mustard, smartweed, or wild oats although EPTC occasionally gives good control of wild oats. Trifluralin temporarily stunted sunflower roots in some trials when the crop was planted the day of application but no permanent injury resulted.

Sunflowers are tolerant of several preemergence herbicides but only chloramben (Amiben) at 3 pounds per acre is cleared. Chloramben controls annual grasses and broadleafs. **Caution:** Do not graze or feed sunflower forage from chloramben-treated areas. For wild oat control in sunflowers see WILD OATS section page 16.

Table 5. Effectiveness of herbicides on major weeds in sugar beets

	Preplanting		Pre-emergence	Postemergence				
	Diallate	EPTC	TCA	Barban	Dalapon	Endothall	Phenmedipham	Pyrazon
Sugar beet tolerance	G	F	G	G	F	F	F	G
Grasses								
Giant foxtail	P	G	G	P	G	P	F	P
Green foxtail	P	G	G	P	G	P	G	P
Yellow foxtail	P	G	G	P	G	P	G	P
Barnyard grass	P	G	G	P	G	P	P	P
Wild oats	G	F	P	G	F	P	P	P
Broadleafs								
Common ragweed	P	F	P	P	P	F	G	G
Lambsquarters	P	F	P	P	P	P	G	G
Marshelder	P	—	P	P	P	G	—	—
Pigweed	P	F	P	P	P	F	P	F
Smartweed	P	P	F	P	P	G	F	G
Wild buckwheat	P	P	P	P	P	G	G	G
Wild mustard	P	P	P	P	P	P	G	G

G = Good F = Fair P = Poor — Inadequate information

CULTURAL PRACTICES FOR CONTROLLING PERENNIAL WEEDS

Perennial weeds such as Canada thistle, perennial sowthistle, field bindweed, leafy spurge, and quackgrass are difficult and expensive to control. Control is usually accomplished best with a combination of cultural practices, cropping systems, and chemicals.

These persistent perennial weeds spread vegetatively as well as by seed. Underground parts of the plants store food and produce new growth. Control programs should be planned to (1) prevent seed production; (2) destroy top growth repeatedly, thereby depleting food reserves; (3) kill underground parts by exposure to drying and freezing at the soil surface; and (4) eliminate small seedlings before they form rhizomes or other reproductive organs.

The following practices have been used successfully in Minnesota. Each farmer may need to adapt these ideas to fit his particular cropping system and soils.

Tillage — Properly timed, repeated destruction of top growth by plowing followed by cultivation at regular intervals or fallowing will eventually exhaust underground food storage organs. Underground parts exposed to the surface will dry and die. Quackgrass is especially susceptible to surface exposure because rhizomes do not extend below the plow layer and can be pulled to the surface by spring-tooth tillage implements. Cultivation must be frequent and continued over a long enough period, usually two or more seasons, to free the soil of all underground rootstocks or rhizomes. Fallowing is effective in dry years but is not very successful in wet years or on poorly drained soils. When the soil is wet, underground parts do not dry when exposed to the surface. Also, under wet conditions, it may be impossible to repeat tillage operations at the proper time to destroy regrowth. The possibility of erosion may prevent the use of this control method on certain fields. If the weed is limited to scattered patches, till these patches separately or use a disk to avoid dragging rootstocks or rhizomes to clean parts of the field.

Tillage practices may be effectively combined with growing winter small grains or short-season, late-planted summer annuals such as forage sorghums, sudangrass, sorghum-sudangrass hybrids, or millet. Various combinations of the following suggested cultural practices should effectively control perennial weeds when used with chemicals.

Fall plow and cultivate at 2- to 3-week intervals until freezeup. A field cultivator equipped with overlapping sweeps operated at a 4-inch depth works well for this job.

In the spring, begin cultivation again as soon as 2 to 3 inches of top growth appears and repeat the cultivations whenever there is 2 to 3 inches of regrowth. Continue cultivations until:

a. Freezeup in the fall.
b. About July 1, when forage sorghums, sudangrass, sorghum-sudangrass hybrids, or millet can be planted. After harvest, cultivate until freezeup.
c. September, when winter rye or winter wheat can be sown. After harvest cultivate until freezeup. These practices may be repeated, used in sequence, or the land fallowed as needed to eliminate the problem weeds. Chemicals should be used in the crops to control the weeds while a crop is growing.

Cultivation — Infestations of perennial weeds can be reduced in row crops by frequent cultivations. Timing cultivations to kill top growth when it is not more than 2 inches tall and to eliminate small seedlings before they develop rhizomes or other storage organs will increase the effectiveness of cultivations. Best results are obtained in corn by check planting and cross cultivating. However, if check planting is used it may be impossible to plant corn populations high enough for optimum yields without overcrowding the corn hill.

Mowing — Frequent mowing will weaken and suppress perennial weeds. Weeds should be mowed by the time the first flowers appear so that seeds will not form and then clipped whenever top growth warrants it.

Areas infested with perennial weeds may be planted to hay crops and cut for hay over several years to weaken the weeds and keep them from spreading.

Management — Good management in growing all crops will help control perennial weeds. Using quality seed of adapted varieties and proper seeding rates helps establish good stands to compete with weeds. Adequate preparation of the seedbed prior to planting eliminates existing vegetation and gives crops at least an even start. Narrower rows may help control weeds by shading the row middles sooner. But the space between rows should be wide enough to cultivate so problem weeds can be controlled by cultivation.

CHEMICALS FOR CONTROLLING PERENNIAL BROAD-LEAVED WEEDS IN CROPS

Perennial broad-leaved weeds such as Canada thistle, perennial sowthistle, field bindweed, and leafy spurge can be suppressed with 2,4-D or MCPA in tolerant crops. Use 2,4-D or MCPA on oats, wheat, barley, or corn; MCPA is less injurious to oats. These chemicals may also be used in conjunction with the tillage and cropping practices mentioned above or in grass pastures.

Proper timing of the spray applications is very important for getting good results. Usually two or more applications during the growing season and retreatment for several years are necessary. The chemicals are most effective if applied when the weeds are just starting to grow in the spring and again near the bud stage of the weeds. Timing will also be influenced by the tolerance of the crop being sprayed. Avoid spraying small grains

with 2,4-D before the five-leaf stage and in the boot stage. Do not spray corn with 2,4-D from tasseling to the dough stage.

