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Weed Control in Corn

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Weed control in corn should be based on an optimum combination of cultural, mechanical and chemical practices. The ideal combination for each field will depend on several factors including crop being grown, kinds of weeds, severity of the weed infestation, soil characteristics, tillage practices, cropping systems, and availability of time and labor. There are many opportunities for reducing the costs of weed control in corn. Knowing the weed species that are present and selecting herbicide(s) with a high level of effectiveness on those weeds at the lowest cost per acre can result in substantial savings. Using band applications supplemented with cultivation is also a money-saving option to consider. Reducing herbicide rates below those recommended increases the possibility of costly failures in weed control. However, applying herbicides at rates higher than those suggested adds unnecessarily to your weed control costs, and may result in corn injury. Applying herbicides at the prescribed time and rate with a carefully calibrated applicator provides the best return on your herbicide investment.

Cultural Practices

Cultural practices for weed control in corn include seedbed preparation, establishing an optimum stand, adequate fertility, and timely cultivations. Weeds that germinate before planting can be destroyed with tillage operations or herbicides. Killing weeds just before planting gives the young crop seedlings a competitive advantage and often improves performance of preplanting or preemergence herbicides.

Early cultivations are most effective for killing weeds and for preventing crop yield reduction due to weed competition or corn root damage. The rotary hoe or harrow works best if used after weed seeds have germinated and are in the "white stage" or just emerging. A rotary hoe, harrow, or cultivator should be used as soon as weeds appear, even if preplanting or preemergence herbicides have been applied, unless a properly timed postemergence herbicide treatment is planned.

Set cultivators for shallow operation to avoid pruning the corn roots 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.

Herbicides

When selecting an appropriate herbicide or combination of herbicide treatments, consider carefully the following factors:

—Label approval for use
—Use of the crop
—Corn tolerance to the herbicide
—Potential for chemical residues that may affect later crops
—Kinds of weeds
—Soil texture
—Soil pH
—Amount of organic matter in the soil
—Climate
—Weather
—Formulation of the chemical
—Application equipment available
—Potential for drift problems

There are a number of herbicides available for use in corn. In setting up a weed control program for several years, it may be advisable to rotate a selection of herbicides from different chemical families, particularly in continuous corn.

Chemical rotations reduce the likelihood of a buildup of resistant weeds or of herbicide residues in the soil. Even if corn is being rotated to other crops, a chemical rotation can be planned for several years in the cropping system. Commonly used herbicides for corn in different chemical families are:

Acetamides—alachlor, metolachlor, propachlor
Benzoic acids—dicamba
Dinitroaniline—pendimethalin
Others—bentazon, bromoxynil
Phenoxys—2,4-D
Substituted ureas—linuron
Thiocarbamates—butylate, EPTC
Triazines—ametryne, atrazine, cyanazine, simazine

This folder summarizes herbicide suggestions for corn, based on numerous experiment station and U.S. Department of Agriculture tests to determine their overall effectiveness. Herbicide labels should be followed.

Table 1 indicates corn tolerance to herbicides suggested for use in corn and relative effectiveness and reliability of these herbicides in controlling common weeds. This table shows general comparative control ratings based on field observations. Under unfavorable conditions, any of the herbicides may give unsatisfactory results. Under favorable conditions control may be better than indicated.

Table 1. Effectiveness of herbicides on weeds in corn[1]

