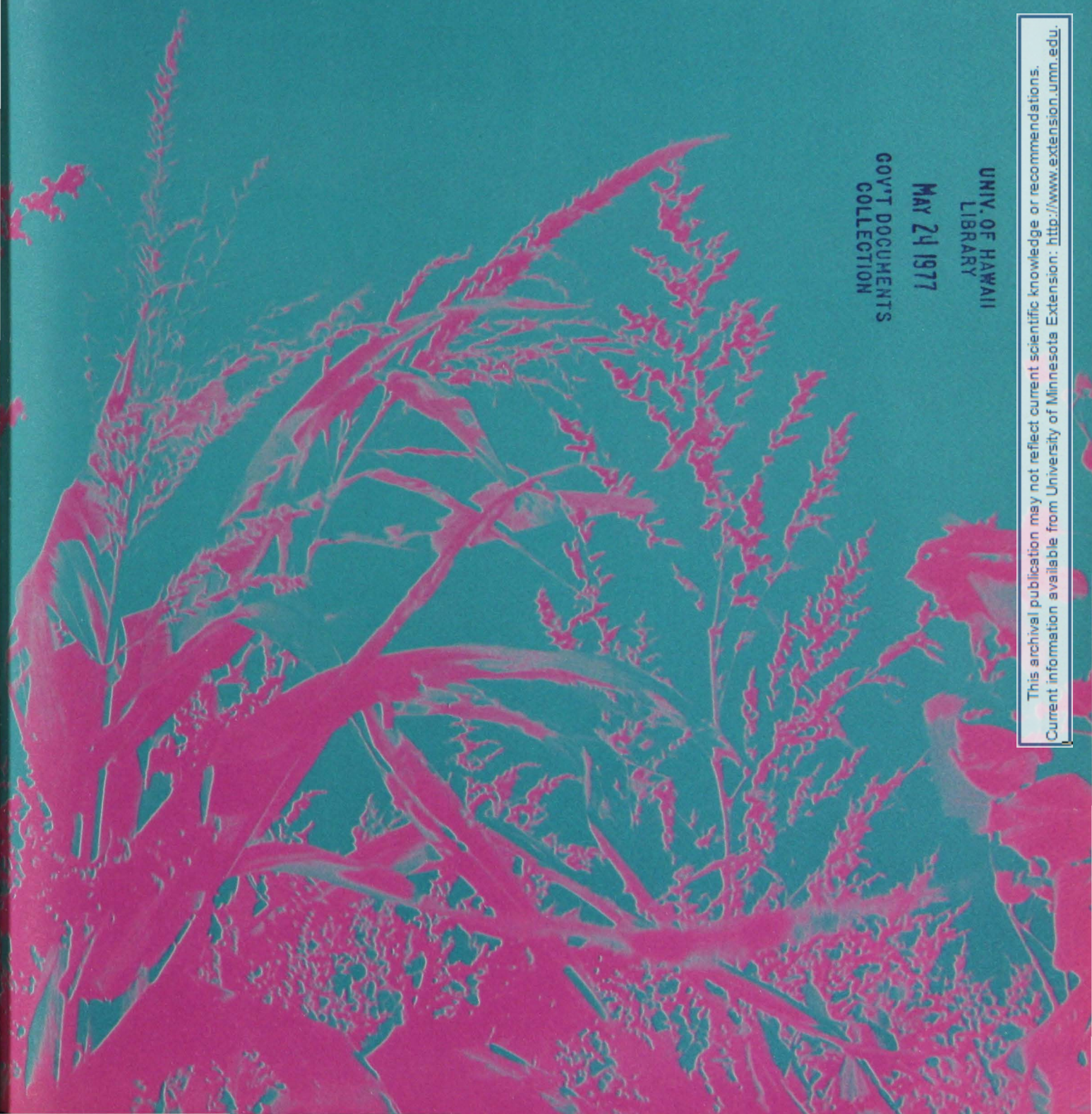
AGRICULTURAL EXTENSION SERVICE, UNIVERSITY OF MINNESOTA • EXTENSION BULLETIN 400

Cultural and Chemical Weed Control

IN FIELD CROPS 1977



Cultural and Chemical Weed Control in Field Crops—1977

Information in this publication is based on research by the Minnesota Agricultural Experiment Station, other experiment stations and U.S. Department of Agriculture on the effectiveness of cultural practices and chemicals for controlling weeds. The suggested chemical uses in this publication are within clearances established by the U.S. Environmental Protection Agency (EPA).

Herbicides are registered by the EPA under the Federal Insecticide, Fungicide, and Rodenticide Act as amended by the Federal Environmental Pesticide Control Act for uses involving food or feed on the basis of finite chemical tolerances or exemptions from the requirement of tolerances established by the Food and Drug Administration. The Federal Food, Drug, and Cosmetic Act, as amended by Public Law 518 (Miller Amendment), makes liable for seizure any raw agricultural commodity 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.

Instructions for registered uses of herbicides are given on container labels. Read and follow these label instructions carefully. Persons using herbicides in a manner contrary to the label instructions are subject to penalty under federal laws.

This publication is for your information. The University of Minnesota or its officers or employees make no claims or representations that the chemicals discussed will or will not result in residues on agricultural commodities and assume no responsibility for results from using herbicides.

Some registrations are under review; therefore, some uses suggested in this bulletin could change during the year. New information will be available from County Extension Agents as changes occur.

Rates: Application rates listed in this publication are broadcast rates and refer to acid equivalent or active ingredient rather than commercial product. In practice, rates will need to be adjusted for varying row widths if applied in bands and for the concentration of the particular product used. See Fact Sheet AgChem No. 5 "How to—Calculate Herbicide Rates and Calibrate Herbicide Applicators."

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 amount; 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. Prevent drift onto nearby susceptible plants.

Return larger quantities of unused herbicides to the manufacturer or store them properly until used. Dispose of empty containers in a safe manner:

1. Rinse container thoroughly with water and use the rinse water in the sprayer.
2. Bury small and decomposable containers in approved and supervised sanitary landfills.
3. Send empty metal pesticide containers of 15 gallon capacity or more back to the manufacturer or to professional drum reconditioners.
4. Observe special label instructions relating to disposal.

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Revised for 1977 by G. R. Miller, professor and extension agronomist, O.E. Strand, associate professor and extension agronomist, and A. G. Dexter, associate professor and extension sugarbeet weed control specialist. Other staff members concerned with field crop weed control in the Department of Agronomy and Plant Genetics include R. Behrens, professor; R. G. Robinson, professor; D. L. Wyse, assistant professor; and R. N. Andersen, plant physiologist, Agricultural Research Service, United States Department of Agriculture.

Follow label instructions carefully when using agricultural chemicals

Issued in furtherance of cooperative extension work in agriculture and home economics, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Roland H. Abraham, Director, Agricultural Extension Service, University of Minnesota, St. Paul, Minnesota 55108. We offer our programs and facilities to all persons without regard to race, creed, color, sex, age, or national origin. 25M— 12-76

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 2 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.

Weed Control Programs

Effective weed control usually results from a combination of cultural, mechanical, and chemical practices. The ideal combination for each field will depend on a number of considerations including: 1) the crop being grown, 2) the kinds of weeds, 3) the seriousness of the weed infestation, 4) the soil type, 5) the cropping system, and 6) the availability of time and labor.

Cultural practices that are optimum for crop growth should be followed. These practices include good seedbed preparation, adequate fertility, optimum stands and row width, and proper seeding date. Tillage operations should be timed to destroy weeds. Tilling the soil immediately before planting will kill weeds that have germinated, thus giving the crop a competitive advantage and often improving weed control from chemicals that do not control weeds that have germinated.

Early cultivations when weeds are small are most effective. Use a rotary hoe, harrow, or cultivator as soon as weeds begin emerging and are in the "white stage," even if herbicides have been applied. Set cultivators for shallow operation to avoid crop root pruning and to reduce the number of weed seeds brought to the surface. Throw enough soil into the row to cover small weeds, but avoid excessive ridging that may encourage erosion or interfere with harvesting. Shallow cultivation should be repeated as necessary to control newly germinated weeds.

Mowing is an effective weed control practice in perennial forage crops and noncropland areas. To be effective, mowing must be done before seeds are formed which means you must mow by the time weeds are in the bud stage or just beginning to bloom. Earlier mowing will reduce weed competition and improve crop yield more than later cutting.

Selecting Chemicals

Selection of an appropriate chemical or combination of chemicals should be based on a consideration of the following factors:

—Label approval for use
—Use of the crop
—Crop and variety tolerance
—Potential for soil residues that may affect following crops
—Kinds of weeds
—Soil texture
—pH of soil
—Amount of organic matter in the soil
—Formulation of the chemical
—Application equipment available
—Potential for drift problems

The information in this publication and on product labels will help you select and use chemicals properly according to the above factors. Proper application of chemicals is essential for obtaining satisfactory results. Follow carefully the suggested rates on labels for specific soil and weed situations. Apply herbicides at the times specified. Delayed applications usually result in poorer weed control and may injure the crop.

Weather conditions will affect herbicide performance. Weed control from soil-applied herbicides may be poor if there is insufficient rain soon after treatment, which will make timely cultivation necessary to control emerging weeds. If rainfall is very heavy, some herbicides may move downward in the soil, resulting in poor weed control and/or crop injury. Temperature and moisture conditions affect the weed control and crop injury resulting from herbicides applied postemergence. Observe label precautions regarding weather conditions and crop size when applying herbicides on growing crops.

Granular Versus Spray Forms of Herbicides

Several herbicides are available in granular or spray forms. With a few exceptions, approximately the same weed control can be expected from either form. Granular forms require no mixing 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. Granular formulations of triazine herbicides require more rain and may result in more soil residues than the spray formulations. Chemicals that cause irritation are less irritating in the granular form than in the spray form.

Herbicide Mixtures

Herbicide mixtures are used to overcome 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 should be used. Use of some mixtures may result in poor weed control or crop injury. Growers or applicators may be responsible for chemical residues in crops, crop injury or lack of weed control resulting from use of unlabeled mixtures.

Weed Control in Field Crops

Corn

Cultural practices—Cultural practices for weed control in corn include seedbed preparation, establishment of an optimum stand, adequate fertility, 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 rough space between rows 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 be used while the weeds are very small also. Set the implements for shallow cultivation to prevent root pruning and to bring fewer weed seeds to the surface. A rotary hoe, harrow, or cultivator should be used as soon as weeds appear even if preemergence applications have been used.

Herbicides

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. Figures in table 1 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.

Table 2 indicates corn tolerance to herbicides suggested for use in corn and relative effectiveness and reliability 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. Some herbicides may be applied to the soil before planting and incorporated 2 to 3 inches into the soil by disking or field cultivating. The disk or field cultivator should be set to operate twice as deeply as the desired depth of incorporation. Use sweep shovels on the field cultivator to get more uniform mixing of the chemical and soil. The field should be disked or cultivated twice, once in each direction, after applying the chemical. To avoid excessive loss of volatile chemicals like EPTC or butylate, the first tillage operation should follow immediately behind the sprayer.

Butylate (Sutan+) and EPTC (Eradicane) applied preplanting and incorporated at 3 to 6 pounds per acre have given good control of annual grasses and fair control of a few annual broadleafs, but these chemicals do not control several annual broadleafs or most perennial weeds. Both chemicals are effective against nutsedge. EPTC may be used to control quackgrass, but results in experiments have been somewhat inconsistent. (See page 18.) Butylate and EPTC are formulated with an antidote chemical to prevent corn injury. A corn seed treatment chemical is also available to prevent corn injury.

Preplanting and disked-in applications of atrazine have resulted in weed control equal to or, under dry conditions, slightly better than preemergence applications without incorporation. Broadcast applications, necessary when preplanting treatments are used, may increase the potential of atrazine carryover compared to banded preemergence applications.

Mixtures of butylate at 3 to 4 pounds per acre and atrazine at 1 to 1½ pounds per acre or cyanazine (Bladex) at 1 to 2 pounds per acre applied preplanting and incorporated have controlled both annual grasses and broadleafs. These mixtures improve broadleaf control compared to butylate alone. Cyanazine does not carry over to the following year and the low rate of atrazine used in the mixture reduces carryover problems from atrazine compared to those caused by the higher rates used when atrazine is applied alone.

Preplanting, disked-in applications of alachlor (Lasso) at 3 to 4 pounds per acre have effectively controlled nutsedge. Control of annual weeds has usually been better with preemergence than with preplanting applications of alachlor, except under very dry conditions. Atrazine or cyanazine may be tank mixed with alachlor to improve broadleaf control.

Preemergence applications of atrazine at 1 to 3 pounds per acre have given good control of annual weeds with no injury to corn. A 3-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 that are low in organic matter.

Atrazine sometimes affects small grains, flax, sugarbeets, soybeans, other legumes, vegetables, and other sensitive crops planted the following spring. The label requires that small grains, flax, sugarbeets, vegetables, and small-seeded legumes or grasses 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 or if application is made after June 10. However, in some years, soybean injury has occurred following use within these restrictions, especially on highly alkaline soils of western 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. Toxic residues are more likely to persist if soil moisture or temperatures are low.

Cyanazine (Bladex) chemically similar to atrazine, has given good control of annual grasses and most broadleafs when applied preemergence. There has been 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 1.2 to 4 pounds per acre, the higher rates are required on soils higher in organic matter and finer textured. Corn injury may occur on sandy soils. Granular formulations of cyanazine have been less effective than sprays under limited rain conditions.

