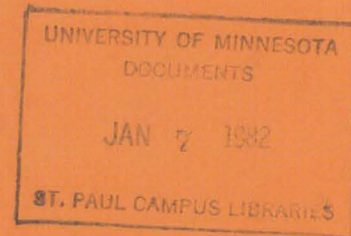


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Special Report 12  
Agricultural Extension Service  
University of Minnesota



# 1982 Minnesota Retail Dealer and Pesticide Applicator Conference

Conducted by  
Agricultural Extension Specialists  
in Agronomy, Entomology,  
Plant Pathology, and Soils

AGRICULTURAL EXTENSION SERVICE  
and OFFICE OF SPECIAL PROGRAMS  
UNIVERSITY OF MINNESOTA  
COOPERATING WITH MINNESOTA  
DEPARTMENT OF AGRICULTURE

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*The information given in this publication is for educational purposes only. Reference to commercial products or trade names is made with the understanding that no discrimination is intended and no endorsement by the Minnesota Agricultural Extension Service is implied.*

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SUMMARY OF 1982 SUGGESTIONS FOR  
THE USE OF INSECTICIDES TO CONTROL MAJOR CROP INSECTS

<u>CROP</u>	<u>PEST</u>	<u>CHEMICAL</u>	<u>RATE</u> ai/A	<u>LIMITATIONS</u> <u>Preharvest interval</u>
Alfalfa	Alfalfa weevil	azinphosmethyl (Guthion)	$\frac{1}{2}$ - $\frac{3}{4}$ lb.	21 days, one application per cutting
		carbofuran (Furadan)	$\frac{1}{4}$ - $\frac{1}{2}$ lb	7 days - $\frac{1}{4}$ lb 14 days - $\frac{1}{2}$ lb
		methyl parathion	$\frac{1}{4}$ lb	15 days
		phosmet (Imidan)	1 lb.	7 days, one application per cutting
		methidathion (Supracide)	$\frac{1}{2}$ lb	10 days
		mixtures of methoxychlor plus diazinon or malathion	1 + $\frac{1}{2}$ or $\frac{3}{4}$ + $\frac{3}{4}$	7 days
	Aphids and Leafhoppers	diazinon	$\frac{1}{2}$ lb	7 days
		dimethoate (Cygon, et al)	$\frac{1}{4}$ - $\frac{1}{2}$ lb	10 days, one application per cutting
		malathion	1 lb.	none
		parathion	$\frac{1}{4}$ lb	15 days
	Cutworms	carbaryl (Sevin)	1 $\frac{1}{2}$ lb	none
		malathion	1 lb	none
		trichlorfon (Dylox, Proxol)	1 lb	7 days
		methomyl (Lannate, Nudrin)	$\frac{1}{4}$ -1 lb	7 days for grazing, none for hay.
Potato leafhopper	azinphosmethyl (Guthion)	$\frac{1}{4}$ - $\frac{1}{2}$ lb	14 days	
	carbaryl (Sevin)	1 lb	none	
	diazinon	$\frac{1}{2}$ lb	7 days	
	methoxychlor	1 lb	7 days	

	malathion	1 lb	none
	methidathion (Supracide)	$\frac{1}{2}$ lb	10 days
	phosmet (Imidan)	1 lb	7 days, one application per cutting
	mixture of methoxychlor with diazinon or malathion		7 days
Grasshoppers	azinphosmethyl (Guthion)	$\frac{1}{2}$ - $\frac{3}{4}$ lb	14 days- $\frac{1}{2}$ 21 days- $\frac{3}{4}$
	carbaryl (Sevin)	1- $1\frac{1}{2}$ lb	none
	carbofuran (Furadan)	2 to 4 oz	7 days, one application per season
	diazinon	$\frac{1}{2}$ lb	7 days
	dimethoate (Cygon, et. al)	$\frac{1}{4}$ - $\frac{1}{2}$ lb	10 days, one application
	malathion	$1\frac{1}{2}$ or $\frac{1}{2}$ lb ULV	5 days ULV none dilute
Corn, Field Armyworm	carbaryl (Sevin)	1-2 lb	None
	malathion	1- $1\frac{1}{2}$ lb	5 days
	methonyl (Lannate, Nudrin)	$\frac{1}{4}$ - $\frac{1}{2}$ lb	3 days forage; none grain
	toxaphene	2 lb	None for grain Do not use stalks, husks, leaves for feed for meat or milk animals.
	trichlorfon (Dylox, Proxol)	1 lb	None
Corn root- worms		Ounces of formulation per 1000 ft. of row	
	carbofuran (Furadan 10 G)	12 oz	
	chlorpyrifos (Lorsban 15 G)	8 oz	
	ethoprop (Mocap 15 G)	8 oz	

fonofos (Dyfonate 20 G)	6 oz 6 oz
isofenphos (Amaze 20 G)	6 oz 6 oz
phorate (Thimet 15 G) (Thimet 20 G)	8 oz 6 oz
terbufos (Counter 15 G)	8 oz

Apply in 6 to 7 inch bands over the rows lightly incorporated at planting time. Liquid formulations should be applied in bands as granules or in split bands at or above seed level away from the seed.

Those products labelled for basal post emergence application should be applied about June 10-20 but may not give adequate control under dry soil conditions.

Do not apply carbofuran (Furadan) in successive years in the same field.

#### Cutworms

Some soil insecticides such as Dyfonate 20 G, Lorsban 15 G, and Mocap 15 G, are labelled for cutworms and may give control of light to moderate infestations when applied at planting time as for rootworms. Heavier infestations may require a postemergence rescue treatment.

	carbaryl (Sevin)	1 - 2 lb spray or bait	None Apply spray in 12 inch bands over rows. Broadcast or band apply bait.
	chlorpyrifos (Lorsban 4E)	1 - 1½ lbs	None. (50 days forage, silage) Broadcast by air or ground equip. Lightly incorporate under dry conditions.
	trichlorfon (Dylox, Proxol)	1 lb	None Apply spray in 12 inch bands over rows,
European Corn Borer, 1st brood	carbaryl (Sevin)	1½ lb	None Spray or granules
	carbofuran (Furadan)	1 lb	Granules; no more than 2 applications.
	diazinon	1 lb	granules. None for grain, 10 days forage.
	fonofos (Dyfonate)	1 lb	30 days, granules
	phorate (Thimet)	1 lb	30 days, one application granules

	toxaphene	2 lb	corn for grain only. granules
Grasshoppers			
	carbaryl (Sevin)	1½ lb	none
	chlorpyrifos (Lorsban 4E)	¼-½ lb	No more than 3 pints 4E per season
	diazinon	½ lb	none
	malathion	1 lb or ½ lb ULV	5 days
	toxaphene	1½ lb	corn for grain only
Seed corn maggot, seed corn beetle, wireworms	diazinon 1oz/bu. lindane ½-1 oz/bu		seed treatment only
seed corn maggot	chlorpyrifos (Lorsban)	1 lb	Band in row at planting time. Lorsban and Amaze may be placed in furrow.
	fonofos (Dyfonate)	1 lb	
	isofenphos (Amaze)	1 lb	
	terbufos (Counter)	1-2 lb	
Wireworms			
	carbofuran (Furadan)	2 lb	Row treatment at planting time. Furadan, Lorsban, Amaze Counter may be placed in furrow. Some of these chemicals plus diazinon are registered for broadcast pre-plant in- corporated treatment
	chlorpyrifos (Lorsban)	1-2 lb	
	ethoprop (Mocap)	1 lb	
	isofenphos (Amaze)	1 lb	
	terbufos (Counter)	1-2 lb	
	fonofos (Dyfonate)	1 lb	
White grubs			
	chlorpyrifos (Lorsban)	2 lb	Broadcast ppi, band or furrow treatment at planting furrow or band at planting
	isofenphos (Amaze)	1 lb	
	terbufos (Counter)	2 lb	furrow or band at planting

Most of these products will aid in reducing white grub damage but may not control heavy infestations.

## Soybeans

Bean Leaf beetle	carbaryl (Sevin)	1 lb	none
Cutworms	carbaryl (Sevin)	1½ lb	none
	toxaphene	1½ lb	21 days, do not feed forage
Grasshoppers	acephate (Orthene)	¼-½ lb	14 days, do not feed forage
	carbaryl (Sevin)	1½ lb	none
	dimethoate (Cygon, et al)	¼-½ lb	7 days
	malathion	½ lb ULV	7 days
	toxaphene	1½ lb	21 days, do not feed forage
Green clover worm	azinphosmethyl (Guthion)	6 to 8 oz	45 days
	<u>Bacillus thuringensis</u> (Dipel, Sok Bt., Thuricide, Biotrol)		as labelled
	carbaryl (Sevin)	1 lb	none
	dimethoate (Cygon, et al)	¼-½ lb	7 days
	fenvalerate (Pydrin)	0.05-0.1 lb	21 days
	malathion	1 lb	7 days
	Seed corn maggot	diazinon	1 oz/bu
lindane		1/2 to 1 oz/bu	" " "



## Small grains

## Aphids

malathion	1 lb	none
methyl parathion	4 oz	none
Penncap M	6-8 oz	15 days
parathion (ethyl)	4 oz	15 days
dimethoate (Cygon, et al)	$\frac{1}{4}$ - $\frac{1}{3}$ lb	wheat only 60 days
disulfoton (DiSyston)	$\frac{1}{4}$ - $\frac{3}{4}$ lb	wheat only 30 days do not graze

## Armyworm

carbaryl (Sevin)	1- $1\frac{1}{2}$ lb	wheat only
malathion	1 $\frac{1}{2}$ lb	21 days
methomyl (Lannate, Nudrin)	$\frac{1}{4}$ - $\frac{1}{2}$ lb	7 days
trichlorfon (Dylox, Proxol)		21 days, no more than 3 applications
toxaphene	2 lb	for grain only do not use straw for feed or bedding

## Grasshoppers

acephate (Orthene)	$\frac{1}{6}$ lb	wheat only
dimethoate (Cygon)	$\frac{1}{4}$ - $\frac{1}{2}$ lb	wheat only 60 days
malathion	1 lb or $\frac{1}{2}$ lb ULV	7 days
methyl parathion (Penncap M)	$\frac{1}{2}$ lb	15 days
toxaphene	$1\frac{1}{2}$ lb	for grain only; do not use straw for feed or bedding for meat or milk animals.

## Wireworms

lindane	$\frac{1}{2}$ to 1 oz/bu	seed treatment only
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## Corn, Sweet

Aphids	diazinon	$\frac{1}{2}$ lb	None
	malathion	1 lb	5 days
	parathion (ethyl)	$\frac{1}{2}$ lb	12 days
	oxydemeton-methyl (Meta Systox-R)	6-8 oz	7 days
Armyworms	carbaryl (Sevin)	$1\frac{1}{2}$ -2 lb	None
	malathion	1 lb	5 days
	methomyl (Lannate, Nudrin)	$\frac{1}{4}$ - $\frac{1}{2}$ lb	none for corn, 3 days for forage
	trichlorfon (Dylox, Proxol)	$\frac{1}{2}$ -1 lb	none
Cutworms	carbaryl (Sevin)	2 lb bait or spray	none
	chlorpyrifos (Lorsban 4E)	1- $1\frac{1}{2}$ lb	None for grain (50 days forage, silage)
	diazinon	4 lb	broadcast ppi
	trichlorfon (Dylox, Proxol)	1 lb	none
European Corn borer	carbaryl (Sevin)	$1\frac{1}{2}$ -2 lb	none
	diazinon	$1\frac{1}{2}$ lb	none
	methomyl (Lannate, Nudrin)	$\frac{1}{4}$ - $\frac{1}{2}$ lb	none (3 days forage, silage)
	methyl parathion (PennCap M)	$\frac{1}{2}$ lb	3 days (12 days forage, silage)
Corn rootworm	chlorpyrifos (Lorsban)	}	Same as for field corn
	ethoprop (Mocap)		
	fonofos (Dyfonate)		
	isofenphos (Amaze)		
	phorate (Thimet)		
	terbufos (Counter)		

Seed corn maggot, beetle, wireworm	diazinon lindane	1 oz/bu $\frac{1}{2}$ -1 oz/bu	Seed treatment only
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## Sugar Beet

Beet webworm	carbaryl (Sevin)	1 $\frac{1}{2}$ lb	14 days, tops
	endosulfan (Thiodan)	1 lb	Do not feed tops
	methomyl (Lannate, Nudrin)	$\frac{1}{4}$ - $\frac{1}{2}$	7 days (30 days tops)
	parathion	4-8 oz	15 days
	trichlorfon (Dylox)	1 lb	14 days

## Cutworms

carbaryl (Sevin)	1-2 lb spray or bait	14 days tops
chlorpyrifos (Lorsban)	1 lb	row treatment at planting time or broadcast spray postemergence.
Trichlorfon (Dylox, Proxol)	1 lb	14 days

## Root maggots

aldicarb (Temik)	1 $\frac{1}{2}$ -2 lb	Row treatment at planting time. Some products are also registered for side dressing at the time of fly activity.
carbofuran (Furadan)	2 lb	
chlorpyrifos (Lorsban)	1 $\frac{1}{2}$ -2 lb	
diazinon	1-2 lb	
fonofos (Dyfonate)	1-1 $\frac{1}{2}$ lb	
terbufos (Counter)	1-2 lb	

## Wireworms

(Some of the root maggot insecticides will also provide wireworm control)

diazinon	4 lb	Broadcast ppi
fonofos (Dyfonate)	4 lb	" "
lindane	½-1 oz/bu	seed treatment

Sunflower	Soil insects	lindane	1-1½ oz/bu	Seed treatment. 2-3/4 oz DB green/bushel.
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Cutworm  
Toxaphene appears to be ineffective. Emergency request will be made for effective material, when needed.

chlorpyrifos (Lorsban)	1 lb.	For seed production fields only
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Treat when stand reduction approaches 25% of recommended stand and larval numbers exceed 1 per 2 sq. ft.

Stem weevil	methidathion (Supracide)	½ lb.	50 days before harvest
	methyl parathion	1 lb.	30 days before harvest

Two adults per plant at 10-20 leaf stage

## Grasshoppers

## Sunflower beetle

## Thistle caterpillar

carbaryl (Sevin)	1¼-2½ lb.	60 days prior to harvest
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toxaphene	1½-2 lb.	Not more than 2 applica- tions. Do not feed or graze plants.
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Plants can be defoliated up to 25% with no effect on yield.

Seed weevil	methidathion (Supracide)	½ lb.	50 days before harvest
	methyl parathion	1 lb.	30 days before harvest

10 to 20 adults per plant. First treatment when 60 to 80% of plants show bloom. Efficacy will be poor when first treatment is made after bloom in entire field is 60 to 70% complete. Second treatment may be necessary. Pollinator activity is of benefit to grower so make every possible attempt to avoid beekills.

## Sunflower moth

## Banded sunflower moth

endosulfan (Thiodan)	1 lb.	No more than 3 applica- tions. Highly toxic to bees.
methidathion (Supracide)	½ lb.	2 treatments at least 50 days prior to harvest
methyl parathion	1 lb.	No more than 3 applica- tions. 30 days before harvest. Highly toxic to bees.

Action levels for sunflower moth = 2 adults per plant at time migrant moth arrives. Banded moth = 8 adults per plant. Banded moth adults are very difficult to monitor.

Sunflower midge Presently labeled compounds have not provided midge control even when applied at short intervals during adult midge flight. When attempting to produce sunflower in the Red River Valley either delay planting or plant on more than one date using midge tolerant hybrids.

## STATUS OF CORN ROOTWORM INSECTICIDES - 1982

<u>Registration</u>	<u>ORGANOPHOSPHATE</u>						<u>CARBAMATE</u>
	<u>Amaze</u>	<u>Counter</u>	<u>Dyfonate</u>	<u>Lorsban</u>	<u>Mocap</u>	<u>Thimet</u>	<u>Furadan</u>
Field corn	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sweet corn	Yes	Yes	Yes	Yes	Yes	Yes	No
Popcorn	Yes	Yes	Yes	Yes	No	No	No
Furrow application	No	Yes	No	Yes	No	No	Yes
Cultivation or basal application							
Granules	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Liquids	Yes	No	No	No	No	No	No
Broadcast application	No	No	Yes	Yes	No	No	No
Liquid-starter fert. mix.	Yes	No	Yes	No	No	No	Yes
<u>Phytotoxicity</u> (with placement near seed or seedling)	Low	Low	Moderate	Low	High	High	Low
<u>Human toxicity</u> (Signal words)*							
Granules	W	D	D	C	W	D	W
Liquids	D	-	D	W	D	-	D
<u>Restricted Use</u>							
Granules	Yes	No	No	No	No	No	No
Liquids	Yes	-	Yes	No	Yes	-	Yes

\* D = Danger, Highly toxic

W = Warning, Moderately toxic

C = Caution, Low to moderately toxic

## EPA RESTRICTED USE PESTICIDES - November 1981

Insecticides

aldicarb (Temik)  
aluminum phosphide (Phostoxin)  
amitraz (BAAM, Mitac)  
azinphosmethyl (Guthion)  
Bolstar  
calcium cyanide  
carbofuran (Furadan 4F, 75 WP)  
chlordane  
chlordimeform (Fundal, Galecron)  
chlorfenvinphos (4072, Supona)  
chlorobenzilate (Acarben)  
chloropicrin  
chlorpyrifos (Killmaster II only)  
demeton (Systox)  
dicrotophos (Bidrin)  
diflurobenzuron (Dimilin)  
dioxathion (DeInav)  
disulfoton (DiSyston EC and liquid conc.)  
endrin  
ethoprop (Mocap EC and liquid conc.)  
EPN  
ethyl parathion  
fensulfothion (Dasanit EC and liquid conc.)  
fenvalerate (Pydrin)  
fonofos (Dyfonate EC and liquid conc.)  
heptachlor  
hydrocyanic acid  
isofenfos (Amaze)  
magnesium phosphide (Fumicel)  
methomyl (Lannate, Nudrin)  
methyl bromide  
methyl parathion

mevinphos (Phosdrin)  
 methamidophos (Monitor)  
 methidathion (Supracide, except nursery stock, safflowers & sunflower)  
 monocrotophos (Azodrin)  
 nicotine alkaloid  
 oxamyl (Vydate)  
 permethrin (Ambush, Pounce)  
 phorate (Thimet EC and liquid conc. and Rampart 10 G)  
 phosphamidon (Dimecron)  
 sodium cyanide  
 sulfotepp  
 tepp

#### Herbicides

acrolein (Aqualin, Magnacide)  
 allyl alcohol  
 diclofop (Hoelon)  
 nitrofen (TOK)  
 paraquat  
 picloram (Tordon) not all formulations  
 pronamide (Kerb)

#### Others

chlorophacinone (Rozol)  
 clonitralid (Bayluscide)  
 Cyclohexamide (Actidione)  
 DBCP  
 fenamiphos (Nemacur)  
 fluoracetimide  
 Mesuro1  
 Milban  
 phosacetim (Gophacide)  
 sodium fluoroacetate (1080)  
 strychnine  
 zinc phosphide

#### Minnesota restricted use pesticides

Inorganic arsenicals for weed control  
 sodium fluoroacetate (1080 & 1081)  
 lindane  
 phosphorous paste



MINNESOTA EUROPEAN CORN BORER FALL SURVEY 1981

<u>DISTRICT</u>	<u>NUMBER COUNTIES</u>	<u>% PLANTS INFESTED</u>	<u>% SHANKS INFESTED</u>	<u>NO. BORERS / 100 PLANTS</u> 1980                      1981	
WC	6	28	6	43	22
C	6	37	11	29	44
EC	5	12	3	30	18
SW	5	27	9	34	25
SC	5	25	6	36	28
SE	5	30	7	28	29
STATEWIDE	32	26	7	33	28

MINNESOTA CORN ROOTWORM ADULT SURVEY 1981

<u>DISTRICT</u>	<u>NUMBER COUNTIES</u>	<u>NUMBER FIELDS CORN/CORN</u>	<u>NUMBER BEETLES/ACRE</u> 1980                      1981		<u>NORTHERN: WESTERN SPECIES</u>	<u>PERCENT LODGED</u>
WC	12	39	32,510	32,333	94:6	0.3
C	9	36	34,920	27,828	99:1	1.8
EC	5	23	4,124	3,860	94:6	0.0
SW	9	27	68,920	52,162	82:18	Trace
SC	9	34	43,696	24,141	92:8	0.3
SE	5	21	52,301	24,253	88:12	0.4
STATEWIDE	49	180	39,412	27,429	91:9	0.5

From the Division of Plant Industry, Minnesota Department of Agriculture.

1981 CORN ROOTWORM  
INSECTICIDE TRIALS  
WASECA

<u>TREATMENT</u>	<u>AV. ROOT RATINGS (1-6)</u>	<u>AV. YIELD BU/A</u>
AMAZE 20G	2.45	189.9
THIMET 15G	2.55	196.0
FURADAN 10G	2.60	200.9
THIMET 20G	2.65	173.0
COUNTER 15G	2.70	184.0
MOCAP 15G	2.85	180.5
LORSBAN 15G	3.05	195.1
DYFONATE 20G	3.55	178.1
CHECK	4.90	148.9

1981 CORN ROOTWORM  
INSECTICIDE TRIALS  
MORRIS (FURADAN HISTORY)

<u>TREATMENT</u>	AV. ROOT RATINGS (1-6) <hr/>	AV. YIELD BU/A <hr/>
AMAZE 20G	2.00	120.4
COUNTER 15G	2.00	118.8
COUNTER 20G	2.00	121.6
LORSBAN 15G	2.10	121.8
THIMET 20G	2.15	118.9
THIMET 15G	2.30	117.0
DYFONATE 20G	2.35	116.0
FURADAN 10G	2.95	122.0
MOCAP 15G	3.05	114.2
CHECK	3.65	107.0

LONG TERM PERFORMANCE OF ROOTWORM INSECTICIDES  
(1971-1981 LAMBERTON, MORRIS, WASECA)

<u>PRODUCT (NO. OF OBSERVATIONS YRS + LOCATIONS)</u>	<u>AV. ROOT DAMAGE RATING (1-6)</u>
COUNTER (20)	2.10
AMAZE (11)	2.13
FURADAN (16)	2.15
THIMET (23)	2.29
DYFONATE (20)	2.30
MOCAP (20)	2.47
LORSBAN (20)	2.48
CHECKS (24)	3.50
FURADAN ON FURADAN "PROBLEM" SITES (9)	3.54

## CUTWORM CONTROL

Cutworms continue to be an annual problem in most crops but are especially damaging to sunflower. We have attempted to have cutworm control trials every season for the past five years. To do this we have spent time seeking initial populations exceeding 5 larvae per square foot irrespective of the host plant in which they occur and irrespective of the cutworm species.

In addition a graduate student, Robert Schmidt, has been examining developmental rates, food consumption, sunflower stand reduction, and early season defoliation by two species of cutworm, the darksided and dingy cutworm in sunflower. He has also worked with us in early season simulated damage. His objective is to develop a more precise predictive "model" for cutworm damage to sunflower, hence an easier system with which to make control judgments.

Two sets of data follow. Morris data were collected in spring wheat seeded on March 23 following a 1980 crop of sunflower. The predominant cutworm was the dingy cutworm and was present in the plot area at the time of our first visit at the level of 8 per square foot. Other portions of the field contained 13 larvae per square foot.

Table I. Dingy cutworm (*Feltia duscens*) control in wheat. Merrill Carlson field. Morris, MN 1981. Robert Schmidt, David Noetzel and Jerrel Christensen.