	Preplanting							Preemergence								Postemergence							
	alachlor (Lasso)	metolachlor (Dual)	atrazine + metolachlor (Bicep)	butylate (Sutan +)	EPTC (Eradicane, Eradicane Extra)	cyanazine (Bladex)	atrazine (AAtrex, others)	alachlor (Lasso)	atrazine (AAtrex, others)	atrazine + metolachlor (Bicep)	dicamba (Banvel)	metolachlor (Dual)	propachlor (Ramrod)	linuron (Lorox)	cyanazine (Bladex)	2-4-D	dicamba (Banvel)	atrazine and oil	cyanazine (Bladex)	bentazon (Basagran)	bromoxynil (Buctril, Brominal)	pendimethalin + atrazine (Prowl + atrazine)	pendimethalin + cyanazine (Prowl + Bladex)
Corn tolerance	G	G	G	G	G	F	G	G	G	G	F	G	G	F	F	F	G	G	F	G	G	F/G	F
Grasses																							
Giant & robust foxtail	G	G	G	G	G	F/G	F	G	F	G	P	G	G	F	F/G	N	N	F	F	N	N	G	G
Green foxtail	G	G	G	G	G	G	G	G	G	G	P	G	G	F	G	N	N	G	G	N	N	G	G
Yellow foxtail	G	G	G	G	G	G	G	G	G	G	P	G	G	F	G	N	N	G	G	N	N	G	G
Barnyardgrass	G	G	G	G	G	F	F	G	F	G	P	G	F	F	F	N	N	F	F	N	N	G	G
Crabgrass	G	G	G	G	G	F/G	P	G	P	G	P	G	G	F	F/G	N	N	P	F	N	N	F/G	G
Panicum	G	G	G	G	G	F	P	G	P	G	P	G	F	F	F	N	N	P	F	N	N	F/G	G
Nutsedge	G	G	G	G	G	P	P	F	P	F	N	F	F	P	P	N	N	F	P	G	N	P	P
Sandbur	F	F	F	G	G	F	F	F	F	G	P	F	P	—	F	P	P	F/G	F	P	N	F	F/G
Quackgrass	N	N	P	N	F	P	G	N	G	P	N	N	N	N	P	N	N	G	P	N	N	P	P
Woolly cupgrass	G	G	G	F	G	P	P	G	P	G	P	G	F	P	P	N	N	F	F	N	N	F	G
Proso millet	F	F	F	F	F/G	P/F	P	F	P	F	P	F	F	P	P/F	N	N	P	P/F	N	N	F	G
Wild oats	P	P	G	F	F	F	G	P	G	G	N	P	P	P	F	N	N	G	F	N	N	G	G
Broadleafs																							
Buffalobur	P	P	P	F	G	P	P	P	P	P	P	P	P	P	P	P	P	G	F	P	G	G	F
Cocklebur	N	N	F	P	P	F	F	N	F	F	F	N	P	F	F	G	G	G	F	G	G	G	F
Kochia	P	P	G	P	F	G	G	P	G	G	F	P	P	F	G	F	G	G	G	—	G	G	G
Lambsquarters	F/P	F/P	G	P	F/G	G	G	F/P	G	G	G	F/P	P	G	G	G	G	G	G	F	G	G	G
Mustard	P	P	G	P	P	G	G	P	G	G	G	P	P	G	G	G	F	G	G	G	G	G	G
Eastern black nightshade	F	F	G	F	F	G	G	G	G	G	F	G	P	P	G	F	F	G	G	P	G	G	G
Pigweed	G	G	G	F	F	F	G	G	G	G	G	G	F	G	F	G	G	G	F	P	G	G	F
Ragweed	P	P	G	P	F	G	G	P	G	G	G	P	P	G	G	G	G	G	G	G	G	G	G
Smartweed	P	P	G	P	P	G	G	P	G	G	G	P	P	G	G	P	G	G	G	G	G	G	G
Velvetleaf	P	P	F	F	F	F	F	P	F	F	F	P	P	F	F	G	G	F	F	G	G	G	G
Wild sunflower	P	P	F	P	P	F	F	P	F	F	F	P	P	F	F	F	G	G	F	G	G	G	G
Canada thistle	N	N	P	N	N	P	P	N	P	P	N	N	N	N	P	F	G	F	P	F	F	P	P
Jerusalem artichoke	N	N	P	N	N	P	P	N	P	P	P	N	N	P	P	G	G	P	P	P	N	P	P
American germander	N	N	P	P	F	P	P	N	P	P	P	N	N	P	P	P	P	G	F	P	N	F	F

[1] G = Good, F = Fair, P = Poor, N = None, — = Insufficient information.

No-Till or Minimum Till

With no-till or minimum till, weed problems may become worse. Winter annual, biennial, and perennial weeds that are destroyed or greatly weakened by conventional tillage survive and grow vigorously early in the spring, long before the corn is planted. Special herbicide treatments may be necessary to control or suppress these weeds. Glyphosate (Roundup) and paraquat (Paraquat Plus, Gramoxone) are very active, non-selective herbicides that will control all emerged weeds. These herbicides have no residual soil activity but can be tank-mixed with a number of herbicides that will provide residual weed control (see table 2). Atrazine and cyanazine (Bladex) may be used early preplant to control weed seedlings, but are relatively ineffective on larger annual, biennial, and perennial weeds. The use of liquid nitrogen or fertilizer as carrier in preplant or preemergence applications of cyanazine improves its burndown effectiveness on larger emerged weeds. If herbicides are applied several weeks or more before corn planting, a postplanting herbicide treatment may be required to provide adequate residual weed control.

Preplanting Applications

Some herbicides may be applied to the soil before planting and incorporated 2 to 3 inches into the soil with a disk, field cultivator, or similar implement. 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, crosswise and lengthwise, after applying the chemical. If the soil is not too moist or rough and is in a good tilth condition, adequate incorporation may be achieved with one pass over the field with some combination implements. To avoid excessive loss of volatile chemicals like EPTC or butylate, the first tillage operation should follow immediately behind the sprayer.