Table 1. 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, 3	1969-76	174	169	87	10	3	51	19	30
Atrazine	3	1959-76	728	699	76	16	8	88	8	4
Cyanazine (Bladex)	3	1969-76	174	169	80	16	4	75	15	10
Cyanazine (early postemergence)	2	1973-76	73	70	67	15	18	87	3	10
Cyanazine + alachlor	2 + 2	1974-76	62	61	87	10	3	80	13	7
Dicamba (Banvel) + alachlor	½ + 2	1972-76	94	90	87	6	6	88	4	8
Propachlor (Ramrod)	5	1965-73, 76	374	365	82	12	6	42	26	32
Atrazine + alachlor	1½ + 2	1970-76	142	137	93	6	1	91	7	2
Atrazine + chloramben (Amiben)	2 + 1	1971-72	39	37	82	15	3	95	5	0
Atrazine +linuron (Lorox)	1½+1½	1965-71	292	291	78	17	5	85	11	4
Atrazine + propachlor	1½ + 3	1967-76	260	267	82	15	3	85	9	6
Atrazine + oil (1½ gal/A) (early postemergence)	2	1966-76	333	326	85	9	6	96	3	1
Atrazine + oil concentrate (½ gal/A) (early postemergence)	2	1975-76	35	35	66	20	14	100	0	0
Atrazine + surfactant (1 pt/A) (early postemergence)	2	1968-69, 71-76	160	157	58	30	11	95	4	1
Linuron + alachlor	1½ + 2	1970-75	120	114	94	5	1	88	6	6
Linuron + propachlor	1½ + 3	1968-73	152	148	88	9	3	78	14	8

*Applied preemergence unless specified early postemergence.

Propachlor (Ramrod, Bexton) 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 and common lambsquarters, but control of other broadleafs has been erratic. Corn has good tolerance to alachlor. Suggested rates are 2 to 3½ pounds per acre in the liquid formulation and 2.4 to 3.9 pounds per acre in the granular formulation (Lasso II).

Metolachlor (Dual), chemically related to alachlor and propachlor, controls annual grasses and redroot pigweed in corn that has good tolerance to the chemical. When incorporated, metolachlor has controlled nutsedge. Metolachlor is labelled for preemergence application at 2 to 3 pounds per acre or at 1¼ to 2 pounds per acre in a mixture with atrazine at 1 to 2 pounds per acre. The corn grain may be fed, but corn treated with metolachlor cannot be grazed or used for silage. Do not plant crops other than corn for 18 months after application.

Penoxalin (Prowl) may be used alone at 1 to 2 or in mixtures at 1 to 1½ pounds per acre for preemergence control of most annual grassy weeds and some broadleafs such as common lambsquarters, pigweed, smartweed, and velvetleaf in corn. In Minnesota trials, this compound has been somewhat less effective on grasses but more effective on broadleafs than alachlor. Tank mixes with atrazine, cyanazine, or dicamba provide a broader spectrum of weed control. Do not use on soils that contain less than 1½ percent organic matter, nor on sands, loamy sands, peat, muck, or clay soils. Corn injury may occur on sandy soils.

Preemergence applications of chloramben (Amiben) or 2,4-D 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, penoxalin, 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 mixture with linuron or penoxalin after corn is up or severe corn injury may 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 on soils low in organic matter. 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 to1½ pounds per acre of each chemical according to soil type. Corn tolerance to this mixture is not as great as to atrazine alone. Corn injury may occur on coarse textured soils that have low organic matter content.

The mixtures of atrazine with propachlor or alachlor and cyanazine with 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 or cyanazine 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. Rates for cyanazine are 1 to 2.2 pounds per acre with 2 to 2½ pounds per acre of alachlor.

Using mixtures of linuron and propachlor or alachlor reduces the potential for corn injury compared to linuron alone since lower rates of linuron are used. These mixtures control broadleafs better than propachlor or alachlor alone. Suggested rates are 1 to 1½ pounds per acre of linuron with 3 pounds per acre of propachlor or 1 to 3 pounds per acre of alachlor. Do not use these mixtures on sandy soils because of possible crop injury from linuron.

A preemergence mixture of alachlor with dicamba (Banvel) improves broadleaf control compared to alachlor alone and improves grass control and reduces corn injury compared to dicamba alone. Dicamba should be applied preemergence only on fine-textured soils with over 2.5% organic matter. Do not incorporate this mixture prior to corn emergence. Harrowing or dragging before corn emerges may increase corn injury.

Table 2. Effectiveness of herbicides on major weeds in corn

	Preplanting					Preemergence								Postemergence			
	Alachlor (Lasso)	Butylate (Sutan +)	EPTC (Eradicane)	Cyanazine (Bladex)	Atrazine	Alachlor (Lasso)	Atrazine	Dicamba (Banvel)	Penoxalin (Prowl)	Propachlor (Ramrod, Bexton)	Metolachlor (Dual)	Linuron (Lorox)	Cyanazine (Bladex)	2,4-D	Dicamba (Banvel)	Atrazine and oil	Cyanazine (Bladex)
Corn tolerance	G	G	G	F	G	G	G	F	F	G	G	F	F	F	G	G	F
Grasses																	
Giant and robust foxtail ..	G	G	G	F	F	G	F	P	F	G	G	F	F	N	N	F	F
Green foxtail	G	G	G	G	G	G	G	P	F	G	G	F	G	N	N	G	G
Yellow foxtail	G	G	G	G	G	G	G	P	F	G	G	F	G	N	N	G	G
Barnyardgrass	G	G	G	F	F	G	F	P	F	F	G	F	F	N	N	F	F
Crabgrass	G	G	G	F	P	G	P	P	F	G	G	G	F	N	N	P	F
Panicum	G	G	G	F	P	G	P	P	F	F	G	G	F	N	N	P	F
Woolly cupgrass	G	F	G	P	P	G	P	P	F	F	—	P	P	N	N	F	F
Wild proso millet	G	F	G	P	P	F	P	P	—	F	—	P	P	N	N	P	P
Nutsedge	G	G	G	P	P	F	P	N	N	F	F	P	P	N	N	F	P
Quackgrass	N	N	F	P	G	N	G	N	N	N	N	N	P	N	N	G	P
Broadleafs																	
Buffalobur	P	F	G	P	P	P	P	P	—	P	P	P	P	P	P	G	P
Cocklebur	N	P	P	F	F	N	F	F	P	P	N	P	F	G	G	G	F
Kochia	P	P	F	G	G	P	G	F	—	P	P	F	G	F	G	G	G
Lambsquarters	F	P	F	G	G	F	G	G	F	P	P	G	G	G	G	G	G
Mustard	P	P	P	G	G	P	G	G	P	P	P	G	G	G	F	G	G
Pigweed	G	F	F	F	G	G	G	G	F	F	G	G	F	G	G	G	F
Ragweed	P	P	F	G	G	P	G	G	P	P	P	G	G	G	G	G	G
Smartweed	P	P	P	G	G	P	G	G	F	P	P	F	G	P	G	G	G
Velvetleaf	P	F	F	F	F	P	F	F	F	P	P	F	F	G	G	F	F
Wild sunflower	P	P	P	F	F	P	F	F	P	P	P	P	F	F	G	G	F
Canada thistle	N	N	N	P	P	N	P	N	N	N	N	N	P	F	G	F	P
Jerusalem artichoke	N	N	N	P	P	N	P	P	N	N	N	P	P	G	G	P	P

G—Good
F—Fair
P—Poor
N—None
—Insufficient information

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 while the weeds are less than 1½ inches tall. Application may be made until corn is 30 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.

The addition of 1 gallon 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. Labeled emulsions of either vegetable or petroleum oils are satisfactory. Various formulations of surfactants and detergents used with atrazine have not improved weed control as much as the use of oils. Suggested atrazine rates for postemergence application with oil are 1.2 pounds per acre for broadleafs and 2 pounds per acre for annual grasses.

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. Corn injury has also occurred when atrazine and oil were applied to corn growing under cold, wet conditions, or if frost occurred shortly before or after application.

Cyanazine (Bladex) is effective on annual grasses and broadleafs as an early postemergence herbicide. It is cleared for use through the 4-leaf stage of corn and before weeds are over 1½ inches tall. Pigweed and lambsquarters have shown some tolerance. Oils or surfactants added to the spray increase the potential for corn injury, but under dry conditions vegetable oils or certain surfactants may be used to improve weed control.

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 4 to 8 inches tall. Onion leafing may occur from 2,4-D applications made in the 2- to 3-leaf stage of the corn. 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, about ⅓ less acid equivalent rate is needed then in the amine form.

Spray drift from either amines or esters of 2,4-D will injure susceptible plants. Since the ester forms are volatile, vapor injury to nearby susceptible crops is a possibility. Low volatile esters should be used rather than high volatile esters. The use of amines eliminates the danger of vapor injury because amines are not very volatile.

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. Do not use spray additives with 2,4-D as corn injury may be increased.

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 at ½ to 1 pound per acre after the 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. Dicamba also controls other broad-leaved weeds except mustard, but does not control grasses. But when used, dicamba drift has often affected soybeans in the vicinity of treated cornfields.

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 2 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. Do not use additives with dicamba.

A mixture of dicamba and atrazine is cleared for use on corn as an early postemergence treatment. The mixture has given good broadleaf control, but grass control has been erratic. Oils and other additives should not be used with the mixture.

Caution: Soybeans and other broad-leaved plants are very sensitive to dicamba. In recent years, there were many instances in which dicamba drift affected soybeans. Users of dicamba must 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. Applications are not recommended at temperatures above 85° F. Effects on soybeans can be reduced by spraying corn early before soybeans have emerged or when they are small, less than 10 inches tall. Do not graze or harvest for dairy feed prior to the milk stage of the grain if corn is treated with dicamba.

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 are considered emergency measures to control heavy weed stands that have become established within corn rows.

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 linuron at 1½ pounds per acre can be applied when the corn is not less than 15 inches tall. Ametryne (Evik) is cleared for use as a directed spray at 1.6 to 2 pounds per acre after corn is 12 inches tall. Do not apply ametryne later than 3 weeks prior to tasseling. Ametryne should not be used on sandy soils. The addition of a wetting agent is necessary for effective weed control with linuron or ametryne. Care must be taken in application to minimize spray on the corn leaves while covering most of the weed foliage with the spray. Either chemical will kill corn leaf tissue it contacts and, if leaf kill is extensive, corn yields may be reduced.

Dry Edible Beans

Cultural practices—Before emergence, bean fields can be spike-tooth harrowed to kill emerging weeds. After beans emerge, implements such as the weeder, rotary hoe or coil spring harrow are preferred over the spiketooth harrow to kill weeds. Only small emerging weeds in the "white" stage can be uprooted and killed without injury to the beans. It may be necessary to harrow the field several times before the first cultivation if weeds continue to emerge. Beans are generally cultivated twice before the vines cover the middles. Hand hoeing for control of weeds that escape tillage is desirable when economically feasible.

Herbicides—Preplanting applications—EPTC (Eptam) at 3 pounds per acre will control most annual grass weeds and some annual broadleafs when applied preplanting and incorporated into the soil. Incorporation to a depth of 3 to 4 inches to avoid loss of the herbicide should be accomplished immediately after application. EPTC may be applied at 4 to 4½ pounds per acre in the fall before planting beans the next spring, but performance has been less consistent than with spring application.

Trifluralin (Treflan) can be applied preplanting in the fall or spring at ½ pound per acre on sandy soils and up to 1 pound per acre on silt and clay soils to control most annual grass and some annual broad-leaved weeds. For best results incorporation should take place immediately or at least within 8 hours of application.

Dinitramine (Cobex) alone or in a mixture with EPTC may be used preplanting and incorporated to control most annual grasses and some annual broad-leaved weeds. Use ⅓ pound per acre on sandy soils, ½ pound per acre on loam and silt loam soils, and ⅔ pound per acre on clay soils. Refer to product label for more specific rate suggestions on different soils. Soil incorporation of dinitramine may be delayed up to 24 hours with satisfactory results.

Profluralin (Tolban) may be applied preplanting with soil incorporation within 4 hours to control most annual grasses and some annual broad-leaved weeds. Use ½ pound per acre on sandy soils and 1 pound per acre on loam and clay soils.

Alachlor (Lasso) may be applied either alone or in a tank mixture with trifluralin (Treflan) as a preplanting, incorporated treatment to control annual grasses, yellow nutsedge, pigweed, and black nightshade. Use 2½ to 3 pounds of alachlor per acre alone or with ½ pound of trifluralin per acre. Incorporate uniformly into the top 2 inches of soil within 8 hours of application and within 7 days of planting.

Preemergence applications—Chloramben (Amiben) will control many annual grass and broad-leaved weeds when applied preemergence at 2 to 3 pounds per acre. The higher rate should be used on clay loam or clay soils or soils with 3 to

8 percent organic matter. Weed control has been good where sufficient rainfall occurred before weeds emerged. A preplanting application of EPTC, trifluralin, dinitramine, or profluralin followed by a preemergence application of chloramben has given good control of both grasses and broadleafs.