The amount of chemical used should be that recommended for the crop being sprayed. Higher rates may cause crop injury. These rates will not eradicate perennial weeds, but the treatments will usually reduce or kill top growth and prevent seed production.

Perennial broad-leaved weed infestations can be effectively reduced by applying 1 to 2 pounds of 2,4-D per acre after harvest of small grains, flax, or other early maturing crops. This treatment will kill legumes. Mow the area after harvest, allow regrowth to reach 6 to 8 inches, and spray while the weeds are still growing vigorously.

In grass pastures, perennial broad-leaved weeds have been controlled with one to two applications per year of 2,4-D at 1 to 2 pounds per acre. Spray when the weeds are growing rapidly and before the bud stage. Repeated treatment for 2 or more years is usually necessary. **Caution:** Do not graze dairy cattle for 7 days after treatment.

Dicamba will suppress Canada thistle in small grains and corn. Use the maximum rate of dicamba listed for the specific crop. Drift may damage soybeans or other broad-leaved plants.

It is not desirable to grow soybeans in Canada thistle infested fields because chemicals cannot be used in soybeans for thistle suppression. If soybeans must be grown, spray with 1 pound per acre of 2,4-D when thistles are a few inches tall and at least 2 weeks before planting soybeans. Delay seedbed preparation and planting of soybeans at least 2 weeks after spraying to allow time for 2,4-D to act and to avoid 2,4-D residue effects on the soybeans.

Amitrole or Amitrole-T will control Canada thistle when applied either in the fall after harvesting crops or in the spring prior to planting corn. The suggested rate is 4 pounds per acre in 30 or more gallons of water. It is important that a full stand of thistles emerges before spraying. Best results follow treatment just before bud stage or when regrowth is 6 to 8 inches tall. If thistles have been spring-plowed, delayed in emergence, are blooming or mature, or if treatment follows harvesting in late summer or fall, it is best to mow and spray the regrowth when it is 6 to 8 inches tall. Plowing or cultivating after spraying is not necessary, but, if done, should be delayed at least 2 weeks after treatment.

Corn may be planted 2 weeks after amitrole or amitrole-T treatments without danger of injury to the corn from residue. **Caution:** Amitrole-treated areas should not be planted to other crops, grazed, or cut for hay for 8 months after treatment.

CHEMICALS FOR CONTROLLING QUACKGRASS

It is possible to greatly reduce or eliminate quackgrass infestations with chemicals. Weather conditions, soil type, timing of treatments, and accompanying tillage will influence the results.

Atrazine is the most effective herbicide for quackgrass control. Preplow applications of 2 to 4 pounds per acre to quackgrass sod in the fall, September to freezeup, or spring, after the frost is out until mid-May, have resulted in nearly complete elimination of quackgrass stands. The low rate is adequate on sandy soils but higher rates are necessary on heavier soils. Treated areas should be plowed and planted to corn only. Other crops are likely to be injured. If 3 to 4 pounds per acre are used, plant corn 2 years to avoid possible carryover injury.

Split applications, 2 pounds per acre of atrazine on quackgrass sod in the fall or early spring and 1 to 2 pounds per acre on the corn as a preemergence treatment, have the advantage of controlling annual weeds in the corn as well as eliminating the quackgrass.

TCA applied at the rate of 22 pounds per acre in September or early October on land that has recently been plowed or thoroughly cultivated has given fair quackgrass control. The next year, if the land is cropped make a second application of 18 pounds per acre after harvest to eradicate the quackgrass.

Normal growth of crops sown or planted in the spring following a fall application of 22 pounds of TCA can be expected from flax, potatoes, sugar beets, oats, corn, and strawberries if normal rainfall has occurred. If it has been dry following the application of TCA, all crops may be injured.

Dalapon will give results similar to those obtained with TCA when applied to the soil or areas of scanty foliage. It is more effective than TCA when applied to a good growth of foliage. Fall treatment of 12 to 15 pounds per acre followed in a week or two by plowing or other similar soil preparation gives good control of quackgrass the following year. Repeated treatments are necessary for eradication. Control is best when rain occurs between treatment and plowing. Response of spring-sown crops to residues of dalapon in the soil is similar to that for TCA.

Dalapon may also be applied to quackgrass in the spring. An application of 5 pounds per acre, when quackgrass leaves are about 6 inches tall, followed in 2 or 3 weeks by plowing or other soil tillage has proved most satisfactory. Crops should not be planted until 4 weeks after the application. Corn, wheat, and soybeans are especially sensitive to small amounts of dalapon in the soil.

WILD OATS

There are two major reasons for the difficulty in controlling wild oats: (1) its habit of shattering its seed before most crops are harvested, and (2) its delayed germination characteristic. Unless the crop in which the wild oats occurs is cut for hay, enough seed is shattered to infest the soil for years. The germination of the seed and the length of time it can remain viable depend on several factors.

Favorable temperature and moisture for germination are most common in fall and spring; very little seed ger-

minates between June and September. Some seeds require afterripening or a rest period in which the seed coat becomes more permeable to oxygen, which is necessary for germination. Seeds kept under favorable conditions usually germinate in 1 to 3 years. However, when seeds are plowed under they may remain dormant and viable for a longer time.

The following cultural methods of control are suggested to reduce the wild oat problem on badly-infested fields. These practices will have to be followed at least 2 or 3 years to be effective.

Tame oats may be planted early and cut for hay before wild oats form seed. Plow immediately after removing the hay crop.

Cultivate shallowly in the spring to break the soil crust and cover seed. Repeat shallow cultivation as needed to kill the wild oats that have germinated, and to bring up other seed that is no longer dormant. About the middle of June sow a crop adapted to late sowing — such as early varieties of flax, corn, proso millet, buckwheat, sudangrass, and soybeans. Use fertilizer and heavy seeding rates. Generally, earlier seeding of higher profit crops and using chemicals is more profitable than late seeding. Delayed seeding may result in lower yields or require using less profitable crops adapted to late planting.

Several herbicides are now available which may be used to control wild oats in a number of crops.