EPTC (Eradicane, Eradicane Extra) and butylate (Sutan +, Genate Plus) applied preplant incorporated give excellent control of annual grasses and some annual broadleaf weeds, but do not control other broadleafs or most biennials and perennials (see table 1). Both chemicals are effective on nutsedge. EPTC may be used for quackgrass control but

trial results have been inconsistent. EPTC is the most effective soil-applied herbicide for wild proso millet and woolly cupgrass control. Following repeated annual use for several years, the weed control effectiveness of EPTC may decline due to an increased rate of EPTC breakdown in the soil.

Preplanting and disked-in applications of atrazine have resulted in weed control equal to or, under dry conditions, 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 or EPTC (Eradicane) and atrazine or cyanazine (Bladex) applied preplanting and incorporated have controlled both annual grasses and broadleafs. These mixtures improve broadleaf control compared to butylate or EPTC alone. Cyanazine does not carry over to the following year, and the lower rate of atrazine used in the mixtures reduces carryover problems from atrazine compared to those caused by the higher rates when atrazine is applied alone.

Preplanting, incorporated applications of alachlor (Lasso) at 3 to 4 pounds per acre or metolachlor (Dual) at 2 to 3 pounds per acre have controlled nutsedge effectively. Under dry conditions, control of annual weeds usually has been improved over preemergence applications by shallow preplanting incorporation of alachlor or metolachlor. Atrazine or cyanazine may be tank mixed with alachlor or metolachlor to improve broadleaf control.

Preemergence Applications

Atrazine at 1 to 3 pounds per acre has given good control of annual weeds with no injury to corn. A 3-pounds-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, sunflowers, soybeans, other legumes, vegetables, and other sensitive crops planted the following spring. The label recommends that small grains, flax, sugarbeets, vegetables, and small-seeded legumes or grasses not be planted in the year following atrazine application.

Soybeans may be injured 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 was 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, using band rather than broadcast applications, and plowing or thoroughly tilling the soil before planting soybeans. Atrazine 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 is not as good under dry conditions as under moderate to heavy rainfall. Within the suggested rates of 1.2 to 4.75 pounds per acre, the high rates are required on soils higher in organic matter and finer-textured soils. Corn injury may occur on sandy soils or when maximum rates are used on heavier soils.

NOTICE: Cyanazine (Bladex) is now undergoing a special review by the U.S. Environmental Protection Agency (EPA) because of concern over the results of a laboratory study on animal birth defects that was inconclusive plus evidence suggesting cyanazine contamination of ground water. In this special review, the EPA is re-examining the health and safety risks and benefits of cyanazine use and will eventually develop recommendations for its future use. As of November, 1985, it seems probable that cyanazine will continue to be available for use by Minnesota farmers during 1986 without label changes. However, it is probable that cyanazine will be labeled as a "Restricted use Pesticide" before the 1987 season.

Propachlor (Ramrod) has given good annual grass control when applied preemergence at 4 to 6 pounds per acre. Propachlor does not 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) and metolachlor (Dual) control annual grasses in corn. Both chemicals also have given good control of redroot pigweed, but control of other broadleafs has been erratic. Preemergence applications have controlled nutsedge on coarse soils that are low in organic matter, but on finer-textured, dark soils, preplanting incorporated applications have controlled nutsedge better than preemergence treatments. Corn has good tolerance to alachlor and metolachlor. Suggested rates for alachlor are 2 to 4 pounds per acre in the liquid formulation and 2.4 to 3.9 pounds per acre in the granular formuation (Lasso II). Metolachlor is labeled for preemergence application at 1.5 to 3 pounds per acre in the liquid and granular formulations. Corn, soybeans, sorghum, root crops, potatoes, pod crops, buckwheat, or small grains may be grown the year after using metolachlor. Any crop may be grown the year following alachlor use.

NOTICE: Alachlor (Lasso) is now undergoing a special review by the U.S. Environmental Protection Agency (EPA) because tests show that tumors are caused when high levels of alachlor are fed daily to laboratory animals over long periods of time. In this special review, the EPA is re-examining all health and safety tests and product benefits from alachlor usage. Recommendations from the EPA on future uses of alachlor will be developed based on their estimates of these risks and benefits. As of November, 1985, it seems probable that alachlor will continue to be available during 1986 for use by Minnesota farmers.

Pendimethalin (Prowl) may be used alone at 3/4 to 2 pounds per acre or in mixtures at 3/4 to 1 1/2 pounds per acre for preemergence control of most annual grassy weeds and some broadleafs in corn. In Minnesota trials, preemergence applications of this compound have 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.

Corn root injury and lodging have sometimes occurred from applications of pendimethalin, especially on sandy soils. In tank mixes with dicamba, do not use on sandy soils or on loams, silts, and silt loams with less than 3 percent organic matter. Incorporating pendimethalin or ridging soil along the row when cultivating may increase corn injury.