Dinoseb amine (Premerge, Dinitro Weed Killer) may be applied preemergence at a rate of 9 pounds per acre, except on sandy soils, or can be used at 3 to 4½ pounds per acre when beans are emerging (not later than crook stage). Weed control has often been erratic and some injury to beans has occurred. Adverse weather or rapid growth of the beans often makes treatment at the time of emergence impractical.

For smartweed and partial control of mustard, chlorpropham (Furloe Chloro IPC) may be applied preemergence at 3 pounds per acre alone or in combination with certain herbicides. See product label for specific use instructions.

Postemergence applications—Bentazon (Basagran) controls many annual broadleafs when applied at ¾ to 1 pound per acre after the first trifoliolate leaf stage of the beans and while weeds are less than 2 inches tall. **Caution:** As of December 1976, bentazon is cleared only for experimental use on a limited acreage.

Flax

Cultural practices—Flax does not compete well with weeds so growers should control weeds in the preceding crop by cultivation or by after harvest tillage or mowing. Late summer or early fall tillage, except where wind or water erosion is a problem, will help control perennial weeds, prevent weed seed production and stimulate fall germination of annual weed seeds. Shallow early spring tillage to stimulate germination of annual weeds such as wild oat, followed by tillage operations and delayed seeding of flax has been successful in some areas. However, the delay in seeding flax usually results in decreased yields. An early maturing flax variety, such as Linnott, should be used if this practice is followed.

Herbicides—EPTC (Eptam) applied preplanting and incorporated at 3 pounds per acre controls most annual grasses and some annual broad-leaved weeds in flax. Stand reduction or injury to flax may occur if unfavorable temperature, soil moisture or other adverse conditions are present during early flax growth. EPTC is labelled for fall application at 4 to 4½ pounds per acre prior to planting flax the next spring.

MCPA amine or ester at ¼ pound per acre will control many broad-leaved weeds in flax. Weeds susceptible to MCPA such as wild mustard, common lambsquarters, common ragweed, marshelder, and field pennycress are usually controlled at this rate of application. More resistant weeds such as redroot pigweed, Canada thistle and perennial sowthistle are usually not controlled, but growth is checked and seed production reduced. For best weed control, MCPA should be applied when flax is 2 to 6 inches tall. Spray as soon as possible after most of the weeds have emerged. Some injury to flax may occur, but reducing the weed competition will usually more than offset any injury from the chemical. Flax injury is less likely with MCPA amine than with MCPA ester. Do not spray flax with MCPA during the period between bud stage and when 90 percent of the bolls have formed. Germination of the flax seed may be reduced by spraying between full bloom and the stage when seeds are colored.

Bromoxynil can be used on flax for annual broadleaved weed control at ¼ to ½ pound per acre. It is especially useful for controlling annual smartweeds and wild buckwheat, which are not controlled by MCPA. For best results, apply when weeds are small. To reduce flax injury, use the lower rate and spray when flax is 2 to 8 inches tall. Do not treat during or after bud stage. Also do not treat during excessively humid weather, when the temperature is over 85° F., or when plants are stressed from lack of moisture.

Dalapon at ¾ pound per acre will kill green, yellow, and giant foxtail in young flax. Best results have occurred when the flax was 2 to 6 inches tall and the weeds were less than 2 inches. Dalapon can be applied in a tank mixture with MCPA to kill susceptible grass and broadleaved weeds with one application, but spraying must be done before flax is 6 inches tall. Dalapon may cause some injury to flax and should not be used unless a serious annual grass population is present. Also, dalapon applied to flax during drought conditions may cause excessive injury. Use 10 to 20 gallons per acre of spray when applying dalapon.

Barban (Carbyne) at ¼ to ⅜ pound per acre may be used for wild oat control in flax. Application should be made when wild oats are in the 2-leaf stage from 4 to 10 days after emergence. Do not spray after flax is in the 12-leaf stage or excessive flax injury will likely result. **Caution:** Do not feed barban-treated flax straw to livestock. Barban may not be used where flax is underseeded with legumes or grasses.

Diallate (Avadex) may be used preplant or preemergence incorporated at 1½ to 2 pounds per acre to control wild oat in flax with no injury to the crop. Diallate at these rates may persist in the soil enough to affect tame oats the next year.

When flax is used as a companion crop to establish alfalfa or other forage legumes or grasses, MCPA may be used for control of susceptible broad-leaved weeds at ⅛ to ¼ pound per acre. Legume seedlings should be at least 2 inches tall and be protected by a canopy of flax or weeds. Sweetclover seedlings are likely to be killed and other legumes injured by MCPA. Dalapon may not be used in flax that is underseeded with legumes or grasses.

Asulam (Asulox) has been used experimentally in flax to control wild oat, some annual grasses and wild mustard and to suppress wild buckwheat and smartweed. Application was made at 1 pound per acre when wild oat was in the 2-to 4-leaf stage and when flax was 1 to 6 inches tall. Considerable lodging or injury to flax occurred at some locations. **Caution:** As of December 1976, Asulam is not cleared for use on flax.

Forages—Alfalfa, Clover, and Grasses

LEGUME ESTABLISHMENT

Cultural practices—Seedling legumes generally are poor competitors with weeds. Management practices such as use of intertilled crops and after harvest tillage to control weeds and prevent weed seed production are desirable. Clipping of weeds in seedling legumes (except sweetclover) when sown alone, mowing the weeds and stubble of companion crops after harvest, and mowing of perennial weed patches aid in weed control. Do not mow after September 1 to allow adequate legume regrowth before frost.

Herbicides—Preplanting incorporated treatments of 2 to 4 pounds of EPTC (Eptam) per acre have given effective control of some annual broad-leaved and most annual grass weeds in alfalfa, red clover, alsike clover, sweetclover and birdsfoot trefoil when these legumes are sown without a grass or a combination crop. Do not use EPTC if grass or a grain companion crop is to be planted with the legume. The herbicide should be incorporated into the soil to a depth of 3 to 4 inches immediately after application.

Benefin (Balan) has given effective control of annual grasses, common lambsquarters and pigweed when applied preplanting and incorporated into the soil just before seeding legumes. Benefin may be used at rates of 1⅛ to 1¼ pounds per acre on alfalfa, birdsfoot trefoil, red, alsike, and ladino clovers. Use the lower rate on coarse textured soils and the higher rate on fine textured soils.

Profluralin (Tolban) has effectively controlled annual grasses, pigweed, and common lambsquarters when applied preplanting and incorporated at ½ to 1 pound per acre just before seeding alfalfa. **Caution:** As of December 1976, profluralin is not cleared, but future clearance is expected for alfalfa establishment.

Postemergence treatments of 2,4-DB amine at ½ to 1½ pounds per acre or 2,4-DB ester at ½ to 1 pound per acre can be used to control broad-leaved weeds in seedling alfalfa, birdsfoot trefoil, red, alsike, and ladino clovers when sown alone. Spray when weeds are less than 3 inches tall and when legumes have 1 to 4 trifoliolate leaves. Wild mustard is not effectively controlled by 2,4-DB. **Caution:** Do not graze for 60 days after treatment or feed hay within 30 days after application.

Seedling stands of alfalfa, birdsfoot trefoil, red, alsike, or ladino clovers established with a small grain companion crop may be sprayed with sodium salt or amine MCPA and 2,4-D amine at rates up to ¼ pound per acre after the companion crop or weeds are large enough to form a protective canopy over the legumes. Seedling legumes established with a flax companion crop may be sprayed with MCPA amine. Because seedling legumes can be seriously injured from these herbicides, do not spray unless it is necessary to control broad-leaved weeds and do not spray unless a canopy of companion crop or weeds is present. Reduced sprayer pressure may help to minimize injury. Do not use 2,4-D or MCPA ester on seedling legumes and do not spray sweetclover with either MCPA or 2,4-D.

ESTABLISHED LEGUMES

Cultural practices—Properly established stands of small-seeded legumes can effectively compete with many annual and perennial weeds. Weeds may become a problem if inadequate soil fertility, low soil pH, poor soil drainage, or poor management of the stand occurs.

Maintaining proper soil fertility and pH levels will increase forage yields and increase legume growth and vigor for better competition with weeds.

Many biennial and perennial weeds common in established legumes may be controlled effectively by harvesting the crop at the best time to prevent weed seed formation and dispersal. If weed seed does mature before the legume is ready for harvest, the forage should be ensiled, if possible. Fermentation in the silo kills many weed seeds.

Herbicides—Simazine (Princep) may 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 injured or killed. 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, gravelly soil, or on soils where soil pH is above 7.5. **Caution:** Do not graze areas treated with simazine for 30 days or cut hay for 60 days after treatment.

Pronamide (Kerb) can be used on pure legume stands of alfalfa, clover, birdsfoot trefoil, or crown vetch to suppress quackgrass and other perennial grasses. Pronamide will also control many annual grasses and some annual broad-leaved weeds but will not control perennial broad-leaved weeds. Suggested rates are 1 to 2 pounds of pronamide per acre applied in the fall when soil temperatures are below 60°F. but before freezeup. The lower rate should be used on coarse textured soils and the higher rate on medium to fine textured soils. Applications may be made in the fall of the seeding year. **Caution:** Do not graze or harvest forage within 25 to 45 days depending on rate of application.

Terbacil (Sinbar) may be applied to pure alfalfa stands established for one or more years at ¼ to ¾ pound per acre to control several annual grasses and broadleafs. Application may be made in the fall or spring while the alfalfa is dormant. There is potential for alfalfa injury, especially on sandy soils or soils with low organic matter. Other crops cannot be planted within 2 years after application.

MCPA is hazardous to use on established legumes and should be used only when a serious weed problem exists. It should be applied only when legumes are dormant in late fall to control susceptible broad-leaved weeds that are present at this time. MCPA amine at ¼ to ½ pound per acre may be used only on alfalfa and red clover to control certain winter annuals such as shepherdspurse and pennycress. Some control of yellow rocket should result, but white cockle is not controlled at these rates.

In established alfalfa, the amine salt of 2,4-DB can be applied at 1 to 1½ pounds per acre or the ester of 2,4-DB can be applied at ¾ to 1 pound per acre in 15 to 30 gallons of water per acre. Apply when the annual broad-leaved weed seedlings are 2 to 3 inches tall (2- to 5-leaf stage). Do not apply when extremes of temperature or moisture are expected within the next few days. **Caution:** Do not graze for 60 days or feed hay for 30 days after application.

PERENNIAL GRASSES

Cultural methods—Broad-leaved weeds may be controlled in perennial forage grasses grown for forage or seed by periodic clipping as needed to prevent weed seed formation. Repeated clipping of perennial weed patches together with fertilizer treatments as needed will favor the grasses and control the weeds.

Herbicides—2,4-D, MCPA, or dicamba will control broad-leaved weeds in established perennial grasses such as timothy, bluegrass, orchardgrass, reed canarygrass, and bromegrass. Combinations of dicamba with 2,4-D or MCPA give better control of mustards and other weeds resistant to dicamba. Dicamba controls perennial thistles more effectively than MCPA or 2,4-D. However, repeated applications of dicamba, 2,4-D or MCPA may be required for complete thistle or other perennial weed control.

In timothy or bluegrass grown for seed, dicamba is effective in controlling small seedlings of white cockle and night-flowering catchfly. If timothy is sown with wheat or oats, spray for these seedling weeds with ⅛ pound per acre of dicamba when the small grain is in the 2- to 5-leaf stage. In established stands of timothy or bluegrass, spring applications of dicamba at ¼ to ½ pound per acre when timothy or bluegrass is 2 to 4 inches tall will control white cockle, night-flowering catchfly, and most other broad-leaved weeds. If spring application is delayed, weed control will be erratic and some injury to timothy may occur.

ESTABLISHED GRASS PASTURES

Cultural practices—In established pastures, good management and controlled grazing are necessary to maintain a productive, weed-free stand. Protect new seedings from grazing until they are well established and graze moderately thereafter. Allowing established pastures a recovery period after grazing by excluding cattle for 3 to 4 weeks on a rotational basis will reduce weeds and increase forage yields. Mowing after each grazing period will control many pasture weeds and encourage new forage growth. Do not clip closer than 3 to 4 inches above the soil.

In very weedy pastures where perennial grasses are thin, reseeding may be the best practice. To be successful, add lime and fertilizer according to soil test, destroy old sod and weeds by plowing or extensive surface tillage and seed an adapted mixture of legumes and grasses in a firm seedbed.

Herbicides—Spraying with 1 or 2 pounds per acre of 2,4-D, MCPA, 2,4,5-T, silvex, or mixtures of these gives better control of broad-leaved weeds or brush with a single application than is obtained with a single mowing treatment. The weeds should be sprayed when perennials are 6 to 8 inches tall and annuals or biennials are 3 to 4 inches tall (usually late May or early June). Silvex and 2,4,5-T, applied alone or in mixtures with 2,4-D, are effective against woody plants and can be applied anytime when brush is fully leaved. Repeated treatment for 2 or more years is usually necessary. Grasses will not be injured at these rates of herbicide, but legumes will likely be killed. MCPA can be used at low rates of about ¼ to ½ pound per acre to control susceptible broad-leaved weeds where legumes such as white clover are present. At higher rates of 1 to 2 pounds per acre, MCPA will control some 2,4-D resistant weeds such as buttercup and spotted knapweed. **Caution:** Do not graze dairy cattle on pastures treated with 2,4-D or silvex for 7 days after treatment. Do not graze dairy animals within 6 weeks after application of 2,4,5-T, do not graze meat animals on 2,4,5-T or silvex treated areas within 2 weeks before slaughter, and do not cut grass for hay during the season of treatment with silvex. Minnesota law requires a permit and application by a licensed commercial applicator for use of 2,4,5-T on an area over 10 acres in size.