Preplant or preemergence incorporated applications of diallate (Avadex) at 1½ to 2 pounds per acre will control wild oats in flax with no injury to the crop. This compound may be used for the control of wild oats in barley if applied after planting at 1¼ pounds per acre. Triallate (Far-go), a related compound, appears somewhat safer to barley and may be applied at the same rate either before or after seeding the barley. Triallate, but not diallate, may be used for the control of wild oats in hard red spring or durum wheat if applied at a lower application rate, 1 pound per acre, after seeding. Lower application rates, afterseeding applications, and greater depth of planting of the grain tend to reduce the possibility of crop injury from diallate or triallate. However, the degree of wild oats control usually decreases as the application rate is reduced. Diallate and triallate require incorporation immediately to prevent losses by evaporation. Alfalfa and clovers may be underseeded in crops treated with diallate.

Fall applications after October 15 of diallate before sugar beets or flax and triallate before barley or spring wheat have been used successfully in northern areas. A good seedbed free of trash should be prepared before application and the chemical incorporated as above. Soil should be worked no more than 2 to 2½ inches in spring. Fall applications are not advised on soils subject to wind or water erosion.

Diallate or atrazine will control wild oats in corn without injury to the corn.

Barban (Carbyne) should be applied to wild oats in the two-leaf stage from 4 to 10 days after emergence to obtain the greatest degree of control. Application rates of 4 to 6 ounces per acre will usually control wild oats in flax, wheat, and barley. Flax is more sensitive to barban than wheat, and barley is least sensitive. Thick stands of crop plants aid in suppression of wild oats and enhance the degree of control obtained with barban. Wild oats control may not be satisfactory in thin crop stands. To reduce crop injury, do not spray barban after wheat or barley is in the 4-leaf stage or more than 14 days after emergence, or after flax is in the 12-leaf stage, nor later than 1 month after sugar beets emerge. **Caution:** Do not allow livestock to graze treated barley, wheat, or sugar beet fields until after the crop is harvested. Do not feed treated flax straw to livestock.

Barban is cleared for early postemergence application in soybeans and sunflowers at rates up to 6 ounces per acre. Apply when most of the wild oats are in the 2-leaf stage. Do not apply after the first trifoliolate leaf stage of the soybeans nor later than 14 days after soybean or sunflower emergence. **Caution:** Do not harvest forage or allow livestock to graze treated fields until after crop harvest.

For information on the control of wild oats in sugar beets, see page 13.

COMPLETE VEGETATION CONTROL IN NONCROPLAND AREAS

Several herbicides are available for controlling small areas of perennial weeds or for complete vegetation control in noncropland areas. These herbicides may prevent the growth of plants for a few weeks to more than 2 years, depending on the chemical and rate of application. Most chemicals do not control all weed species, so read the label for weeds controlled by a specific product. The cost on an acre basis may be rather high for these chemical treatments. Use of chemicals for this type of weed control must also comply with the provisions of the Miller Amendment to the Federal Food, Drug, and Cosmetic Act (see page 2).

Be sure the treatment you select agrees with your planned future use of the area. Larger dosages than those suggested below will give better and more lasting control. Higher rates are usually more necessary on low than on high, dry locations. Lower rates and less water or other carrier are needed if applications are made before plant growth is large and dense.

Short-term control — For a temporary kill, use 5 to 10 pounds per acre of dalapon plus 1 to 2 pounds per acre of 2,4-D ester. This treatment works best if applied when the weeds are small and controls both grasses and broad-leaved weeds.

Paraquat is a contact herbicide that kills topgrowth of weeds when applied at ½ to 1 pound per acre in 50 to 100 gallons of water. Paraquat is more effective

against young, succulent weeds. There is no soil residual. Perennial weeds will regrow.

Long-term control — To control vegetation on noncropland for at least 1 year, the compounds and rates described below may be used. Numerous mixtures of these materials are available.

Picloram alone at 1 to 2 pounds per acre or mixed with 2,4-D gives excellent control of perennial broadleaved weeds such as Canada thistle, sowthistle, field bindweed, Russian knapweed, and leafy spurge in nonagricultural lands.

Dicamba may be used at 5 to 10 pounds per acre for control of broad-leaved perennials. It should be applied to the foliage or soil when the weed is actively growing.

Trichlorobenzoic acids are effective in controlling perennial broad-leaved weeds when applied at 15 to 20 pounds acid equivalent per acre. Mixtures of dichloro, trichloro, and tetrachloro benzoic acids (PBA) at rates of 30 to 50 pounds per acre have been as effective as TBA.

Mixtures of TBA and borates effectively control perennial broad-leaved weeds and annual weeds. These are not recommended for controlling perennial grasses.

Substituted urea compounds effectively control vegetation for an extended time. Monuron and diuron are related compounds that control vegetation; apply 20 to 40 pounds per acre (⅛ to ¼ pound per square rod). Diuron is the slower acting, but has the longer residual. Monuron and diuron are wettable powders applied as sprays.

Borate compounds at 10 pounds of B_2O_3 per square rod or borate-chlorate mixtures at 8 pounds of active ingredient per square rod have given satisfactory vegetation control. Another treatment may be required for surviving plants, beginning the second spring after the original treatment.

Mixtures of monuron and borates are designed for use as nonselective residual herbicides on industrial sites.

Bromacil controls annual and perennial weeds in noncropland where bare ground is desired. Bromacil should be applied just before or during active growth of weeds. Rates vary from 3 to 15 pounds per acre according to the weed species; refer to the label for specific rates.

Atrazine and simazine are effective for complete vegetation control when applied at 10 to 20 pounds per acre, either as granules or sprays. They are not very effective on some woody plants.

Prometone (Pramitol) is a related triazine material that gives a more rapid kill of existing top growth.

A mixture of amitrole and simazine (Amizine) gives the persistence of simazine in length of vegetation control and the amitrole portion of the mixture quickly kills young vegetation that persists for long periods when simazine is used alone.

Erbon is a nonselective herbicide effective on most broad-leaved and grass weeds. Docks, nutsedge, milkweed, and Canada thistle are resistant to erbon. Apply as a spray at 1 pound per square rod.

NIA 11092 (Tandex) is toxic to many grasses and broad-leaved weeds when applied preemergence or postemergence. Suggested rates are 2.4 to 24 pounds per acre depending on the species to be controlled.