Treatment	Rate ai/a in pounds	Percent Control	Corrected* Percent Control
Lorsban	1.0	93	83
Pydrin	0.1	92	81
Ambush	0.1	79	50
Toxaphene	3.0	68	24
Check	-	58	0

\*Corrected using Abbotts formula

At the time this field was first observed we felt the cutworm population was consuming enough wheat to keep the field black. Bob Schmidt wanted to follow this population to measure individual larval growth, however, so control was delayed until May 11. Larval counts per square foot dropped from eight to about 2.25 over a 3 week period prior to chemical application. Pre-treatment counts taken in the morning of May 11 were 2.25 with no significant difference between plots. Insecticides were applied in about 25 gallons of total material per acre that afternoon. Post treatment counts were made at 72 hours. Percent control and corrected percent control are contained in Table I.

What is particularly striking is the high mortality in the untreated plots. This mortality was identical with that in untreated portions of the remainder of the field and so is probably not due to insecticide drift or larval migration. The second major point is that control with toxaphene at very high rates did not significantly exceed the untreated check. Lorsban, Pydrin and Ambush provided approximately equal control. There were no yield differences here so the economic thresholds were not exceeded or to say it simply, chemical control did not pay.

A second trial was carried out with Blake Peterson on the Carl Jensen farm in Roseau county. The predominant cutworm was the redbacked cutworm which were migrating and feeding as they moved from a timothy field into flax. The initial larval population was 5.8 per square foot with no significant differences between plots. Insecticides were applied the evening of the day (June 5, 1981) on which pretreatment counts were made.

Table II. Redbacked (*Euxoa ochrogaster*) and dingy cutworm control in flax. Carl Jensen field. Roseau, MN 1981. David Noetzel and Blake Peterson.

Treatment	Rate ai/a in pounds	Percent Control	Corrected* Percent Control
Pounce	0.1	94.6	91.0
Pydrin	0.1	89.3	82.0
Ambush	0.1	88.8	81.9
Lorsban	1.0	88.2	81.0
MV 770 (Stauffer)	1.0	75.2	60.0
Sevin XLR	1.5	43.6	9.0
Toxaphene	3.0	39.8	2.9
Check	-	38.0	0

\*Corrected using Abbotts formula

Post treatment counts were taken 72 hours after insecticide application. Again the striking thing about this test is the high cutworm mortality in the check during just a three day period following treatment. And toxaphene did not outperform check. Pounce, Pydrin, Ambush, and Lorsban provided equal control at the rates used.

In five years of trials at nine locations we have not observed cutworm control with toxaphene to exceed untreated checks. These trials have included darksided, dingy and redbacked cutworm in sunflower, small grain and flax. Soil conditions at treatment time have ranged from severe drought (i.e., no measurable rainfall for 6 months prior to treatment) in 1980 to extremely moist conditions in 1981. We are speculating that what we earlier believed to be acceptable control with toxaphene was really normal mortality in cutworm populations. Hence toxaphene for cutworm control will be dropped from 1982 recommendations.

## SUNFLOWER INSECTS

The major insect problems in sunflower in Minnesota during 1981 were sunflower midge, sunflower seed weevil and banded sunflower moth. Almost all fields also have some internal stem damage due primarily to Apion activity. The relationship of this insect injury to stalk rotting organisms (e.g., premature ripening) is not clear.

## Sunflower midge

A late season swing through the west central and northwest sunflower growing areas of Minnesota provided additional observations on midge injury. Damage was present in all parts of the Red River Valley and extended outward onto lighter soils and rolling country sometimes as far as 20 to 30 miles from the valley edge. The most severe injury, however, was in the northern valley centered around Donaldson, Minnesota and south to Stephen. Moderate to severely injured fields ( a few totally destroyed) were more widely spread than in 1979, the year of the last locally severe injury.

In summary, we saw a somewhat more severe midge problem than in 1979 and certainly more widespread than in any previous year. However, we do feel that our early estimate of a 10 percent reduction in yield in Minnesota, based on all July 1 acres, was a reasonably good one. This was certainly no disaster, but not a bright note either.

In some areas it was hard to find fields showing even slight midge injury. In eastern Roseau, Marshall, Pennington, and Polk we observed some of the best sunflower fields we have ever seen; many had no midge damage present. Midge populations were probably low or nil in these areas.

It is quite clear that under moderate to heavy midge pressure (and maybe under light infestations as well), none of the present insecticides appear to reduce damage. We had theorized that materials that had greater activity against the adult fly might provide hope. Direct observations of adult flies ovipositing on freshly treated plants quickly dispelled that idea.

There are some fairly positive aspects of the problem, however. Fields in every area visited, sometimes those adjacent to a field with severe midge damage, yielded the normal one ton plus of seed. Why did these fields escape the midge? There are three apparent reasons for the escape.

First, sunflower hybrids exist that are either tolerant or resistant to light to moderate midge pressure. Several hybrids appear to be superior in this respect.

Secondly, many fields escaped due to time of planting. It's very apparent that fields planted in late May and early June were generally free of midge. This was readily confirmed wherever midge was present as indicated

by paired undamaged and damaged fields. It was further supported by the observation that we appeared to have had a single peak of midge adults the first week in July. (In looking back at 1980 and 1979 the adult emergence also occurred the first week in July in both years.)

Lastly, we know so little about adult midge movement that it is possible that winds may have carried these adults into some fields and away from others. We are confident that this was much less a factor than the first two observations.

Although some insect control tools appear not to function against the sunflower midge, there are others that do. Seed companies should be encouraged to discontinue midge susceptible sunflower lines. At the same time, selection of midge tolerant lines should be strongly encouraged. The value of late planting in escaping midge also needs to be examined objectively in several areas of the valley.

#### Sunflower seed weevil

The numbers of adults observed in the Breckenridge, Foxholm, and Wheaton areas exceeded twenty per plant in many fields. Data from plots, CPM monitored and growers' fields are still being analyzed. Tentative observations seem to indicate that control is extremely variable with some suggestion that single applications of parathion at one pound in fields with infestation levels of 20 adult weevils per plant may not be profitable. We are having great difficulty in demonstrating any effect on yield with only 10 weevils per plant.

#### Banded sunflower moth

This insect was much more abundant in 1981 than 1980. 1980 data indicated economic injury in about 3% of monitored fields. The adult moth must be monitored in a manner similar to sunflower moth in order to make control judgments. This has proven to be a most difficult procedure.



## POTATO DEFOLIATION DEMONSTRATIONS

Workable action levels for insecticide control of defoliating insects in potato in Minnesota have been developed by Dr. Radcliffe and his students. However, monitoring of fields in the Agricultural Extension Service has seemed to indicate either improper timing of foliar applications or treatments before defoliation estimates indicate economic benefit will accrue.

Taken together this indicates the need for demonstration of the relationship of defoliation vs. yield in our potato growing areas. Again Radcliffe's work in the metropolitan area is excellent for that area. His group has clearly indicated that yield and defoliation relationships have remained constant over several years. But there are not too many similar trials in the northwestern part of Minnesota. Also the effect of defoliation on yield in early, mid and late season cultivars needs examination.

The following two trials are the beginning of a series comparing yield and defoliation to be carried out in conjunction with the Crop Pest Management program. It is intended that these will be placed in cooperating growers' fields representative of the major potato producing areas of the state.

One trial was located on the Sherwood Peterson farm near Baker, MN. The potato cultivar was Anoka and was hand defoliated by removing complete leaves on the 11th of July 1981. Plots were three adjacent hills bordered on each end by a non-defoliated plant. Yields were collected on 10 September 1981. Weights for each of the three hills were kept separate and compared statistically. There were no positional differences in yield. Thus the yields which are tabulated in Table 1 are reported on a per hill basis but are an average of 18 hills/treatment. There were no statistical differences in yield.

Table 1. Hand defoliation of potato and yields at Baker, MN 1981.

<u>Treatment in percent defoliation</u>	<u>Yield in pounds/hill</u>
10	4.69
20	4.07
30	4.13
50	4.03
70	4.18
0	3.93

A second trial near Crookston was located on the Kenneth Kellar field. A portion of a field of Russet Burbank potatoes was left untreated until average defoliation for the area was 25%. Then, following treatment with Pydrin on the 6th of July, three hill plots with similar insect damage as indicated by an average of five evaluators were staked and defoliation recorded. Defoliation per plot ranged from none to 90%. Yields were collected on the 9th of September on center hills only.

Table 2. Colorado potato beetle defoliation and yields at Crookston, MN 1981.

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<u>Range in percent defoliation</u>	<u>Number of plots</u>	<u>Yield in pounds/hill</u>
0- 5	14	1.64
6-14	12	1.68
15-20	12	1.56
21-50	14	1.23
51-	8	1.08

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There were significant reduction of yields above 21% defoliation in this field. However, there is little if any effect on yield when defoliation is at or below the crop pest management action level.

## COLORADO POTATO BEETLE CONTROL

The question of Colorado potato beetle resistance to insecticides is raised each time an insecticide application fails to provide nearly complete control of that insect. Dr. Radcliffe and his students have generated information over the years which do not indicate the presence of CPB resistance in Minnesota to the presently labeled materials. Insecticide trials in 1981 near East Grand Forks and Crookston provide further observations on efficacy of many insecticides on CPB populations in the northwestern part of the state.

Table I. Control of Colorado potato beetle. 1981. J. Vanascek farm. East Grand Forks, MN. Johnston, Radcliffe and Cuperus.

Treatment	Pounds AI/a	Percent Control 24 hours	Percent Control 7 days
Check	0	0	0
Monitor	0.75	97.7*	93.2*
Lannate	0.45	81.1	69.3
Lannate	0.9	88.0	77.4
Phosphamidon	0.5	99.3	93.2
Pydrin	0.05	95.1	99.8
	0.1	97.1	98.9
	0.2	97.4	100.0
Vydate**	0.45	99.1	100.0
	0.9	99.4	100.0
Sevin XLR	1.0	99.4	99.7
Sevin 80 WP	1.0	99.7	100.0
Furadan	0.5	99.0	100.0
Azodrin	0.75	84.5	98.6
Thiodan	1.0	99.0	96.7
Imidan	1.0	98.7	99.8

\* Corrected using Abbotts formula

\*\* Not presently labeled in Minnesota

Plots were treated on 2 July 1981. The data indicate that excellent control of 2nd through 4th instar CPB was obtained with most currently labeled insecticides. In 1981 the seasonal development of CPB was such that a single properly timed application of foliar insecticide would have been sufficient for season long CPB control, if it were required at all.

A second set of plots were established near Crookston. Because insecticide performance was outstanding in the Vanascek trials rates of several compounds were reduced (Table 2). Chemicals were applied to Russet Burbank potatoes on 9 July 1981.

Table II. Control of Colorado potato beetle. 1981. R. Kellar farm. Crookston, MN. Johnston, Radcliffe and Cuperus.

Treatment	Pounds AI/a	Percent Control at 24 Hours
Check	0	0
Monitor	0.5	95.9*
Phosphamidon	0.25	99.5
Imidan	0.5	98.5
Pydrin	0.025	97.2
Pydrin	0.05	99.7
Vydate**	0.25	99.4
Sevin XLR	0.75	98.7
Sevin 80 WP	0.75	97.8
Furadan	0.25	99.4
Azodrin	0.75	99.0
Guthion	0.25	99.5
Thiodan	0.75	99.2

\* Corrected using Abbotts formula

\*\* Not presently registered in Minnesota

The control was remarkably good even with insecticide rates reduced by 25 to 50%.

These plots along with the defoliation studies provide considerable insight into judgment making in CPB control. The excellent insecticide efficacy permits us to use the thresholds Dr. Radcliffe and his group have provided because we know nearly complete control can be obtained. It appears probable that even years when CPB control is needed a single properly timed application of insecticide (and certainly no more than two) will provide maximum economic return. And finally the effectiveness of such a wide array of chemicals widens our chemical options. Both reduced number of applications and rotation in chemicals should greatly reduce the potential for development of resistance in CPB.

## NITRATE SOIL TEST FOR CORN IN MINNESOTA

## Introduction

A nitrate soil test has been used for several years in western Minnesota for small grains, sunflowers, and sugarbeets. Research on corn has shown that predicting nitrogen needs by using a nitrate test along with a formula accounting for soil moisture, previous crop, and other factors is also fairly reliable in this area of the state. The nitrate test is a decided improvement over predicting nitrogen needs of corn in western Minnesota which were previously based only on past cropping history and yield goal.

## What is the nitrate soil test?

The nitrate soil test measures nitrate-nitrogen ( $\text{NO}_3^-$ -N), the major form of nitrogen taken up by corn and most other crops. The nitrate test must be run on a soil sample from a 0 to 24 inch depth, and in many cases on a second sample from the 24 to 48 inch depth. A deep sample is required because corn roots can utilize substantial amount of nitrate from this depth in the soil profile.

## Why use it?

Nitrogen fertilizer recommendations for a specific yield of corn have been based on estimates of the nitrogen supplying capacity of the soil as affected by organic matter level and previous crop. This approach gives a good estimate under average conditions. But it does not consider the variability in nitrates in the soil profile, which can range from almost none to most of crop's nitrogen need depending on soil and weather conditions and on past crop yields and fertilizer practices. Testing for nitrates in the soil profile improves the accuracy of a nitrogen recommendation and determines which fields in a given year will need lower or higher than average rates of nitrogen to reach optimum yields.

## Where can the nitrate test be used?

Use of the nitrate test is recommended only in western Minnesota. This is an area of limited rainfall where only minimal changes in nitrate level are generally observed between fall or spring sampling and the growing season. In the remainder of the state, where rainfall is greater, the potential for large nitrogen losses due to leaching or denitrification make the nitrate test less reliable for determining nitrogen fertilizer rates.

Even in western Minnesota the nitrate test is not recommended on coarse textured soils (sandy loam or coarser) where leaching losses may be large or on very poorly drained soils where denitrification losses are often great.

## What is the sampling procedure?

Sampling for nitrates must be done every year since the amount of nitrate in the profile may vary dramatically from year to year. Sampling may be done in the fall after September 15 or in the spring.

Samples must be taken to a depth of 24 inches. A better nitrogen recommendation can be made if a second sample for the 24 to 48 inch depth is also taken. Do not take a single sample to a 48 inch depth.

Each sample should be a composite of 15 cores taken from a uniform sample area if not more than 20 acres. In some cases where soil type and crop and fertilizer history are known to be uniform an area as large as 30 to 40 acres may be included in one sample. Mix the sample thoroughly and remove about a pint of soil.

Samples must be air-dried as quickly as possible to stop microbial activity which may change the nitrate level. To dry the soil, spread it on a clean sheet of paper or plastic. Samples should be dry within 24 hours.

When is a second deeper sample (24 to 48 inches) important?

A second sample from 24 to 48 inch depth can improve the nitrogen recommendation where substantial amounts of nitrate have accumulated at this lower depth. This happens when crop uptake is less than the amount of nitrogen available in the root zone. This situation occurs when past nitrogen rates have been higher than needed, when large amounts of manure have been applied, or when yields have been substantially reduced by drought, hail, or other factors. Deeper sampling may also be advisable during the initial years of nitrate testing when sub-soil nitrate levels are unknown.

What other information is needed?

The following information is essential for an accurate nitrogen recommendation and must be included on the information sheet with the sample:

1. Sampling depth
2. Expected yield of corn
3. Previous crop

What are the limitations of the nitrate test?

Successful use of the nitrate test depends on only minimal change in nitrate level occurring after the time of sampling. For this reason the test is applicable to western Minnesota only, poorly drained or sandy soils must be avoided, and sampling must be done after September 15. Even with these precautions the test is not fool proof. If heavy rains occur after the time of sampling, especially in conjunction with warm weather, large losses of nitrogen by leaching and/or denitrification may occur. The nitrate test would no longer be correct and either adjustment of the recommended nitrogen rate or re-sampling are necessary.

How is the nitrogen recommendation made?

The recommended nitrogen rate is determined by a two-step procedure:

1) The approximate yield of corn that could be obtained without added nitrogen is estimated based on a nitrogen index consisting of three nitrogen sources-- available nitrate in the soil profile, estimated nitrogen release from organic

matter, and contribution due to a legume previous crop. 2) The amount of fertilizer nitrogen required to raise the yield to a realistic yield goal is calculated. This procedure is outlined below:

NI = nitrogen index

$N_{0-24}$  = nitrate N (lb/A) in 0 to 24 inch depth

$N_{24-48}$  = nitrate N (lb/A) in 24 to 48 inch depth

$N_{OM}$  = N released from soil organic matter

$N_{PC}$  = N contribution from a legume previous crop

$Y_{0N}$  = Yield of corn without added N

$N_F$  = fertilizer N to apply

YG = yield goal

$$1) \text{ NI} = 0.9 \times N_{0-24} + 0.25 \times N_{24-48} + N_{OM} + N_{PC}$$

$$2) \text{ } Y_{0N} = \frac{\text{NI}}{1.5}$$

$$3) \text{ } N_F = 2.5 \times \left( \text{YG} - \frac{\text{NI}}{1.5} \right) = 2.5 \times (\text{YG} - Y_{0N})$$

#### Explanation

1) Nitrogen Index (NI) consists of three factors:

- a) Available water in the soil profile influences uptake of nitrate-N by the plant. Therefore, the available Nitrate-N is based on a 20 year average of water uptake by the plant at 2 feet soil depths. If no 24 to 48 inch sample is provided, an average figure of 40 lbs.  $\text{NO}_3\text{-N/A}$  is used.
- b) N release from soil organic matter ( $N_{OM}$ ). For fine textured soils in western Minnesota, most of which are 3 to 6% organic matter, this is estimated as 80 lbs/acre, so  $N_{OM} = 80$ .
- c) N contribution from a legume previous crop ( $N_{PC}$ ). Nitrogen due to microbial N fixation and other factors are not reflected in the nitrate test. Values for  $N_{PC}$  are as follows:

<u>Previous Crop</u>	<u><math>N_{PC}</math></u>
corn, small grain, sunflowers	0
soybeans	15
poor stand of alfalfa	30
good stand of alfalfa	60

- 2) Approximately 1.5 NI units are needed to produce a bushel of corn. Therefore, the potential yield without added fertilizer N is:

$$Y_{0N} = \frac{NI}{1.5}$$

- 3) About 2.5 lbs. of fertilizer N are needed for each bushel yield increase beyond the yield without N. So fertilizer N is calculated as:  $N_F = 2.5 \times (Y_G - Y_{0N})$

A minimum N rate may be recommended even if calculated N rate is 0. See table in next section.

#### Example

nitrate  $N_{0-24} = 60$  lb/A

yield goal = 140 bu/A

nitrate  $N_{24-48} = 100$  lb/A

previous crop = corn ( $N_{PC} = 0$ )

1)  $NI = .9 \times 60 + .25 \times 100 + 80 + 0 = 54 + 25 + 80 + 0 = 159$

2)  $Y_{0N} = \frac{159}{1.5} = 106$  bu/A

3)  $N_F = 2.5 \times (140 - 106) = 2.5 \times 34 = 85$  lbs/A

Nitrogen index of 159 is adequate for a 106 bu/A corn yield. To produce 140 bu/A requires 85 lb N/A as fertilizer.

An alternative method of determining N recommendation is to use the following table.

#### Nitrate test for corn in western Minnesota

Subtract  $1.5 \times NO_3^- - N, 0-24"$ , (lb/A) from the value in the table to obtain amount of fertilizer N to apply.\*

Yield Goal	Previous Crop			
	Corn, Small Grain Sunflowers	Soybeans	Poor Stand Alfalfa	Good Stand Alfalfa
160 or more	250	225	200	150
150	225	200	175	125
140	200	175	150	100
130	175	150	125	75
120	150	125	100	50
110	125	100	75	25
100	100	75	50	0
90	75	50	25	0
80 or less	50	25	0	0

\*See next page



\*Assumes  $\text{NO}_3^-$ -N of 40 lb/A in 24-48" depth. If 24-48" sample is run subtract 40% of the amount over 40 lb/A [i.e.  $.4 (N_{24-48"} - 40)$ ] from the amount of N to apply.

#### Minimum N Rate

Yield goal of 90 bu/A or less

If calculated N rate is less than 25 but more than -25, apply 25 lb N/A.

If calculated N rate is less than -25, apply 0.

Yield goal of over 90 bu/A

If calculated N rate is less than 50 but more than -50, apply 50 lb N/A.

If calculated N rate is less than -50, apply 0.

Using the earlier example, the calculation is as follows:

1) Assuming 40 lb/A in 24 to 48 in. depth

$$200 - 1.5 \times 60 = 200 - 90 = 110$$

2) Adjusting for actual nitrate N in the 24 to 48 in. depth

$$110 - .4 \times (100 - 40) = 110 - .4 \times 60 = 110 - 24 = 86 \text{ lb N/A}$$

## DISEASES OF FIELD CROPS - 1981

## Corn

Stalk rot and lodging are common problems in several fields this year. Each year stalk rot is usually found. Reports of 30-50 percent lodging have been heard, yet my field counts have not usually run that high. At one test location with a susceptible hybrid, lodging averaged 55 percent when inoculated with the eyespot fungus. In another plot with several lines you could clearly see hybrid differences. It is very difficult to rank hybrids but growers should examine their fields, observe the various field trials in their area and select varieties showing resistance to lodging. This year some fields also exhibited premature dying. This symptom is caused by root and stalk rot that kills the plant or at least stops water movement before the crop is mature. The plants suddenly appear dry and are dead. The root system of such plants were usually sparse and discolored. Stalk decay develops next. These symptoms progress rapidly to complete death and plants appear frosted. Stalks are dry and dead in 7-10 days. Plants prematurely killed by stalk rots will have light weight, chaffy ears. Cob drop may be a problem where stalk rots are severe and caution should be exercised in storing this grain.

Since stalk rot was more prevalent in Minnesota this year and usually is present at some level, growers should consider the following common factors favoring stalk rots and control suggestions.

## Factors favoring stalk rots:

- 1) Fungal stalk rots are generally more severe when N is in excess in relation to K.
- 2) Leaf blight, hail or insect damage reduced leaf area and increased the potential for stalk rot.
- 3) Insects aid in the development of stalk rots by carrying spores into tissues, causing wounds through which fungi enter stalks and roots, and reducing the photosynthetic area.
- 4) Genetic resistance involves multiple genes some with major effects.
- 5) Early maturing hybrids are generally more susceptible than full season hybrids, especially when harvest is delayed.
- 6) High plant populations and narrow rows increase stalk rot potential.
- 7) Severe stalk rots may involve several organisms.

## Management practices:

- 1) Select resistant hybrids adapted to your area.
- 2) Plant sound, disease-free seed treated with a fungicide.
- 3) Attain balance soil fertility especially between N & K by applying fertilizer based on soil test results.

- 4) Adjust the plant population to the particular hybrid, the fertility levels, soil type and available soil moisture of your field.
- 5) Crop rotation and clean plow down of crop residue may reduce stalk rot in some cases.
- 6) Control root attacking and stalk attacking insects using approved resistant hybrids, cultural practices, and chemicals where needed and feasible.
- 7) Harvest when the crop is mature (appropriate grain moisture level) to prevent losses from lodging.
- 8) When possible irrigate during droughts until 50-55 days after flowering.

### Eyespot

Eyespot was found over a wide area in the state, but severity was highly variable. Cases of severe and early infection were generally in fields of corn following corn with minimum tillage. Leaves were killed prematurely and yield losses resulted. Eyespot was not restricted to irrigated corn. The symptoms simply developed earlier under those conditions. Eyespot again reduced yields at Staples under irrigation either inoculated or as a result of natural inoculum. Inoculation of the Eyespot fungus at Waseca reduced corn yield by 41 bushels.