Dicamba 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 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 broadleaved 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

Cultural practices—Early germinating weeds may be destroyed by tillage during seedbed preparation. Sowing clean seed at an adequate seeding rate will also reduce weed populations. Small grain must be seeded early for best yields, so repeated spring tillage to control weeds with delayed seeding of small grain is not feasible. Early spring seeding also reduces annual grass weed problems such as foxtail that are increased by late seeding. If adverse weather prevents early seeding and annual grass weeds develop, harrowing in the very early growth stages will reduce weed populations.

Herbicides—Broad-leaved weeds have been the major weed problem in small grains. Wider use of the less competitive, shorter-strawed, semidwarf wheats has increased the need for both broadleaf and grass control. Several effective broad-leaved weed control herbicides are available. Close attention to suggested rates and times of application as given on the label is necessary to reduce small grain injury potential.

In late seedings of semidwarf spring wheat, heavy stands of foxtail may be a problem. Control is possible with postplant preemergence incorporated applications of trifluralin at ½ to ¾ pound per acre. Wheat should be planted 2 to 3 inches deep with a press-wheel drill. Trifluralin should be applied after planting and incorporated shallowly with a spike-tooth or flexible-tined harrow. Shallow planting or deeper incorporation of trifluralin may result in wheat injury especially on coarser textured soils that are low in organic matter. Under extremely dry conditions trifluralin may persist in the soil enough to affect sensitive crops such as corn, oats, grain sorghum, and sugarbeets planted the next year. Plowing with a moldboard plow reduces the potential for residue injury. **Caution:** As of December 1976, trifluralin has not been cleared for use on spring wheat in Minnesota.

Wheat and barley are relatively tolerant to 2,4-D from the time five full leaves appear until the early-boot stage. During this period 1/6 to ½ pound 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 these crops. Oats are less tolerant to 2,4-D and some injury 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 the amine form and no more than ½ pound per acre. **Caution:** Do not cut for forage or graze treated grain fields for 2 weeks after treatment with 2,4-D. To avoid crop injury don't spray small grain seedlings with less than five leaves or small grains in the boot stage of development. Varietal differences in wheat and barley have been unimportant but oat varieties differ in their response to 2,4-D.

Small grains may be sprayed with 2,4-D amine or ester at ½ to 1 pound per acre when grains are in the dough stage to control large weeds that may interfere with harvest. **Caution:** If ester formulations are used for this treatment, do not feed treated straw to livestock.

Small grains, especially oats, 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.

Bromoxynil controls many annual broad-leaved weeds, including some 2,4-D and MCPA resistant weeds such as wild buckwheat and smartweed in wheat, barley, and oats when applied at ¼ to ½ pound per acre. The lower rate is effective on small weed seedlings up to the 4 leaf stage. Some injury to small grains has occurred at the higher rate. If weeds are beyond the 4 leaf stage, or are less susceptible to bromoxynil, use ⅜ pound per acre or refer to product label for higher rate suggestions. Spray when small grains are in the 2-leaf to early boot stage. Good coverage of weeds is essential for good control.

Bromoxynil can also be used in combination with MCPA ester at ¼ pound of each material per acre on wheat or barley. Apply before the 3- to 4-leaf stage of the weeds and before the 3- to 4-leaf stage of wheat or barley for best results. Bromoxynil does not control perennials. **Caution:** Do not forage or graze for 30 days after application of bromoxynil or bromoxynil-MCPA mixtures.

Dicamba at ⅛ pound per acre controls broad-leaved weeds such as wild buckwheat and smartweed that are tolerant to 2,4-D and MCPA 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 more tolerant than wheat to dicamba. Use of dicamba on barley is not advised because of poor crop tolerance. Applications made at the 2- to 5-leaf stage of small grain growth are the least injurious to the grains. **Caution:** Do not graze treated areas or harvest for dairy feed prior to crop maturity.

Picloram (Tordon 22K) may be used at rates of ¼ to ⅜ ounces per acre in a tank mixture with 2,4-D amine at ¼ to ⅜

Table 3. Effectiveness of herbicides for weed control in small grains and flax.

Herbicide	Performance rating of herbicide on weeds*					Crop tolerance and herbicide clearance†			
	Wild mustard	Wild buck-wheat, annual smart-weeds	Canada & perennial sowthistle	Pigweed, lambs-quarters, common ragweed	Wild oat	Oats	Wheat	Barley	Flax
2,4-D amine	G	F	F	G	N	F	G	G	—
2,4-D ester	G	F	F	G	N	P	F	G	—
MCPA amine	G	F	F	G	N	G	G	G	G
MCPA ester	G	F	F	G	N	G	G	G	F
Bromoxynil (Buctril, Brominal)	F	G	N	G	N	G	G	G	F
Dicamba (Banvel)	P	G	G	G	N	G	F	P	—
Triallate (Far-go, Avadex-BW)	N	N	N	N	G	—	G	G	—
Diallate (Avadex)	N	N	N	N	G	—	F	F	F
Barban (Carbyne)	N	N	N	N	G	—	F	F	F
Difenzoquat (Avenge)	N	N	N	N	G	—	**	G	—
EPTC (Eptam)	P	P	N	F	F	—	—	—	F

*P=poor, F=fair, G=good, N=no control.

†P=poor, F=fair, G=good, —=not cleared for use.

**Wheat varieties differ in tolerance. Use only on spring wheat variety Era, or on winter wheat.

pound per acre for control of wild buckwheat, kochia, Russian thistle, and other broad-leaved weeds in spring barley and spring and winter wheat not underseeded with a legume. Use the low rates when weeds are small and the higher rates when weeds are more advanced or under dry conditions. One application of the tank-mix combination may be applied per year from the four-leaf stage up to the boot stage of spring wheat or barley and on winter wheat after resumption of active growth in the spring up to boot stage. **Caution:** Picloram may persist in the soil for more than 12 months. Therefore, use only on land which will be fallowed or replanted to a grass or grain crop the following year. Do not spray when wind drift will threaten picloram sensitive crops such as soybeans, field beans, peas, potatoes, sugar beets, sunflowers, or alfalfa.

For wild oat control, triallate (Far-go) may be used in hard red spring or durum wheat at 1 to 1¼ pounds per acre, applied after seeding and incorporated into the soil. Barley is more tolerant to triallate and rates of 1¼ to 1½ pounds per acre may be used, applied either before or after seeding and soil incorporated. In each case, use the lower rate of triallate liquid and the higher rate for triallate granules. Diallate (Avadex) may be used for wild oat control in barley seeded alone or underseeded with alfalfa, or sweet, red, and alsike clover. Apply after planting at 1¼ pound per acre and incorporate into the soil. Fall applications of liquid or granular formulations of triallate before spring planting of barley and wheat and of diallate before barley have been used successfully in northern areas that are not subject to wind or water erosion. A good seedbed free of trash should be prepared before incorporating the chemicals to a depth of 2 inches. A shallow seedbed, no more than 2 inches deep, should be prepared in the spring. To minimize possible crop thinning, seed wheat or barley just below the treated soil layer.

Barban (Carbyne) can be used for wild oat control in spring wheat or barley. It should be applied at ¼ to ⅜ pound per acre when wild oats are in the 2-leaf stage from 4 to 10 days after wild oat emergence. Thick stands of small grain aid in suppression of wild oat. Control may not be satisfactory in thin crop stands. To reduce crop injury, do not spray barban after wheat or barley is in the four-leaf stage or more than 14 days after emergence. **Caution:** Do not allow livestock to graze treated barley or wheat until after the crop is harvested.

Difenzoquat (Avenge) at ⅝ to 1 pound per acre has controlled wild oat when applied on wild oat with 3 to 5 leaves. Barley has good tolerance, but some wheat varieties are susceptible to injury. Era is the only variety of spring wheat that has label approval for applying difenzoquat. The suggested rate depends on the density of wild oat plants with higher rates required for denser wild oat stands. Difenzoquat may be used with MCPA and bromoxynil. Do not apply difenzoquat when plants are wet or if rain is expected within 6 hours.

Small Grains—Winter Wheat and Rye

Cultural practices—Winter annuals and/or perennials are usually the major weed problems in fall sown cereal grains. Perennials should be controlled by tillage or herbicides before or during seedbed preparation. Seeding of winter wheat should be completed by September 20 and rye should be seeded by October 1 so the crops are well established before winter and able to compete well with weeds.

Herbicides—2,4-D and MCPA can be used to control most broad-leaved weeds in winter wheat and rye if applied in the spring after the grain is fully tillered but before the boot stage. Use 2,4-D amine at ¼ to ¾ pound per acre and 2,4-D ester at ¼ to ½ pound per acre. Higher rates of 2,4-D, up to 1½ pounds per acre may be used from dough stage to harvest if necessary to control broad-leaved weeds. Rates over 1 pound per acre are more likely to cause crop injury. **Caution:** Do not feed treated straw to livestock. MCPA amine or ester can be used at ¼ to ¾ pound per acre. See the product label for specific use instructions. Do not spray winter wheat or rye in the fall. **Caution:** Do not graze or feed forage from 2,4-D treated fields within 2 weeks after treatment.

Bromoxynil controls many annual broad-leaved weeds, and especially controls wild buckwheat and smartweed in winter wheat and rye when applied in the spring at ¼ to ½ pound per acre. For best results spray when weeds are in the seedling stage and after wheat or rye has fully tillered. Bromoxynil may be used with MCPA for better control of wild mustard. **Caution:** Do not forage or graze for 30 days after treatment.

Dicamba at ⅛ pound per acre plus either MCPA or 2,4-D at ¼ to ⅜ pound per acre may be used in winter wheat for broadleaved weed control. Apply after winter dormancy and before grain begins to joint. **Caution:** Do not graze treated areas or harvest for dairy feed prior to crop maturity.

Difenzoquat (Avenge) may be used for wild oat control in winter wheat. (See discussion under spring small grains.)

Forage Sorghum, Sorghum-Sudan Crosses, and Sudangrass

Cultural practices—Sorghum, sudangrass, and crosses of these two are warm season crops and should not be planted until about May 20 to June 5 in Minnesota. Delayed planting until soil temperatures are warm enough for rapid crop seed germination provides an excellent opportunity for early weed control by tillage. The use of a rotary hoe or harrow will kill small weeds as they are emerging. A row cultivator with shovels set for shallow cultivation should be used after the crop and weeds emerge.

Herbicides—Atrazine may be used to control many annual grass and broad-leaved weeds in forage sorghum and sorghum-sudan hydrids. Atrazine is not registered for use on sudangrass. Application may be made preplanting (within 2 weeks of planting), preemergence, or postemergence. Do not use atrazine on sandy soils. On medium and fine textured soils with organic matter levels of more than 1½ percent, atrazine can be used at 2 to 3 pounds per acre. However, some crop injury may occur at the higher rate, especially if heavy rains follow application or if sorghum or sorghum crosses are under certain stress conditions. Postemergence treatments with atrazine alone should be made before weeds are more than 1½ inches tall. If an emulsifiable oil is used with atrazine for postemergence control of broad-leaved weeds, use no more than 1.2 pounds of atrazine per acre and apply before broadleafs are 4 to 6 inches tall. **Caution:** Do not graze or feed forage from treated areas for 21 days following application.

Propazine (Milogard) may be applied preemergence for annual grass and broad-leaved weed control in forage sorghum (but not in sorghum-sudan crosses or sudangrass) at 2 pounds per acre. Do not use propazine on sandy soils.

For the control of broad-leaved weeds in forage sorghum, sorghum-sudan crosses or sudangrass, 2,4-D amine or ester may be used when these crops are 4 to 12 inches tall. Application at earlier or later stages of the crop may result in serious crop injury. Use 2,4-D amine at ¼ to ½ pound per acre or 2,4-D ester at 1/6 to ⅓ pound per acre. **Caution:** Do not graze or harvest for 14 days after 2,4-D treatment.

Grain Sorghum

Cultural practices—Sorghum will not germinate or grow in cold soil. Therefore, late planting in warmer soil, May 20 to June 5, 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.

Herbicides—Treatment with propachlor (Ramrod), propazine (Milogard), atrazine or terbutryn (Igran) is usually necessary to prevent drastic reduction in sorghum yield due to weed competition. These herbicides control annual grasses in sorghum. Propazine, atrazine, and terbutryn also kill broad-leaved annual weeds. Propachlor at 4 to 4.8 pounds per acre, terbutryn at 1.6 to 2.4 pounds per acre, or propazine at 2 pounds per acre are applied preemergence.

Atrazine may be applied preplanting, preemergence or postemergence for annual grass or broadleaf control at 1.6 to 2.4 pounds per acre depending on soil type and organic matter content. If soil is worked after application, avoid deep incorporation. Postemergence applications should be made before weeds exceed 1½ inches in height. A mixture of atrazine at 1.2 pounds per acre plus special emulsifiable oils at 1 gallon per acre in water may be used for broad-leaved weed control. Approved emulsions of either vegetable or petroleum oils are satisfactory. Apply before broad-leaved weeds exceed 4 to 6 inches in height.