The weeds reinfesting sterilized areas are usually broad-leaved species. Relatively inexpensive treatments with 2,4-D ester at 1 pound per acre may maintain areas free of vegetation for several additional years.

Table 6. Chemicals for Noncropland Weed Control (fencerows, building sites, rights-of-way, parking lots, etc.)

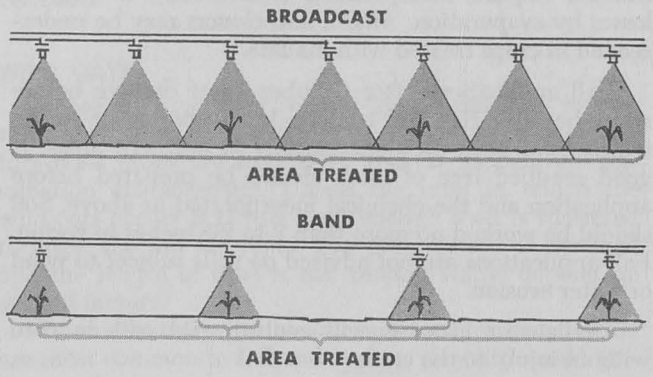
Weeds controlled		
Grasses	Broadleafs	Broadleafs and grasses
dalapon	dicamba	amitrole, amitrole-T
TCA	2,4-D	AMS
mixtures	fenac	atrazine
	PBA	borates
	picloram	bromacil
	silvex	diuron
	2,3,6-TBA	erbon
	TBP	monuron
	2,4,5-T	NIA 11092
	mixtures	paraquat
		prometone
		simazine
		mixtures

Follow manufacturer's recommendations on rates and times of application. Consider possible damage to nearby trees, shrubs, grass, crops, and possible movement of chemicals with water or wind.

Farm Sprayer Calibration and Adjustment

Uniform application of spray chemicals is essential for effective weed control. A small variation in the rate of application may result in poor kill of the weeds or injury to the crop, thereby causing a loss of time, effort, and money.

Rates in this publication are in terms of active ingredient or acid equivalent per acre treated. Rate per acre in the treated area should be the same for broadcast as for band applications. But proportionately less material is used per crop acre with band than broadcast applications. For example, a 3-pound-per-acre rate requires 3 pounds of material per crop acre with broadcasting but only half as much per crop acre (1½ pounds)



if a 15-inch band is treated on rows spaced 30 inches apart.

To determine how much liquid a sprayer applies per acre:

1. Check the output of all nozzles for a set time to make sure that all nozzles discharge at the same rate.

2. Start with a full tank of clean water and have the pressure adjusted as you will use it in the field (usually 20 to 40 pounds).

3. Drive exactly ⅛ mile (40 rods) (660 feet) in a field at the speed you will use when spraying — usually 4 to 5 miles per hour. Mark throttle setting or speed indicator reading and maintain same speed when spraying.

4. Refill the tank, carefully measuring the amount of liquid required. (If water spillage from a full tank is a problem, you can use a calibrated stick to measure amount of liquid used.)

To calculate broadcast application rate:

$$\frac{\text{Number of gallons used X 66}}{\text{Boom width in feet}} = \text{gallons per acre.}$$

Example: If 2½ gallons were used in ⅛ mile and the width covered by the boom is 24 feet, multiply 2½ by 66 and divide by 24. The result is 6.9 gallons per acre.

To calculate band application rate (volume per acre applied to the area within the band that is sprayed);

$$\frac{\text{Number of gallons used X 66}}{\text{Band width in feet X Number of bands}} = \text{gallons per acre.}$$

Example: If 1½ gallons were used in ⅛ mile and the sprayer applied 4 bands 15 inches (1¼ feet) in width, multiply 1½ X 66 and divide by 1¼ X 4. The result is 19.8 gallons per acre.

This is the volume per acre applied to the area within the band that is sprayed.

To determine the amount of herbicide formulation to use per acre sprayed:

1. Determine the number of pounds of acid equivalent or active ingredient suggested per acre for your situation. Use acid equivalent if it appears on the label. Otherwise, use active ingredient.

2. For dry materials, divide the number of pounds of active ingredient or acid equivalent desired by the percent of active ingredient or acid equivalent in the commercial product to determine the number of pounds of the material to apply per acre. Example: If 3 pounds of active ingredient are required and the commercial product is an 80 percent active ingredient powder, divide 3 by .8 = 3.75 pounds of commercial powder per acre.

For liquids, determine the volume of commercial product to apply per acre to get the proper amount of acid equivalent or active ingredient per acre. Example: If ½ pound of acid equivalent is required per acre and the commercial product contains 4 pounds acid equivalent per gallon, then 1 quart contains 1 pound acid equivalent; 1 pint contains ½ pound acid equivalent.

Similar calculations were used to make table 6.

To determine the amount of herbicide to put in the tank:

1. Divide the number of gallons the tank will hold by the number of gallons your sprayer applies per acre. This will give you the number of acres one filling will spray.

2. Multiply the number of acres the tank will spray by the amount of herbicide to be used per acre. This will give the amount of herbicide to be used per tankful.

Granule Applicator Calibration

1. Determine the number of pounds of active ingredient or acid equivalent suggested per acre for your situation from this publication.

2. Divide the number of pounds of active ingredient or acid equivalent desired by the percentage of active ingredient or acid equivalent in the commercial material to determine the number of pounds of the material to apply per acre or determine from table 6.

3. Consult the manufacturer's recommendation to make approximate setting. Adjust setting on each hopper.

4. Select an area for a test run, preferably in the field to be treated, so that speed and traction conditions are constant. Measure off a distance of 660 feet (40 rods).

5. Fill hoppers and attach a suitable container (sack, pail, etc.), to each hopper spout to catch granules from each hopper.

6. Put machine in gear and drive the measured distance at the same speed that will be used when applying the chemical.

7. Weigh the material collected from each hopper. Multiply this weight in pounds by 66 and divide by the band width (in feet). This will give the pounds of granular material applied per acre on the area treated. In equation form:

$$\frac{\text{Weight of granules in pounds} \times 66}{\text{Band width in feet}} = \text{Pounds of granules applied per acre}$$

8. Readjust machine output and repeat the calibration process until the desired amount is obtained from each hopper.

Weights and Measures

1 pound = 16 ounces; 454 grams.