Eyespot was first reported in the United States in 1968. It is most common in North Central and Northeastern states. The fungus, Kabatiella zeae survives the winter as resistant hyphae in infected corn residue. The next spring and throughout the growing season, fungal spores are produced and released during moist periods. New lesions develop on susceptible corn leaves. Lower, older leaves are first infected and when wet weather or prolonged dew is present even the upper, younger leaves become infected. The Eyespot lesion is an oval-circular yellow spot which develops a brown or tan center with a ring of darker color and a yellowish halo. When many spots occur in a small area the entire leaf may die. Rotation or plow down of infected corn residue reduces Eyespot. Resistance is available also.

In addition to the common Maize Rust, Puccinia sorghi, Southern rust was reported in Minnesota this past season. Puccinia polysoria, Southern rust, occurs principally in the Southeastern United States and has been reported as far north as Indiana, Illinois, and southern Wisconsin. Southern Rust resembles common rust with very subtle differences. These differences can be identified in the laboratory.

### Head smut

Head smut of corn caused by Sphacelotheca reiliana (Kuhn) Clint, was recognized on August 1, 1980 in a field at the Staples AVTI, in Wadena County. Surveys since then identified additional infected fields in Otter Tail, Stearns, and Todd Counties. Head Smut was present in 1981 in all locations except Stearns County where the fields infested in 1980 were either planted to grain or soybeans. Since this disease differs from common smut in that Head Smut is soil-borne and infects the corn plant in the seedling stage, seed treatment or soil treatments were tested as a control method.

Corn hybrids, a susceptible and a moderately susceptible were planted in artificially infested soil on each of three planting dates, 4/28, 5/12, and 5/27. Chemicals as seed treatments, granules over the furrow or in the furrow and as a spray were applied. Data are reported as percentage infection. The plants were examined on 9/23, 9/24, and 10/8 for Head Smut sori on either the tassel and/or the ear. A group of selected hybrids was also evaluated for resistance to this disease in a similar manner. A hybrid performance was averaged over the three planting dates and ranked into 4 groups: resistant, moderately resistant, moderately susceptible, and susceptible. This information is offered to the public to aid those growers in making appropriate hybrid selections.

## PERCENT OF HEAD SMUT

## Hybrid

	Susceptible		Moderately Susceptible			
	Planting Dates					
	4/28	5/12	5/27	4/28	5/12	5/27
Check	26.1	30.8	34.3	12.9	10.2	8.7
Vitavax 34 4 oz/100 #	34	26.2	20.8	11.4	10.8	11.1
Baytan oz ai/100#						
0.25	16.1	15.5	13.9	4.1	6.2	13.6
0.50	7.1	8.6	4.3	5.3	4.8	4.5
0.75	4.1	5.8	1.5	0.8	0.7	2.6
1.0	0	2.3	0.9	2.5	2.9	2.1
Ciba Geigy 88531 gm ai/Kg						
0.25	27.9	31.1	27.2	5.3	9.6	5.3
0.50	15.2	23.7	11.3	3.3	6.4	6.8
1.0	15.0	32.6	13.4	8.9	7.0	3.4
Ciba Geigy 64250 Spray 100 gm ai/A	28.9	29.4	22.3	5.0	15.4	9.7
Granule in furrow 100 gm ai/13,081 row ft.	0	0.8	0	0	0	0
Granule-Surface band 100 gms ai/13,081 row ft	--	4.8	3.5	--	2.9	1.7

## Soybeans

Phytophthora root rot, caused by the fungus Phytophthora megasperma f. sp. glycinea is increasing due to increased acreage. Phytophthora can kill plants at all stages of growth, directly reducing stands or if plants survive production is restricted. The incidence and severity of disease depends on soybean variety, soil type, soil drainage, rainfall and cultural practices. Phytophthora root rot develops in fields with poor drainage and in locations that remain saturated for 7-14 days due to excessive rainfall. Resistant varieties should be used when they out-yield susceptible varieties. Some susceptible varieties will out-yield resistant varieties in the absence of the disease.

Variety	Phytophthora Races		
	1	3, 6-9	4-5
Portage	S	S	S
Altona	R	MR	MR
Norman	S	S	S
McCall	S	S	S
Clay	S	S	S
Evans	R	MS	MS
Swift	MS	MS	MS
Steele	R	S	S
Hodgson	MS	MS	MS
Hodgson 78	R	MS	MS
Weber	MS	MS	MS
Corsoy	S	MS	MS
Corsoy 79	R	R	S
Vickery	R	R	S
Wells	R	S	S
Wells II	R	R	S

Soybean cyst nematode (SCN) survey by the Minnesota Department of Agriculture verified areas containing SCN in Kandiyohi, Brown, Cottonwood, Blue Earth, Waseca, Martin, Faribault, and Freeborn Counties. No new locations have been detected in 1981 as of 11/10/81.

White mold, Sclerotinia sclerotium is a persistent fungal problem in fields where inoculum levels are increased by susceptible crops such as sunflowers, sugarbeets, or dry beans. This disease and fungus are favored by wet weather. The fungus survives winter periods as sclerotia in soil and with cool moist conditions, that is, under a closed canopy of soybean leaves the sclerotia

produce spores that infect blossoms, leaves, and stems. Infected plants wilt and die, producing lower yields and more sclerotia to further infest the field. At present all soybeans are susceptible. Production of soybeans in narrow rows in fields which are infested favors the disease. Fields with white mold history should be planted to non-susceptible crops.

## Cereal Crops

Scab of wheat and barley was of little economic importance in growing season 1981. Scab did not develop because the climatic conditions were relatively dry during heading.

The dry conditions in the southwestern area of the state contributed to the very low yields of wheat. The plants under stress became infected with root rot, putting more stress on the plant, resulting in early dying and low yields. For the most part, the root rot was caused by either *Fusarium* and/or *Helminthosporium* fungi.

In west central and northwestern Minnesota, the rain was adequate to produce better crop stands of wheat and barley. Most of the newer barley varieties withstood the leaf spot diseases, except in the far north where excessive rains provided the best possible conditions for leaf spot. The wheat was not so fortunate, even though good yields were obtained, leaf spots, *Septoria* and Tan Spot reduced yields by 10 to 15 bushels per acre. These figures were obtained from growers who applied fungicide on their crop and also had non-treated strips as check areas.

The incidence and early on-set of the leaf spot diseases related to cropping sequence and varieties being grown. For instance, farms with wheat on wheat stubble had severe Tan Spot in June before heading. On clean plowed land the disease developed much later.

The leaf spot disease control program is based first on having a sufficient stand to produce a good yield and the potential of favorable weather to produce a good crop. The application of the fungicide only protects the potential crop yield. The application of fungicide will not provide a yield that is not in the field.

## Sugarbeets

*Cercospora* Leaf Spot was the real disease problem on the 1981 crop. This disease will be of major concern for beet growers for several years to come. I have not seen leaf spot of this extent since the mid-50s.

The disease was most damaging in the southern growing area--extending north to Crookston. Above Grand Forks, the disease was kept in check with fungicides or was very light.

The occurrence of fungal strains, immune to the MBC systemic fungicides certainly adds a new dimension to this problem. We do not know the total extent of the immune strains. However, experiences in other beet growing areas makes it quite possible that these strains will be widespread and persistent.

As the growers identify yield and sugar quality it will be seen that the leaf spot epidemic was a costly experience. In addition to yield loss, cost of control must be considered.



For next year, most of the beet acreage will be planted to susceptible varieties, and the most acceptable fungicides, are the protectant types. In addition, the infected plant residue from this year's crop is the source of inoculum for next year's disease. With favorable weather for growing the crop we have on hand there is a very good chance of another leaf spot epidemic.

Growers will have to consider when making their planting commitment that they may need to make several applications of fungicide to protect their crop. Disease control will have to start earlier than in previous years. In 1981 disease control warnings were made on July 18.

### Potatoes

1981 was the year for our introduction of *Sclerotinia* (white mold) on commercial potato fields. We do not have any information at this time as to crop loss or potential storage losses. White mold is also a devastating disease on dry beans, sunflowers, and soybeans.

Early Blight, once thought to be an aide in maturing the early crop, is causing important crop loss. Data from this year's experiments at the Rosemount Experiment Station and the Potato Farm at Grand Forks, identify these losses along with the importance of fungicide applications.

Late Blight has already resulted in some early storage loss. This disease comes with infected seed or may come from infected plants growing on cull piles.

*Rhizoctonia* was damaging in the northern growing areas. Stand loss was very common early in the season. *Rhizoctonia* is most destructive when carried on the seed. The small dirt-like particles on the tuber is the survival stage of this fungus.

*Verticillium* Wilt was observed in many fields in epidemic proportions. This soil-borne disease is causing serious crop loss, both yield and quality. Crop rotation, disease-free seed, and soil fumigation are methods of controlling wilt.

Ring Rot seems to be making a comeback. Storage and field losses were observed in 1981. Disease-free seed and sanitation will control Ring Rot.

### Sunflowers

Sunflowers certainly are a host for plant pathogens. A new race of mildew, and a new race of rust are present. Varieties previously resistant to these two diseases are now showing up as susceptible. White Mold (*Sclerotinia*) was a problem, as expected. Chances are very good that this disease will continue to be more damaging. Early dying, caused by different species of *Fusarium* was not as prominent in 1981. By early dying we are referring to the dying of the plant in mid-August, where the entire plant turns brown, not black, not blotchy.

*Phoma* infection results in the black blotches in the stem at the leaf nodes. There may be a seed treatment available for seed borne mildew before planting time.

## Rust on Pinto Beans

Rust on Pinto beans was especially prevalent during the last growing season (1981). Specific fields which were not sprayed, or sprayed too late did not yield near their potential. Losses due to this disease can be devastating.

Rust first appears as small chlorotic pale spots, (lesions), usually slightly yellow with a small dark center. As the disease progresses, the spots enlarge and are covered with a brick red rust (summer) spores, which spread the disease. With cooler weather, these lesions will develop black, (overwintering) spores.

Bean rust is caused by the fungus (Uromyces phaseoli dar. pytica ) and symptoms appear 10-15 days after infection. The earlier these symptoms appear, the greater the potential for crop yield reproduction.

Cultural practices are important in slowing initial infection by this fungus. Three to four years rotations are recommended to help control this disease. Following bean harvest, all refuse should be plowed under as completely as possible as soon as convenient, because refuse is a primary source of inoculum for the next year's growing season. Chemical control of early rust infection is easily accomplished when the disease is identified in the early stages. Fungicides, such as Coppers, Manebs, and Zinebs, will control the disease.

The chemicals used to prevent rust infection on pinto beans are protectants. They will not cure the disease already present, but will help prevent spread and subsequent infection. Tests of various fungicides at Staples, Minnesota have indicated their effectiveness as protectants (table 1). In this study U.I. 111 variety pinto beans were planted on May 29, 1980. Plots were 4 rows wide with 30 inch spacing. Four applications of each treatment were conducted. Fertilizer, herbicides, and water were provided for optimum yield performance on this soil type. Rust spore suspensions were inoculated on July 10 and 24 to provide disease conditions. Readings of rust pustules were taken on July 31 and August 13, using the severity rating scale in the Minnesota Agricultural Extension Service Plant Pathology Fact Sheet No. 20. These readings were then converted to the index values presented in table 1 for statistical analysis and comparison purposes. Four applications of the fungicides at a 60 gallon per acre rate were accomplished by a ground sprayer once 7 days before the first inoculation and at 10 day intervals after the first inoculation.

Six different fungicides were evaluated for their rust control effectiveness, (table 1). The fungicide used, reading index, yield per acre, cost per acre, and net return per acre are presented in table 1. Data are arranged in order of increasing disease indexes. Statistical analysis placed the fungicides into good, average, and poor categories. Chemicals within a grouping are similar in effectiveness and significantly different from those in the other groupings.

Bravo and Dithane M-22 provided the best rust control and has the highest yields, while the copper containing fungicides were less effective. Yield was highly correlated to these incidences as indicated by the lowest yielding plots having the highest indexing value (most disease).

Bravo is presently not cleared for rust control in dry beans, but these data will be used to support such a clearance. Dithane M-22 is cleared and presently seems about equal to Bravo and its ability to control rust.

The copper compounds listed are presently cleared for use in bacterial blight control and dry edible beans.

Fungicide trials at Staples during the last growing season were designed to discover differences in the effectiveness of Bravo 500 when applied at different concentrations, at different times of the disease cycle, and number of applications. The data from this trial are summarized in table 2.

The results of these data indicate that the earlier a fungicide is applied the more control can be expected. Sprays applied to treatment 9 and 3, respectively, were done when disease ratings were 1-2 (see Plant Pathology Fact Sheet 20) on 10-20 percent of the leaves. These data show that even with early applications of fungicide, substantial losses can occur but do not compare to the potential loss if a spray program is not initiated. These data also show that early applications are more effective than applications made later in the season, (at middle to last stages of the disease development). This is because much of the leaf area has already been destroyed. More investigations are needed to show the relative effectiveness of sprays with rust inoculations at different stages of the plant growth. Inoculations in this trial were done at very early bloom.

These data have the potential of being used in a computerized program to indicate potential yield losses (due to disease) and relative benefits of spray programs. Staff in the Department of Plant Pathology, University of Minnesota are working on developing such a prediction scheme using data collected in trials such as those integrating disease severity, stage of growth, weather, potential yield loss, and percent of yield increase due to spray programs. Reports of the progress on this work will be recorded later.

Table 1.

## EFFECTS OF VARIOUS FUNGICIDES ON DISEASE RATINGS, YIELD AND NET

## RETURN OF PINTO BEANS, 1980

Good Control		Reading Index		Final Yield	Chemical	Net Return
		7/31	8/13	(lbs./acre)	Cost/Acre	acre
°Bravo	4 pt	2.92	7.00	2882	\$72	\$382
*Diathane M-22	2 lb	7.00	13.58	2672	\$30	\$370
Bravo	2 pt	10.91	20.73	2765	\$44	\$382
Bravo	3 pt	10.33	31.83	2540	\$58	\$304
Average Control						
√Kocide 101	1 lb	25.00	49.42	2097	\$23	\$215
*TOP COP	2 qt	33.33	56.25	2203	\$31	\$237
√CITCOP 4E	1.2 qt	25.00	59.25	1883	\$24	\$155
√KOCIDE 404S	1 qt	34.50	59.83	1929	\$25	\$166
√CITCOP 4E	2 qt	35.42	60.75	1939	\$29	\$165
Poor Control						
Check	0	62.50	98.25	1246	0	----

° not yet cleared for control in dry edible beans

\* cleared for use in rust control in dry edible beans

√ cleared for use in bacterial blight control in dry edible beans

Table II.

Pinto Time/Rate Spray - 1981  
Bravo 500

Placement	Trt	June 4	July 10(57)	July 15	July 27(39)	Aug 3(32)	Aug10(25)	Aug 17(18)	H Sept. 9-12 (98-109)			cost/A	Return/A @ .27
									Yield	% Loss	% Gain		
1	8	P 4	I 4	4 4	4 4				2,499.0	---	302.1	70.00	436.92
2	2	P 2	I 2	2 2	2 2				2,159.0	13.6	247.4	42.00	373.12
3	9	P -	I 4	4 4	4 4				1,638.0	34.5	170.3	52.50	221.95
4	3	P -	I 2	2 2	2 2				1,558.0	37.7	150.7	31.50	221.35
5	12	P -	I 4	4 4	-				1,347.0	46.1	116.7	35.00	160.88
6	6	P -	I 2	2 2	-				1,222.0	51.1	96.6	21.00	141.13
7	7	P -	I 2	-	-				1,051.0	57.9	69.1	10.50	105.46
8	13	P -	I 4	-	-				1,047.0	58.1	68.5	17.50	97.38
9	4	P -	I -	2 2					1,024.0	59.0	64.8	21.00	87.67
10	10	P -	I -	4 4					952.5	61.9	53.3	35.00	54.37
11	11	P -	I -	-	4				817.0	67.3	31.5	17.50	35.28
12	14	P -	I -	-	-	4			685.3	72.6	10.3	17.50	- .28
13	5	P -	I -	-	2				671.8	73.1	8.0	10.50	3.08
14	1	P -	I -	-	-	-			621.5	75.1	--	-0-	----

P = Planted

I = Inoculated with rust fungus.

2, 4 = 2 PT/A application on date indicated respectively.

## White mold, a persistent problem in dry bean production

White mold, (caused by Sclerotinia sclerotiorum) is a persistent problem in dry bean production, especially with the increased number of dry bean acreages and the tendency to shorten rotation periods. The last two years white mold has caused substantial losses within the dry bean area.

White mold is a fungus disease which is most serious during wet weather. The wind blown fungus spores colonize dead bean tissue (dried blossoms, leaves), then proceed into living tissue causing a watery soft rot. The characteristic symptoms of white mold are a white cottony growth on the surface of decaying tissue. Some of the fungus growth will develop into dark hard bodies called sclerotia. Sclerotia survived adverse (winter) conditions in the field. The disease probably will be noticed when the plant growth covers the space between the rows and when the soil surface is cool and moist enough for sclerotia to germinate. Infected plants will often wilt rapidly and appear bleached. Affected seed is discolored (often orange and chalky) and is lightweight.

Crop rotation helps prevent the build-up of enough inoculum to cause white mold in edible beans. A rotation of 3-4 years between beans and other susceptible crops is recommended. Sunflowers, potatoes, sugarbeets, and soybeans should not be grown in close rotation with edible beans since they are susceptible to white mold. Small grains, corn, or forages are recommended in a rotation with edible beans to prevent increase of white mold inoculum.

One or two applications of the fungicides Benlate or Topsin - M have provided good control of white mold. When applying this fungicide, it is important that the first application be made when the field is in 10-25 percent bloom, and the second application should be made after the full bloom stage or during late bloom. Fungicide applications should be considered if white mold has been a problem on the field in previous years, or when cool conditions are forecast for the last month of the growing season.

For most effective results, fungicide applications for control of this disease must be made before the disease is obvious. Management decisions concerning applications at this early stage of growth are sometimes difficult to make, therefore it is important to use the guidelines previously mentioned. These fungicides are systemic, are absorbed in the plant, and migrate from the bottom of the plant to the top. Complete coverage of plants with these fungicides is necessary for best effect.

## Alfalfa

Verticillium wilt of alfalfa is a serious disease in Northern Europe. Although present since 1918, serious losses occurred only from the early 1950s. Verticillium wilt was discovered in Canada in 1912 and in the United States (Washington, Oregon, Idaho) in 1976 and Wisconsin in 1980. It is believed to have been present in Wisconsin for some time and was also reported in Minnesota in 1981. Currently more work (survey and testing) must be done in Minnesota to find the extent and seriousness of this disease in Minnesota's alfalfa production.

## Cause

Verticillium wilt is caused by a fungus called Verticillium albo-atrum. The fungus invades the vascular system of the alfalfa plants and reduces the flow of water and nutrients to the stems and leaves. That results in reduced top growth, wilt, and death of foliage. Yield and quality are reduced, but also diseased plants may be more susceptible to winter kill or may even be killed during the growing season. The fungus survives as dark mycelial strands in infested plant debris, infected alfalfa plants, alfalfa seed, susceptible weed species, and other susceptible crops.

## Symptoms

Early symptoms of Verticillium are temporary flagging (wilting) of the upper leaves on warm days, and a yellow or pinkish-orange discoloration on some leaflets. Chlorotic, V-shaped lesions at the leaf tip and following the leaf midrib are common. As the disease progresses, entire leaflets become yellow, then bleached, dessicated and twisted, and are easily detached leading to defoliation. Frequently the stem will remain green and erect long after all its leaflets have become bleached and dessicated. Unilateral symptom development, that is, the development of symptoms on some shoots from a crown but not on others from that same crown, is also a reliable symptom to use in diagnosing Verticillium wilt. At early disease stages, only one or a few shoots of infected plants will show symptoms. Later, the more seriously affected plants will be stunted with most of their shoots showing severe symptoms.

The disease also is characterized by individual, seriously affected plants standing among apparently healthy plants. As the epiphytotic becomes more acute, diseased plants become more prevalent. Symptoms are most intense, hence, best observed, just before first harvest in the spring. There are usually no external symptoms of the disease on the roots. Internally, the taproot may show yellow to brown vascular discoloration and infected roots remain firm.

## Disease Cycle

Verticillium albo-atrum does not survive in the soil, but is introduced into alfalfa fields by one of the following means: 1) seed may be infected or infested plant debris (pods, stems, leaves, etc.) may be carried with the seed; 2) harvest equipment used in infested fields may carry infested

debris or spores may be carried on the cutter bar and other machinery parts; 3) wind-borne spores may be carried through the atmosphere from adjacent, infested fields, diseases volunteer alfalfa plants or other hosts (weeds) growing in headlands, water ways and road-side ditches; 4) infested hay that is fed to livestock in production fields or infested hay associated with manure.

Once V. albo-atrum is introduced into a field, it is subsequently spread during the growing season by harvest activities and wind-borne spores. Diseased plant tissue, when associated with cool, moist conditions, will become covered with spores of V. albo-atrum which may be disseminated to freshly cut stems or crowns damaged by harvest activities. It also is possible that root contact between healthy and diseased plants may be another means of plant-to-plant spread within an infested field.

The appearance and severity of Verticillium wilt is associated with age of stand, number of harvests per year, weather conditions during the growing season, stage of crop development, vigor of plant growth and alfalfa variety. Verticillium wilt is rarely observed in the seeding year. A trace of infection may be observed the first two harvest years, but disease prevalence and severity generally increase in the third harvest year. It is very difficult to predict how rapid the disease will develop. Verticillium wilt is favored by cooler temperatures and moist conditions. Onset of disease development is more rapid in vigorously growing plants and symptoms are strongly expressed during the floral bud stage. The more rapid the onset of disease, the sooner spores are produced on infected tissues, resulting in more inoculum for spread of the pathogen throughout the field. Symptoms are expressed more in the spring and fall, but are greatly reduced in mid-summer during the normally warmer and drier weather unless cool, moist weather prevails.

Verticillium wilt does not appear to be greatly favored by topography or soil conditions in a field such as pH. Some evidence indicates that Verticillium wilt is less severe in heavy soils compared to lighter textured soils. However, we have not detected Verticillium wilt in alfalfa grown in sandy soils in Wisconsin.

At this time the importance of Verticillium wilt in Minnesota alfalfa production is unknown. Variety testing and control measures need to be evaluated and developed. A first need is to define the extent of the disease in Minnesota. Although plant symptoms are very useful for diagnosis of Verticillium wilt, plant specimen must be microscopically examined for presence of Verticillium albo-atrum for a positive diagnosis. Submit the entire plants for diagnosis. Place root in plastic bags. Send sample to Plant Disease Clinic, Department of Plant Pathology, 1519 Gortner Avenue, University of Minnesota, St. Paul, Minnesota 55108. Be sure to indicate clearly the location of the field where the sample was taken.