Mixtures approved for preemergence application are propachlor at 2½ to 4 pounds per acre plus atrazine at 1 to 1.6 pounds per acre and propachlor at 2¼ to 3 pounds per acre plus propazine at 0.8 to 1 pound per acre. **Caution:** Do not graze or feed forage within 21 days after application of atrazine or propachlor-atrazine. Do not graze or feed sorghum forage from propachlor-treated fields to dairy cattle.

Atrazine, terbutryn, or propazine should not be used on sandy soils, as injury to sorghum may occur, but some mixtures of propachlor with atrazine or propazine are approved. Rainfall or overhead irrigation at the time of sorghum emergence may result in injury from terbutryn. Terbutryn should not be used until the soil temperature has reached 60° F for at least 3 consecutive days. Winter wheat may be planted 4 months or more after terbutryn application.

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 ¼ pound per acre is also approved for control of broad-leaved weeds in sorghum if applied within 10 to 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 planting of the crop kills many weeds. Postemergence cultivation with the rotary hoe, harrow, or cultivator is effective if done when the weeds are small and soil conditions are favorable. Even when preemergence herbicides are used, and especially if dry conditions prevail for several days, the rotary hoe, harrow or cultivator should be used as soon as weeds appear at the soil surface.

Herbicides—Table 4 shows the performance of some 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 (less than 50 percent of the weeds controlled). Evaluations were made about 5 weeks after application.

Table 5 indicates soybean 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, alachlor (Lasso), butralin (Amex), dinitramine (Cobex), fluchloralin (Basalin), penoxalin (Prowl), profluralin (Tolban), trifluralin (Treflan), and vernolate (Vernam) have given good control of annual grasses, pigweed, and common lambsquarters when applied as preplanting soil-incorporated treatments. Other broad-leaved weeds are usually not adequately controlled. Preplanting incorporated applications of vernolate or alachlor (Lasso) have also controlled nutsedge.

Selection of the proper rate of these chemicals is especially important to obtain satisfactory weed control and avoid excessive soybean injury. The proper rate depends on soil texture and the amount or organic matter in the soil. Be sure to read label rate charts carefully for specific rate information. The suggested rate ranges are: dinitramine, ⅓ to ⅔ pound per acre; fluchloralin, ½ to 1½ pounds per acre; penoxalin, ½ to 1½ pounds per acre; alachlor, 2½ to 4 pounds per acre; butralin, 1½ to 3 pounds per acre; profluralin, ½ to 1 pound per acre; trifluralin, ½ to 1 pound per acre; vernolate, 2 to 3 pounds per acre.

Under extremely dry conditions, fluchloralin, profluralin, and trifluralin may persist in the soil enough to affect sensitive crops such as corn, small grains, grain sorghum, and sugarbeets planted the next year. Plowing with a moldboard plow reduces the potential for crop injury from residues of these herbicides compared to reduced tillage such as with a chisel-plow, field cultivator, or disk.

Proper incorporation of the above chemicals can be accomplished with a tandem disk, field cultivator with sweep shovels, rotary cultivator, or power driven rotary tiller. Pulling a spike-tooth harrow behind the disk or field cultivator is also advisable. Operating the disk or field cultivator 3 to 4 inches deep and the rotary cultivator or tiller at 2 to 3 inches usually gives the desired depth of incorporation. Observe label instructions for proper equipment depth and speed of operation. The chemicals should be incorporated while applying or within a few minutes after application. To get uniform incorporation, the disk or field cultivator should be operated twice over the field in different directions. With early applications, one operation can be done at application time and the second just prior to planting. Incorporation is usually better when the soil surface is dry enough to permit good soil mixing. Vernolate should not be applied to wet soils because a considerable amount of the chemical may be lost as vapor resulting in poor weed control.

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 rough cloddy fields or on fields subject to serious wind erosion, water erosion, or flooding.

Several preemergence chemicals are labeled for use after some of the preplanting treatments to improve broad-leaved weed control. Other combination treatments may be labeled by planting time. Over preplanting dinitramine, profluralin, or trifluralin applications, preemergence applications of chloramben, linuron, or metribuzin have given improved grass and broad-leaved weed control and chlorpropham has controlled annual smartweeds. Metribuzin is also labeled for tank mixing with trifluralin and applying as a preplanting incorporated treatment, but more severe early soybean injury has resulted from this method of use than if the metribuzin was applied preemergence. Chloramben is also labeled for use over other preplanting applied chemicals. Metribuzin should not be used with vernolate because of potential soybean injury problems.

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. Chloramben at 2 to 3 pounds per acre has worked well as a preemergence treatment over dinitramine, profluralin, trifluralin and vernolate applied preplanting. Chloramben is also labeled for use preemergence with alachlor, dinoseb or linuron.

Alachlor (Lasso) has given good annual grass control in soybeans. Alachlor has given fair to good control of redroot pigweed, black nightshade and common lambsquarters, but control of other broadleafs has been erratic. Soybeans have good tolerance to alachlor. Suggested rates are 2 to 3½ pounds per acre in the liquid formulation and 2.4 to 3.9 pounds per acre in the granular formulation. Alachlor has usually controlled annual weeds better when applied preemergence than preplanting, but preplanting incorporated treatments controlled nutsedge better than preemergence applications.

Alachlor is labeled for use preemergence on soybeans in mixtures with chloramben, chlorbromuron, chlorpropham, dinoseb, naptalam plus dinoseb, linuron, and metribuzin. These mixtures will improve annual broad-leaved weed control, but soybean injury may occur under certain conditions.

Preemergence applications of linuron (Lorox) at ½ to 2½ pounds per acre or chlorbromuron (Maloran) at 1 to 4 pounds per acre control annual broad-leaved weeds and grasses in soybeans. Both chemicals are 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. Linuron or chlorbromuron may be used in mixtures with alachlor.

Chlorpropham (Furloe Chloro IPC) applied preemergence at 2 to 3 pounds per acre has given good control of smartweed. 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.

Metribuzin (Sencor, Lexone) is a preemergence herbicide that has given good annual broadleaf control and fair annual grass control at rates of ⅜ to ¾ pounds per acre. Early soybean injury has frequently occurred at the higher rates. Metribuzin should not be used on Altona or Steele varieties which are more susceptible to injury. Metribuzin may be used at ¼ to ½ pound per acre in a mixture with 2 to 2½ pounds per acre of alachlor, or as a preemergence treatment over preplanting trifluralin. Do not use on soils low in organic matter, or on sandy soils. Injury may be more severe on alkaline soils or on soils with atrazine residues.

Dinoseb (DNBP) applied preemergence or up to the cotyledon stage of the soybeans, usually controls mustard satisfactorily, but has not consistently controlled most other weeds. Good results on emerged weeds are dependent on relatively warm temperatures and some crop injury may occur.

Naptalam plus dinoseb (Dyanap) as a preemergence treatment up to the crook-stage of soybeans has given fair broadleaf control but poor grass control and serious soybean injury has sometimes occurred. This mixture may be used preemergence with alachlor.

Bifenox (Modown) is a preemergence herbicide that has given fair to good annual broadleaf control and inconsistent annual grass control. Soybean tolerance is limited and malformation and stunting of young soybeans often occurred. Bifenox may be used as a preemergence treatment over trifluralin or as a preemergence mixture with alachlor.

Postemergence applications: Cocklebur can be controlled by applying 2,4-DB amine at 0.2 pound per acre as a directed spray when soybeans are 8 to 12 inches tall or over the top of soybeans from 10 days before bloom up to midbloom. Cocklebur 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

Table 4. 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), pre	2½, 3	1969-76	139	136	88	7	5	60	23	17
Bentazon (Basagran), pst	¾	1973-75	45	45	13	18	69	78	13	9
Bifenox (Modown)	2	1975-76	27	26	33	33	33	65	19	16
Chloramben (Amiben), pre	3	1959-76	483	467	75	16	9	76	16	8
Dinitramine (Cobex), ppi	⅝, ⅔	1972-76	63	62	75	16	9	60	29	11
Linuron (Lorox), pre	2	1962-75	381	368	53	25	22	68	18	14
Metribuzin (Sencor, Lexone), pre	½, ⅝	1972-76	73	72	70	17	13	75	14	11
Profluralin (Tolban), ppi	1, 1½	1973-76	54	51	81	13	6	51	41	8
Trifluralin (Treflan), ppi	1	1965-76	214	205	86	11	4	59	26	15
Alachlor, pre + linuron, pre	2 + 1½	1971-76	96	93	87	11	2	83	7	10
Alachlor, pre + bentazon, pst	3 + ¾	1973-76	57	53	84	9	7	87	9	4
Alachlor, pre + dinoseb, pre	2½ + 4½	1973-76	60	58	84	13	3	71	15	14
Alachlor, pre + metribuzin, pre	2 + ½	1974-76	47	44	92	6	2	89	4	7
Trifluralin, ppi + bentazon, pst	1 + ¾	1973-74	31	28	81	16	3	86	14	0
Trifluralin, ppi + bifenox (Modown), pre	¾ + 2	1975-76	24	23	92	4	4	92	4	4
Alachlor + naptalam + dinoseb (Dyanap)	2 + 3 + 1½	1975-76	27	26	78	4	18	50	35	15
Trifluralin, ppi + chloramben, pre	¾ + 2	1971-76	85	82	92	7	1	89	9	2
Trifluralin, ppi + chloroxuron, pst	¾ + 1½	1968-72	85	80	89	8	3	88	8	4
Trifluralin, ppi + linuron, pre	¾ + 1½	1970-76	104	100	89	9	2	90	6	4
Trifluralin, ppi + metribuzin, ppi	¾ + ½	1974-75	32	31	94	3	3	97	3	0
Trifluralin, ppi + metribuzin, pre	¾ + ½	1974-76	42	40	93	5	2	92	5	3

*ppi—preplanting incorporated
pre—preemergence
pst—postemergence

Table 5. Effectiveness of herbiciees on major weeds in soybeans

	Preemergence						Preplanting						Postemergence		
	Alachlor (Lasso)	Chloramben (Amiben)	Chlorbromuron (Maloran)	Chlorpropham (Furloe Chloro IPC)	Linuron (Lorox)	Metribuzin (Sencor, Lexone)	Alachlor (Lasso)	Dinitramine (Cobex)	Fluchloralin (Basalin)	Profluralin (Tolban)	Trifluralin (Treflan)	Vernolate (Vernam)	Chloroxuron (Tenoran)	2,4-DB	Bentazon (Basagran)
Soybean Tolerance	G	G	F	G	F	F	G	F	F	F	F	F	F	P	G
Grasses															
Giant foxtail	G	G	F	P	F	F	G	G	G	G	G	G	P	N	N
Green foxtail	G	G	F	P	F	F	G	G	G	G	G	G	P	N	N
Yellow foxtail	G	G	F	P	F	F	G	G	G	G	G	G	P	N	N
Barnyardgrass	G	G	F	P	F	F	G	G	G	G	G	G	P	N	N
Nutsedge	F	P	P	N	P	P	G	N	N	N	N	G	N	N	F
Broadleafs															
Black nightshade	G	F	P	P	P	P	G	F	P	P	P	P	—	—	F
Cocklebur	P	P	P	P	P	F	P	N	N	N	N	P	F	F	G
Kochia	P	G	F	P	F	G	P	G	G	G	G	—	—	—	—
Lambsquarters	F	G	G	P	G	G	F	G	G	G	G	G	F	P	P
Mustard	P	F	G	F	G	G	P	N	N	N	N	F	G	P	G
Pigweed	G	G	G	P	G	G	G	G	G	G	G	G	F	P	P
Common ragweed	P	G	G	P	G	G	P	P	N	N	N	P	P	P	G
Smartweed	P	G	F	G	F	G	P	F	P	P	P	P	P	P	G
Velvetleaf	P	F	F	P	F	F	P	P	N	N	N	F	P	P	G
Venice mallow	P	G	G	P	G	G	P	P	P	P	P	G	—	P	G
Wild sunflower	P	P	P	P	P	F	P	N	N	N	N	P	F	P	G

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

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. Broadleaved 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 occur 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.

Bentazon (Basagran) gives excellent control of several annual broad-leaved weeds, Canada thistle, and yellow nutsedge when applied postemergence in soybeans. Pigweeds and common lambsquarters are somewhat tolerant. Bentazon does not control grasses. It is most effective if applied when weeds have the first two to four leaves and soybeans are in the first trifoliolate leaf stage. It can be applied to within 65 days of soybean harvest but weed control is not as good and the treatment is less economical than early application. Suggested rates are ¾ to 1½ pounds per acre depending on the kinds of weeds and weed size. Bentazon has been more effective if applied when foliage is dry and during the day. Early morning, late evening, and night applications were less effective than daytime applications. Rain before 8 to 24 hours after application reduces weed control from bentazon.

Barban (Carbyne) can be used as a postemergence treatment for wild oat control in soybeans. Rates up to 6 ounces per acre are applied when most of the wild oats are in the two-leaf stage. Do not apply after the first trifoliolate leaf stage of the soybeans nor later than 14 days after soybean emergence.