Table 2. Herbicide choices for use in corn

Herbicide	Active ingredient, lb/A or (formulation/A)	Remarks
NO TILL or MINIMUM TILL		
glyphosate (Roundup)	.75 to 3 (1 to 4 qt)	Kills emerged weeds. Has no soil activity so usually combined with residual herbicides. Apply prior to corn emergence to prevent corn kill.
Labeled mixtures*		
alachlor (Lasso, Bronco)	2.5 to 4	Adds preemergence control of most annual grasses and some broadleafs.
alachlor + atrazine	2 to 3 + 1 to 2	Adds preemergence control of most annual grasses and broadleafs.
alachlor + cyanazine (Bladex)	2 to 3 + 1 to 2.2	Adds preemergence control of most annual grasses and broadleafs.
atrazine	2 to 3	Adds preemergence control of most annual broadleafs and some grasses.
atrazine + metolachlor (Dual)	1.2 to 2 + 1.5 to 2.5	Adds preemergence control of most annual broadleafs and grasses.
metolachlor (Dual)	1.5 to 2.5	Adds preemergence control of most annual grasses and some broadleafs.
paraquat (Paraquat Plus or Gramoxone)	.25 to 1 (1 to 4 pt)	Kills emerged weeds. Has no soil activity so usually combined with residual herbicides. Apply prior to corn emergence to avoid corn kill. **A restricted use herbicide.**
Labeled mixtures*		
atrazine	2 to 3	Adds preemergence control of most annual broadleafs and some grasses.
cyanazine (Bladex)	1.2 to 4	Adds preemergence control of most annual broadleafs and many grasses.
alachlor + atrazine	2 to 2.5 + 1 to 2	Adds preemergence control of most annual broadleafs and grasses.
metolachlor (Dual)	1.5 to 2.5	Adds preemergence control of most annual grasses and some broadleafs.
metolachlor + atrazine	1.2 to 2 + 1.5 to 2.5	Adds preemergence control of most annual grasses and broadleafs.
cyanazine (Bladex 80W) (Bladex 4L) (Bladex DF)	1.25 to 4.75 (1.5 to 6 lb) (1.25 to 4.75 qt) (1.35 to 5.3 lb)	Kills small weeds and gives preemergence control of annual broadleafs and some grasses. Prior to corn emergence the use of nitrogen or fertilizer solutions as carriers improve burndown. If applied more than 15 days before planting a preemergence herbicide will be needed.
Labeled mixtures*		
alachlor (Lasso)	2 to 2.5	Improves preemergence control of annual grasses and pigweeds.
atrazine	.4 to 1.6	Improves preemergence control of some broadleafs. Use reduced rates of cyanazine.
metolachlor (Dual)	1.25 to 2.5	Improves preemergence control of annual grasses and pigweeds.
pendimethalin (Prowl)	.75 to 1.5	Improves preemergence annual grass control. Apply after planting. Do not incorporate.
atrazine + alachlor	.4 to 1.6 + 2 to 2.5	Improves preemergence control of most annual broadleafs and grasses.
atrazine + metolachlor	.4 to 1.6 + 1.25 to 2.5	Improves preemergence control of most annual broadleafs and grasses.
2,4-D	.38 to .75	Improves control of emerged broadleaf perennials and pigweeds.
atrazine (Atrazine 80W) (Atrazine 4L) (Atrazine DF)	2 to 3 (2.5 to 3.75 lb) (2 to 3 qt) (2.2 to 3.3 lb)	Kills emerged weed seedlings and provides preemergence control of most annual broadleafs and some grasses. Prior to corn emergence, use of liquid fertilizer or nitrogen solutions as carrier improves weed burndown.