FUNGICIDES FOR USE ON FIELD CROPSCEREALSSEED TREATMENT - WHEAT, BARLEY, AND OATS

<u>Common Name</u>	<u>Trade Names</u>	<u>Bunt Control</u>	<u>Seedling Blight Control</u>	<u>Remarks</u>
Captan	Captan Orthocide Evershield (Several other names)		G**	Combination with maneb or zineb for bunt
Captan-HCB	Ortho seed protectant	G	G	
Carboxin	Vitavax			For control of loose smut
Carboxin & Thiram	Vitavax 200 Evershield	F	F	For bunt, seedling blight and loose smut control
Maneb	ABSCO DB Green ABSCO DB Yellow cover-up Granol NM	F	G	DB Green & Granol NM are combined with Lindane
Maneb	Granox NM	G	G	
PCNB	Terra-coat Terra-coat	G G	F F	Combined with Terroazole Combined with Terroazole
Polyram		F	G	
TCMTB	Busan (Cover-up L)	G	F	
Thiram	Arasan-75 Evershield Thiram	F F	G G	

\* Seed injury may occur if high moisture seed is treated and stored.

\*\* F = Control Fair  
G = Control Good

Sugar BeetsSeed Treatment

See Label for Rates & Precautionary Instructions		For Control of Damping-Off				Remarks
		Aphanomyces	Pythium	Phoma	Rhizoctonia	
Captan 35.2%	Slurry	-	-	-	-	General Seed Treatment
Demosan 65W	Slurry	-	G	-	G	May be used as a supplemental treatment
Lesan	Slurry	E	E	P	P	May need 6 oz. on high clay soils, do not exceed 4 oz on light soil.

NOTE: For maximum protection use with a fungicide that controls Rhizoctonia & Phoma. CAUTION: See label for care in handling.

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Maneb 80%						
Dithane	drillbox	-	G	-	G	
Maneb + Zinc 80%						
Dithane M-22 Special	drillbox	-	G	-	G	
PCNB + Etirdiazole	liquid					
Terra-coat 1-205	or slurry	G	G	F	E	
Terra-coat SD-205	slurry	G	G	F	E	
Thiram	drillbox					
Arasan 50 Red	or Dust	-	-	G	G	
Arasan 50 Red ND	Dust	-	-	G	G	

P = Poor, F = Fair, G = Good, E = Excellent, - = No data

Cercospora Leaf Spot

Control requires - early irregular applications, at recommended rates.

Copper

CITCOP 4E  
 CITCOP 6E  
 Copper County - N  
 Kocide 101  
 Kocide 404  
 Oxy-Cop 8L  
 Tribasic Copper  
 Sulfate

## Mancozeb

Dithane M-45  
 Dithane M-45  
 Flowable  
 Manzate-200

## Maneb

Dithane M-22  
 Manex

## Metiram

Polyram

## Metiram + Maneb

Blite-Out

Triphenyl Tin  
Hydroxide

Duter

MBC

Benomyl 50%  
 Benlate

Thiabendazole 42%  
 Mertect 3407

Thiophanate-methyl 70%  
 TOPSIN-M

Remarks

For all fungicide use see label for rate and limitations. Do not use less than minimum rate, during favorable conditions of infection the spray schedule may be closed-up. When leaves are wet for 8½ continuous hours, temperature above 62° (optimum 75°) conditions are favorable for infection.

NOTE: Strains of the Cercospora fungus Resistant to these fungicides have been identified. These fungicides are not recommended for use in the southern beet area. They may still be effective in areas where the new strain of Cercospora are not present.

The fungicides in the MBC group are systemic in that the chemical enter into the plant. However, this chemical does not move from old leaves to the new leaves.

Powdery MildewFungicides for Powdery Mildew ControlRemarks

## Benomyl

Benlate

## Sulfur

\*BIG 8 that is  
flowable 64%Magnetic 6  
flowable 51%

That flowable 52%

TOP-COP + Sulfur

Apply sulfur if mildew appears by mid-August. One application usually gives adequate protection for 4 weeks.

CopperSee listing under  
cercospora leaf spot

See label for rate and limitations.

\*Can be used in irrigation systems.

Rhizoctonia and Scab

PCNB - Terraclor emulsifiable concentrate  
(Broadcast or in-furrow application)  
See label for rates and limitations

CornSeed Treatment

Most seed corn is treated prior to delivery. Over treatment with Vitavax 34 is recommended to prevent the introduction of corn Head Smut, by spores on the seed. Treat just shortly before planting.

Eyespot - RustManeb Fungicides

Check label for limitations on use of sweet corn silage. Late planted sweet corn is subject to crop loss by rust.

PotatoesSeed Piece Treatment

Captan  
Orthocide Plus  
(Captan + Mertect)

Maneb  
Polyram  
Zineb  
Dust Treat  
(Zineb + Streptomycin)

Late Blight and Early Blight

Bravo  
Copper

Kocide 101

Difolatan  
Duter (no spreader sticker)  
Mancozeb

Dithane M-45  
Manzate 200

Maneb

Dithane M-22  
Manzate

Zineb  
Polyram  
Blight Out  
(Polyram + Maneb)

Cereal Leaf Diseases

Dithane M-45  
Manzate 200  
Maneb  
Zineb  
Kocide 101

Remarks

See label for Rates  
and Limitations

Apply by air, using minimum of 5 gallons  
of water per acre, and spread-sticker  
per label. See label for rate and  
limitations.

## HEAD SMUT OF CORN, HYBRID RANK

<u>Resistant</u>	<u>Moderately Resistant</u>	<u>Moderately Susceptible</u>	<u>Susceptible</u>
Cenex 2203	Pfizer T-950	Cenex 3138	Holden's CB 59G
Cenex 3015	Dekalb EX1212	Midland M-2087	A 671
Cenex 3139	NK X6668	Dekalb XL-11	MN4201
Dekalb XL-14AA	MN8301	Blaney B607	Cenex 2155
Funk's G-4256	Holden's L632	Dekalb EX1112	NK PX24
Lester Pfister 1430	Dekalb EX3333	Pfizer T-930	Code 47
McCurdy M-X956	Blaney S6389	NK PX11	Funk's G-5048
NK PX37	Payco SX-442-N	Kaltenberg KX58	Dekalb XL-12
	Midland M-1085A	RBA Super 4+	Blaney S4800
	Funk's G-4435	A654	NK PX7
	Payco SX-431-N	Kaltenberg KX31	NK PX449
	Ramy X-13	MN7301	Ramy EX14739
	NK PX419	Payco SX-411-N	NK PX485
	Kaltenberg KX59	Kaltenberg KX390	MN5301
	X117	Lester Pfister 1428	Kaltenberg KX362
	Cenex 2110	Wilson 1300	Payco 3X-155-N
	McCurdy M-4855	Blaney S3242	Ramy X-135
	Funk's G-4180	W153R	Code 7
	Dekalb XL-23	Dekalb XL-314	C0109
	Blaney S4402	Lester Pfister 1222	Payco SX-599-N
	Funk's G-4085	Ramy X-150	Payco 3X-227-N
	Cenex 3018	A554	Holden's LH39
	Dekalb XL-36	Pfizer T-X90	
	Blaney B101	MN6305	
	Cenex 3011	RBA Super 80	
	Cenex 2108	Ramy X-200	
	A661	Wilson 1100B	
	NK PX 443	Midland M-1051TY	
	Blaney S2184	Payco SX-637-N	
	Ramy X-22	Ramy X-16	
	McCurdy M-5596	Payco SX-555-N	
	Blaney S2202	Payco SX-711-N	
	Midland M-1088	Midland M-3080	
	CM105	Kaltenberg KX53	
	Cenex 2004		

continued on this page (all four columns Moderately Resistant)

<u>Moderately Resistant</u>	<u>Moderately Resistant</u>	<u>Moderately Resistant</u>	<u>Moderately Resistant</u>
Funk's G-4315	Sokota MS27	Midland M-3093	Code 48
A661 X A665	Dekalb XL-13	Midland M-3090B	Kaltenberg KX44
Midland M-3095A	Midland M-1090B	Holden's LH38	Cenex 3121
Ramy X-14	Cenex 2111	Payco SX-680-N	NK X6392
Cenex 2106	Cenex 2119	Pfizer T-1000	McCurdy M-3410
Blaney S5602	Funk's G-4224	Code 97	Cenex 3123
RBA Super 4	Sokota 78-A	Ramy X-20	Blaney S2101WX
McCurdy M-4436	Cenex 2093	Ramy X-33	LP 7801
Dekalb XL-32A	Midland M-1051DR	Funk's G-4426	Cenex 3094
A634	Payco SX-620-N	Blaney S4406WX	Funk's G-4323
Dekalb XL-15	C0109 X CM105	RBA 3040	Payco SX-386-N
Holden's LH74	McCurdy M-46	RBA 94	Blaney S2322
RBA 94+	Midland M-1080	Pfizer T-1069	Blaney B606
RBA S3060	Dekalb XL-6	Midland M-1001B	RBA 104+
Blaney S6595A	Funk's G-4143	Dekalb XL-18	Cenex 2091
Code 8	Sokota TS20	Kaltenberg KX33	Funk's G-4141A
Pfizer T-1058	Dekalb XL-25A	Kaltenberg KX54A	Blaney S3306
Kaltenberg KX47	McCurdy M-4664	MN 5202	RBA 105+
A632	Cenex 2134	Cenex 3103	MN4202

CHEMICALS FOR DISEASE CONTROL IN DRY BEANS

<u>CHEMICAL</u>	<u>LABELED USE*</u>	<u>RATE</u>	<u>COMPANY</u>
<u>Seed Treatment</u>			
Lesan	seed rot, damping off	1 gal/100 lbs. seed	Mobay
Captan	seed treatment, damping off, soil treatment	see Label	Chevron Stauffer; Hopkins Guftufson Inc.
Hopkins bean seed protectant	seed treatment - labeled in Michigan, Nebraska, New York, North Dakota, & Wisconsin only.	3 oz/bu	Hopkins Chemical Co.
Diazinon - Captan seed protectant	seed treatment, damping off and seedling blight	3 oz/bu	Hopkins Chemical Co.
Agrox - 3-way	damping off, seed decay, seed corn maggot and wireworm	3 oz/bu planter box	ICI, U.S. Inc.
Arasan 50-Red	seed treatment, seed decay, damping off, seedling blights	1/3 tsp/lb seed	Dupont
Arasan 50-Red ND	seed treatment, seed decay, damping off, seedling blights	1/3 tsp/lb seed	Dupont
Arasan 70-S	seed treatment, seed decay, damping off, seedling blights	230 cc/cwt seed	Dupont
Demasan 65W	seed treatment, seed decay, damping off, seedling blights	6 oz/100 lbs seed	Dupont
Agrox 2-way	damping off, seed decay	3-1/3 oz/cwt	ICI, Chipman Chemical
Agri-Strep 500 62.6%	seed rot, halo blight	8 oz/100 lb seed	Merck & Co.

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\* Check label for special restrictions as to use and time before harvest



CHEMICALS FOR DISEASE CONTROL IN DRY BEANS

<u>CHEMICAL</u>	<u>LABELED USE*</u>	<u>RATE</u>	<u>COMPANY</u>
<u>Foliar Sprays</u>			
Fungus Diseases			
Bravo 500	rust on <u>Snap Beans Only</u>	4½ pts/acre	Diamond Shamrock
Dithane M-22	rust, downy mildew	1-3 lbs/acre	Rohm & Haas
Dithane M-22 Special	rust, downy mildew	1-3 lbs/acre	Rohm & Haas
Dithane Z-78	rust, Anthracnose	3-4 lbs/acre	Rohm & Haas
Kocide 404S	bacterial blight, halo & common rust	1-3 qts/acre	Kocide Chemical Corp.
Benlate	white mold grey mold	1½-2 lbs/acre 1-2 applications	Dupont
Maneb 80	Anthracnose & downy mildew	1.9 lbs/acre	Pennwalt
Topsin-M	white mold grey mold	1.5-2 lbs/acre once or twice	Pennwalt
Dichlone 50WP	Anthracnose	1-½ lbs/acre	FMC
Kalospray	powdery mildew, leaf spot rust	4-7 lbs	FMC
Zineb 75 wetttable power	rust, Anthracnose	1½-2 lbs	FMC
Manex	Anthracnose, downy mildew, rust	1.2-1.6 qts/acre	Griffin Corp.
Citco	angular leaf spot	2-4 lbs/acre	City Service Co.
Tri-Basic	Anthracnose		
Copper	bacterial blight		
Sulfate	downy mildew		

\*Check label for special restrictions as to use and time before harvest.

CHEMICALS FOR DISEASE CONTROL IN DRY BEANS

<u>CHEMICAL</u>	<u>LABELED USE*</u>	<u>RATE</u>	<u>COMPANY</u>
Manzate	lima beans, downy mildew & Anthracnose	1½-3 lbs/acre	Dupont
Manzate D	lima beans downy mildew dry beans, rust North Dakota Only	1½-3 lbs/acre	Dupont
Top cop with sulfur	rust, halo blight on dry beans MN.24-C SLN# MN80-0013	see label	Stoller Chemical Co.
<u>Bacterial Diseases</u>			
Kocide 101	bacterial blight, halo & common rust	1-3 lbs/acre	Kocide Chemical Corp.
Kocide 606	bacterial blight, halo & common rust	1-1/3 to 4 pts/acre	Kocide Chemical Corp.
Kocide 404S	bacterial blight, halo & common rust	1-3 qts/acre	Kocide Chemical Corp.
Citco Tri-Basic Copper Sulfate	angular leaf spot Anthracnose bacterial blight downy mildew	2-4 lbs/acre	City Service Co.
Flowable Tri-Basic Copper	bacterial blights	1-2 qts/acre	City Service Co.
Citcop 6E	bacterial blights	1/3 gal/acre	City Service Co.
Citcop 4E	bacterial blights	2 qts/acre	City Service Co.

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\*Check label for special restrictions as to use and time before harvest.

## HERBICIDES

This is a listing of some herbicides now sold for major crop use in Minnesota. The application rate refers to pounds of active ingredients or acid equivalent per acre on a broadcast basis. The information given is not intended to replace label instructions; follow label instructions closely. Refer to Agricultural Extension Service, University of Minnesota, fact sheets and folders on weed control by crop and to product labels for additional information.

Acifluorfen (Blazer) - Rohm and Haas

Use--Control of many annual broadleaf weeds in soybeans, including eastern black nightshade.

Rate of application--3/8 to 1/2 pound per acre.

Time of application--Postemergence; acifluorfen effectively controls broadleaf weeds in soybeans when applied before the weeds exceed the four (4) true-leaf stage. Weeds treated after they exceed the maximum size listed on the herbicide label will not be adequately controlled. Top growth will die, but in most cases regrowth will occur from the roots or lower stems of larger established broadleaf weeds.

Remarks--Rain or irrigation within six (6) hours of application may reduce the effectiveness of acifluorfen. Hot and humid weather increases the effectiveness of acifluorfen. The herbicide should not be applied when recent daytime temperatures are below 70° F.

Acifluorfen may cause minor temporary injury to treated soybean leaves. The injury will appear as a speckled yellowing, and/or a crinkling of the treated leaves. The herbicide does not affect new growth. Actively growing soybeans usually recover quickly.

Formulation--2 pounds per gallon liquid.

Alachlor (Lasso, Lasso II) - Monsanto

Use--Annual grass control in corn, dry beans and soybeans, some broadleaf control. Use in preemergence mixtures with atrazine, cyanazine, dicamba, or linuron on corn; with linuron, chlorpropham, bifenox, dinoseb, dinoseb + naptalam, chloramben or metribuzin on soybeans; and preplanting with trifluralin on dry beans. Used in minimum tillage corn with paraquat or glyphosate and atrazine, cyanazine, or simazine. In minimum tillage soybeans with glyphosate or paraquat and metribuzin or linuron.

Rate of application--2 to 4 pounds per acre on corn and soybeans and 2 to 3 pounds per acre on dry beans in the liquid formulation.  
--2.4 to 3.9 pounds per acre in the granular formulation on corn or soybeans.

Alachlor (Lasso, Lasso II) (continued)

Time of application--preplanting or preemergence; preplanting preferred for nutsedge control. Can be used with atrazine on corn up to the time corn is 5 inches tall or with dicamba until corn is 3 inches tall and weeds reach the 2-leaf stage. Postemergence treatments should not be applied with fluid fertilizer.

Remarks--Research results show good control of annual grasses and pigweed and fair lambsquarters control. Control of other broadleaves was not consistent. Alachlor alone or with atrazine can be applied with center pivot irrigation for corn. Adzuki beans are very susceptible to injury from alachlor.

Formulation--Lasso--4 pounds per gallon liquid.  
Lasso II--15 percent granules.  
Lasso + atrazine--9 + 6 percent granules.

Ametryne (Evik) - Ciba-Geigy

Use--Annual weed control in corn.

Rate of application--1 1/2 to 2 pounds per acre.

Time of application--Postemergence directed after corn is at least 12 inches tall. Do not apply later than 3 weeks before tasseling.

Remarks--Care must be taken to avoid contact with corn leaves. A surfactant should be added. This is usually considered an emergency treatment. May be used for wild proso millet control when corn is more than 12 inches tall and millet is less than 4 inches tall.

Formulation--80 percent wettable powder.

Asulam (Asulox) - Rhone-Poulenc

Emergency use--Asulam was granted an emergency label in 5 Northwest Minnesota counties in 1981 to control wild oat and to suppress foxtail and wild buckwheat in flax. CAUTION: As of November 1, 1981, asulam is not cleared for use on flax but an emergency (Section 18) label is expected for 1982.

Rate of application--1 1/4 pounds per acre.

Time of application--Postemergence when the majority of wild oat are in the 3-4 leaf stage.

Remarks--Flax injury may occur if asulam is applied under stress conditions or at other growth stages.

Formulation--3.34 pounds per gallon liquid.

Atrazine (AAtrex and several other trade names) - Ciba-Geigy, Shell and others

Use--Weed control in corn and sorghum and quackgrass control. Effective in controlling quackgrass with a fall and/or early spring application followed

by plowing. Only corn can be planted following treatment. Used in mixtures with alachlor, linuron, metolachlor, paraquat, simazine or propachlor and with butylate or EPTC plus crop protectant on corn.

Rate of application--(1) Weed control in corn: 1.2 to 3 pounds per acre. Use higher rate on fine-textured soils or soils with high organic matter. (2) Weed control in sorghum: 2 to 3 pounds per acre. (3) Quackgrass control: 3 to 4 pounds per acre; a split application of 2 pounds per acre in the fall before plowing and 2 pounds per acre in the spring works best on quackgrass.

Time of application for weed control in corn and sorghum--Preemergence or pre-plant in corn and postemergence in corn and sorghum. If applied postemergence, applications before weeds are 1 1/2 inches tall are more effective than later applications. Atrazine is cleared for use on corn up to layby-stage (about 30 inches tall) of the corn, but weed control is usually not as good on larger weeds. Addition of emulsifiable petroleum or vegetable oils has improved performance of postemergence atrazine sprays on corn. Various formulations of surfactants and detergents used with atrazine have not improved weed control as much as the use of oils.

Remarks--Susceptible crops have been injured in rotation following treated crop. To minimize injury to susceptible crops following corn, use the lowest rate consistent with good weed control; use band applications rather than broadcast applications and thoroughly till soil before planting susceptible crops. Cool temperatures can increase the possibility of corn injury. Do not graze or feed treated corn or sorghum for 21 days after postemergence application.

Formulation--80 percent wettable powder, 4 pounds per gallon dispersible liquid, 90 percent water dispersible granule.

### Barban (Carbyne) - Velsical

Use--Control of wild oat in wheat, barley, flax, soybeans, sugarbeets, sunflowers and peas.

Rate of application--1/4 to 3/8 pound per acre on wheat, barley, and flax; 3/4 to 1 pound per acre on sugarbeets; 3/8 pound per acre on sunflowers and soybeans.

Time of application--Postemergence, when most wild oat are in 2-leaf stage (from the time the second leaf first appears until the third leaf first appears). Time of application is critical. Spray peas before the 6-leaf stage, flax before the 12-leaf stage, and within 30 days of emergence of sugarbeets, sunflower, mustard, and soybeans. Sequential applications (2 sprays of barban) each at 1/4 pound per acre may be made to barley and wheat. Make the first application when the majority of the wild oat are in the 2-leaf stage. The second application (if needed) may be made when the second flush of wild oat are in the 2-leaf stage. If the first application is missed, a single application of 1/2 pound per acre may be made in the 2 1/2 to 3 1/2-leaf stage.

Remarks--Flax and small grain injury sometimes occurs; injury on flax has been more severe. Observe feeding restrictions on label.

Formulation--1 pound per gallon liquid.

Benefin (Balan) - Elanco

Use--Annual grass control in seedling legumes.

Rate of application--1 1/8 to 1 1/2 pounds per acre.

Time of application--Preplanting. (Do not apply after seeding)

Remarks--Must be incorporated into the soil by disking in two different directions before planting.

Formulation--1 1/2 pounds per gallon liquid.

Bentazon (Basagran) - BASF

Use--Control of most annual broadleaf weeds, including hairy nightshade, Canada thistle, and nutsedge in soybeans, corn, dry or succulent edible beans and peas; in a mixture with atrazine for postemergence use in corn.

Rate of application--3/4 to 1/2 pounds per acre in soybeans and corn; 3/4 to 1 pound per acre in dry and succulent edible beans and peas. Lower rates are for small, susceptible weeds; higher rates are for larger or more tolerant weeds. Oil concentrate at 1 quart/A can be used in all labeled crops except peas when ground application equipment is used.

Time of application--Postemergence--Bentazon is most effective when the weeds are in the 2 to 4 leaf stage. Soybeans, dry beans, snap and green beans usually have the first to second trifoliolate leaf when the weeds are at the correct size for treatment. Corn is tolerant at all stages, but is usually sprayed when corn has 1 to 5 leaves. To improve control of lambsquarters and pigweed in corn a postemergence mixture of bentazon, atrazine and oil concentrate can be used. Peas may be treated after 3 pairs of leaves (4 nodes) are present. Do not apply to crops growing under stress such as drought, cold weather, or previous herbicide injury. On thistle and nutsedge, treat when the weeds are 8 to 12 inches and apply a second application 10 days after the first. Do not apply more than a total of 2 pounds of bentazon per acre in one crop year.

Remarks--Rain or irrigation within 24 hours after application may reduce the effectiveness of bentazon. Weed control has been more consistent from applications made during the day than from early morning, late evening, or night applications. Applications made when plants are dry are more effective.

Formulation--4 pounds per gallon liquid--1.66 pounds per gallon bentazon + 1.66 pounds per gallon atrazine (Laddock).

Bifenox (Modown) - Rhone-Poulenc

Use--Control of some annual broad-leaved weeds in soybeans. May be used alone or as a preemergence application after trifluralin, or in a preemergence mixture with alachlor.

Rate of application--1.6 to 2 pounds per acre.

Time of application--Preemergence.

Remarks--Soybean tolerance is limited and malformation and stunting of young soybeans often occur. Grass control has been inconsistent. Do not apply

after soybeans start emerging.

Formulation--80 percent wettable powder, 4 pounds per gallon liquid.

Bromoxynil (Brominal, Buctril) - Union Carbide, Rhone-Poulenc

Use--Annual broadleaf control in wheat, barley, oats, and flax. Used in mixture with MCPA ester in wheat, barley, and oats. This mixture may be tank-mixed with diclofop (Hoelon) to control annual grasses and broadleaves in wheat and barley.

Rate of application--1/4 to 1/2 pound per acre; 1/4 pound per acre in mixture with MCPA at 1/4 pound per acre.

Time of application--From 2-leaf to early boot stage of wheat, oats, or barley. When flax is 2 to 8 inches tall. Early applications more effective on weeds.

Remarks--Controls wild buckwheat and smartweed better than MCPA. Does not control perennials. Injures legumes. Some small grain injury has occurred at higher rates.