1 gallon = 4 quarts; 8 pints; 128 fluid ounces; 256 level tablespoons; 3,785 cubic centimeters; (milliliters).

1 tablespoon = 3 teaspoons; ½ fluid ounce; 14.8 milliliters.

1 acre = 43,560 square feet; 160 square rods; an area 208.7 feet square; an area 16½ feet wide and ½ mile long.

1 mile = 5,280 feet; 1,760 yards; 320 rods.

1 rod = 5½ yards; 16½ feet.

Table 7. Amounts of herbicide products of different concentrations to use per acre for various application rates

Concentration of herbicide formulation	Amount of formulation to use per acre broadcast to obtain an active ingredient or acid equivalent rate of				
	⅛ lb.	¼ lb.	½ lb.	¾ lb.	1 lb.**
Pounds of active ingredient or acid equivalent per gallon	pints	pints	pints	pints	pints
1	1.0	2.0	4.0	6.0	8.0
1½	.67	1.33	2.67	4.0	5.33
2	.50	1.0	2.0	3.0	4.0
3	.33	.67	1.33	2.0	2.67
4	.25	.50	1.0	1.50	2.0
5	.20	.40	.80	1.20	1.60
6	.16	.33	.67	1.0	1.33
7	.14	.29	.57	.86	1.14
8	.125	.25	.50	.75	1.0
9	.11	.22	.44	.67	.89
10	.10	.20	.40	.60	.80
Percentage of active ingredient or acid equivalent in dry formulation	lb.*	lb.	lb.	lb.	lb.
2	6.25	12.5	25.0	37.50	50.0
5	2.50	5.0	10.0	15.0	20.0
8	1.56	3.12	6.25	9.38	12.50
10	1.25	2.50	5.0	7.50	10.0
20	.62	1.25	2.5	3.75	5.0
25	.50	1.0	2.0	3.0	4.0
30	.42	.83	1.67	2.50	3.33
40	.31	.62	1.25	1.88	2.50
50	.25	.50	1.0	1.50	2.0
60	.208	.42	.83	1.25	1.67
65	.192	.38	.77	1.15	1.54
70	.178	.36	.72	1.07	1.43
75	.167	.33	.67	1.0	1.33
80	.156	.31	.62	.94	1.25
85	.147	.29	.59	.88	1.18
90	.139	.28	.56	.83	1.11

* To convert to ounces multiply by 16.
** For rates over 1 lb/A, multiply amount for 1 lb/A by the desired rate.

Table 8. Herbicide names and formulations

Common name	Trade name[1]	Chemical name	Concentration and commercial formulation[2]
Alachlor	Lasso	2-chloro-2′,6′-diethyl-N-(methoxymethyl) acetanilide	4 lb/gal L, 10% G
Amitrole	Amino-triazole, Amizol, Weedazol, Mixtures	3-amino-1,2,4-triazole	50, 90% WSP
Amitrole and Simazine	Amizine		15% amitrole WSP 45% simazine WP
Amitrole-T	Amitrol-T, Cytrol	3-amino-1,2,4-triazole plus ammonium thiocyanate	2 lb/gal L
AMS	Ammate	ammonium sulfamate	95% WSP
Atrazine	AAtrex, Atratol, Mixtures	2-chloro-4-ethylamino-6-isopropylamino-s-triazine	80% WP 8% P
Atrazine and prometryne	Primaze		40% atrazine, 40% prometryne WP
Atrazine and linuron	Several		30.8% linuron, 30.8% atrazine WP
Barban	Carbyne	4-chloro-2-butynyl m-chlorocarbanilate	1 lb/gal L

[1] "Several" means there are numerous trade names for this chemical. "Mixtures" means the chemical is mixed with other chemicals in commercial formulations.
[2] G — granular, L — liquid, WP — wettable powder, WSP — water-soluble powder, P — pellets

Table 8. Herbicide names and formulations (con't)

Common name	Trade name[1]	Chemical name	Concentration and commercial formulation[2]
Benefin	Balan	N-butyl-N-ethyl-a,a,a-trifluro-2,6-dinitro-p-toluidine	1½ lb/gal L
Boron compounds (borax, sodium pentaborate, boron trioxide, anhydrous sodium, biborate, and mixtures.)	Several, Mixtures		Various
Bromacil	Hyvar-X, Hyvar-XL Hyvar-XWS. Mixtures	5-bromo-3-sec-butyl-6-methyluracil	80% WP, 3 lb/gal L, 50% WSP Various
Bromoxynil	Buctril, Brominal	3,5-dibromo-4-hydroxybenzonitrile	2 lb/gal L
Bromoxynil and MCPA	Bronate, Brominal Plus		2 lb/gal bromoxynil, 2 lb/gal MCPA L
Butylate	Sutan	ethyl di-isobutylthiolcarbamate	6 lb/gal L, 10% G
C-6313	Maloran	N-(4-bromo-3-chlorophenyl)-N'-methoxy-N'-methyl urea	50% WP
C-6989	Preforan	p-nitrophenyl 2-nitro-4-(trifluoromethyl) phenyl ether	3lb/gal L, 15% G
CDAA	Randox	2-chloro-N,N-diallylacetamide	4 lb/gal L 20% G
CDAA and TCBC	Randox-T	CDAA plus trichlorobenzylchloride	3.1 lb/gal CDAA, 6.3 lb/gal TCBC L 11.7% CDAA, 23.3% TCBC G
Chloramben	Amiben, Vegiben	3-amino-2,5-dichlorobenzoic acid	10% G, 2 lb/gal L
Chloramben and dinoseb	Dynoram, Premerge 21		1 lb/gal chloramben, 2 lb/gal dinoseb L
Chloroxuron	Tenoran	N-(4-chlorophenoxy)=phenyl-N,N-di=methylurea	50% WP
Chlorpropham (CIPC)	Chloro IPC, Mixtures	isopropyl N-(3-chlorophenyl)=carbamate	10% G 4 lb/gal L
Cycloate	Ro-neet	S-ethyl N-ethylthiocyclohexane=carbamate	6 lb/gal L
Dalapon	Basfapon, Dowpon, Kenapon, Radapon, Mixtures	2,2-dichloropropionic acid	74% WSP 5 lb/gal L
Dalapon and TCA	Dowpon C		46.5% dalapon, 26.2% TCA WSP
DCPA	Dacthal	dimethyl 2,3,5,6-tetrachloroterephthalate	50, 75% WP
Diallate	Avadex	S-2,3-dichloroallyl N,N-diisopropyl=thiolcarbamate	4 lb/gal L, 10% G
Dicamba	Banvel, Mixtures	3,6-dichloro-o-anisic acid	4 lb/gal L
Dicamba and MCPA	Banvel-M		1.25 lb/gal dicamba, 2.50 lb/gal MCPA L
Dinoseb (DNBP)	Several, Mixtures	4,6-dinitro-o-sec-butylphenol	1, 3, 5 lb/gal L 10% G
Diuron	Karmex, Mixtures	3-(3,4-dichloro=phenyl)-1,1-dimethylurea	L, WP, G Varies
Endothall	Endothal, Herbicide 273	7-oxabicyclo-(2.2.1) heptane-2,3-dicarboxylic acid	1.46 lb/gal L 3 lb/gal L 5% G
EPTC	Eptam	ethyl N,N-dipropyl=thiocarbamate	6 lb/gal L, 10% G
EPTC and 2,4-D	Knoxweed		4 lb/gal EPTC, 1.6 lb/gal 2,4-D L 10% EPTC, 4% 2,4-D G