Labeled mixtures*		
alachlor (Lasso)	2 to 2.5	Improves preemergence annual grass control.
glyphosate (Roundup)	.75 to 3	Improves burndown of emerged weeds. Use only before corn emergence.
metolachlor (Dual or Bicep)	1.5 to 2.5	Improves preemergence annual grass control.
paraquat (Gramoxone)	.25 to 1	Improves burndown of emerged weeds. Use only before corn emergence.
pendimethalin (Prowl)	.75 to 1.5	Improves preemergence annual grass control. Apply after planting. Do not incorporate.
PREPLANT INCORPORATED		
butylate (Sutan +, Genate Plus)	4 to 6 (3.75 to 7.33 pt)	Controls most grasses and some broadleafs. Incorporate immediately. Safeners have been added to protect corn from injury.
Labeled mixtures*		
atrazine	.75 to 1.5	Improves broadleaf weed control.
cyanazine (Bladex)	1.5 to 2	Improves broadleaf weed control.
atrazine + cyanazine	.5 to 1 + 1 to 2	Improves broadleaf weed control.
EPTC (Eradicane) (Eradicane Extra)	3 to 6 (3.75 to 7.33 pt) (4 to 8 pt)	Controls most grasses and some broadleafs. Incorporate immediately. Eradicane contains a safener to protect corn from EPTC. Eradicane Extra contains a safener plus an extender which increases EPTC soil life.
Labeled mixtures*		
atrazine	1 to 1.5	Improves broadleaf weed control.
cyanazine	1.5 to 2	Improves broadleaf weed control.
PREPLANT INCORPORATED or PREEMERGENCE		
alachlor (Lasso) (Lasso II)	1.5 to 4 (1.5 to 4 qt) (16 to 26 lb)	Controls many annual grasses and some broadleaf weeds. Use high rate and incorporate for nutsedge.
Labeled mixtures*		
atrazine	1 to 1.85	Improves broadleaf weed control.
cyanazine (Bladex)	1 to 2.4	Improves broadleaf weed control.
dicamba (Banvel)	.5	Preemergence onlyon medium or fine soils above 2.5% O.M. Improves broadleaf control.
atrazine + cyanazine	.75 to 1.25 + 2	Improves broadleaf weed control.
linuron (Lorox)	.67 to 3	Do not incorporate. Improves broadleaf control.
atrazine (Atrazine 80W) (Atrazine 4L) (Atrazine DF)	2 to 4 (2.5 to 5 lb) (2 to 4 qt) (2.2 to 4.4 lb)	Controls many broadleaf weeds and grasses. Use split application for quackgrass. May carry over and injure sensitive crops. See label restrictions on rotational crops.
Labeled mixtures*		
alachlor (Lasso)	2 to 3	Improves annual grass control.
butylate (Sutan +)	4 to 6	Improves annual grass control. Preplant incorporated only.
cyanazine (Bladex)	.75 to 3.75	Reduces atrazine carryover. Improves annual grass control.
EPTC (Eradicane)	3 to 6	Improves annual grass control. Preplant incorporated only.
linuron (Lorox)	.67 to 3	Do not incorporate. Reduces atrazine carryover.
metolachlor (Dual or Bicep)	1.5 to 2.5	Improves annual grass control.
pendimethalin (Prowl)	.75 to 1.5	Improves annual grass control. Do not incorporate.
propachlor (Ramrod)	4 to 6	Improves annual grass control. Do not incorporate.
simazine (Princep)	1 to 2	Improves crabgrass and fall panicum control. Increased carryover.
metolachlor + simazine	1.5 to 2.5 + 1 to 2	Improves annual grass control. Increased carryover.