Formulation--2 pounds per gallon liquid. Formulations of 2 pounds per gallon of bromoxymil + 2 pounds per gallon of MCPA ester are available (Brominal Plus, Bronate).

Butylate (Sutan +) - Stauffer

Use--Control of annual grasses in corn. Used in mixtures with atrazine or cyanazine for annual grass and broadleaf control. A three-way mixture with atrazine and cyanazine is labeled.

Rate of application--3 to 6 pounds per acre.

Time of application--Preplanting, fall preplanting between October 1 and November 15.

Remarks--Must be incorporated into the soil. Proper incorporation can be accomplished by disking field twice, once in each direction, immediately after applying chemical. Sutan + contains a chemical additive to prevent corn injury. Can be applied alone or with atrazine or cyanazine with dry bulk or fluid fertilizer. Sutan + is labeled for use in center pivot irrigation systems.

Formulation--6.7 pounds per gallon liquid, 10 percent granular.

Chloramben (Amiben) - Union Carbide

Use--Control of annual broadleaf weeds and annual grasses in soybeans, sunflowers, and dry edible beans, including adzuki beans. Postemergence applications can be made to soybeans up to the second trifoliate leaf stage. Chloramben is labeled for tank mixing with trifluralin, pendimethalin, linuron, alachlor, dinoseb, metribuzin and metolachlor.

Rate of application--2 to 3 pounds per acre.

Time of application--Preemergence, preplant incorporated or on soybeans, up to the second trifoliolate leaf stage of soybeans.

Remarks--Chloramben must be moved into the soil by rainfall or incorporated before weeds sprout to be effective. Incorporated treatments result in improved weed control under dry conditions, however, preemergence applications are more effective when rainfall occurs soon after application. Excessive moisture may leach chloramben below the zone of weed seed germination. This is particularly true in coarse textured (sandy) soils.

Early stunting of soybeans has been observed under some conditions, but the crop usually outgrows the injury. Chloramben is cleared for use on corn at 1 to 2 pounds per acre, but experiment station tests showed a definite injury potential to corn and erratic weed control at these rates. Severe stunting of corn occurred in some fields following heavy rains.

Formulation--2 pounds per gallon liquid: 10 percent granular.

#### Chlorpropham (Furloe) - PPG

Use--Annual smartweed control in soybeans.

Rate of application--2 to 3 pounds per acre.

Time of application--Preemergence or preplanting.

Remarks--May be used preplanting in mixtures with alachlor, paraquat, profluralin, trifluralin, or vernolate. Does not control weeds other than annual smartweed.

Formulation--4 pounds per gallon liquid.

#### Cyanazine (Bladex) - Shell

Use--Annual grass and broadleaf control in corn. Preemergence with atrazine, paraquat, propachlor (Bexton), metolachlor (Dual), or alachlor (Lasso). Preplanting with alachlor (Lasso), metolachlor (Dual), butylate (Sutan +), or EPTC (Eradicane). Used for minimum tillage corn with paraquat. Used preemergence on grain sorghum in mixtures with propachlor.

Rate of application--2 to 4 pounds per acre depending on soil texture and organic matter, 1 to 2.2 pounds per acre with alachlor, 0.8 to 2 pounds per acre with butylate, 1 1/2 to 2 pounds per acre with EPTC (Eradicane), 0.8 to 2.5 with metolachlor.

Time of application--Preplanting, preemergence, or postemergence on corn through the 4-leaf stage. For postemergence, use only the 80 percent wettable powder, not the 4 pounds per gallon liquid dispersible formulation.

Remarks--Do not add petroleum oils to postemergence applications or severe corn injury may result. When applied postemergence under droughty or arid



conditions, certain surfactants or emulsifiable vegetable oils may be used with the wettable powder formulation, but under moist conditions, these additives may cause severe corn injury. Can be applied preemergence with fluid fertilizer or through center pivot irrigation systems. Cool temperatures, rain, or dew can increase potential for injury.

Formulation--80 percent wettable powder, 4 pounds per gallon dispersible liquid.

Cycloate (Ro-neet) - Stauffer

Use--Annual grass and broadleaf control in sugar beets.

Rate of application--3 to 4 pounds per acre.

Time of application--Preplanting.

Remarks--Must be incorporated immediately and thoroughly, tillage tool should be operated 4 to 6 inches deep.

Formulation--6 pounds per gallon liquid, 10 percent granules.

2,4-D - (Various trade names and manufacturers)

Use--Broadleaved weed control in corn, small grains, and grass pastures.

Rate of application--Corn and small grains: 1/6 to 1 pound per acre depending on formulation used, method of application, the size and kinds of weeds, weather conditions, and stage of crop growth. See label. Grass pastures: 1 to 2 pounds per acre depending on kind of weeds to be controlled.

Time of application--Postemergence. Corn--4 inches to tasseling or after dough stage. Use drop nozzles after corn is 8 inches tall. Wheat and barley--5th leaf to early boot; oats--6th leaf to early boot; pastures--spring or fall when weeds are actively growing.

Remarks--Do not graze dairy cattle for 7 to 14 days after treatment of pastures with 2,4-D (see label).

Formulation--Liquids of various concentrations.

Dalapon (Dowpon M, Dalapon-85) - Dow

Use--Grass control in flax and sugar beets. Quackgrass control in the fall before planting corn, potatoes, dry beans, or sugar beets in the spring.

Rate of application--(1) Flax: 3/4 pound per acre. (2) Sugar beets: 2 to 3 1/2 pounds per acre. (3) 6 to 11 pounds per acre for fall quackgrass control.

Time of application--(1) Flax and sugar beets: when grasses are not more than 2 inches tall. Postemergence until sugar beets reach 6-leaf stage, directed from 7-leaf stage until beets are 14 inches. (2) For quackgrass control, apply

on growing quackgrass; plow 10 days later.

Remarks--Adding a surfactant to the dalapon spray mix improves wetting and improves grass control; crop injury may also be increased.

Formulation--74 percent water soluble powder.

2,4-DB (Butoxone, Butyrac 200) - Rhone-Poulenc, Union Carbide

Use--Broadleaved weed control in seedling stands of alfalfa, birdsfoot trefoil, and clovers and established stands of alfalfa. Cocklebur control in soybeans.

Rate of application--1/2 to 1 1/2 pounds amine and 1/2 to 1 pound ester per acre on forage legumes. 1/5 pound amine per acre on soybeans.

Time of application--Postemergence when seedling legumes have 1 to 4 trifoliate leaves and weeds less than 3 inches tall or on established legumes in the fall when weeds are less than 3 inches tall. For cocklebur control in soybeans, apply as a directed spray when soybeans are 8 to 12 inches high and cocklebur no more than 3 inches tall.

Remarks--Do not spray drought stressed soybeans or soybeans that show symptoms of phytophthora root rot disease. Do not apply when extreme temperatures are expected within 2 to 3 days. Observe feeding and time of harvest precautions on the label.

Formulation--1.75 or 2 pounds per gallon liquid.

Desmedipham (Betanex), Desmedipham + Phenmedipham (Betamix) - Nor-Am

Use--Annual grass and broadleaf control in sugar beets, less effective on grasses. Desmedipham is more effective on redroot pigweed than the mixture of desmedipham + phenmedipham.

Rate of application--1 to 1 1/4 pounds per acre of total active ingredient.

Time of application--Early postemergence after sugar beets have four true leaves. Weeds should not have more than four true leaves for best control.

Remarks--Applications of desmedipham and phenmedipham following preplanting EPTC or preemergence TCA have sometimes resulted in sugar beet injury. To reduce injury do not use more than 1 pound per acre where preplanting or preemergence herbicides have been used and do not apply if highest temperature expected during the day exceeds 85° F. If temperatures are approaching this limit, application in the late afternoon will decrease injury potential. Split applications (use of a half-rate followed in 5 to 7 days by a second half rate) have reduced sugar beet injury and improved weed control compared to a single application at the full rate.

Formulation--1.3 pounds per gallon liquid.

Diallate (Avadex) - Monsanto

Use--Control of wild oat in alfalfa, barley, flax, sugar beets, potatoes, soybeans, forage legumes, corn, lentils, and peas.

Rate of application--1 1/4 pounds per acre on barley; 1 1/2 to 2 pounds per acre on other crops.

Time of application--Preplanting on flax or sugar beets; postseeding (pre-emergence) on barley. Fall application is a possibility before sugar beets. Granules may be used in fall, but are not recommended for spring.

Remarks--Quite volatile and must be incorporated soon after application. Incorporate preplanting applications with disk, cultivator, or harrow to a depth of 2 inches. In postseeding applications, incorporate chemical with two harrowings at right angles. Small grain injury has been observed, particularly with preplanting application. Do not apply to field in ridged condition. This chemical irritates skin and eyes; use caution when handling. Diallate may persist in the soil enough to affect tame oats planted the next year.

Formulation--4 pounds per gallon liquid, 10 percent granules.

Dicamba (Banvel, Banvel II) - Velsicol

Use--Postemergence control of most broadleaved weeds except wild mustard in wheat, oats, corn, and grass pastures. Especially useful for controlling wild buckwheat and smartweed in wheat and oats. Can be used preemergence with alachlor or metolachlor, or as an overlay treatment until corn is 5 inches tall following butylate, EPTC +, alachlor, metolachlor, propachlor, atrazine, cyanazine or pendimethalin. May be applied postemergence on corn with 2,4-D or atrazine. No oil or surfactants should be added to postemergence applications.

Rate of application--1/8 pound per acre with MCPA at 1/4 pound per acre in wheat and oats; 1/8 to 1/4 pound per acre alone or with 2,4-D in corn; 1/4 to 8 pounds per acre in grass pastures; 1/4 to 1/2 pound (1/2 to 1 pint) per acre with alachlor preemergence on corn.

Time of application--From 2- to 5-leaf stage of wheat and oats. Up to time corn is 2 feet tall and not within 15 days of tasseling. Application made too close to tasseling can cause barren ears. When perennial broadleaf weeds are 8 to 12 inches tall and up to bud stage in grass pastures.

Remarks--Can be combined with MCPA in wheat and oats or with 2,4-D in corn for control of mustard and other broad-leaved weeds. If used on pastures, observe grazing restrictions on label. Do not mix additives with dicamba or crop injury may result. Do not apply preemergence on sandy soils or soils with less than 2 percent organic matter. Avoid drift to nearby susceptible broadleaf crops. Considerable drift injury has occurred on soybeans. To prevent drift, follow the application instructions on the label. Apply in 20 gallons or more

water per acre; set pressure at 20 psi or less; do not apply to corn when soybeans in the area are over 10 inches tall; do not use on a day the temperature is expected to be over 85° F.; apply when wind is less than 5 mph; do not apply after corn is 2 feet tall.

Formulation--2 or 4 pounds per gallon liquid; 5 percent granules; commercial combinations with MCPA and 2,4-D are available.

Diclofop (Hoelon) - American Hoechst

Use--Annual grass control in soybeans and small grains, including wild oat and volunteer corn.

Rate--3/4 to 1 1/4 pounds per acre for wheat and soybeans  
--3/4 to 1 pound per acre for barley

Time of application--Diclofop effectively controls many annual grasses including wild oat and volunteer corn in fall and spring seeded wheat, spring seeded barley, and soybeans. Annual grasses including wild oat can be controlled with diclofop up to the 4 leaf stage. Use 1 1/4 pounds of diclofop per acre when the weeds have 3 to 4 leaves, lower rates when the weeds have 3 or fewer leaves. Treat yellow foxtail and crabgrass before they reach the 3 leaf stage. Volunteer corn should be treated after the corn plants have emerged, but before the tallest corn plants exceed 10 inches in height.

The time of diclofop application also depends on the crop. Fall and spring seeded wheat should not be treated after the 4 leaf stage. Spring seeded barley should not be treated after the 3 leaf stage. Injury may result from applications made after the crop exceeds the maximum labeled leaf stage. Soybeans should be treated before the formation of the sixth trifoliolate leaf.

Remarks--Diclofop is most effective when applied to weeds that are growing rapidly. Weed control may be reduced if treatment is made under dry soil conditions, or when weather conditions are otherwise not favorable for rapid growth.

Do NOT tankmix diclofop with any other pesticide (except for the combination bromoxynil + MCPA ester), and do NOT apply diclofop within 7 days of the application of another pesticide. The presence of another pesticide in the tank or on the leaves of treated weeds may reduce the effectiveness of diclofop.

Diclofop is a restricted-use pesticide and can be applied only by a certified applicator. Adhere to ALL label requirements concerning safe handling and use of this herbicide.

Formulation--3 pounds per gallon liquid.

Difenzoquat (Avenge) - American Cyanamid

Use--Controls wild oat in barley, winter wheat, Era, Butte, Kitt, Olaf, spring wheat, and all varieties of durum wheat except Lakota and Wascana.

Rate of application--5/8 to 1 pound per acre depending on density of wild oat population.

Time of application--Postemergence when majority of wild oat plants are in the 3- to 5-leaf stage of growth.

Remarks--Difenzoquat may be tank-mixed with 2,4-D amine, MCPA amine, bromoxynil or a mixture of MCPA and bromoxynil. Apply difenzoquat in 5 to 20 gallons of water per acre by ground equipment or 3 to 10 gallons of water per acre by aircraft, but use a surfactant when applying over 10 gallons of water per acre. Do not apply before a rain or when plants are wet from dew or rain and do not make more than one application per season. Do not graze treated fields or cut treated forage for silage.

Formulation--2 pounds per gallon liquid.

Dinoseb (Premerge and others) - Dow

Use--Control of annual weeds in dry beans, corn, forage legumes, small grains, and soybeans. In preemergence mixture with alachlor (Lasso) on soybeans.

Rate of application--Varies with crop, soil type, and temperature. See label.

Time of application--Preemergence and/or postemergence depending on crop. Follow label instructions closely.

Remarks--Results vary with soil and temperature conditions. Crop injury may occur.

Formulation--Liquids of various concentrations.

Endothal (Endothal, Herbicide 273) - Pennwalt

Use--Control of annual smartweed, wild buckwheat, and marshelder in sugar beets.

Rate of application--3/4 to 1 1/2 pounds per acre.

Time of application--Postemergence when sugar beets have 4 to 6 leaves.

Remarks--Excessive injury, especially to very small sugar beets, may occur if temperatures are above 80° F. Poor weed control may result at temperatures below 60° F.

Formulation--3 pounds per gallon liquid and 5 percent granular.

EPTC (Eptam); EPTC Plus Crop Protectant (Eradicane) - Stauffer

Use--EPTC: Control of annual grasses and some broadleaves in sugar beets, seedling legumes, sunflowers, flax, and dry edible beans except adzuki beans. EPTC can be mixed with trifluralin (Treflan) on dry beans. EPTC plus crop protectant (Eradicane) can be used in corn, especially for nutsedge, wild proso millet; gives some quackgrass control. Eradicane can be used in mixtures or as a three-way combination with atrazine and cyanazine on corn and Eptam may be mixed with trifluralin on dry beans.

Rate of application--EPTC: 2 to 3 pounds per acre on sugar beets spring applications or 4 to 4 1/2 pounds per acre for fall applications; 3 pounds per acre on seedling legumes, sunflowers, flax (fall application only) and dry edible beans; Eradicane: 3 to 6 pounds per acre in corn.

Time of application--Preplanting.

Remarks--Must be incorporated immediately to avoid loss of chemical by volatility. Eradicane and Eptam can be applied with dry bulk and liquid fertilizers or through center pivot irrigation.

Formulation--Eptam: 7 pounds per gallon liquid; 10 percent granular; Eradicane: 6.7 pounds per gallon liquid.

#### Ethofumesate (Nortron) - Fisons

Use--Control of some annual broadleaves and grassy weeds in sugar beets. Use in mixtures with TCA or as a preemergence application following fall application of EPTC.

Rate of application--1.12 to 3.75 pounds per acre.

Time of application--Preplanting, preemergence, or postemergence.

Remarks--Incorporation has improved weed control. Soil residues may affect wheat, barley, and oats the following year. Sugar beet injury may occur, especially on coarse-textured soils if used in combination with cycloate or EPTC, or if used postemergence in combination with desmedipham and phenmedipham.

Formulation--1 1/2 pounds per gallon liquid and 4 pounds per gallon dispersible liquid.

#### Fluchloralin (Basalin) - BASF

Use--Annual grass, pigweed, and common lambsquarters control in soybeans. Labeled for a tank mix with metribuzin.

Rate of application--1/2 to 1 1/2 pounds per acre, depending on soil type.

Time of application--Preplant incorporated.

Remarks--Fluchloralin must be mixed thoroughly with the top 1 to 2 inches of soil for optimum results. This can be effectively accomplished by incorporating the herbicide twice with a disk or similar implement. The second incorporation should be carried out at a right angle (90 degrees) to the direction of the first incorporation for best results. Fluchloralin must be incorporated at least once within 8 hours of application to prevent herbicide loss from the soil surface.

Formulation--4 pounds per gallon liquid.

Glyphosate (Roundup) - Monsanto

Use--Non-selective control of many annual and perennial weeds before planting alfalfa, edible beans, peas, barley, corn, oats, sorghum, soybeans, and wheat. Spot treatment of weeds in these same crops after crop emergence, but crop will be killed or severely injured. May also be used in minimum tillage systems as tank mixtures with alachlor, metolachlor, atrazine, linuron, simazine, metribuzin, and cyanazine.

Rate of application--3/4 pound per acre for annual weeds less than 6 inches tall; 1 1/2 to 3 pounds per acre for perennial weeds.

Time of application--In the fall or spring before crops are planted. See label for proper timing on each weed species. Apply to actively growing foliage.

Quackgrass and wirestem muhly--when grass is at least 8 inches tall (3 or 4 leaf stage) and actively growing.

Canada thistle--bud stage in spring or before frost in fall.

Field bindweed--at or beyond full bloom.

Common milkweed--late bud to flower stage.

Can be applied with recirculating sprayers, roller or rope-wick applicators in soybeans. Volunteer corn control has been acceptable with all of these applicators, but research information is incomplete on control of other species.

Remarks--Take extreme care when using this product to avoid drift since most plants are susceptible to injury.

Formulation--3 pounds acid equivalent per gallon liquid.

Linuron (Lorox) - DuPont

Use--Preemergence weed control in corn and soybeans and directed postemergence in corn. Used in mixtures with atrazine, alachlor, glyphosate, paraquat, or propachlor preemergence on corn and with alachlor, chloramben, metolachlor, glyphosate or paraquat preemergence on soybeans.

Rate of application--(1) Corn: 1/2 to 1 1/2 pounds per acre preemergence in combination with equal rates of atrazine active ingredient or with 3 pounds per acre of propachlor or with 1 1/2 to 3 pounds per acre of alachlor; 1 1/2 pounds per acre with wetting agent in postemergence directed spray applications. (2) Soybeans: 1/2 to 2 1/2 pounds per acre; (rate differs with soil types) or 1/2 to 1 1/2 pounds per acre with 1 1/2 to 3 pounds per acre of alachlor or preemergence over preplanting trifluralin.

Time of application--(1) Corn: preemergence or directed spray postemergence when corn is at least 12-18 inches tall and weeds are 8 inches or less in height. (2) Soybeans: preemergence.

Remarks--Use in postemergence directed spray applications does not eliminate

early season competition between weeds and corn. This early competition can reduce yields. Linuron has caused injury (stand reduction and stunting) to corn and soybeans in some Minnesota trials, particularly on sandy soils. On corn, do not apply linuron within 60 days of harvest.

Formulation--50 percent wettable powder, 4 pounds per gallon dispersible liquid.

#### MCPA (Various trade names and manufacturers)

Use--Broadleaved weed control in small grains, flax, and pastures.

Rate of application--Small grains: 1/6 to 2/3 pounds per acre depending on formulation used, size and kinds of weeds, weather conditions, and stage of crop growth. Flax: 1/4 pound per acre. Grass pastures: 1/2 to 2 pounds per acre depending on weed susceptibility. See label.

Time of application--Postemergence. Small grains--two leaves to early boot; flax--2 to 6 inches. In pastures, when perennial weeds are 6 to 8 inches tall or in the rosette stage and actively growing.

Formulation--Liquids of various concentration.

#### Metolachlor (Dual) - Ciba-Geigy

Use--Control of annual grasses, pigweed, and nutsedge in corn and soybeans. Used in mixtures with atrazine, cyanazine, simazine, or dicamba in corn or with metribuzin, linuron, naptalam + dinoseb, chloramben, and chlorpropham in soybeans. For minimum tillage corn in mixtures with glyphosate, paraquat, atrazine, or simazine and soybeans with linuron, metribuzin, glyphosate or paraquat.

Rate of application--1 1/2 to 3 pounds per acre.

Time of application--Preplanting, incorporated; preemergence; or early post-emergence alone or with atrazine when weeds are in 2-leaf stage and corn is less than 5 inches tall.

Remarks--Metolachlor can be applied with fluid fertilizer or with center pivot irrigation systems. Do not use on popcorn or sweet corn.

Formulation--8 pounds per gallon liquid. Metolachlor plus atrazine (Bicep) 2 1/2 plus 2 pounds per gallon dispersible liquid.

#### Metribuzin (Lexone, Sencor) - DuPont, Mobay

Use--Annual weed control in soybeans. Control of certain annuals, winter annuals, and biennials in established alfalfa or alfalfa-grass mixtures. Better on broadleaves than grasses. Can be used on soybeans in mixtures with alachlor, metolachlor, chloramben, glyphosate, paraquat, trifluralin, profluralin, or pendimethalin.

Rate of application--Soybeans: 3/8 to 7/8 pound per acre depending on soil



texture and organic matter. 1/4 to 3/4 pound per acre with alachlor or over trifluralin. 1/4 to 1/2 pound per acre in mixtures with trifluralin, profluralin, pendimethalin, or chloramben. Alfalfa (established one year or more): 3/8 to 1 pound per acre depending on soil texture and kinds of weeds present.

Time of application--Soybeans: Preplanting or preemergence. Alfalfa: When alfalfa is dormant, spring or fall.

Remarks--Soybeans: Early soybean stunting and necrosis have frequently occurred with this chemical. Consult the label for restrictions for use on various soil types. Soybean injury may occur on coarse-textured soils low in organic matter. Crop injury may occur on calcareous soils or alkaline soils with a pH over 7.5 or in conjunction with soil applied organic phosphate pesticides. Certain soybean varieties, Tracy and Altona, are susceptible to injury. Alfalfa: May be used to control perennial grasses in alfalfa. Lower rates will suppress grasses. Higher rates will severely reduce forage grass stands. Do not graze or harvest alfalfa within 28 days of treatment.

Formulation--50 percent wettable powder, 75 percent "dry flowable granule," 4 pounds per gallon dispersible liquid.

#### Naptalam + dinoseb (Dyanap) - Uniroyal

Use--Preemergence and postemergence control of some annual broadleaves and grasses in soybeans. May be used alone or with alachlor (Lasso) or metolachlor.

Rate of application--Preemergence: 2 to 4 pounds of naptalam plus 1 to 2 pounds of dinoseb per acre alone or with 2 pounds of alachlor. Rates vary with soil type. Postemergence: 1/2 to 1 pound of naptalam plus 1 to 2 pounds of dinoseb per acre.

Time of application--Preemergence up to emergence of soybeans when used alone or preemergence with alachlor. Postemergence after soybeans have the second trifoliolate leaf up to when soybeans are 20 inches tall.

Remarks--Preemergence application may cause crop injury, especially if heavy rains occur or on sandy soils. Postemergence treatment may injure crop when temperatures are high or if improperly applied. Follow application and rate instructions on the labels.