Sugarbeets

Herbicides may be used in sugarbeets to supplement conventional cultivation practices. Hand labor, mostly hoeing, may still be 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, desmedipham, or pyrazon may be applied postemergence following preemergence or preplanting herbicide applications. However, the sugarbeet 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 6 indicates sugarbeet tolerance to herbicides suggested for use in sugarbeets 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 oat, may be controlled by TCA at 5 to 7 pounds per acre applied preemergence. **Caution:** TCA is not cleared for use on sugarbeets 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. Fall applications of EPTC at 4 to 4½ pounds per acre have performed well and can be used in the Red River Valley area. Applications should be made after October 15 until freeze-up and incorporated immediately and thoroughly. 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 highest rates. If postemergence treatments of other herbicides are planned, the lower rate of EPTC should be used to reduce sugarbeet 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 matter soils. Cycloate has resulted in less sugarbeet injury than EPTC, but cycloate has given slightly more variable weed control. Less sugarbeet 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 5 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 sugarbeets. 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 usually required to control wild oat and some sugarbeet 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 sugarbeets are 14 inches tall. If repeated applications are used, no more than 6 pounds per acre can be applied in any single growing season. Use of a surfactant in the spray mixture with dalapon may improve grass control, but sugarbeet injury may be increased.

Pyrazon (Pyramin) controls many annual broad-leaved weeds when applied preemergence or early postemergence. If applied premergence pyrazon should be used in combination with TCA to give control of most annual broad-leaved weeds and grasses. Pyrazon plus TCA should be used only on medium- to coarse-textured soils with less than 5 percent organic matter and a rain shortly after application is necessary for best results.

A mixture of pyrazon and dalapon (Pyramin Plus) has given good annual grass and broadleaf control if applied when broadleafs have no more than two true leaves. The suggested rate is 3.8 pounds per acre of pyrazon and 2.2 pounds per acre of dalapon. Best weed control occurred when the mixture was applied postemergence following use of a preplanting or preemergence herbicide. Results on soils with more than 5 percent organic matter have been erratic.

Diallate (Avadex) at 1½ to 2 pounds per acre may be applied in the fall or spring as a preplanting soil-incorporated treatment to control wild oat in sugarbeets. At these rates, diallate may persist in the soil enough to affect tame oats the next year. Barban (Carbyne) at ¾ to 1 pound per acre may be used to control emerged wild oat. Wild oat should be sprayed in the two-leaf stage.

Certain broad-leaved weeds—annual smartweed, wild buckwheat, and marshelder—may be controlled by a post-

Table 6. Effectiveness of herbicides on major weeds in sugarbeets

	Preplanting		Preemergence	Postemergence					
	Diallate (Avadex)	EPTC (Eptam)	TCA	Barban (Carbyne)	Dalapon (Dowpon, Basfapon)	Endothall (Herbicide 273)	Desmedipham (Betanex)	Phenmedipham (Betanal)	Pyrazon (Pyramin)
Sugarbeet tolerance	G	F	G	G	F	F	F	F	G
Grasses									
Giant foxtail	P	G	G	P	G	P	P	F	P
Green foxtail	P	G	G	P	G	P	P	F	P
Yellow foxtail	P	G	G	P	G	P	P	F	P
Barnyardgrass	P	G	G	P	G	P	P	P	P
Wild oat	G	F	P	G	F	P	P	P	P
Broadleafs									
Common ragweed	P	F	P	P	P	F	G	G	G
Lambsquarters	P	F	P	P	P	P	G	G	G
Marshelder	P	—	P	P	P	G	—	—	—
Pigweed	P	F	P	P	P	F	G	P	F
Smartweed	P	P	F	P	P	G	F	F	G
Wild buckwheat	P	P	P	P	P	G	F	G	G
Wild mustard	P	P	P	P	P	P	G	G	G

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

emergence application of endothall at ¾ to 1½ pounds per acre. Sugarbeets should have 4 to 6 true leaves when endothall is applied. Do not apply endothall later than 40 days after sugarbeet 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 sugarbeets. Endothall may cause leaf burn on the sugarbeets 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 some annual grasses and most annual broad-leaved weeds except redroot pigweed. Desmedipham (Betanex) is a similar chemical for early postemergence treatment which at 1 to 1¼ pounds per acre has given good control of pigweed, common lambsquarters, common ragweed, and wild mustard and fair control of annual smartweeds and wild buckwheat. It does not control grasses.

To avoid possible sugarbeet injury from desmedipham (Betanex) and phenmedipham (Betanal), several precautions should be observed. The sugarbeets should have at least four leaves before treatment. Do not apply if the highest temperature on the day of application exceeds 85°F. Use no more than 1 pound per acre following EPTC or TCA. Start application late in the afternoon or early in the evening so cool temperatures follow application. Set the proper band width near the top of the sugarbeets so that the beets rather than the ground receive the proper rate. Calibrate the sprayer very carefully.

When sugarbeets are planted early in the spring or when good moisture conditions prevail well into the season, late germinating weeds can become a problem and the use of an herbicide after thinning may be advisable. Trifluralin (Treflan) is cleared at ¾ lb/A and EPTC (Eptam) is cleared at 3 lb/A for use on sugarbeets after thinning for annual grass and broadleaf control. The chemicals should be broadcast applied and incorporated immediately with cultivators or tillers adjusted to mix them thoroughly with soil in the row without damaging the sugarbeets. The crop should be clean cultivated before application since established weeds are not controlled. Exposed sugarbeet roots should be covered with soil prior to trifluralin application to reduce the possibility of injury.

Sunflowers

Cultural practices—Sunflowers normally do not emerge for 10 days to 2 weeks after planting. Therefore, weeds frequently emerge before sunflowers. Many weeds can be killed by spike-tooth or coil spring harrowing about 1 week after planting. After sunflowers emerge, such implements as the weeder, rotary hoe, and spike-tooth or coil spring harrow may be used to kill weeds because the sunflower seedlings are more strongly rooted and are usually not injured if the implement is properly adjusted. More than one such tillage operation may be needed if seedling weeds continue to emerge. Weeds that are missed in these early tillage operations may be controlled by cultivation between the rows. However, sunflowers are more easily damaged or broken by the cultivator than is corn.

Herbicides—EPTC (Eptam) can be used at 3 pounds per acre, preplanting and incorporated immediately, to control most annual grasses and many annual broad-leaved weeds. EPTC gives some control of wild oat, but does not control wild mustard or smartweed. Trifluralin (Treflan) can be used preplanting, incorporated, at ½ pound per acre on sandy soils low in organic matter, ¾ pound per acre on medium textured soils or sandy soils with 2 to 5 percent organic matter, and 1 pound per acre on silt loam or clay soils or on sandy soils with over 5 percent organic matter. Trifluralin controls most annual grasses and some annual broad-leaved weeds, but is not effective on wild mustard, common ragweed, or smartweed. Either EPTC at 4 to 4½ pounds per acre or trifluralin at ½ to 1 pound per acre may be applied in the fall prior to planting sunflowers in the spring.

Dinitramine (Cobex) may be used preplanting and incorporated to control most annual grasses and some annual broad-leaved weeds. Use ⅓ pound per acre on sandy soils, ½ pound per acre on loam and silt loam soils, and ⅔ pound per acre on clay soils. Refer to product label for more specific rate suggestions on different soils. Soil incorporation may be delayed up to 24 hours with satisfactory results.

Profluralin (Tolban) may be used preplanting and incorporated at ¾ pound per acre on sandy soils, and at 1 pound per acre on loam and clay soils to control most annual grass and some annual broad-leaved weeds. Although immediate soil incorporation is preferred, a delay of up to 4 hours for profluralin and up to 8 hours after application of trifluralin is acceptable.

Chloramben (Amiben) can be used to control many annual grasses and broad-leaved weeds when applied preemergence at 2 to 3 pounds per acre. Use the low rate on sandy soils of less than 3 percent organic matter. Chloramben does not control wild oat. If sufficient rainfall does not fall within 3 to 4 days after application, use a rotary hoe or similar implement for shallow tillage to assist in weed control. **Caution:** Do not graze or feed sunflower forage from chloramben-treated areas. Excellent weed control has been obtained when EPTC, trifluralin or profluralin was applied preplanting followed by chloramben applied preemergence.

Barban (Carbyne) may be used for wild oat control in sunflowers at ¼ to ⅜ pound per acre applied when most of the wild oats are in the 2-leaf stage. Do not apply later than 14 days after sunflower emergence.

Special Weed Problems

Perennial Weeds

Perennial weeds such as Canada thistle, perennial sowthistle, field bindweed, Jerusalem artichoke, leafy spurge, nutsedge, 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.

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.

Perennial Broad-leaved Weeds in Crops

Perennial broad-leaved weeds such as Canada thistle, perennial sowthistle, field bindweed, Jerusalem artichoke, and leafy spurge can be suppressed with 2,4-D or MCPA in tolerant crops. Use 2,4-D or MCPA on oats, wheat or barley; MCPA is less injurious to oats. 2,4-D can be used in corn. 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, grass pastures, and corn. Use the maximum rate of dicamba listed for the specific crop. Drift may damage soybeans or other broad-leaved plants.

Canada thistle can be controlled in the fall or spring before planting soybeans. Spray with 1 pound per acre of 2,4-D in the fall 10 days before plowing or in the spring 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. Do not use dicamba before planting soybeans as serious crop injury can occur.

Bentazon (Basagran) may be used as a postemergence treatment to control Canada thistle or perennial sowthistle in soybeans. Two applications of ¾ pound per acre each have been more effective than a single application of 1 to 1½ pounds per acre. The first application should be when thistles are 3 to 6 inches tall. Repeat the treatment 10 to 14 days later. If a single application is used, apply when tallest thistles are 6 to 8 inches.

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.

Glyphosate (Roundup) is a new chemical that has given excellent quackgrass control in experiments when applied at 1 to 1½ pounds per acre. The chemical is applied as a spray on the foliage of actively growing quackgrass in the fall or spring before plowing. The field may be plowed and planted three or more days later. Underground rhizomes as well as topgrowth are killed. Other vegetation is also killed. Glyphosate is not active through the soil and leaves no residue in the soil that affects subsequently planted crops. Normal control practices are needed to control annual weeds in crops grown after glyphosate applications. Glyphosate is cleared for use in fields before planting barley, corn oats, sorghum, soybeans, and wheat.

Atrazine is an 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.

Prelanting incorporated applications of EPTC (Eptam, Eradicane) may be used to control quackgrass, but results have been somewhat inconsistent. Use of EPTC in the spring following fall application of glyphosate or atrazine has looked promising in research trials with corn. The higher rates of EPTC labelled for the crop to be planted should be used to control quackgrass. Before applying EPTC, the field should be plowed, then disked, to thoroughly cut up the rhizomes.

Dalapon (Dowpon, Radapon) applied postemergence in the fall to the foliage of actively growing quackgrass has given fair to good quackgrass control the following year. Dalapon should be applied at 11 pounds per acre in the fall and followed by plowing or other similar tillage 1 to 2 weeks after application. Repeated treatments in successive years may be needed to eradicate quackgrass. Control is better if rain occurs between treatment and plowing. Corn, dry beans, some varieties of potatoes, and sugarbeets may be planted in the spring following fall treatment. However, some crop injury may occur if it has been dry following application of dalapon. Use of a surfactant in the spray mixture with dalapon will improve wetting of the foliage and grass control.

Dalapon may also be applied to quackgrass in the spring, but spring applications are not as practical as fall applications in Minnesota because planting is delayed and there is more risk of crop injury from dalapon residues in the soil. The lower rate, 6 pounds per acre, that can be used in the spring is less effective on the quackgrass than the higher rates that can be used in the fall. Corn, dry beans, some varieties of potatoes, and sugarbeets may be planted but not until at least 4 weeks after the dalapon application.

Yellow Nutsedge

Yellow nutsedge is a perennial weed that propagates from seeds and from underground rhizomes and tubers (nuts) that are formed on the rhizomes. The grass-like leaves of nutsedge are light green and the seedheads are yellow to brown. The nuts are ⅛ to ½ inch in diameter and tan to brown in color. The stems are triangular in cross section. Nutsedge usually becomes established in wet areas of fields. The weed is spread by tillage operations which scatter the seeds, rhizomes, and nuts.

Nutsedge can be controlled, but usually not eliminated, by using a combination of cultural practices and chemicals. Infested spots of fields should be tilled separately from the remainder of the field to avoid dragging plant parts to clean areas of the field. Nutsedge is not tolerant of intense shade. So growing crops with a dense canopy such as narrow-rowed soybeans helps suppress nutsedge. Repeated cultivations are usually needed to destroy regrowth and new seedlings, even where chemicals are used.

Fallowing has given effective control in dry years, but, in wet years, the tubers are just transplanted and continue to grow. Disking or dragging about every 3 weeks or when sprouts appear should considerably reduce the nutsedge population in a dry year.

Preplanting incorporated application of high rates of alachlor (Lasso), butylate with protectant (Sutan+), or EPTC with protectant (Eradicane) in corn and alachlor or vernolate (Vernam) in soybeans usually gives good nutsedge control. If other crops that are tolerant to EPTC such as potatoes, sunflowers, or dry edible beans can be grown in the infested areas, EPTC without the protectant may be used to control nutsedge. Alachlor and propachlor (Ramrod) applied preemergence have sometimes controlled nutsedge, but have not been as effective as the preplanting treatments discussed above.

Some regrowth and new plants can be expected to occur following herbicide applications. These can be controlled by cultivation. In corn, early postemergence applications of atrazine and oil have been effective in controlling regrowth following preplanting treatments with the chemicals discussed above. Directed applications of linuron (Lorox) or ametryne (Evik) have also been partially effective for controlling nutsedge in larger corn.