* Follow label directions and precautions of all products in a mixture.

Table 2. Herbicide choices for use in corn

Herbicide	Active ingredient, lb/A or (formulation/A)	Remarks
butylate + safener (Sutan +, Genate Plus)	4 to 6 (3.75 to 7.33 pt)	Use preplant and incorporate immediately. Controls many annual grasses, some broadleaf weeds and nutsedge.
Labeled mixtures*		
atrazine	.75 to 1.5	Improves broadleaf weed control.
cyanazine	1.5 to 2	Improves broadleaf weed control.
atrazine + cyanazine	.5 to 1 + 1 to 2	Improves broadleaf control.
cyanazine (Bladex 80W) (Bladex 4L) (Bladex DF)	.6 to 4.75 (.75 to 5.9 lb) (.6 to 4.75 qt) (.67 to 5.3 lb)	Controls many broadleaf weeds and grasses. Weak on pigweeds.
Labeled mixtures*		
alachlor (Lasso)	2 to 2.5	Improves annual grass control.
atrazine	.5 to 1.5	Improves pigweed control.
butylate (Sutan +, Genate Plus)	1.5 to 2	Improves annual grass control. Use preplant incorporated only.
EPTC (Eradicane)	1.5 to 2	Improves annual grass control. Use preplant incorporated only.
metolachlor (Dual)	1.25 to 2.5	Improves annual grass control.
pendimethalin (Prowl)	.75 to 1.5	Improves annual grass control. Do not incorporate.
EPTC + safener (Eradicane) (Eradicane Extra)	3 to 6 (3.75 to 7.33 pt) (4 to 8 pt)	Use preplant and incorporate immediately. Controls many grasses, some broadleaf weeds and nutsedge. Eradicane Extra has longer soil activity. Repeated annual use reduces weed control effectiveness.
Labeled mixtures*		
atrazine	1 to 1.5	Improves broadleaf weed control.
cyanazine	1.5 to 2	Improves broadleaf weed control.
metolachlor (Dual 8E) (Dual 25G)	1.5 to 3 (1.5 to 3 pt) (6 to 12 lb)	Controls many annual grasses and some broadleafs. Can be applied early preplant, either alone or in tank mixtures for weed control in minimum- or no-till corn. Use high rate and incorporate for nutsedge.
Labeled mixtures*		
atrazine	1 to 2	Improves broadleaf weed control.
cyanazine	.8 to 2.5	Improves broadleaf weed control.
dicamba (Banvel)	.5	Improves broadleaf control. Preemergence only on medium or fine soils above 2.5 O.M.
propachlor (Ramrod 4L) (Ramrod 20G)	4 to 6 (4 to 6 qt) (20 to 30 lb)	Preemergence only. Controls many grasses and some broadleaf weeds.
Labeled mixtures*		
atrazine	1 to 1.6	Improves broadleaf weed control.
linuron (Lorox)	.67 to 3	Improves broadleaf weed control.
POSTEMERGENCE		
ametryne (Evik)	1.6 to 2 (2 to 2.5 lb)	Directed spray to corn over 12 inches tall for weeds no more than 4 inches tall. To avoid serious corn injury do not spray the upper leaves or whorl.
atrazine with oil (Atrazine 80W) (Atrazine 4L) (Atrazine DF)	1.2 to 2 (1.25 to 2.5 lb) (1 to 2 qt) (1.1 to 2.2 lb)	Controls small grasses up to 1.5 inches tall and broadleafs to 4 inches tall but pigweed and lambsquarters to 6 inches tall. See label for oil rates and specifications. If weed control is poor, cultivation will be required.
Labeled mixture*		
pendimethalin (Prowl)	.75 to 1.5	Apply to corn in the spike to 4-leaf stage. Do not add oil. Improves grass control.
bentazon (Basagran)	.5 to .75 (1 to 1.5 pt)	Controls small annual broadleafs, Canada thistle and yellow nutsedge. Second application may be required for Canada thistle and nutsedge.
Labeled mixture*		
atrazine (Laddox)	(2.4 to 3.6 pt)	Improves broadleaf weed control. Always add oil concentrate.
bromoxynil (Brominal ME4) (Buctril)	.25 to .5 (.5 to 1 pt) (1 to 1.5 pt)	Controls small broadleaf weeds in corn up to 14 inches tall. Corn foliage burn may occur.
Labeled mixtures*		
atrazine	.5 to 1.2	Improves pigweed control. Rate too low for grass control. Do not use oil.
2,4-D	.25	Improves pigweed and perennial broadleaf control.
cyanazine (Bladex 80W) (Bladex DF)	1.2 to 2 (1.5 to 2.5 lb) (1.35 to 2.2 lb)	Controls small broadleafs and grasses. Weak on pigweed. Do not spray corn if the 5th leaf is visible. Do not use Bladex 4L. Under dry conditions add surfactant or vegetable oil.
Labeled mixtures*		
atrazine	.4 to .6	Improves pigweed control.
dicamba (Banvel)	.25 to .33	Improves pigweed control. Avoid drift to sensitive crops.
pendimethalin (Prowl)	.75 to 1.5	Safer on smaller corn. Best for small proso millet and woolly cupgrass.
dicamba (Banvel) (Banvel II)	.25 to .5 (.5 to 1 pt) (1 to 2 pt)	Controls many annual and perennial broadleaf weeds. Corn up to 36 inches tall. Use drop nozzles in corn over 10 inches tall. May be used as an overlay following soil-applied herbicides. Avoid spray or vapor drift to soybeans or other sensitive crops.
Labeled mixtures*		
alachlor (Lasso)	1.5 to 4	Before corn is 3 inches tall. Provides annual grass control.
atrazine	1.25 to 4	Before grasses are 1.5 inches tall. Provides grass control.
cyanazine (Bladex 80W)	1.5 to 2	Corn not beyond four leaves and grass up to 1.5 inches tall. Provides grass control.
2,4-D	.12 to .25	Use drop nozzle after corn is 8 inches tall. Improves mustard control.
linuron + surfactant (Lorox WP) (Lorox L)	.62 to 1.5 (1.25 to 3 lb) (.62 to 1.5 qt)	Directed spray to corn over 15 inches tall for weeds up to 5 inches tall. To avoid serious corn injury do not spray the upper leaves or whorl. Controls broadleafs and grasses.
2,4-D amine ester	.25 to .5 (4 lb/Gal) (.5 to 1 pt) (4 lb/Gal) (.5 to .75 pt)	Controls emerged annual and perennial broadleaf weeds. Use drop nozzles after corn is 10 inches tall. Do not spray from before tasseling until the silks are brown. Corn stalk brittleness commonly occurs when the corn stalk is elongating. Higher 2,4-D rates, 1 to 2 lb/A, may be used after the hard dough stage to control perennials and large annuals. Avoid spray drift to soybeans or other sensitive crops.

* Follow label directions and precautions of all products in a mixture.

Preemergence Herbicide Mixtures

Mixtures of atrazine with alachlor, linuron, metolachlor, pendimethalin, 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 after corn is up, or severe corn injury may occur.