[1] "Several" means there are numerous trade names for this chemical. "Mixtures" means the chemical is mixed with other chemicals in commercial formulations.
[2] G — granular, L — liquid, WP — wettable powder, WSP — water-soluble powder, P — pellets

Table 8. Herbicide names and formulations (con't)

Common name	Trade name[1]	Chemical name	Concentration and commercial formulation[2]
Erbon	Baron, Novege	2-(2,4,5-trichloro= phenoxy) ethyl- 2,2-dichloro= propionate	1, 4 lb/gal L
Fenac	Fenac, Mixtures	2,3,6-trichloro= phenylacetic acid	1½ lb/gal L 10% G
Fenac and amitrole and atrazine	Fenamine		.55 lb/gal fenac, .33 lb/gal amitrole, 1.0 lb/gal atrazine L
Linuron	Lorox, Mixtures	3-(3,4-dichlorophenyl)-1- methoxy-1-methylurea	50% WP
Linuron and propachlor	Londax		15% linuron, 30% propachlor WP 5% linuron, 10% propachlor G
MCPA	Several, Mixtures	2-methyl-4- chlorophenoxy= acetic acid	Various L
Monuron	Telvar, Mixtures	3-(p-chloro= phenyl)-1,1-di= - methylurea	G, L, WP Various
Neburon	Several, Mixtures	1-butyl-3-(3,4- dichlorophenyl) -1-methylurea	Various WP
NIA 11092	Tandex	m-(3,3-dimethylureido)phenyl tert-butylcarbamate	80% WP, 4% G
Nitralin	Planavin	4-(methylsulfonyl) 2,6-dinitro-N,N- dipropylanaline	75% WP
Norea	Herban, Mixtures	3-(hexahydro-4, 7-methanoindan-5- yl)-1,1-dimethylurea	80% WP
Norea and amiben	Noraben		1.5 lb/gal amiben, 1.2 lb/gal norea L
Norea and atrazine	Herban 21A		53.33% norea and related, 26.67% atrazine WP
Naptalam (NPA)	Alanap	N-1-naphthyl= phthalamic acid	2 lb/gal L, 10% G
Naptalam and chlorpropham, (NPA and CIPC)	Alanap Plus		2 lb/gal naptalam 1½ lb/gal chlorpropham L 7.5% naptalam 5% chlorpropham G
Naptalam and chlorpropham	Solo		2 lb/gal naptalam 2 lb/gal chlorpropham L 10.7% naptalam, 10.3% chlorpropham G
Naptalam and dinoseb (DNBP)	Dyanap		2 lb/gal naptalam 1 lb/gal dinoseb L
Paraquat	Paraquat	1,1'-dimethyl-4,4'- bipyridinium salts	2 lb/gal L
PBA	Several, Mixtures	polychlorobenzoic acid	Various L
PCP	Several, Mixtures	pentachloro= phenol	L, WP, WSP, G Various
Phenmedipham	Betanal	3-methoxycarbonylaminophenyl- N-(3'-methylphenyl) carbamate	1.3 lb/gal L
Picloram	Borolin, Tordon Beads, Mixtures	4-amino-3,5,6- trichloropicolinic acid	2% G

[1] "Several" means there are numerous trade names for this chemical. "Mixtures" means the chemical is mixed with other chemicals in commercial formulations.
[2] G — granular, L — liquid, WP — wettable powder, WSP — water-soluble powder, P — pellets

Table 8. Herbicide names and formulations (con't)

Common name	Trade name[1]	Chemical name	Concentration and commercial formulation[2]
Picloram and 2,4-D	Tordon 212		1 lb/ gal picloram, 2 lb/gal 2,4-D L
Prometone	Pramitol	2-methoxy-4,6-bis(isopropylamino)-s-triazine	2 lb per gallon L 5% P
Prometryne	Caparol, Mixtures	2,4-bis (isopropylamino)-6-methylmercapto-s-triazine	80% WP
Propachlor	Ramrod	2-chloro-N-iso= propylacetanilide	65% WP 20% G
Propazine	Propazine, Milogard	2-chloro-4,6-bis(isopropylamino)-s-triazine	80% WP
Pyrazon	Pyramin	5-amino-4-chloro-2-phenyl-3(2H)-pyridazinone	80% WP
Pyrazon and dalapon	Pyramin Plus		27% pyrazon, 18.5% dalapon WP
S-6115	Outfox	2-chloro-4-cyclopropylamino-6-isopropylamino-s-triazine	1 lb/gal L
SD 15418	Bladex	2-(4-chloro-6-ethylamino-s-triazin-2-ylamino)-2-methylpropionitrile	80% WP, 4 lb/gal L
Silvex	Several, Mixtures	2-(2,4,5-trichloro= phenoxy)propionic acid	L, G Various
Simazine	Princep, Mixtures	2-chloro-4,6-bis(ethylamino)-s-triazine	80% WP, 4% G
Sodium arsenite	Several, Mixtures		L, WP Various
Sodium chlorate	Several, Mixtures		WSP Various
TBA	Several, Mixtures	2,3,6-trichloro= benzoic acid	Various
TBP	Several, Mixtures	2,3,6-trichloro= benzyloxypropanol	Various
TCA	TCA, Mixtures	trichloroacetic acid	4.76 lb/gal L 84%, 80.2% WSP
Triallate	Far-go	S-2,3,3-trichloro= allyl N,N-diiso= propylthiocar= bamate	4 lb/gal L
Trifluralin	Treflan	a, a, a, -tri= fluoro-2,6-dinitro-N,N-di= propyl-p-toluidine	4 lb/gal L, 5% G
2,4-D	Several, Mixtures	2,4-dichlorophenoxy= acetic acid	L, G Various
2,4-DB	Butyrac, Butoxone	4-(2,4-dichlorophenoxy)= butyric acid	L Various
2,4,5-T	Several, Mixtures	2,4,5-trichloro= phenoxyacetic acid	L Various
Vernolate	Vernam	S-propyl dipropyl= thiocarbamate	6 lb/gal L 10% G