Bentazon (Basagran) may be used as a postemergence treatment to control nutsedge in soybeans. Two applications of ¾ pound per acre each have been more effective than a single application of 1 to 1½ pounds per acre. The first application should be when the nutsedge is 3 to 6 inches tall. Repeat the treatment 10 to 14 days later. If a single application is used, apply when the tallest nutsedge is 6 to 8 inches.

Table 7. Herbicide names and formulations

Common name	Trade name[1]	Concentration and commercial formulation[2]
Alachlor	Lasso	4 lb/gal L
	Lasso II	15% G
Alachlor and atrazine	Lasso + atrazine	9+6% G
Ametryne	Evik	80% WP
Amitrole	Amino-triazole, Amizol, Weedazol, Mixtures	50, 90% WSP
Amitrole and simazine	Amizine	15% amitrole WSP 45% simazine WP
Amitrole-T	Amitrol-T, Cytrol	2lb/gal L
AMS	Ammate	95% WSP
Atrazine	AAtrex,Atrazine, Several, Mixtures	80% WP, 4 lb/gal L 8% P
Atrazine and propachlor	AAtram	6.66% atrazine, 13.34% propachlor G
Barban	Carbyne	1 lb/gal L
Benefin	Balan	1½ lb/gal L
Bentazon	Basagran	4 lb/gal L
Bifenox	Modown	80% WP
Boron compounds (Borax, sodium pentaborate, boron trioxide, anhydrous sodium, biborate, and mixtures.)	Several, Mixtures	Various
Bromacil	Hyvar-X, Hyvar-XL Mixtures	80% WP, 2 lb/gal L, Various
Bromoxynil	Buctril, Brominal	2 lb/gal L
Bromoxynil and MCPA	Bronate, Brominal Plus	2 lb/gal MCPA L 2 lb/gal bromoxynil L
Butralin	Amex	4 lb/gal L
Butylate and protectant	Sutan +	6, 6.7 lb/gal L, 10% G
Chloramben	Amiben	10% G, 2 lb/gal L
Chlorbromuron	Maloran	50% WP
Chloroxuron	Tenoran	50% WP
Chlorpropham (CIPC)	Furloe Chloro IPC Mixtures	10% G 4 lb/gal L
Cyanazine	Bladex	80% WP, 15% G, 4 lb/gal L
Cycloate	Ro-neet	6 lb/gal L
Dalapon	Basfapon, Dowpon M, Mixtures	74% WSP 5 lb/gal L
Dalapon and TCA	Dowpon C.	46.5% dalapon, 26.2% TCA WSP
DCPA	Dacthal	50, 75% WP
Desmedipham	Betanex	1.3 lb/gal L
Diallate	Avadex	4 lb/gal L, 10% G
Dicamba	Banvel, Mixtures	4 lb/gal L
Dicamba and 2,4-D	Banvel-K	1.25lb/gal dicamba 2.50 lb/gal 2,4-D
Dicamba and 2,4,5-T	Banvel 2+ 2	2 lb/gal dicamba 2 lb/gal 2,4,5-T
Dicamba and MCPA	Banvel-M, MonDak	1.25 lb/gal dicamba, 2.50 lb/gal MCPA L
Difenzoquat	Avenge	2 lb/gal L
Dinitramine	Cobex	2 lb/gal L
Dinoseb (DNBP)	Several, Mixtures	1, 3, 5 lb/gal L 10% G
Diuron	Karmex, Mixtures	L, WP, G Varies
Endothall	Endothal, Herbicide 273	1.46 lb/gal L 3 lb/gal L 5% G
EPTC	Eptam	6, 7 lb/gal L, 10% G
EPTC and protectant	Eradicane	6.7 lb/gal L
Fenac	Fenac Mixtures	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
Fluchloralin	Basalin	4 lb/gal L
Glyphosate	Roundup	3 lb/gal L
Linuron	Lorox, Mixtures	50% WP
MCPA	Several, Mixtures	Various L
Metolachlor	Dual	6 lb/gal L
Metribuzin	Sencor, Lexone	50% WP
Monuron	Telvar, Mixtures	G, L, WP Various

[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 7. Herbicide names and formulations (con't)

Common name	Trade name[1]	Concentration and commercial formulation[2]
Neburon	Several, Mixtures	Varous WP
Naptalam (NPA)	Alanap	2 lb/gal L, 10% G
Naptalam and dinoseb (DNBP)	Dyanap, Kleen Krop	2 lb/gal naptalam 1 lb/gal dinoseb L
Paraquat	Paraquat	2 lb/gal L
PBA	Several, Mixtures	Various L
Penoxalin	Prowl	4 lb/gal L
Phenmedipham	Betanal	1.3 lb/gal L
Picloram	Tordon 22K, Tordon 10K Tordon Beads, Tordon K, Amdon 10K	10%, 2% G 2 lb/gal L
Picloram and 2,4-D	Tordon 212,	1 lb/gal picloram + 2 lb/gal 2,4-D L
	Tordon 101 Amdon 101	½ lb/gal picloram + 2 lb/gal 2, 4-D L
Picloram and 2,4,5-T	Tordon 155	1 lb/gal picloram + 4 lb/gal 2,4,5-T L
Profluralin	Tolban	4 lb/gal L
Prometone	Pramitol	2 lb per gal L 5% P
Pronamide	Kerb	50% WP
propachlor	Ramrod, Bexton	65% WP 20% G
Propazine	Propazine, Milogard	80% WP
Pyrazon	Pyramin	80% WP
31.4% Pyrazon and dalapon	Pyramin Plus	31.4% pyrazon + 18.5%dalapon WP
Silvex(2,4,5-TP)	Several, Mixtures	L, G Various
Simazine	Princep, Mixtures	80% WP, 4% G
Sodium chlorate	Several, Mixtures	WSP Various
TBA	Several, Mixtures	Various
TBP	Several, Mixtures	Various
TCA	TCA, Mixtures	4.76 lb/gal L 79.3% WSP
Terbacil	Sinbar	50% WP
Triallate	Far-go, Avadex-BW	4 lb/gal L 10% G
Trifluralin	Treflan	4 lb/gal L. 5% G
2,4-D	Several, Mixtures	L, G Various
2,4-DB	Butryac 200 Butoxone	2 lb/gal L
2,4,5-T	Several, Mixtures	L Various
Vernolate	Vernam	6, 7 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

Table 8. 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 feed.

Crop	Chemicals	Pounds per acre of active ingredient or acid equivalent broadcast	Time	Remarks	EPA registration limitations on crop use
Corn	alachlor (Lasso) (Lasso II)	2 to 4 2.4 to 3.9	Preemergence or preplanting		
	atrazine	1 to 3	Preplanting, preemergence or early postemergence	Atrazine may injure crops the following year	Do not graze or feed forage for 21 days after treatment
	EPTC with protectant (Eradicane)	3 to 6	Preplanting incorporation	Do not use on corn seed stock.	None
	butylate (Sutan +)	3 to 6	Preplanting incorporation	Do not use on corn seed stock.	None
	propachlor (Ramrod, Bexton)	4 to 6	Preemergence		None
	cyanazine (Bladex)	2 to 4 2	Preemergence Early Postemergence	Do not use on sandy soils.	None
	atrazine and alachlor	1 to 2+ 1½ to 2½	Preemergence		Do not graze or feed forage for 21 days after treatment.
	cyanazine and alachlor	1 to 2.2+ 2 to 2½	Premergence	Do not use on sandy soils.	None
	dicamba (Banvel) + alachlor	½ + 2 to 2½	Preemergence	Do not use on sandy soils or soils with less than 2.5% organic matter	Do not graze or feed silage prior to milkstage.
	atrazine and butylate	1 to 1½ + 3 to 4	Preplanting incorporation		Do not graze or feed forage for 21 days after treatment.
	cyanazine and butylate	1 to 2 + 3 to 4	Preplanting incorporation	Do not use on corn seed stock.	None
	atrazine and propachlor	1 to 1½ + 2 to 3¾	Premergence		None
	linuron (Lorox) and alachlor	½ to 1½ + 1 to 3	Preemergence	Do not use on sandy soils.	Do not graze or harvest immature corn for feed within 12 weeks after treatment.
	linuron and propachlor	1 to 1½ + 2 to 3	Preemergence	Do not use on sandy soils.	None
	2,4-D amine 2,4-D ester	¼ to ½ 1/6 to ⅓	Corn 4 inches to tasseling	Broadleafs only. Corn most susceptible during rapid growth. Use drop nozzles after corn is 8 inches tall.	Do not forage or feed fodder for 7 days following 2,4-D application.
	2,4-D amine 2,4-D ester	½ to 1 ⅓ to ⅔	Corn over 3 feet	Spray base of stalks only.	
	dicamba (Banvel) dicamba+2,4-D amine	⅛ to ¼ ⅛+¼	Postemergence before corn is 2 feet tall and not within 15 days of tasseling.	See Precautions on page 7 to reduce risk of serious drift problems.	Do not graze or harvest for feed before milk stage.
Winter wheat	2,4-D amine 2,4-D ester MCPA	¼ to ¾ ¼ to ½ ¼ to ¾	Wheat fully tillered to boot stage.		Do not graze or feed forage from 2,4-D treated fields within 2 weeks after treatment. None for MCPA
	dicamba+ MCPA amine dicamba + 2,4-D amine	⅛ + ¼ to ⅜ ⅛ + ¼ to ⅜	After winter dormancy until wheat begins to joint.		Do not graze dicamba-treated fields or harvest for dairy feed prior to crop maturity.
	bromoxynil bromoxynil+ MCPA ester	¼ to ½ ¼ + ¼	Wheat fully tillered to boot stage		Do not forage or graze for 30 days after treatment with bromoxynil.

Table 8. 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	EPA registration limitations on crop use
Spring wheat or barley	2,4-D amine 2,4-D ester	¼ to ⅔ 1/6 to ½	Fifth leaf to early boot	Amine less injurious to crop. May injure legumes.	Do not forage or graze for 2 weeks after treatment.
	MCPA amine MCPA ester	¼ to ⅔ 1/6 to ½	Two leaf to early boot	May injure legumes.	None
	bromoxynil and MCPA esters	¼ + ¼	Two leaf to early boot	Use for smartweeds or wild buckwehat. Do not use on underseeded legumes.	Do not forage or graze for 30 days after treatment.
	bromoxynil (Brominal, Buctril)	¼ to ½	Two leaf to early boot		
Spring wheat or oats	dicamba and MCPA amine	⅛ + ¼	Two-to five-leaf stage	Kills legumes. Use if weeds include smartweeds or wild buckwheat.	Do not graze treated areas or harvest for dairy feed prior to crop maturity.
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 ester bromoxynil	¼ to ⅔ 1/6 to ½ ¼ to ⅜	Two leaf to early boot		None None Do not forage or graze for 30 days after treatment.
Flax	MCPA	¼	Flax 2 to 6 inches	Mixture of MCPA amine with dalapon for broadleaved and grass weeds.	None
	dalapon	¾	Flax 2 to 6 inches		None
	EPTC (Eptam)	3	Preplanting incorporation		None
	bromoxynil	¼ to ½	Flax 2 to 8 inches	For smartweed, wild buckwheat in 2 to 4 leaf stage.	Do not graze for 30 days after treatment.
Alfalfa and clover in small grains	2,4-D amine or MCPA amine	⅛ to ¼	Not before clover is 2 inches tall	Injures legumes. Canopy of crop or weeds reduces injury. Do not use on sweetclover.	Do not graze dairy animals on treated areas within 7 days after application of 2,4-D.
Alfalfa, sweetclover, and birdsfoot trefoil in flax	MCPA amine	⅛ to 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)	1⅛ to 1½	Preplanting incorporation		None
	EPTC (Eptam)	2 to 3	Preplanting incorporation		None
	2,4-DB amine 2,4-DB ester	½ to 1½ ½ to 1	1 to 4 trifoliolates on legumes	Sweetclover injured.	Do not graze within 60 days or cut hay within 30 days after application.