> NOTICE: Linuron (Lorox) is now undergoing a special review by the U.S. Environmental Protection Agency (EPA) because tests show that tumors may occur when high levels of linuron are fed daily to laboratory animals over long periods of time. In this special review, the EPA is re-examining all health and safety tests and product benefits from linuron usage. Recommendations from the EPA on future uses of linuron will be developed based on their estimates of these risks and benefits. As of November, 1985, it seems probable that linuron will continue to be available during 1986 for use by Minnesota farmers.

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 to using linuron alone. Rates vary from 1/2 to 1 1/2 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 or cyanazine with alachlor, metolachlor, or propachlor control broad-leaved weeds better than alachlor, metolachlor, or propachlor 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.

Using mixtures of linuron and propachlor or alachlor reduces the potential for corn injury compared to using linuron alone since lower rates of linuron are used. These mixtures control broadleafs better than propachlor or alachlor alone. Suggested rates are 1 to 1 1/2 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 or metolachlor with dicamba (Banvel) improves broadleaf control compared to alachlor or metolachlor alone and improves grass control and reduces corn injury compared to dicamba alone. Dicamba should be applied preemergence only on medium- or fine-textured soils with more than 2.5 percent organic matter. Do not incorporate this mixture prior to corn emergence. Harrowing or dragging before corn emerges may increase corn injury.

Early Postemergence Sprays

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 1 1/2 inches tall. Application may be made until corn is 30 inches tall. Drop nozzles should be used when the corn height exceeds 10 inches to keep the spray out of the tops of the corn and to give better spray coverage on the weeds.

Adding 1 gallon per acre of special oils with an emulsifier or 1/4 to 1/2 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 using oils. Suggested atrazine rates for postemergence applications 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 adding 2,4-D to this mixture. Corn injury has occurred also when atrazine and oil were applied to corn growing under cold, wet conditions, or if frost occurred shortly before or after application.

Cyanazine (Bladex 80W and 90DF) is effective on annual grasses and broadleafs as an early postemergence herbi-

Table 3. Herbicide names and formulations

Common name	Trade name	Concentration and commercial formulation[1]
alachlor	Lasso Lasso II	4 lb/gal L 15% G
alachlor-atrazine	Lasso-Atrazine	2.5 + 1.5 lb/gal F
ametryne	Evik	80% WP
atrazine	AAtrex, others	80% WP, 90% WDG, 4 lb/gal F
atrazine-metolachlor	Bicep	2 + 2.5 lb/gal F
bentazon	Basagran	4 lb/gal L
bentazon-atrazine	Laddok	1.66 + 1.66 lb/gal F
bromoxynil	Brominal Buctril	4 lb/gal L 2 lb/gal L
butylate-protectant	Sutan +	10% G, 6.7 lb/gal L
butylate-protectant-atrazine	Sutazine	4.8 + 1.2 lb/gal L
cyanazine	Bladex	80% WP, 90% WDG, 4 lb/gal F
dicamba	Banvel Banvel II	4 lb/gal L 2 lb/gal L
EPTC-protectant	Eradicane	6.7 lb/gal L
EPTC-protectant-extender	Eradicane Extra	6 lb/gal L
linuron	Lorox	50% WP, 4 lb/gal F
metolachlor	Dual	25% G, 8 lb/gal L
pendimethalin	Prowl	4 lb/gal L
propachlor	Ramrod	20% G, 65% WP, 4 lb/gal F
propachlor-atrazine	Ramrod and Atrazine	3 lb + 1 lb/gal F
2,4-D	several	various

[1]G = granular, L = liquid, WP = wettable powder, WDG = water dispersible granule, F = flowable.

cide. The 4L formulation is not cleared postemergence because corn leaf burn is more likely to occur. Cyanazine is cleared for use through the 4-leaf stage of corn and before weeds are more than 1 1/2 inches tall. Pigweed and lambsquarters have shown some tolerance. Vegetable oils or surfactants added to improve weed control effectiveness under dry conditions increase the potential for corn injury and have resulted in severe corn leaf kill and stand reduction if heavy rains or dews and cool temperature occur soon after application. Smaller corn, spike to 2-leaf stage, is less likely to be injured than larger corn, 3- to 4-leaf stage.

Under dry weather conditions add an emulsible vegetable oil or a surfactant at their recommended rates. Do not use petroleum-based crop oils because corn leaf kill and stand reductions may occur. Do not add vegetable oils or surfactants under moist, rainy conditions because corn injury may occur. Do not apply this treatment under cold, wet conditions or to weather-stressed corn. Corn yellowing, leaf kill and stunting may result from this treatment, particularly if cold, adverse growing conditions occur after application. Extreme or extended cold and wet conditions following treatment may result in reduced corn stands. Do not use cyanazine on corn grown for seed.

Any rotational crop may be planted in the fall or spring following the cyanazine treatment.

Tridiphane (Tandem), when added to postemergence applications of atrazine plus oil or cyanazine (Bladex) has frequently improved the control of small annual grasses in trials at several locations over several years. **Caution**: EPA clearance is expected before the 1986 growing season but has not been received as of November, 1985.