[1] "Several" means there are numerous trade names for this chemical. "Mixtures" means the chemical is mixed with other chemicals in commercial formulations.
[2] G — granular, L — liquid, WP — wettable powder, WSP — water-soluble powder, P — pellets
A chemical name occupying two lines separated by an equal (=) sign is joined together without any separation if written on one line.

Table 9. Suggestions for chemical control of weeds in field crops. Application rates are on a broadcast basis and refer to acid equivalent or active ingredient rather than amount of commercial product. Avoid repeated and prolonged contact with all herbicides, especially direct contact with the skin and eyes. Check label restrictions for use of crops for food or forage.

Crop	Chemicals	Pounds per acre of active ingredient or acid equivalent broadcast	Time	Remarks	USDA registration limitations on crop use
Wheat or barley	2,4-D amine 2,4-D ester	¼ to ⅜ ⅛ to ¼	Fifth leaf to early boot	Amine less injurious to crop.	Do not forage or graze for 2 weeks after treatment.
	MCPA amine MCPA ester	¼ to ⅜ ⅛ to ¼	Two leaf to early boot		None
	bromoxynil	⅜	Two leaf to early boot	Injures legumes	None
	bromoxynil and MCPA esters	¼ + ¼	Two leaf to early boot	Injures legumes	None
Wheat or oats	dicamba (Banvel) and MCPA	⅛ + ¼	Two- to five-leaf stage	Kills legumes	Do not graze or feed forage or threshings to livestock.
Oats	2,4-D amine	¼ to ½	Sixth leaf to early boot	MCPA less injurious to crop.	Do not forage or graze for 2 weeks after treatment.
	MCPA amine MCPA amine	¼ to ⅜ ⅛ to ¼	Two leaf to early boot		None
Flax	MCPA	¼	Flax 2 to 6 inches	Mixture of MCPA amine with TCA or dalapon for broad-leaved and grass weeds.	None
	TCA	5	Flax 2 to 6 inches	Grass weeds except wild oats.	None
	dalapon	¾	Flax 2 to 6 inches	See section on wild oats.	None
Corn	alachlor (Lasso)	2 to 3	Preemergence		Do not graze or harvest immature corn for feed within 12 weeks after treatment.
	atrazine (AAtrex)	1 to 4	Preplanting, Preemergence or early postemergence	Atrazine may injure crops the following year.	Do not graze or feed forage from treated areas for 21 days after treatment.
	butylate (Sutan)	4	Preplanting incorporation	Grass weeds only.	None
	propachlor (Ramrod)	4 to 5	Preemergence	Grass weeds only.	None
	atrazine and alachlor	1 to 2 + 1½ to 2½	Preemergence		Do not graze or harvest immature corn for feed within 12 weeks after treatment.
	atrazine and butylate	1 to 1½ + 3 to 4	Preplanting incorporation		None
	atrazine and linuron (Lorox)	½ to 1½ of each	Preemergence	Do not use linuron on sandy soils.	None
	atrazine and propachlor	1 to 1½ + 2 to 3¾	Preemergence		None
	linuron and propachlor	1 to 1½ + 2 to 3	Preemergence	Do not use on sandy soils.	None
	2,4-D amine	¼ to ½	After two-leaf stage to layby	Broadleafs only.	None
	2,4-D ester	1/6 to ½	After two-leaf stage to layby	Corn most susceptible during rapid growth.	None
			After two-leaf stage to layby	Use drop nozzles after corn is 8 inches tall.	
	2,4-D amine	½ to 1	After layby	Spray base of stalks only.	None
	2,4-D ester	⅓ to ⅝	After layby	Spray base of stalks only.	None

Table 9. Suggestions for chemical control of weeds in field crops (con't.)

Crop	Chemicals	Pounds per acre of active ingredient or acid equivalent broadcast	Time	Remarks	USDA registration limitations on crop use
Alfalfa and clover in small grains	2,4-D amine or MCPA amine	¼	Not before clover is 2 inches tall	Injures legumes. Canopy of crop or weeds reduces injury. Do not use on sweet clover.	Do not graze dairy animals on treated areas within 7 days after application of 2,4-D.
	2,4-DB	½ to 1½			Do not graze or cut hay from treated fields within 30 days after treatment.
Alfalfa, sweetclover, and birdsfoot trefoil in flax	dalapon	¾		Will injure red and alsike clover.	None
	MCPA amine	¼	Not before clover is 2 inches tall	Sweetclover injured. Canopy of crop or weeds reduces injury.	None
Legume establishment without a companion crop	benefin (Balan)	1½ to 1½	Preplanting incorporation		None
	EPTC (Eptam)	3	Preplanting incorporation		Do not graze or harvest for feed within 14 days after application.
	2,4-DB	½ to 1	Legumes 2 to 3 inches	Sweetclover injured.	Do not graze livestock or cut hay from treated fields within 30 days after treatment.
	dalapon	1	Legumes 2 to 3 inches	Will injure red and alsike clover.	Do not feed first year's growth to dairy animals or animals being finished for slaughter.
Established legumes	2,4-DB amine 2,4-DB ester	½ to 2 ½ to 1	When annual weeds are 2 to 3 inches tall or perennials 6 to 8 inches tall	Do not use more than ¾ pound per acre of ester form on red clover.	Do not graze treated areas nor feed straw or hay from treated crops to livestock within 30 days after application.
Grain sorghum	propachlor (Ramrod)	4	Preemergence	Grass weeds only.	Do not graze or feed forage to dairy cattle.
	norea (Herban)	2.4	Preemergence		None
	propazine	2	Preemergence		None
	atrazine	2	Early postemergence		Do not graze or feed forage from treated area within 21 days after application.
	2,4-D amine	½	4 to 12 inches	For broad-leaved weeds.	None

Table 9. Suggestions for chemical control of weeds in field crops (con't.)