Table 8. 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	EPA registration limitations on crop use
Established alfalfa	2,4-DB amine 2,4-DB ester	½ to 1½ ½ to 1	When annual weeds are 2 to 3 inches tall (2 to 5 leaves)	Do not use more than ¾ pound per acre of ester on red clover.	Do not graze within 60 days or cut hay within 30 days after application.
	simazine (Princep)	0.8 to 1.6	Fall	May injure alfalfa.	Do not graze for 30 days or cut hay for 60 days after treatment.
Established grass pastures	2,4-D 2,4,5-T MCPA dicamba silvex	½ to 2 1 to 2 ¼ to 2 ½ to 1 1 to 2	Before bud stage, preferably when weeds are 2 to 6 inches tall and growing vigorously. When woody plants are fully leaved.	Rate depends on kinds of weeds. Use low rates of MCPA if legumes are present. Use 2,4-D, 2,4,5-T or silvex for woody plant control. Avoid drift, especially of dicamba to susceptible crops, particularly soybeans.	Do not graze dairy animals on treated areas within 7 days after application of 2,4-D or silvex. Do not graze dairy animals within 6 weeks after application of 2,4,5-T. Do not graze meat animals on areas treated with 2,4,5-T or silvex for 14 days prior to slaughter. Do not graze dairy animals for 7 to 21 days after application of these rates of dicamba. See label. Do not cut grass for hay during the season of treatment with silvex.
Dry edible beans	chloramben (Amiben)	3	Premergence		None
	EPTC (Eptam)	3	Preplanting incorporation		None
	trifluralin (Treflan)	½ to 1	Preplanting incorporation		None
	profluralin (Tolban)	½ to 1	Preplanting incorporation		None
	dinitramine (Cobex)	⅓ to ⅔	Preplanting incorporation		None
	alachlor (Lasso)	2½ to 3	Preplanting or preemergence		None
Grain sorghum	propachlor (Ramrod)	4 to 4.8	Premergence	Grass weeds only.	Do not graze or feed forage to dairy animals.
	propazine (Milogard)	2	Preemergence		None
	atrazine and propachlor	1 to 1.6 + 2½ to 4	Preemergence		Do not graze or feed forage to dairy animals.
	propazine and propachlor	0.8 to 1 + 2¼ to 3	Preemergence		Do not graze or feed forage to dairy cattle.
	atrazine	1.6 to 2.4	Preemergence or early postemergence		Do not graze or feed forage from treated areas within 21 days after application.
	2,4-D amine	½	4 to 12 inches	For broad-leaved weeds.	None

Table 8. 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	EPA registration limitations on crop use
Tame mustard	trifluralin (Treflan)	½ to ¾	Preplanting incorporated		None
Soybeans	alachlor (Lasso) (Lasso II)	2 to 4 2.4 to 3.9	Preemergence	Incorporate preplanting for nutsedge control.	None
	chloramben (Amiben)	3	Preemergence		None
	chlorpropham (Furloe Chloro IPC)	2 to 3	Preemergence	For smartweed control.	None
	chloramben + alachlor	2 + 2	Preemergence		None
	chlorbromuron Maloran) and alachlor	¾ to 2¼ + 1½ to 2½	Preemergence	For medium textured soils with less than 4% organic matter	None
	linuron and alachlor	½ to 1½ + 1 to 3	Preemergence		None
	metribuzin (Sencor, Lexone) and alachlor	¼ to ½ + 2 to 2½	Preemergence	See page 13.	None
	dinitramine (Cobex)	⅓ to ⅔	Preplanting	Must be incorporated.	None
	fluchloralin (Basalin)	½ to 1½	Preplanting	Must be incorporated	Do not graze or feed forage.
	profluralin (Tolban)	½ to 1	Preplanting	Must be incorporated.	None
	trifluralin (Treflan)	½ to 1	Preplanting	Must be incorporated.	None
	vernolate (Vernam)	3	Preplanting	Incorporate immediately	None
	bentazon (Basagran)	¾ to 1½	Soybeans in first trifoliolate, weeds less than 2 inches	Controls most annual broadleafs, Canada thistle, nutsedge	Do not apply within 65 days of harvest. Do not feed treated forage or hay to livestock.
	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 amine	1/5	Postemergence	For cocklebur control.	Do not harvest within 60 days after application.
Sugarbeets	TCA	5 to 7	Preemergence	For grass weeds except wild oat.	Do not use treated tops for food or feed.
	dalapon	2 to 3	Beets up to 6-leaf stage	For grass weeds except wild oat.	None
		2½ to 3½	Directed, beets 7-leaf stage to 14 inches		
	diallate (Avadex)	1½ to 2	Preplating incorporation	For wild oat.	Do not graze unharvested crop
	barban (Carbyne)	⅝ to ¾	Wild oats in two-leaf stage	For wild oat.	Do not allow livestock to graze treated fields until after crop is harvested.
	phenmedipham (Betanal)	1 to 1½	Early postemergence	See page 15.	Do not apply with in 90 days of harvest.
	desmedipham (Betanex)	1 to 1¼	Early postemergence	See page 15.	
	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 15.	None
	EPTC (Eptam)	2 to 3	Preplanting incorporation	For grass and some broad-leaved weeds.	None

Table 8. 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	EPA registration limitations on crop use
Sunflowers	chloramben (Amiben)	2 to 3	Premergence		Do not graze or feed forage.
	dinitramine(Cobex)	⅓ to ⅔	Preplanting incorporation		None
	EPTC (Eptam)	3	Preplanting incorporation		None
	trifluralin (Treflan)	½ to 1	Preplanting incorporation		None
	profluralin (Tolban)	¾ to 1	Preplanting incorporation		Do not feed treated forage to livestock.

Table 9. 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	EPA registration limitations on crop use
Canada and sowthistle	2,4-D amine	½	Just before bud	Can spray in tolerant crops.	See crop
	2,4-D ester	1	Fall rosette	Plow or clip in fall and spray when 6 inches.	See crop
	dicamba	⅛ to ¼		See crop discussion. Drift may affect sensitive crops. Use for patch treatment of 2,4-D-resistant thistles.	See discussion sections on oats, wheat, corn, and pastures.
	bentazon (Basagran)	¾ each time-two applications or 1 to 1½ one application	3- to 6-inch thistles Repeat 10 days later. 6- to 8-inch thistles	For soybeans Split applications usually better than one.	See soybeans
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
Germander, field mint	atrazine + oil	2	Early postmergence	For corn	See crop
Jerusalem artichoke	2,4-D	⅜ to ½	6-inch artichoke. Repeat when regrowth reaches 6 to 8 inches.	Use during crop tolerant periods in corn, small grains, pastures.	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	In corn, wheat, or barley. Culitivate after harvest until freezeup.	See crop

Table 9. Suggestions for chemical control of specific weeds on cropland. (con't)

Weed	Chemicals	Pounds per acre of active ingredient or acid equivalent broadcast	Time	Remarks	EPA registration limitations on crop use
Yellow nutsedge	alachlor (Lasso)	4		For corn, soybeans	See crop
		3		For dry beans	See crop
	butylate (Sutan +)	4 to 6		For corn	See crop
	EPTC (Eptam)	3	Preplanting, incorporated	For dry beans, sugarbeets, sunflowers	See crop
	EPTC + protectant (Eradicane)	4 to 6		For corn	See crop
	vernolate (Vernam)	3		For soybeans	See crop
	atrazine + oil	2	Postemergence after a preplanting treatment when nutsedge is less than 3 inches tall.	For corn	See crop
	bentazon (Basagran)	¾ each time-two applications or 1 to 1½ one application	3- to 6-inch nutsedge Repeat 10 days later. 6- to 8-inch nutsedge	For soybeans. Split applications usually better than one.	See crop
Quackgrass	dalapon (Dowpon, Radapon)	11	Fall	Foliage application, plow 1 or 2 weeks later. May plant corn, dry beans, some varieties of potatoes, sugarbeets next spring.	Do not graze treated areas in year treated.
	atrazine	2 to 4	Spring or fall Split application in fall and spring preferred.	Use low rate on sandy soils. Only corn can be grown the year after treatment.	See corn.
	glyphosate (Roundup)	1½	Fall or Spring before plowing	Quackgrass should be at least 8 inches tall (3 to 4 leaf stage) and actively growing.	For use before planting barley, corn, oats, sorghum, soybeans, wheat. Do not feed or graze treated crops within 8 weeks after application.
	EPTC (Eradicane)	6	Preplanting incorporated	For more consistent control, apply glyphosate or atrazine in the fall followed by EPTC in the spring.	
Wild oat	barban (Carbyne)	¼ to ⅜	When wild oat is in two-leaf stage	Rate for wheat, barley, flax, soybeans, sunflower.	Do not allow livestock to graze treated wheat, barley, sugarbeet, sunflower, or soybean fields until after crop is harvested. Do not feed soybean forage or flax straw from treated fields.
	barban (Carbyne)	¾ to 1		Rate for sugarbeets.	
	diallate (Avadex)	1½ to 2 (liquid)	Preplanting or preemergence, fall or spring	Rate for flax and sugarbeets; must be incorporated into soil.	None
	diallate (Avadex)	1½ to 2 (granules)	Fall or spring, preplanting incorporated.	For sugarbeets.	None.
	triallate (Far-go)	1 to 1¼ (wheat) 1¼ to 1½ (barley)	Preplanting or preemergence fall or spring.	Must be incorporated into soil. Use the higher rate for granules, lower rate for liquids.	Do not graze livestock on treated areas.
	difenzoquat (Avenge)	⅝ to 1	When wild oat has 3 to 5 leaves.	For barley, winter wheat, Era spring wheat.	Do not graze treated fields or cut for silage. Grain and straw can be fed.

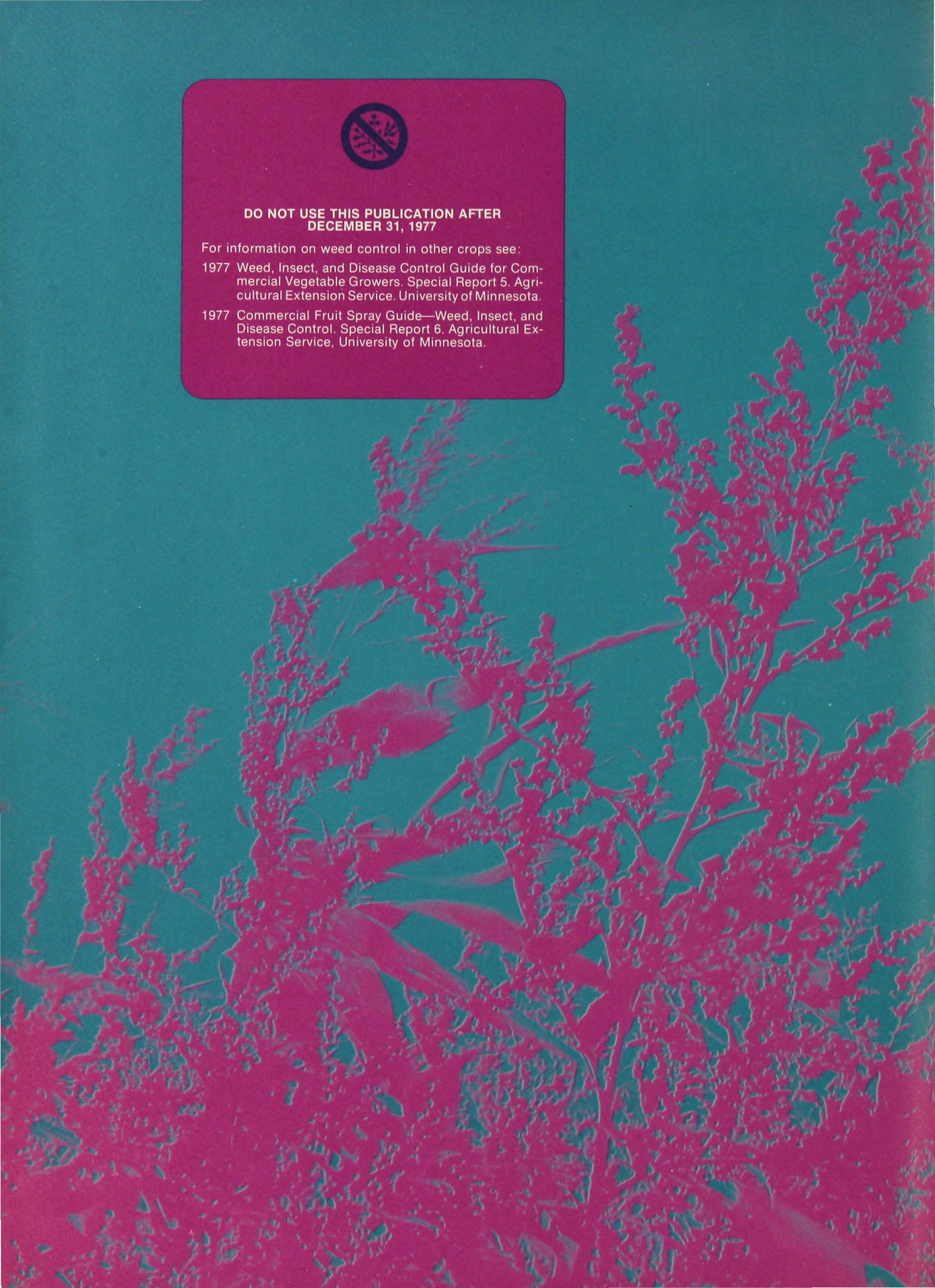
Weights and Measures

1 pound=16 ounces; 454 grams.
1 ounce=28.35 grams.
1 gallon=4 quarts; 8 pints; 128 fluid ounces; 256 level tablespoons; 3,785 cubic centimeters; (milliliters); 3.785 liters
1 tablespoon=3 teaspoons; ½ fluid ounce; 14.8 milliliters.
1 pound per acre=1.12 kilograms per hectare.
1 kilogram per hectare=0.892 pound per acre.
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.
1 hectare=2.47 acres.
1 liter=1.057 quarts
1 kilogram=2.205 pounds.

Table 10. 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 in lb/A.



DO NOT USE THIS PUBLICATION AFTER DECEMBER 31, 1977

For information on weed control in other crops see:

1977 Weed, Insect, and Disease Control Guide for Commercial Vegetable Growers. Special Report 5. Agricultural Extension Service. University of Minnesota.

1977 Commercial Fruit Spray Guide—Weed, Insect, and Disease Control. Special Report 6. Agricultural Extension Service, University of Minnesota.