Bentazon (Basagran) may be applied alone or in a mixture with atrazine as a postemergence treatment in corn to control certain annual broadleaf weeds, Canada thistle, and nutsedge. Corn has good tolerance to bentazon, but do not apply it when corn is stressed from adverse growing conditions. Apply when annual weeds are less than 2 inches tall, but some species may be controlled up to 10 inches tall. Rain within 24 hours after application will reduce the effectiveness of bentazon. Do not mix bentazon with fertilizers. A non-phytotoxic oil concentrate or crop oil may be mixed with bentazon or with a combination of bentazon and atrazine for applications in corn to improve weed control.

Alachlor (Lasso) may be applied postemergence in a mixture with dicamba (Banvel) to corn less than 3 inches tall. Alachlor or metolachlor (Dual) may be applied with atrazine on corn that is no more than 5 inches tall to control weeds in the 2-leaf stage or smaller. Propachlor (Ramrod) alone or mixed with atrazine may be applied after corn has emerged to control grasses up to the 2-leaf stage. Annual grass control may be less consistent in these postemergence applications than that from preemergence applications.

Pendimethalin (Prowl) in mixtures with atrazine or cyanazine (wettable powder or dispersible granule) may be applied after corn emergence, but not later than when corn is in the 4-leaf stage and when weeds are no more than 1 inch tall. These mixtures have been effective against annual grasses and broadleafs. The early postemergence application of pendimethalin and cyanazine used following a preplanting application of EPTC greatly improves the control of proso millet and woolly cupgrass. However, corn leaf burn and stand reductions are possible if cool, wet weather occurs soon after treatment. Applications to corn in the spike to 2-leaf stage are safer but weed control effectiveness is best if the weeds have emerged.

Bromoxynil (Brominal, Buctril) applied at 1/4 to 1/2 pound per acre as an early postemergence spray controls some annual broadleaf weeds, including annual smartweeds, wild buckwheat, cocklebur, kochia, common lambsquarters, pigweed, common ragweed, Russian thistle, wild sunflower, and wild mustard. Bromoxynil does not control grasses or perennial weeds. To be most effective, bromoxynil must be applied when weeds have 2 to 4 leaves and corn is less than 6 inches tall. Corn leaf burn may occur, especially under conditions of high temperature or high humidity. Follow specific label information for bromoxynil use in tank mixes with 2,4-D or atrazine.

Postemergence Applications

Annual broadleaf weeds can be controlled with broadcast postemergence applications of 1/4 to 1/2 pound per acre of 2,4-D amine when the corn is 4 to 8 inches tall. More severe onion leafing may occur from 2,4-D applications made in the 2- to 3-leaf stage of the corn.

The 1/4-pound rate has been adequate for susceptible weeds and is less dangerous to corn. The 1/2-pound rate has been satisfactory for moderately resistant weeds, but corn usually has been injured by this rate. Rainfall within 8 hours after application reduces the effectiveness of 2,4-D amines more than the effectiveness of 2,4-D esters. About 1/3 less acid equivalent of 2,4-D esters is needed than of the 2,4-D amines.

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. Using 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.

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 the last cultivation, 2,4-D ester at 1/2 pound per acre or 2,4-D amine at 3/4 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 1/2 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 it does not control grasses. But when used, dicamba drift has often affected soybeans in the vicinity of treated cornfields.

Dicamba may be used in corn at 1/8 to 1/2 pound per acre, either alone or in mixtures with 2,4-D amine at 1/4 to 1/2 pound per acre. Do not use dicamba at 1/2 pound per acre after the corn is 5 inches tall. The lower rate of dicamba has given satisfactory weed control with less crop effect than the higher rate. Applications can be made until corn is 3 feet tall or until 15 days before tassel emergence, whichever occurs first. Do not use on corn grown for seed. Later applications, especially when corn is tasseling, may result in poor kernel set. Use drops after corn is 8 inches tall. Do not use additives with dicamba.

Mixtures of dicamba and atrazine or cyanazine are cleared for use on corn as early postemergence treatments. These mixtures have given good broadleaf control, but grass control has been erratic. Oils and other additives should not be used.

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 spray drift at the time of application or vapor drift for several days after application. Spray 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. Reduce spray and vapor drift effects on soybeans by spraying corn early in the season when temperatures are lower and before soybeans have emerged, or when they are small. Do not graze or harvest for dairy feed prior to the milk stage of the grain if corn is treated with dicamba.

Directed Sprays

These cannot be used on small corn. Therefore, early season weed growth must be controlled by some other means (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 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 1 1/2 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. Adding 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 the corn leaf tissue it contacts and, if leaf kill is extensive, corn yields may be reduced.

Read the pesticide label and follow the instructions as a final authority on pesticide use.

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