Formulation--2 pounds naptalam and 1 pound dinoseb per gallon liquid.

#### Oxyfluorfen (Goal) - Rohm and Haas

Use--Control of some annual broad-leaved weeds in no-till soybeans only. May be used alone, as a preemergence application after trifluralin or in a pre-emergence mixture with alachlor.

Rate of application--1/4 to 3/8 pounds per acre.

Time of application--Preemergence.

Remarks--Soybean tolerance is limited. Malformation and stunting of young soybeans often occurs, especially under wet, cool conditions. Do not apply after soybeans start emerging. Do not use on muck or peat soils or on conventionally tilled soils.

Formulation--2 pounds per gallon liquid.

### Paraquat - Chevron, ICI

Use--Paraquat is a contact herbicide for killing vegetation before planting or before crops emerge, and as a desiccant for weeds in soybeans and sunflowers (oil seed varieties only). A special local needs registration is also available in Minnesota for postharvest desiccation of Kentucky bluegrass fields to facilitate burning.

Rate of application--1/8 to 1 pound per acre depending on use and crop. Use X-77 spreader with paraquat.

Time of application--Apply paraquat before planting or before the crop emerges for seedling weed control in minimum and no-till cropping situations. As a preharvest desiccant, paraquat is applied after the crop is physiologically mature. In soybeans, application should be made when the beans are fully developed, at least 1/2 of the leaves have dropped, and the leaves left on the plant are turning yellow or when the soybean seeds are at 30 percent moisture or less. In sunflowers, application should be made when the seed is at 35 percent moisture or less. Sunflower head color is no longer considered a good indicator of maturity.

Remarks--Paraquat kills growing annual weed seedlings, but only the top growth of perennials. Paraquat is highly toxic and has a "restricted use" classification (can be applied only by a certified applicator). A small amount could be fatal if swallowed. Avoid contact with the eyes or skin and do not breathe the spray mist. Follow precautions on the label.

Formulation--2 pounds per gallon liquid.

### Pendimethalin (Prowl) - American Cyanamid

Use--Preemergence control of annual grasses and some annual broadleaved weeds in corn. Can use alone or in a mixture with atrazine, cyanazine (Bladex), or dicamba (Banvel) for broader spectrum weed control in corn. Preplanting incorporated or preemergence in soybeans alone or in mixtures with metribuzin, chloramben, and linuron.

Rate of application--1 to 2 pounds per acre on corn; 1/2 to 1 1/2 pounds per acre on soybeans.

Time of application--Preemergence or early postemergence, up to 2-leaf stage of corn and weeds up to 1 inch tall, with atrazine or cyanazine in corn; pre-emergence or preplanting in soybeans.

Remarks--Do not use on soils containing less than 1 1/2 percent organic matter, nor on sands, loamy sands, peat, muck, or clay soils. There is crop injury potential on soils with lower organic matter and sandy soils. Weed control has not been consistent on clay soils, peat and muck. Do not drag corn fields before crop emerges and do not incorporate on corn fields. On soybeans, incorporate 1 to 2 inches deep. Can be used with liquid fertilizer.

Formulation--4 pounds per gallon liquid.

Picloram (Tordon) - Dow

Use--One formulation (Tordon 22K) is cleared for use in a tank-mix combination with 2,4-D amine for control of certain broadleaf weeds in spring and winter wheat and barley. All formulations may be used on non-cropland, except do not use near rivers, lakes or other water supplies.

Rate of application--A tank-mix combination of 1/4 ounce picloram (Tordon 22K) and 1/4 pound 2,4-D amine for wheat and barley.

Time of application--Postemergence, when wheat or barley is in the 4 to 6-leaf stage and weeds are small.

Remarks--A higher rate of application, 3/8 pound per acre of picloram and 3/8 pound per acre of 2,4-D amine is cleared for use in the same crops when weeds are more advanced or under dry conditions. This higher rate may be applied from the 6-leaf stage to early boot stage. Apply picloram only on small grain fields that will be fallowed or replanted to a grass or grain crop the following year. Do not use on small grain to be underseeded to a legume. Do not use on sandy soils where ground water level is within 10 feet of the soil surface.

Formulation--(Tordon 22K) 2 pounds per gallon liquid.

Profluralin (Tolban) - Ciba-Geigy

Use--Annual grass, pigweed, and common lambsquarters control in soybeans, sunflowers, dry beans including adzuki beans, and alfalfa.

Rate of application--1/2 to 1 1/2 pounds per acre depending on soil type on all crops listed except for adzuki beans.

Time of application--Preplanting, incorporated.

Remarks--May be mixed with metribuzin or used with overlay treatments of linuron and mixtures of naptalam and dinoseb in soybeans and may be mixed with EPTC in dry edible beans except for adzuki beans. Can be applied with liquid or dry bulk fertilizer.

Formulation--4 pounds per gallon liquid.

Propachlor (Ramrod, Bexton) - Monsanto, Dow

Use--Annual grass control in soybeans grown for seed, corn, and grain sorghum. Used in mixtures with atrazine or cyanazine or linuron on corn and with atrazine, cyanazine, or propazine on sorghum.

Rate of application--3 to 6 pounds per acre.

Time of application--Preemergence.

Remarks--Propachlor is cleared to use on corn for grain, seed or forage, but on soybeans for seed only. Do not use propachlor-treated soybeans for food,

feed, or oil. Can be used with liquid fertilizer.

Formulation--65 percent wettable powder; 20 percent granular, 4 pounds per gallon dispersible liquid, or Ramrod/atrazine, 48 + 21 percent wettable powder, 3 + 1 pounds per gallon flowable.

Propanil (Stampede) - Rohm and Haas

Use--Control of green and yellow foxtail and specific broadleaf weeds in hard red spring wheat.

Rate of application--1 1/2 pounds per acre alone or 1 1/8 pounds per acre in combination with 1/4 pound per acre of an iso-octyl ester formulation of MCPA.

Time of application--Postemergence when a majority of the foxtail is in the 2 to 3 leaf stage. Usually at this time the wheat will be in the 3 to 4 leaf stage.

Remarks--Do not apply propanil beyond the 5 leaf stage of the wheat or at rates of more than 1 1/2 pounds per acre, or severe injury to the crop may result. Do not tank mix with herbicides other than MCPA iso-octyl ester formulations. Do not apply Stampede to wheat that has been treated with soil applied systemic insecticides such as Furadan, Thimet or Disyston within the past year. Do not graze treated crop or cut for green chop feed.

Formulation--3 pounds per gallon liquid.

Pronamide (Kerb) - Rohm and Haas

Use--Annual and perennial grass control in pure stands of alfalfa, clover, birdsfoot trefoil, or crown vetch.

Rate of application--1 to 2 pounds per acre.

Time of application--Fall when soil temperatures are below 60<sup>0</sup> F. but before freeze-up.

Remarks--Do not graze or harvest alfalfa within 25 to 45 days depending on the rate of application or other crops for 120 days after application. Use only on established legume plantings or on new plantings after the legume has reached the trifoliolate leaf stage.

Formulation--50 percent wettable powder.

Propazine (Milogard) - Ciba-Geigy

Use--Control of annual grasses and broadleaved weeds in grain sorghum. Used in mixtures with propachlor on grain sorghum.

Rate of application--0.8 to 2 pounds per acre.

Time of application--Preemergence.

Formulation--80 percent wettable powder.

Pyrazon (Pyramin) - BASF

Use--Control of most annual broadleaves in sugar beets. Has been more effective on medium to coarse textured soils with less than 5 percent organic matter.

Rate of application--3.8 to 7.6 pounds per acre.

Time of application--Preemergence or preplanting incorporated.

Remarks--A rain shortly after application is necessary for best results. Incorporation usually improves weed control.

Formulation--75.5 percent wettable powder or 4.2 pounds per gallon dispersible liquid.

Simazine (Princep) - Ciba-Geigy

Use--Control of grasses and broadleaved weeds in alfalfa, birdsfoot trefoil for seed, and corn.

Rate of application--0.8 to 1.6 pounds per acre on alfalfa and birdsfoot trefoil; 2 to 4 pounds per acre on corn.

Time of application--On established alfalfa, after last cutting in the fall and before the ground is frozen. Preplanting or preemergence on corn.

Remarks--Residues in the soil may injure susceptible crops planted the following year.

Formulation--80 percent wettable powder, 4 pounds per gallon liquid and 90 percent water dispersible granules.

TCA - Hopkins

Use--Control of annual grasses except wild oat in sugar beets.

Rate of application--5 to 7 pounds per acre.

Time of application--Preemergence.

Formulation--4.76 pounds per gallon liquid.

Terbacil (Sinbar) - DuPont

Use--Control of several annual broadleaf and grass weeds in alfalfa that has been established for one or more years. Treatment will not control established perennial weeds.

Rate of application--0.4 to 1.2 pounds per acre depending upon weed species to be controlled and on soil type and organic matter percentage. Use lower rate on coarse-textured soils with less than 2 percent organic matter.

Time of application--In the fall after alfalfa plants become dormant or in the spring before new growth starts.

Remarks--Do not use on seedling alfalfa or on alfalfa-grass mixtures or other mixed stands. Do not apply on established stands after new growth starts in the spring. Do not replant treated areas to any crop within two years after last application as injury to subsequent crops may result. There is potential for alfalfa injury, especially on sandy soils or soils low in organic matter.

Formulation--80 percent wettable powder.

### Triallate (Far-go, Avadex-BW) - Monsanto

Use--Control of wild oat in spring and durum wheat and barley, peas and lentils.

Rate of application--1 to 1 1/4 pounds per acre on wheat; 1 1/4 to 1 1/2 pounds per acre on barley. Lower rates are for liquid formulation and higher rates are for granular formulation.

Time of application--Postseeding (preemergence) for wheat; preplanting or post-seeding for barley (postseeding preferred). Fall application prior to barley or spring wheat is a possibility.

Remarks--Must be incorporated by two harrowings at right angles for post-seeding applications. Incorporate preplanting applications as described previously for diallate. In postseeding applications, seed crop to a depth of 2 to 3 inches. Do not apply to a field in a ridged condition. Do not plant domestic oats where triallate was used the previous year. This chemical irritates skin and eyes; use caution when handling.

Formulation--4 pounds per gallon liquid; 10 percent granules.

### Herbicides for the Future

Chlorsulfuron (Glean) - DuPont (available in 1982 in limited quantities on an experimental use permit)

Use--Control of most broadleaf and several grass weeds in wheat, barley and oats.

Time of application--Early postemergence use of chlorsulfuron plus a surfactant appears to be the most effective treatment in Minnesota.

Remarks--Chlorsulfuron is a very active herbicide. Rates of 1/8 to 1/2 ounces/A of the 75 percent dry flowable formulation are effective in controlling many common small grain weeds. Because of the extreme sensitivity of certain rotational crops such as sugar beets to chlorsulfuron, it is likely that the production of certain of these crops will be restricted during the next growing season on fields treated the previous year.

Formulation--75 percent dry flowable, water dispersible, granule.

BAS-9052-OH (Poast) - BASF

(Available in 1982 on a sales experimental use basis (EUP) for use in soybeans. Label clearance for soybeans expected for 1983 crop season.)

Potential Use--Control of grass weeds in most broadleaf crops.

Time of Application--Early postemergence

Remarks--BAS-9052-OH has given excellent control of most annual grass weeds plus several "hard to control" annual grass weeds such as wild proso millet and woolly cupgrass in soybeans. In addition, BAS-9052-OH gives good suppression of several perennial grass weeds such as quackgrass and complete control of other perennials such as wirestem muhly. It is most effective when used with an oil concentrate.

Formulation--1.53 pounds per gallon liquid.

## SUGGESTIONS FOR CHEMICAL CONTROL OF WEEDS IN FIELD CROPS

**Table 1. 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	Incorporate for nutsedge. May shallow incorporate for annual weeds.	None
	metolachlor (Dual)	1.5 to 3	Preplanting or preemergence		None
	atrazine	1 to 3	Preplanting, preemergence or early post-emergence	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 +)	4 to 6	Preplanting incorporation	Do not use on corn seed stock (Breeders, Foundation, Increase)	None
	propachlor (Ramrod, Bexton)	4 to 6	Preemergence		None
	cyanazine (Bladex)	2 to 4 2	Preplanting Preemergence Early Postemergence (80 W only).	Do not use on sandy soils. Use oil or surfactant postemergence under arid conditions only. (80 W only).	None
	atrazine and alachlor	1 to 2+ 1½ to 2½			
	atrazine and metolachlor	1 to 2+ 1¼ to 2½	Preplanting or preemergence		
	cyanazine and alachlor	1 to 2.2+ 2 to 2½	Preplanting or preemergence	Do not use on sandy soils.	None
	cyanazine and metolachlor	0.8 to 2.5+ 1.25 to 2.5	Preplanting or preemergence	Do not use on sand or on loamy sand with less than 1% organic matter.	None
	cyanazine and propachlor	1 to 1.8 + 2.5 to 6	Preemergence	Do not use on sands with less than 2% organic matter.	None
	dicamba (Banvel) + alachlor	½ + 2 to 2½	Preemergence	Use only on medium or fine textured soils with more than 2.5% organic matter	Do not graze or feed silage prior to milk stage.
	dicamba and metolachlor	½ + 2 to 2½	Preemergence	Use only on medium or fine textured soils with more than 2.5% organic matter	Do not graze or feed silage prior to milk stage.
	atrazine and butylate	1 to 1½ + 3 to 4	Preplanting incorporation	Do not use on corn seedstock (Breeders, Foundation, Increase)	Do not graze or feed forage for 21 days after treatment.
	cyanazine and butylate	1 to 2 + 3 to 4			
	atrazine and EPTC (Eradicane)	1 to 1½ + 3 to 4	Preplanting incorporation	Do not use on corn seedstock.	None
cyanazine and EPTC (Eradicane)	1½ to 2 + 3 to 4	Preplanting incorporation	Do not use on corn seedstock.	None	
atrazine and propachlor	1 to 1½ + 2 to 3¾	Preemergence		None	



Table 1. (continued) Suggestions for chemical control of weeds in field crops.

Crop	Chemicals	Pounds per acre of active ingredient or acid equivalent broadcast	Time	Remarks	EPA registration limitations on crop use
Corn	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
	pendimethalin (Prowl) and atrazine	.75 to 1.5 + 1 to 1.5	Early postemergence (spike to 2-leaf stage corn)	Apply before weeds are 1 inch tall	None
	pendimethalin and cyanazine (80 W)	.75 to 1.5 + 1 to 2	Early postemergence (spike to 2-leaf stage corn)	Apply before weeds are 1 inch tall	None
	2,4-D amine	½ to ½ } ½ to ⅓ }	Corn 4 inches to tasseling	Broadleaves 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 ester				
	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	⅓ to ¼ ⅓ + ¼	Postemergence before corn is 2 feet tall and not within 15 days of tasseling.	See Precautions on page 6 to reduce risk of serious drift problems.	Do not graze or harvest for feed before milk stage.
bentazon (Basagran)	¾ to 1	Weeds 2 to 6 inches	Early applications most effective	None	
bentazon + atrazine (Laddock) + oil concentrate	½ to ¾ + ½ to ¾ + 1 qt/A	Postemergence before weeds 2 to 4 inches and corn 1 to 5 leaves.	Control broadleaves only	Do not graze treated area or feed treated to livestock 21 days following application.	
Alfalfa, sweet-clover, and birdsfoot trefoil in flax	MCPA amine	⅓ 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) EPTC (Eptam) profluralin (Tolban)	1⅓ to 1½ } 2 to 3 } ½ to 1 }	Preplanting incorporation	Alfalfa only	None None None
	2,4-DB amine	½ to 1½	1 to 4 trifoliolates on legumes	Sweetclover injured.	Do not graze within 60 days or cut hay within 30 days after application.
	2,4-DB ester	½ to 1			
Established alfalfa	2,4-DB amine 2,4-DB ester	½ to 1½ ½ to 1	When annual weeds are 1 to 3 inches tall (2 to 5 leaves)	May injure alfalfa	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.
	metribuzin (Lexone, Sencor)	¾ to 1 } ¼ to ¾ }	Fall or spring when alfalfa is dormant.	May injure alfalfa.	Do not graze or harvest within 28 days of application.
	terbacil (Sinbar)			May injure alfalfa.	Do not plant other crops within 2 years after application.
	pronamide (Kerb)	1 to 2	Fall	May injure alfalfa	Do not graze or harvest alfalfa within 25 to 45 days after application.

Table 1. (continued) Suggestions for chemical control of weeds in field crops.

Crop	Chemicals	Pounds per acre of active ingredient or acid equivalent broadcast	Time	Remarks	EPA registration limitations on crop use
Established grass pastures	2,4-D	½ 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, dicamba or mixture of these for woody plant control. Avoid drift, especially of dicamba to susceptible crops, particularly soybeans and sunflowers.	Do not graze dairy animals on treated areas within 7 to 14 days after application of 2,4-D. See label. Do not cut 2,4-D treated grass for hay for 30 days. Do not graze dairy animals for 7 to 21 days after application of these rates of dicamba. See label.
	MCPA	¼ to 2			
	dicamba	½ to 1			
Dry edible beans	chloramben (Amiben)	3	Preemergence		None
	EPTC (Eptam)	3	Preplant incorporation	Incorporate immediately. Do not use on adzuki beans.	None
	trifluralin (Treflan)	½ to 1	Preplant incorporation		None
	profluralin (Tolban)	½ to 1	Preplant incorporation		None
	alachlor (Lasso)	2½ to 3	Preplant incorporation	Do not use on adzuki beans.	None
	bentazon (Basagran)	¾ to 1	Postemergence	Beans in first trifoliolate, weeds less than 2 inches and 4 true leaves.	None
Sugarbeets	TCA	5 to 7	Preemergence	For grass weeds except wild oat.	Do not use treated tops for food or feed.
	pyrazon (Pyramin) + TCA	3.8 to 7.6 + 5 to 7	Preemergence or preplanting incorporation	Has been less effective on soils with more than 5% organic matter	None
	dalapon	2 to 3	Beets up to 6-leaf stage	For grass weeds except wild oat.	None
			Directed, beets 7-leaf stage to 14 inches		
	diallate (Avadex)	1½ to 2	Preplanting incorporation	For wild oat. Spring or fall application.	Do not graze unharvested crop
	barban (Carbyne)	¾ to 1	Wild oat in two-leaf stage	For wild oat.	Do not allow livestock to graze treated fields until after crop is harvested.
	desmedipham + phenmedipham (Betamix)	0.365 to 0.6 + 0.365 to 0.6	Early postemergence		Do not apply within 90 days of harvest.
	desmedipham (Betanex)	1 to 1¼	Early postemergence		
	endothall (Herbicide 273)	¾ to 1½	Early postemergence	For wild buckwheat and annual smartweed.	None
	EPTC (Eptam)	2 to 3—spring 4 to 4.5—fall	Preplanting incorporation	For grass and some broad-leaved weeds.	None
	ethofumesate (Nortron)	2 to 3¾	Preplanting incorporation		None
	cycloate (Ro-neet)	3 to 4	Preplanting incorporation	For grass weeds and some annual broadleaves. Similar performance to EPTC but less injury.	None

Table 1. (continued) Suggestions for chemical control of weeds in field crops.

Crop	Chemicals	Pounds per acre of active ingredient or acid equivalent broadcast	Time	Remarks	EPA registration limitations on crop use
Sugarbeets	ethofumesate (Nortron) + desmedipham (Betanex)	1.12 to 1.5+ 0.73 to 1.0	Postemergence, beets with 6 leaves or larger	Improved weed control and more sugarbeet injury than from desmedipham or desmedipham + phenmedipham.	Do not apply these combinations to crops previously treated with ethofumesate.
	ethofumesate (Nortron) + desmedipham + phenmedipham	1.12 to 1.5+ 0.365 to 0.5+ 0.365 to 0.5			
Soybeans	acifluorfen (Blazer)	¾ to ½	Early postemergence (soybeans in first trifoliolate, weeds less than 2 inches tall and 4 true leaves)	Controls many annual broadleaves, including black nightshade	Do not graze or use soybean hay or forage.
	alachlor (Lasso)	2 to 4	Preplant incorporation or preemergence	Incorporate for nutsedge control	None
	chloramben (Amiben)	3	Preplant incorporation or preemergence	May shallow incorporate for annual weeds.	None
	chlorpropham (Furloe Chloro IPC)	2 to 3	Preplant incorporation or preemergence	For smartweed control	None
	diclofop (Hoelon)	¾ to 1¼	Early postemergence when soybeans are between the first and sixth trifoliolate leaf stage, before annual grasses exceed 4 leaves before volunteer corn exceeds 10 inches	Controls many annual grasses, any volunteer corn	Do not graze or use soybean hay or forage.
	linuron	½ to 2½	Preemergence	Increased soybean injury potential at high use rates. Use in combinations at lowered use rates. Do not use on soils with organic matter above 5 percent or below ½ percent	None
	metolachlor (Dual)	1½ to 3	Preplant incorporation or preemergence	Incorporate for nutsedge control	Do not graze or feed soybean hay or forage.
	metribuzin (Sencor Lexone)	¼ to ¾	Preplant incorporation or preemergence	Increased soybean injury potential at high use rates. Use in combinations at lowered use rates. See label for soil restrictions. Soybean injury may occur on alkaline soils, sandy soils or where atrazine residues are present.	None
	fluchloralin (Basalin)	½ to 1½	Preplant incorporation	Must be incorporated	Do not graze or feed forage
	pendimethalin (Prowl)	½ to 1½	Preplant incorporation	Incorporate	None
	profluralin (Tolban)	½ to 1	Preplant incorporation	Must be incorporated	None
	trifluralin (Treflan)	½ to 1	Preplant incorporation	Must be incorporated	None
	vernolate (Vernam)	2 to 3	Preplant incorporation	Incorporate immediately	None
bentazon (Basagran)	¾ to 1½	Early postemergence (soybeans in first trifoliolate, weeds less than 2 inches and 4 true leaves)	Controls most annual broadleaves, Canada thistle, nutsedge	None	

Table 1. (continued) Suggestions for chemical control of weeds in field crops.

Crop	Chemicals	Pounds per acre of active ingredient or acid equivalent broadcast	Time	Remarks	EPA registration limitations on crop use			
Soybeans	2,4-DB amine	½	Postemergence directed	For cocklebur control	Do not harvest within 60 days after application			
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.	For broadleaves	Do not graze or feed forage from 2,4-D treated fields within 2 weeks after treatment. None for MCPA			
	dicamba + MCPA amine	⅛ + ¼ to ⅜				After winter dormancy until wheat begins to joint.	For broadleaves	Do not graze dicamba treated fields or harvest for dairy feed prior to crop maturity.
	dicamba + 2,4-D amine	⅛ + ¼ to ⅜	Wheat fully tillered to boot stage	For broadleaves	Do not forage or graze for 30 days after treatment with bromoxynil.			
	bromoxynil bromoxynil + MCPA ester	¼ to ½ ¼ + ¼				1 to 4 leaf stage of grass weeds (wheat) 1 to 3 leaf stage of grass weeds (barley)	For annual grass weeds including wild oat. Use high rate for larger weeds. May be tank-mixed with bromoxynil. Do not apply other herbicides within one week of diclofop application.	Do not graze treated areas or harvest forage from treated fields prior to grain harvest.
	diclofop	¾ to 1¼ (wheat) ¾ to 1 (barley)	4-leaf to early boot	May persist in the soil to harm most broadleaf crops. Use only where grass or grain crop will be planted the following year.	None			
	picloram and 2,4-D amine	¼ to ¾ + ¼ to ¾						
Rye	2,4-D amine 2,4-D ester MCPA amine or ester	¼ to ¾ ¼ to ½ ¼ to ¾	Rye fully tillered to boot stage		Do not graze or feed forage from 2,4-D treated fields for 2 weeks after treatment. None for MCPA.			
Spring wheat	propanil	1½	3 to 5 leaf stage of wheat	For annual grasses and certain broadleaves. May cause temporary leaf injury or a slight delay in maturity. Do not use on fields previously treated or to be treated this year with organophosphorus or carbamate insecticides.	Do not graze treated crop or cut for green chop feed.			
	propanil + MCPA iso-octyl ester	1⅛ + ¼	2 to 4 leaf stage or grass weeds					
Spring wheat or barley	2,4-D amine 2,4-D ester	¼ to ⅔ ⅓ 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 ⅓ ⅓ to ½	Two leaf to early boot	May injure legumes.	None			
	trifluralin (Treflan)	½ to ¾	Postplanting incorporation	Improper application may result in crop injury. May be tank-mixed with triallate.	None			

Table 1. (continued) Suggestions for chemical control of weeds in field crops.