Crop	Chemicals	Pounds per acre of active ingredient or acid equivalent broadcast	Time	Remarks	USDA registration limitations on crop use
Soybeans	alachlor (Lasso)	2 to 3	Preemergence		None
	chloramben (Amiben)	3	Preemergence		None
	chlorpropham (Chloro-IPC)	2 to 3	Preemergence	For smartweed control.	None
	linuron (Lorox)	½ to 2½	Preemergence	For medium textured soils with less than 4% organic matter.	None
	linuron and alachlor	½ to 1½ + 1½ to 3	Preemergence		None
	norea and chloramben (Noraben)	0.8 to 1.2 + 1 to 1.5	Preemergence	Do not use on sandy soils.	None
	trifluralin (Treflan)	½ to 1	Preplanting incorporation	Must be well incorporated.	None
	vernolate (Vernam)	3	Preplanting incorporation	Incorporate well immediately.	None
	chloroxuron (Tenoran)	1 to 1½	Soybeans in first trifoliolate, weeds less than 2 inches	Controls certain broadleafs. See page 13.	Do not apply within 90 days of harvest. Do not graze treated fields.
	2,4-DB	1/5	Postemergence	For cocklebur control.	None
Sugar beets	TCA	6 to 8	Preemergence	For grass weeds except wild oats.	Do not use treated tops for food or feed.
	dalapon	2 to 3	Beets up to 6-leaf stage	For grass weeds except wild oats.	None
		2½ to 3½	Directed, beets 7-leaf stage to 14 inches		
	diallate (Avadex)	1½ to 2	Preplanting incorporation	For wild oats.	Do not graze unharvested crop.
	barban (Carbyne)	⅜ to ¾	Wild oats in two-leaf stage	For wild oats.	Do not allow livestock to graze treated fields until after crop is harvested.
	phenmedipham (Betanal)	1 to 1½	Early postemergence	See page 13.	None
	endothall	¾ to 1½	Early postemergence	For wild buckwheat and annual smartweed.	None
	pyrazon + dalapon (Pyramin Plus)	3.8 + 2.2	Early postemergence	See page 13.	None
	EPTC (Eptam)	2 to 2½	Preplanting incorporation	For grass and some broad-leaved weeds.	None
Dry edible beans	EPTC (Eptam)	3	Preplanting incorporation		None
	trifluralin (Treflan)	¾ to 1	Preplanting incorporation		None
Sunflowers	chloramben (Amiben)	3	Preemergence		Do not graze or feed forage.
	EPTC (Eptam)	3	Preplanting incorporation		None
	trifluralin (Treflan)	½ to 1	Preplanting incorporation		None
Established grass pastures	2,4-D	½ to 2			Do not graze dairy animals on treated areas within 7 days after application.
			Before bud stage, preferably when weeds are 2 to 6 inches tall and growing vigorously	Rate depends on kinds of weeds. Use low rates of MCPA if legumes are present.	
	2,4,5-T	1 to 2			None
	MCPA	¼ to 2			None

Table 10. Suggestions for chemical control of specific weeds on cropland. Follow label precautions carefully.

Weed	Chemicals	Pounds per acre of active ingredient or acid equivalent broadcast	Time	Remarks	USDA registration limitations on crop use
Canada and sowthistle	2,4-D amine	½	Just before bud	Can spray in tolerant crop.	See crop
	2,4-D ester	1	Fall rosette	Plow or clip in fall and spray when 6 inches.	See crop
	amitrole or amitrole-T	4	Just before bud or regrowth when 6 to 8 inches after clipping or plowing	A full stand before spraying is important.	Do not plant to crops other than corn or graze for 8 months after treatment.
	dicamba (Banvel)	⅛ to ¼		See crop recommendations. Drift may affect sensitive crops.	See section on oats, wheat, corn and pastures.
Field bindweed	2,4-D ester	1	Late fall	Re-treat second year.	See crop
	2,4-D amine	½	Bud to bloom		See crop
Leafy spurge	2,4-D ester	2 to 3	Bud	After grain harvest or on grass pastures. Re-treat growth when 4 to 6 inches.	See crop
	2,4-D ester	½	Bud	Safest in wheat or barley. Cultivate after harvest until freezeup.	See crop
Quackgrass	TCA	22	Sept. or early Oct.	Best on plowed ground.	See crop
		18	Next fall after harvest	To kill escaped plants.	See crop
	dalapon	12 to 15	Fall	Foliage application, plow 1 or 2 weeks later.	See crop
	dalapon	5	Spring	Foliage application, plow 1 or 2 weeks later.	See crop
	atrazine (AAtrex)	2 to 4	Spring or fall	Use low rate on sandy soils. Only corn can be grown the year after treatment.	See crop
Wild oats	barban (Carbyne)	¼ to ⅜	When wild oats is in two-leaf stage	Rate for wheat, barley, flax, soybeans, sunflower.	Do not allow livestock to graze treated wheat, barley, sugar beet, sunflower, or soybean fields until after crop is harvested. Do not feed soybean forage or flax straw from treated fields.
	barban (Carbyne)	⅜ to ¾	When wild oats is in two-leaf stage	Rate for sugar beets.	Do not allow livestock to graze treated wheat, barley, sugar beet, sunflower, or soybean fields until after crop is harvested. Do not feed soybean forage or flax straw from treated fields.
	diallate (Avadex)	1½ to 2	Preplanting or preemergence	Rate for flax and sugar beets; must be incorporated into soil.	Do not graze unharvested crop.
	triallate (Far-go)	1 (wheat) 1¼ (barley)	Preplanting or preemergence	Must be incorporated into soil.	Do not graze livestock on treated areas.