Crop	Chemicals	Pounds per acre of active ingredient or acid equivalent broadcast	Time	Remarks	EPA registration limitations on crop use
Spring wheat or barley	bromoxynil and MCPA esters	$\frac{1}{4} + \frac{1}{4}$	Two leaf to early boot	Use for smartweeds or wild buckwheat. Do not use on underseeded legumes.	Do not forage or graze for 30 days after treatment.
	bromoxynil (Brominal, Buctril)	$\frac{1}{4}$ to $\frac{1}{2}$	Two leaf to early boot		
	diclofop	$\frac{3}{4}$ to $1\frac{1}{4}$ (wheat)	1 to 4 leaf stage of grass weeds (wheat)	For annual grass weeds including wild oat. Use high rate for larger weeds. May be tank-mixed with bromoxynil. Do not apply other herbicides within one week of diclofop application.	Do not graze treated areas or harvest forage from treated fields prior to grain harvest.
		$\frac{3}{4}$ to 1 (barley)	1 to 3 leaf stage of grass weeds (barley)		
	picloram and 2,4-D amine	$\frac{1}{64}$ to $\frac{3}{28}$ + $\frac{1}{4}$ to $\frac{3}{8}$	4-leaf to early boot	May persist in the soil to harm most broadleaf crops. Use only where grass or grain crop will be planted the following year.	None
Spring wheat or oats	dicamba and MCPA amine	$\frac{1}{6} + \frac{1}{4}$	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	$\frac{1}{4}$ to $\frac{1}{2}$	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	$\frac{1}{4}$ to $\frac{2}{3}$ $\frac{1}{6}$ to $\frac{1}{2}$ $\frac{1}{4}$ to $\frac{3}{8}$	Two leaf to early boot	Bromoxynil for smartweed and wild buckwheat.	None None Do not forage or graze for 30 days after treatment.
Flax	MCPA	$\frac{1}{4}$			Flax 2 to 6 inches
	dalapon EPTC (Eptam)	$\frac{3}{4}$ 2 to 3	Flax 2 to 6 inches Preplanting incorporation	Fall application only	None None
	bromoxynil	$\frac{1}{4}$ to $\frac{1}{2}$	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	Some formulations of 2,4-D amine or MCPA amine (See label)	$\frac{1}{6}$ to $\frac{1}{4}$	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.
Sunflowers	chloramben (Amiben)	2 to 3	Preemergence		Do not graze or feed forage.
	EPTC (Eptam)	2 to 3	Preplanting incorporation		None
	trifluralin (Treflan)	$\frac{1}{2}$ to 1	Preplanting incorporation		None
	profluralin (Tolban)	$\frac{3}{4}$ to 1	Preplanting incorporation		Do not feed treated forage to livestock.
	pendimethalin (Prowl)	$\frac{1}{2}$ to $1\frac{1}{2}$	Preplanting incorporation		Do not feed treated forage to livestock.

**Table 2. 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 (Banvel)	⅓ 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.
	glyphosate (Roundup)	1½	Bud stage or in fall before frost	May be used before planting or for spot treatment in barley, corn, oats, sorghum, soybeans, wheat (kills crop)	Do not feed or forage subsequently grown crop for 8 weeks after application.
	bentazon (Basagran)	¾ to 1 each time-two applications or 1 to 1½ one application	8- to 12-inch thistles Repeat 7 to 10 days later. 8- to 12-inch thistles	For soybeans or corn Split applications usually better than one.	See crop
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
	glyphosate (Roundup)	2¼ to 3¾	Full bloom to frost	May be used before planting or for spot treatment in barley, corn, oats, sorghum, soybeans, wheat (kills crops)	Do not feed or forage subsequently grown crop for 8 weeks after application.
Germander, field mint	atrazine + oil	2	Early postemergence	For corn	See crop
	EPTC (Eradicane)	4 to 6	Preplanting, incorporated	For corn	See crop
Jerusalem artichoke	2,4-D	⅔ 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. Cultivate after harvest until freezeup.	See crop
Yellow nutsedge	metolachlor (Dual)	3	Preplanting, incorporated	For corn, soybeans	See crop
	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		For dry beans, sugarbeets, sunflowers	See crop
	EPTC + protectant (Eradicane)	4 to 6		For corn	See crop
	vernolate (Vernam)	3		Postemergence after a preplanting treatment when nutsedge is less than 3 inches tall.	For soybeans
atrazine + oil	2	For corn	See crop		

**Table 2. (continued) 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	EPA registration Remarks	EPA registration limitations on crop use
	bentazon (Basagran)	¾ to 1 each time-two applications or 1 one application	6- to 8-inch nutsedge Repeat 7 to 10 days later. 6- to 8-inch nutsedge	For soybeans or corn Split applications usually better than one.	See crop
Quackgrass	dalapon (Dowpon)	11	Fall	Foliage application, plow 1 or 2 weeks later. May plant corn, dry beans, some varieties of potatoes, sugar-beets next spring.	Do not graze treated areas in year treated.
	EPTC (Eradicane)	6	Preplanting incorporated	For more consistent control, apply glyphosate or atrazine in the fall followed by EPTC in the Spring.	
Quackgrass	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.
	Wirestem muhly (muhlenbergia)				
	glyphosate (Roundup)	1½	Fall or Spring before plowing or for spot treatment in crop (kills crop)	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.
Wild oat	barban (Carbyne)	¼ to ¾	When wild oat is in two-leaf stage. Before 4-leaf stage of spring small grains, before 12-leaf stage of flax, within 30 days after emergence of sugarbeet, sunflower, mustard, soybean	Rate for wheat, barley, flax. Two applications may be made. Rate for semidwarf wheat varieties, sunflower, mustard, soybeans	Do not allow livestock to graze treated fields until after crop is harvested. Do not feed soybean forage or flax straw from treated fields.
	barban (Carbyne)	¾			
	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		Rate for corn	
	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. May be tank-mixed with trifluralin or wheat or barley.
	difenzoquat (Avenge)	¾ to 1	When wild oat has 3 to 5 leaves.	For barley, winter wheat and the spring and durum wheat varieties listed on the label.	Do not graze treated fields or cut for silage. Grain and straw can be fed.
	diclofop (Hoelon)	¾ to 1¼	When grass weeds have 1 to 4 leaves. Use higher rates for larger weeds.	May be tank-mixed with bromoxynil	Do not graze treated areas or cut for forage prior to grain harvest.

Effectiveness of herbicides on weeds in corn<sup>1</sup>

	Preplanting						Preemergence								Postemergence							
	Alachlor (Lasso)	Metolachlor (Dual)	Butylate (Sutan+)	EPTC (Eradicane)	Cyanazine (Bladex)	Atrazine (AAtrex, others)	Alachlor (Lasso)	Atrazine (AAtrex, others)	Dicamba (Banvel)	Metolachlor (Dual)	Pendimethalin (Prowl)	Propachlor (Ramrod, Bexton)	Linuron (Lorox)	Cyanazine (Bladex)	2,4-D	Dicamba (Banvel)	Atrazine and oil	Cyanazine (Bladex)	Bentazon (Basagran)	Bentazon + atrazine (Laddock)	Pendimethalin (Prowl) + atrazine	Pendimethalin (Prowl) + cyanazine (Bladex 80W)
<i>Corn tolerance—</i>	G	G	G	G	F	G	G	G	F	G	F	G	F	F	F	G	G	F	G	G	F/G	F
<i>Grasses—</i>																						
Giant & robust foxtail	G	G	G	G	F	F	G	F	P	G	F	G	F	F	N	N	F	F	N	F	G	G
Green foxtail	G	G	G	G	G	G	G	G	P	G	F	G	F	G	N	N	G	G	N	F	G	G
Yellow foxtail	G	G	G	G	G	G	G	G	P	G	F	G	F	G	N	N	G	G	N	F	G	G
Barnyardgrass	G	G	G	G	F	F	G	F	P	G	F	G	F	F	N	N	F	F	N	F	G	G
Crabgrass	G	G	G	G	F	P	G	P	P	G	F	G	F	F	N	N	P	F	N	P	F/G	G
Panicum	G	G	G	G	F	P	G	P	P	G	F	G	F	F	N	N	P	F	N	P	F/G	G
Nutsedge	G	G	G	G	P	P	F	P	N	F	N	F	P	P	N	N	F	P	G	G	P	P
Quackgrass	N	N	N	F	P	G	N	G	N	N	N	N	P	P	N	N	G	P	N	P	P	P
Woolly cupgrass	G	G	F	G	P	P	G	P	P	G	F	F	P	P	N	N	F	F	N	P	F	F/G
Wild proso millet	F	F	F	F/G	P/F	P	F	P	P	F	F	F	P	P/F	N	N	P	F	N	P	F	F/G
Wild oat	P	P	F	F	F	G	P	G	N	P	F	P	G	F	N	N	G	F	N	G	G	G
<i>Broadleaves—</i>																						
Buffalo bur	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	P	P	F	F	N	F	F	N	P	P	P	F	G	G	G	F	G	G	G	F
Kochia	P	P	P	F	G	G	P	G	F	P	F	P	F	G	F	G	G	G	F	G	G	G
Lambsquarters	F	P	P	F/G	G	G	F	G	G	P	P	P	G	G	G	G	G	G	F	G	G	G
Mustard	P	P	P	P	G	G	P	G	G	P	P	P	G	G	G	F	G	F	G	G	G	G
Pigweed	G	G	F	F	F	G	G	G	G	G	F	F	G	F	G	G	G	F	P	G	G	F
Ragweed	P	P	P	F	G	G	P	G	G	P	P	P	G	G	G	G	G	G	G	G	G	G
Smartweed	P	P	P	P	G	G	P	G	G	P	F	P	F	G	P	G	G	G	G	G	G	G
Velvetleaf	P	P	F	F	F	F	P	F	F	P	F	P	F	F	G	G	F	F/G	G	G	G	G
Wild sunflower	P	P	P	P	F	F	P	F	F	P	P	P	F	F	F	G	F	F/G	F	F	P	P
Canada thistle	N	N	N	N	P	P	N	P	N	N	N	N	P	P	F	G	P	P	F	P	P	P
Jerusalem artichoke	N	N	N	N	P	P	N	P	P	N	N	N	P	P	G	G	P	P	P	P	P	P
American germander	N	N	P	F	P	P	N	P	P	N	N	N	P	P	P	P	G	F	P	F	F	F

<sup>1</sup> G = Good, F = Fair, P = Poor, N = None



Effectiveness of herbicides on major weeds in soybeans

	Preplant incorporated										Preemergence								Postemergence						
	Alachlor (Lasso)	Chloramben (Ariben)	Fluchloralin (Basalin)	Metolachlor (Dual)	Metribuzin (Sencor or Lexone)	Pendimethalin (Prowl)	Profluralin (Tolban)	Trifluralin (Treflan)	Vernolate (Vernam)	Alachlor (Lasso)	Bifenox (Modown)	Chloramben (Ariben)	Chlorpropham (Furloc Chloro IPC)	Naptalam + Dinoseb (Dyanap)	Linuron (Lorox)	Metolachlor (Dual)	Metribuzin (Sencor or Lexone)	Oxyfluorfen (Goal)	Acifluorfen (Blazer)	Bentazon (Basagran)	2,4-DB (Butoxone or Butyrac 200)	Diclofop (Hoelon)	Dinoseb (Premerge)	Naptalam (Alanap L)	Naptalam + Dinoseb (Dyanap)
Soybean tolerance	G	G	F/G	G	F	F/G	F/G	F/G	F	G	P	G	G	P	F	G	F	-	F	G	P	G	P	G	F
<b>Grasses</b>																									
Giant foxtail	G	G	G	G	F	G	G	G	G	G	P	G	P	F	G	F	P	P	P	Z	Z	G	P	P	P
Green foxtail	G	G	G	G	F	G	G	G	G	G	P	G	P	F	G	F	P	P	P	Z	Z	G	P	P	P
Yellow foxtail	G	G	G	G	F	G	G	G	G	G	P	G	P	F	G	F	P	P	P	Z	Z	G	P	P	P
Barnyardgrass	G	F	F	F	P	F	F	F	F	F	P	F	P	F	F	F	F	F	F	Z	Z	F	F	F	F
Wild proso millet	G	F	F	F	P	F	F	F	F	F	P	F	P	F	F	F	F	F	F	Z	Z	F	F	F	F
Nutsedge	G	P	Z	G	P	Z	Z	Z	G	F	P	Z	P	P	F	P	P	P	P	Z	Z	P	P	P	P
<b>Broadleaves</b>																									
Black nightshade	F	F	P	F	P	P	P	P	P	G	F	G	P	P	G	P	G	G	F	F	F	Z	F	F	F
Hairy nightshade	F	F	P	F	P	P	P	P	P	G	F	G	P	P	G	P	G	G	F	F	F	Z	F	F	F
Cocklebur	P	P	Z	F	P	Z	Z	Z	P	P	P	P	P	P	Z	P	P	P	P	Z	Z	P	P	P	P
Kochia	P	P	G	P	P	G	G	G	P	P	P	P	P	P	P	P	P	P	P	Z	Z	P	P	P	P
Lambsquarters	F	F	F	P	P	F	F	F	F	F	P	F	P	F	F	F	F	F	F	Z	Z	P	P	P	P
Mustard	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	Z	Z	P	P	P	P
Pigweed	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	P	P	P	P	P	P
Common ragweed	P	P	Z	P	P	Z	Z	Z	P	P	P	P	P	P	P	P	P	P	P	Z	Z	P	P	P	P
Giant ragweed	P	P	Z	P	P	Z	Z	Z	P	P	P	P	P	P	P	P	P	P	P	Z	Z	P	P	P	P
Smartweed	P	P	Z	P	P	Z	Z	Z	P	P	P	P	P	P	P	P	P	P	P	Z	Z	P	P	P	P
Velvetleaf	P	P	Z	P	P	Z	Z	Z	P	P	P	P	P	P	P	P	P	P	P	Z	Z	P	P	P	P
Venice mallow	P	G	Z	P	F	Z	Z	Z	P	P	P	P	P	P	P	P	P	P	P	Z	Z	P	P	P	P
Wild sunflower	P	P	Z	P	F	Z	Z	Z	P	P	P	P	P	P	P	P	P	P	P	Z	Z	P	P	P	P

G = good; F = fair; P = poor; N = no control; - = insufficient information.

## Effectiveness of herbicides on major weeds in sugar beets

	Preplanting			Preemergence or Preplanting			Postemergence				
	Cycloate (Ro-neet)	Diallate (Avadex)	EPTC (Eptam)	Ethofumesate (Nortron)	Pyrazon (Pyramin)	TCA	Barban (Carbyne)	Dalapon (Dowpon, Basapon)	Endothall (Herbicide 273)	Desmedipham (Betanex)	Desmedipham + Phenmedipham (Betamix)
<b>Sugar beet tolerance</b>	G	G	F	G	G	G	G	F	F	F	F
<b>Grasses</b>											
Giant foxtail .....	G	P	G	G	P	G	P	G	P	P	F
Green foxtail .....	G	P	G	G	P	G	P	G	P	P	F
Yellow foxtail .....	G	P	G	P	P	G	P	G	P	P	F
Barnyardgrass .....	G	P	G	P	P	G	P	G	P	P	P
Wild oat .....	F	G	F	F	P	P	G	F	P	P	P
<b>Broadleaves</b>											
Common ragweed .....	F	P	F	P	G	P	P	P	F	G	G
Lambsquarters .....	F	P	F	F	G	P	P	P	G	G	G
Marsheider .....	P	P	F	P	G	P	P	P	G	P	P
Pigweed .....	F	P	F	G	G	P	P	P	G	G	P
Smartweed .....	P	P	F	G	G	F	P	P	G	F	P
Wild buckwheat .....	P	P	P	G	G	P	P	P	G	F	G
Wild mustard .....	P	P	P	P	G	P	P	P	G	G	G
Volunteer sunflower .....	P	P	P	P	G	P	P	F	P	P	P
Kochia .....	P	P	F	G	F	P	P	P	P	F	P
Common cocklebur .....	P	P	P	P	F	P	P	P	F	G	G

G — Good  
F — Fair  
P — Poor

## Effectiveness of herbicides on major weeds in small grains and flax 1/

	Small grains											Flax						
	trifluralin (Treflan)	triallate (Far-go)	diallate (Avadex)	2,4-D amine or ester	MCPA amine or ester	bromoxynil (Brominal/ Buctril)	dicamba (Banvel)	picloram (Tordon 22K)	barban (Carbyne)	difenzoquat (Avenge)	diclofop (Hoelon)	propanil (Stampede)	MCPA amine/ester	bromoxynil	dalapon (Dowpon)	barban (Carbyne)	diallate (Avadex)	EPTC (Eptam)
<b>Grasses</b>																		
Green foxtail.....	G	N	N	N	N	N	N	N	N	N	G	G	N	N	G	N	N	G
Yellow foxtail.....	G	N	N	N	N	N	N	N	N	N	F	G	N	N	G	N	N	G
Barnyardgrass .....	G	N	N	N	N	N	N	N	N	N	G	G	N	N	G	N	N	G
Wild oat .....	P	G	G	N	N	N	N	N	G	G	G	P	N	N	F	G	G	F
<b>Broadleafs</b>																		
Wild mustard .....	N	N	N	G	G	F	P	P	N	N	N	F	G	F	N	N	N	P
Wild buckwheat .....	P	N	N	F	F	G	G	G	N	N	N	G	F	G	N	N	N	P
Lambsquarters .....	G	N	N	G	G	G	G	F	N	N	N	G	G	G	N	N	N	F
Pigweed .....	G	N	N	G	G	G	G	F	N	N	N	G	G	G	N	N	N	F
Smartweed (annuals) .....	P	N	N	F	F	G	G	P	N	N	N	P	F	G	N	N	N	P
Common ragweed .....	N	N	N	G	G	G	G	F	N	N	N	P	G	G	N	N	N	F
Giant ragweed .....	N	N	N	G	G	G	G	F	N	N	N	P	G	G	N	N	N	P
Kochia .....	P	N	N	G	G	G	G	F	N	N	N	F	G	G	N	N	N	P
Marshelder .....	P	N	N	G	G	G	G	F	N	N	N	P	G	G	N	N	N	P
Canada thistle .....	N	N	N	F	F	N	G	P	N	N	N	N	F	N	N	N	N	N
Perennial sowthistle .....	N	N	N	F	F	N	G	P	N	N	N	N	F	N	N	N	N	N

G = good; F = fair; P = poor; N = no control

1/ Effectiveness ratings apply if herbicide is used according to label recommendations as to rate, time of application, etc. and if favorable temperature and moisture conditions prevail.

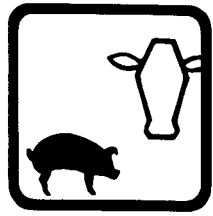
## HERBICIDE NAMES

This is an alphabetical list of trade names of herbicides commonly used on cropland in Minnesota. The active ingredient(s) in these products is given across from the chemical's common name.

<u>Trade Name</u>	<u>Common Name/Active Ingredient</u>
AAtrex	atrazine
Alanap	naptalam (NPA)
Amdon 10K	picloram
Amdon 101	picloram and 2,4-D
Amiben	chloramben
Asulox	asulam
Avadex	diallate
Avadex-BW	triallate
Avenge	difenzoquat
Balan	benefin
Banvel	dicamba
Banvel II	dicamba
Banvel K	dicamba and 2,4-D
Basagran	bentazon
Basalin	fluchloralin
Bexton	propachlor
Betamix	desmedipham + phenmedipham
Betanex	desmedipham
Bicep	metolachlor + atrazine
Bladex	cyanazine
Blazer	acifluorfen
Brominal	bromoxynil
Brominal Plus	bromoxynil and MCPA
Bronate	bromoxynil and MCPA
Buctril	bromoxynil
Butoxone	2,4-DB
Butyrac 200	2,4-DB
Carbyne	barban
Dacthal	DCPA
Dow General	dinoseb
Dowpon M	dalapon
Dowpon C	dalapon and TCA
Dual	metolachlor
Dyanap	naptalam and dinoseb
Endothal	endothal
Eptam	EPTC
Eradicane	EPTC plus crop protectant
Evik	ametryne
Far-go	triallate
Furloe	chlorpropham

<u>Trade Name (continued)</u>	<u>Common Name/Active Ingredient</u>
Glean	chlorsulfuron
Goal	oxyfluorfen
Herbicide 273	endothall
Hoelon	diclofop
Kerb	pronamide
Kleen-Krop	naptalam and dinoseb
Lasso	alachlor
Lasso II	alachlor 15-percent granules
Lexone	metribuzin
Lorox	linuron
Milocep	propazine and metolachlor
Milogard	propazine
Modown	bifenox
MonDak	dicamba and MCPA
Nortron	ethofumesate
Paraquat	paraquat
Poast	sethoxydim
Premerge	dinoseb (DNBP)
Princep	simazine
Prowl	pendimethalin
Pyramin	pyrazon
Pyramin Plus	pyrazon and dalapon
Ramrod	propachlor
Ro-Neet	cycloate
Roundup	glyphosate
Sencor	metribuzin
Sinbar	terbacil
Stampede	propanil
Sutan +	butylate plus crop protectant
TCA	TCA
Tolban	profluralin
Tordon	picloram
Tordon 212,101	picloram and 2,4-D
Treflan	trifluralin
Vernam	vernolate
Weedmaster	dicamba and 2,4-D

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.



ENTOMOLOGY  
FACT SHEET No. 14—Revised 1982  
JOHN LOFGREN

# Controlling Corn Rootworms

If you farm in the southern half of Minnesota and plant corn in fields that were in corn the year before, you can expect infestations of corn rootworms. Localized infestations also occur in other parts of the state.

Rootworms are the larvae of two species of small leaf beetles (family Chrysomelidae). The northern corn rootworm, *Diabrotica longicornis*, and the western corn rootworm, *D. virgifera*, are the species of particular concern to Minnesotans. The adult of the southern corn rootworm, *D. undecimpunctata* (also known as the "spotted cucumber beetle"), is commonly found in Minnesota during the summer, but larval infestations in corn apparently occur only rarely in some southernmost counties.

## HABITS

Eggs of the northern and western rootworms overwinter in the soil in corn fields where they were laid the previous summer and fall. Hatching begins in June and continues into the summer. The young larvae begin to feed on corn roots. If the worms cannot find corn roots, almost all will starve to death. There is evidence that some worms can survive on roots of certain grasses, but the number is insignificant. The worms feed most heavily on the tender, succulent roots, often tunneling inside the larger roots. When full grown, the worms enter the pupal stage in the soil and make the transformation to beetles.

Some adults begin emerging in mid-July and usually reach a peak in August. The beetles feed on pollen and fresh silks. Silk feeding may be severe enough to interfere with the fertilization of the kernels, causing poorly-filled ears. It occurs when extremely large numbers of beetles are present just at the time of pollination. As the pollen and fresh silks disappear, the beetles may move out of the field into later corn or to other food sources such as a wide variety of pollinating flowers. Beetle feeding, mating, and egg laying continue until cold weather puts an end to their activity. Surveys have shown that more than 90 percent of the beetles found in a year are found in cornfields that were in corn the previous year.

## DAMAGE

The most important damage is that caused by worms feeding in and on the roots. The usual symptom related to root damage is lodging. There are many causes of lodging, so just because a field exhibits this symptom after an extremely violent rain and wind storm doesn't mean that rootworms are responsible. On the other hand, rootworm feeding may cause reduced yields with very little lodging. The only way to be sure is to dig up the roots and examine them for the presence of worms or their damage. Rootworms are slender, whitish larvae, about 1/4-to 3/4-inch long when full grown. They have dark shiny heads and a dark area on top of the tail end.

Research in other states has shown that late-planted fields often escape serious infestation, but under Minnesota conditions planting late is not a good practice. Corn planted after June 1 will not be heavily infested, but the yield potential will be reduced due to the shorter growing season.

A number of other factors influence the damage caused by rootworms. Some lines of corn have the ability to regenerate roots and outgrow the pruning done by the worms. Some hybrids probably are more tolerant than others. Planting early and maintaining adequate soil fertility will provide larger, more vigorous, and well-established plants by the time rootworm feeding begins. Adequate soil moisture will allow damaged plants to survive and produce better than they could under drought conditions. Extremely heavy rains or strong winds will greatly increase the lodging caused by rootworm feeding. In general, rootworm damage will be accentuated by adverse growing conditions.

## PREVENTION AND CONTROL

1. Do as good a job as you can in all aspects of corn production. Select hybrids adapted for your area, maintain adequate fertility as determined by soil tests and cropping history, use the best methods of seedbed preparation and other cultural practices for your soils, plant early, and reduce weed competition.
2. Rotate crops to avoid continuous corn if rotation will fit your farm plans. Because rootworm eggs are laid in corn fields in the fall, practically all infestations are in corn following corn. There have been some reports of rootworm damage in first year corn, but these have been very rare. Some can be explained by the presence of volunteer corn in the previous year's crop. Sometimes an early frost or severe drought may cause the adults to move out of the corn before they have laid eggs. This may result in localized infestations in first year corn, especially following soybeans or small grain.
3. Use insecticides in fields likely to be infested. An average of one or more beetles per plant is an indication that the field should be treated with a soil insecticide if it is replanted to corn.

## PLANTING TIME TREATMENTS

Apply one of the recommended insecticides in a 7-inch band on the row with a planter attachment. Be sure to calibrate the applicator accurately and adjust it to place the insecticide properly.

The insecticide granules should be deposited just ahead of the press wheels or in such a way that there is a covering of soil over the chemical. The granules should *not* be deposited in direct contact with the seed unless the product label indicates an in-furrow application may be made. Try out the applicator and get it adjusted correctly for each change in moisture condition and soil type. For some fields you may

need covering blades behind the shoes or a length of chain behind each press wheel to get adequate coverage. Under minimum tillage, crop residues and rough soil conditions may make proper placement difficult. You may want to try one of the insecticides labeled for furrow placement. Liquid formulations of some products also are available and may be sprayed in a band ahead of the press wheels.

Some rootworm insecticides are registered for application with a starter fertilizer, but it is more difficult to obtain good placement with these mixtures, and plant injury may result. If used, place in a split band at least two inches from the seed.

## RATES OF APPLICATION

All insecticides should be used at a full pound of active ingredient per acre on a 40-inch row basis, even though the label may indicate a range of rates. For rootworm control *only* there is no need to exceed 1 pound even if the label includes higher rates for other soil insects. For control of other soil insects of corn see Entomology Fact Sheet 7.

Insecticide, formulation	Rate of formulated product	
	Per acre, 40-inch rows	Per 1000 ft. of row, any row spacing
carbofuran, Furadan 10G	10 pounds	12 ounces
chlorpyrifos, Lorsban 15G	6½ pounds	8 ounces
ethoprop, Mocap 10G	10 pounds	12 ounces
15G	6½ pounds	8 ounces
fonofos, Dyfonate 20G	5 pounds	6 ounces
isofenphos, Amaze 20G	5 pounds	6 ounces
phorate, Thimet 15G	6½ pounds	8 ounces
20G	5 pounds	6 ounces
terbufos, Counter 15G	6½ pounds	8 ounces

## CULTIVATION TREATMENT

Some insecticides are registered for postemergence basal application in June. In most cases, results will not be as good as the planting time treatment, especially if conditions are dry following the application. Apply at base of plant and cover with soil.

## ROTATING CHEMICALS

In some cases an insecticide may give inadequate control after several years of continual use. This problem has been noticed most commonly with the carbamate compounds (Bux earlier and Furadan more recently). To help prevent such failures, it is suggested that Furadan not be used in fields in which it was used the previous year or in fields where it failed previously.

## BEETLE CONTROL

If beetles become extremely numerous in fields just at pollination time it may pay to control them, but such cases are rare. Usually corn has passed the pollination stage by the time beetle emergence reaches its peak, but late silking fields may benefit from treatment. Treat such fields *before* they are

50 percent silked and while pollen still is being shed, if there are about 10 or more beetles per plant, and if the silks are being clipped back into the husks. Use diazinon, carbaryl (Sevin), or malathion at 1 pound active ingredient per acre by means of aircraft or a high clearance sprayer. Ultra-low volume concentrate malathion also can be applied by aircraft at 4 to 8 fluid ounces per acre. Apply malathion at least 5 days before harvest. Some of these products are toxic to bees and other nontarget insects. Do not treat fields while bees are active, and do not allow drift to bee yards.

## PREDICTING NEED FOR INSECTICIDES

Fields may be scouted in August to determine need for treatment if put back into corn the following year. Check at least five locations representative of the field. Make a count of the rootworm adults on 10 plants at each site. If the beetle count averages one or more per plant at any time, plan to treat the field next year. If the count is less than one per plant the first count, make another count one week later. If the count never reaches one per plant, it will probably not pay you to treat that field the following year.

If the field is not scouted, you should assume that it should be treated if it is replanted to corn.

## CAUTION

All insecticides are toxic and must be used with care. Avoid exposure to skin, lungs, mouth, and eyes. Wear protective clothing when directed to do so on the manufacturer's label.

Do not breathe dust or vapors, and do not eat or smoke while handling chemicals or until after washing thoroughly. Take a can of water, a basin, and soap to the field so you can wash your hands immediately after each filling of the equipment or other contact with insecticides. When you finish for the day, bathe thoroughly and change clothes. To protect yourself, follow these and all other precautions on container labels.

Many of these chemicals can kill fish if streams or lakes are contaminated with lethal doses. Avoid treating corn on steep slopes where heavy rains could carry the chemicals into surface waters. Rotate away from continuous corn if possible. Use recommended soil conservation practices for your soils to prevent erosion.

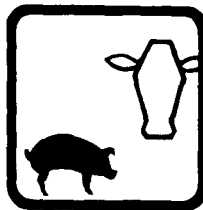
Some granular products are toxic to birds. Avoid leaving granules exposed on the soil surface, especially at ends of fields where equipment is lifted.

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AGRICULTURAL CHEMICALS  
FACT SHEET No. 9—Revised 1982  
OLIVER E. STRAND

## Wild Oat Identification and Control



### IDENTIFICATION OF WILD OAT

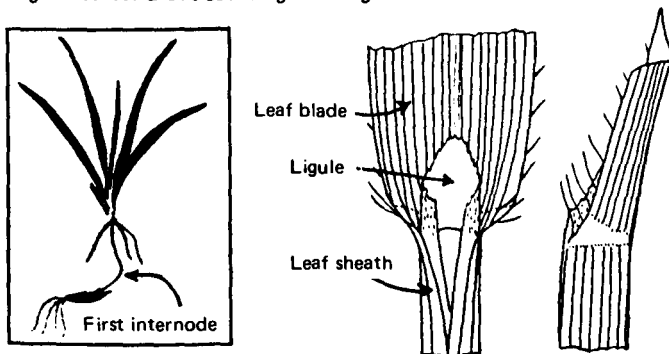
Wild oat is a competitive annual weed that grows from seed. A member of the grass family, wild oat usually germinates when temperatures are cool in early spring or in late fall. Very little wild oat seed germinates during June through September. Wild oat has dormancy characteristics that prevent germination until the seed is fully mature. Germination is often delayed for more than 1 year. However, wild oat seed usually germinates within 3 years unless it is buried deeply into the soil where it can remain dormant for years.

The delayed germination characteristic of wild oat, its habit of shattering its seed before most crops are harvested, and its similarity in growth habit to the cereal grains have often resulted in severe infestations of wild oat among cereal grains.

It's easy to identify mature wild oat in most crops. The inflorescence (head) of a mature wild oat plant is a spreading, open panicle that often droops over in contrast to the more compact and erect inflorescence of cultivated oats.

However, identification of wild oat seedlings is more difficult. Nevertheless, it's important because effective chemical control can be initiated in most crops if wild oat is identified in the two-leaf stage. Wild oat seedlings may be identified if seedlings are carefully dug up so that seed, roots, and leaves are intact. Wild oat seedlings have these vegetative characteristics (figure 1).

Figure 1. Wild oat seedling and vegetative characteristics



- Elongation of the first internode. Wild oat seed can readily emerge from varying depths in the soil because of this characteristic. The distance between the seed, with its seminal (seed) roots, and the crown roots, located just under the soil surface, depends on the depth of emergence.
- Open-leaf sheath with overlapping margins.
- Prominent membranous ligule, often ragged on top.
- No auricles.
- Basal margin of leaf blade often has stiff, prominent hairs.
- The leaf blades of many grasses have a characteristic twist or spiral turn (as you look down on them from above). The leaf twist of wild oat is counterclockwise. Barley and wheat leaves twist clockwise. Cultivated oats also have a counterclockwise twist to the leaves.
- Wild oat seed has lemma and palea (hulls) attached to the caryopsis (grain), with a twisted and bent awn (beard) arising from the back of the lemma. The seed has prominent hairs at the base (point of attachment) and is yellow-brown to brownish-black. However, the awns and hairs may be partially or entirely broken off after being buried in the soil. Many of the seeds have a prominent oval depression at the base, often called a "sucker mouth" (figure 2).

Figure 2. Wild oat seed showing sucker mouth



### WILD OAT CONTROL

#### Cultural control

- Wild oat lying on the soil surface in the fall is exposed to weathering. These exposed seeds have a shorter dormancy period than those worked into the soil in the fall. Therefore, avoid fall tillage if wild oat is a problem. Cultivate shallowly as soon as the soil is workable in early spring to break the soil crust, covering the wild oat seed to stimulate early germination. Repeat shallow cultivation as needed to kill wild oat plants that have germinated. Plant wheat, barley, or flax within 1 to 2 weeks of normal planting time to avoid excessive loss of crop yields. Chemical control is usually necessary in addition to limited tillage.
- Shallow tillage may be repeated several times in the spring to control wild oat. Delay planting the crop until wild oat seed becomes dormant, about mid-June. Then plant a crop adapted to late sowing, such as early varieties of flax, corn, proso millet, buckwheat, sudangrass, and soybeans. Use fertilizer and heavy seeding rates to provide additional crop competition.



—Harrowing a few days after the spring-sown crop has germinated and before it is up can considerably reduce early germinating wild oat stands. If soil conditions are dry, harrowing may also be done after small grains and most row crops are up. However, harrowing should be done before small grain begins to tiller or stool. Do not harrow flax.  
 —Cultivated oats may be planted early in the season on fields badly infested with wild oat. The crop may then be cut for

hay or silage before wild oat seed matures.  
 —Plant crop seed of an adapted variety that is free of wild oat seed.

### Chemical control

Earlier seeding of wheat or barley and the use of an herbicide to control wild oat is usually more profitable than is delayed seeding or planting alternative crops.

**Table 1. Chemicals for wild oat control in field crops**

Crop	Chemicals	Pounds active ingredient/A	Time of Application	Remarks	Environmental Protection Agency limitation on use
Spring, durum or winter wheat or barley	triallate (Fargo, Avadex-BW)	1 to 1½ (wheat) 1¼ to 1½ (barley)	Postplanting, incorporated (wheat). Preplanting or postplanting, incorporated (barley).	Use higher rates for granules, lower rates for liquid; granules best for fall application. See label.	Do not graze livestock on treated areas.
	barban (Carbyne)	¼ to 3/8	When wild oat is in the two-leaf stage. A second application at ¼ lb/A may be made if a second flush of wild oat occurs. If the first application is missed, a single application of up to ½ lb/A may be made at the 2½- to 3½-leaf stage except on durum wheat.	Use high rate on semidwarf wheat varieties. Do not spray after the four-leaf stage of wheat or barley.	Do not graze treated fields until after harvest.
	difenzoquat (Avenge)	5/8 to 1	When wild oat is in the three- to five-leaf stage.	Use only on barley, winter wheat, and on spring wheat and durum varieties listed on the label. May tank mix with most other broadleaf herbicides. See label.	Do not graze treated fields or cut for silage. Grain and straw can be fed, however.
Flax	diclofop (Hoelon)	3/4 to 1 (barley) 3/4 to 1¼ (wheat)	When wild oat is in the one- to three-leaf stage (barley). When wild oat is in one- to four-leaf stage (wheat).	May be tank-mixed with broxynil on wheat and barley. Use high rate for larger weeds.	Do not graze or feed forage from treated fields prior to grain harvest.
	diallate (Avadex)	1½ to 2	Incorporate before planting or emergence in spring or apply in fall within 2 to 3 weeks of soil freezeup and incorporate into soil.		None.
Alfalfa and clover; underseeded: In barley—	barban	¼ to 3/8	When wild oat is in two-leaf stage.	Do not apply after the 12-leaf stage of flax.	Do not graze treated fields until after harvest.
	diallate	1¼	Incorporate after planting but before emergence.		None.
In flax—	diallate	1½ to 2	Incorporate before planting or emergence.		None.
Alfalfa and clover; seeded alone	diallate	1½ to 2	Incorporate before planting in fall or spring.		None.
Sugar beets	diallate	1½ to 2	Incorporate before planting in fall or spring. (Make fall application within 3 weeks of soil freezeup.)		None.
	barban	3/4 to 1	When wild oat is in two-leaf stage.	Do not apply later than 30 days after sugar beets emerge.	Do not graze treated fields until after harvest.
Sunflowers and soybeans	barban	3/8	When wild oat is in two-leaf stage.	Do not apply after the first trifoliolate leaf stage of soybeans nor later than 30 days after soybean or sunflower emergence.	Do not graze treated fields until after harvest.
Corn	diallate	1½	Incorporate before planting or emergence, spring.		None.

NOTE: Atrazine will control wild oat in corn, but may carry over in the soil to damage susceptible crops the following year. EPTC (Eptam, Eradicane) gives fair control of wild oat in crops where these chemicals may be used.

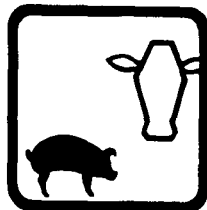
**Table 2. Herbicide names and formulations used for wild oat control**

Common name	Trade name	Concentration and commercial formulation
barban	Carbyne	1 lb/gal L.
diallate	Avadex	4 lb/gal L.
diclofop	Hoelon	3 lb/gal L.
difenzoquat	Avenge	2 lb/gal L.
triallate	Far-go, Far-go, Avadex-BW	4 lb/gal L. 10% G.

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**CAUTION:** Avoid repeated and prolonged contact with all herbicides, especially direct contact with skin and eyes. Check label directions and restrictions. Avoid wind drift of herbicides to susceptible crops or ornamentals. For more information on herbicides, specific rates of application, and safety precautions, refer to the product label.



AGRICULTURAL CHEMICALS  
FACT SHEET No. 10—Revised 1982  
OLIVER E. STRAND

## Weed Control In Flax

### FLAX

Flax does not compete well with weeds, so weed control is essential for obtaining high flax yields. Shallow early spring tillage to stimulate germination of annual weeds, followed by tillage operations to kill these weeds, and delayed seeding of flax has been a successful method of weed control. However,

the delay in seeding flax usually decreases yields. Therefore, appropriate preplanting and postharvest tillage, together with suitable weed control chemicals, should be used for best results (tables 1, 2, and 3).

**Table 1. Suggestions for chemical weed control in flax not underseeded with a legume**

Chemicals <sup>1</sup>	Pounds per acre of acid equivalent or active ingredient broadcast	Time of application	Remarks	Environmental Protection Agency limitations on use
MCPA amine or ester Dalapon	$\frac{1}{4}$ } $\frac{3}{4}$ }	Flax 2 to 6 inches.	MCPA for broadleaves; dalapon for grasses; mixture of MCPA amine and dalapon for broad-leaf and grass control. Dalapon may injure flax.	None
EPTC (Eptam)	3	Preplanting incorporation.	Some flax injury has occurred. For annual grasses and some broadleaves.	None
Bromoxynil (Brominal, Buctril)	$\frac{1}{4}$ to $\frac{1}{2}$	Flax 2 to 8 inches.	For annual broadleaves, smartweed and wild buckwheat in two- to four-leaf stage.	Do not graze for 30 days after treatment.

<sup>1</sup>See table 5 for trade names of herbicides.

**Table 2. Suggestions for broadleaf weed control in flax underseeded to a legume**

Chemicals	Pounds per acre of acid equivalent broadcast	Time of application	Remarks	Environmental Protection Agency limitations on use
MCPA amine	$\frac{1}{8}$ to $\frac{1}{4}$	Flax 4 to 6 inches tall. Not before legumes are 2 inches tall.	Legumes injured, canopy of crop or weeds reduces injury. Sweetclover injured.	None

### WILD OAT CONTROL IN FLAX

Wild oat is very competitive with flax; if not controlled, it may reduce crop yields by one-third or more. A combination of cultural and chemical practices is needed for effective control.

**Table 3. Chemicals for wild oat control in flax**

Chemicals	Pounds per acre of active ingredient broadcast	Time of application	Remarks	Environmental Protection Agency limitations on use
diallate (Avadex)	$1\frac{1}{2}$ to 2	Preplanting or pre-emergence.	Must be incorporated into soil. May be used where flax is underseeded with alfalfa or clover.	None
barban (Carbyne)	$\frac{1}{4}$ to $\frac{3}{8}$	When wild oat is in two-leaf stage.	Do not spray barban after the 12-leaf stage of flax. Use the high rate for wild oat populations over 50 plants/sq. ft.	Do not feed flax straw from treated fields to livestock or graze treated fields until after harvest.

**Table 4. Effectiveness of herbicides for weed control in flax<sup>1</sup>**

Herbicides	Performance rating of herbicide on weeds							Crop tolerance Flax
	Wild mustard	Wild buck-wheat, annual smartweeds	Canada thistle, perennial sowthistle	Pigweed, common lambsquarters, and ragweed	Annual grasses			
					Wild oat	other		
MCPA amine	G	F	F	G	N	N	G	
MCPA ester	G	F	F	G	N	N	F	
bromoxynil	F	G	N	G	N	N	F	
dalapon	N	N	N	N	F	G	F	
EPTC	P	P	N	F	F	G	F	
diallate	N	N	N	N	G	N	F	
barban	N	N	N	N	G	N	F	

<sup>1</sup>P = poor, F = fair, G = good, N = no control.

**Table 5. Herbicide names and formulations used in flax**

Common name	Trade name	Concentration and commercial formulations <sup>1</sup>
MCPA	Several, mixtures	See product label
dalapon	Dowpon M, Basfapon	5 lb/gal L, 74% WSP
EPTC	Eptam	7 lb/gal L, 10% G
bromoxynil	Brominal, Buctril	2 lb/gal L
diallate	Avadex	4 lb/gal L, 10% G
barban	Carbyne	1 lb/gal L

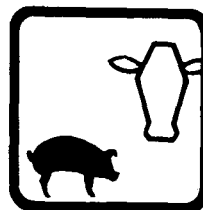
<sup>1</sup>L = liquid, G = granular, WSP = water soluble powder.

**CAUTION**

Avoid repeated and prolonged contact with all herbicides, especially direct contact with skin and eyes. Check label directions and restrictions carefully. Avoid wind drift of herbicides to susceptible crops and ornamentals. This fact sheet is intended only as a summary of weed control information on flax. For more information, refer to product labels.

Trade names are used to identify herbicides. Omission of other trade names of similar herbicides is unintentional. Inclusion of a trade name does not imply endorsement, and exclusion does not imply nonapproval.

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AGRICULTURAL CHEMICALS  
FACT SHEET No. 11—Revised 1982  
OLIVER E. STRAND

# Weed Control In Sunflowers

## CULTURAL METHODS OF WEED CONTROL

Harrowing and cultivation are important methods of weed control in sunflowers. Sunflowers normally do not emerge for 10 days to 2 weeks after planting, so weeds frequently emerge before the sunflowers do. Many weeds can be killed by shallow tillage with a spike tooth or coil spring harrow about 1 week after planting. Because sunflower seedlings are strongly rooted, these implements and others such as the weeder and rotary hoe can be used to kill weeds after the sunflowers emerge. However, the tillage implements must be properly adjusted, and tillage after sunflower emergence should be delayed until the sunflower seedlings have two or more leaves. Harrowing may normally be done in any direction and may be done several times if weeds continue to emerge and if field conditions are suitable. Weeds missed by early tillage may be controlled by cultivation between the rows. However, for adequate weed control, chemical weed control is usually necessary in addition to tillage (table 1).

## CHEMICAL WEED CONTROL IN SUNFLOWERS

This fact sheet summarizes chemicals for weed control in sunflowers. For additional information, refer to the product label.

Proper herbicide application and favorable soil and weather conditions are necessary for optimum herbicide performance. The soil should be easily worked, not wet or cloddy, to ensure maximum mixing with soil particles during preplant

herbicide incorporation. Adequate soil moisture is needed to insure good herbicide activity. Dry conditions at the point where the germinating weed seedling contacts the herbicide will reduce effectiveness.

All the herbicides registered for use in sunflowers, with the exception of chloramben (Amiben), which may be applied preplant incorporated or preemergence, must be applied preplant incorporated. No herbicide is registered for postemergence use in sunflowers. EPTC (Eptam), trifluralin (Treflan), and profluralin (Tolban) are primarily grass herbicides. In addition, they control some broadleaf weeds under conditions favorable for herbicide activity. EPTC must be incorporated immediately after application. The other preplanting herbicides should be incorporated as soon as possible, but soil incorporation may be delayed for up to 4 hours for profluralin, up to 24 hours for trifluralin, and up to 7 days for pendimethalin. Good incorporation thoroughly mixes the herbicide with the soil to a depth of 3 to 4 inches and is best accomplished by incorporating the herbicide twice with a disk or similar implement at a minimum speed of 4 to 6 mph. The second incorporation should be carried out at a right angle (90 degrees) to the direction of the first incorporation to ensure thorough mixing of the herbicide with the soil, which is essential for good weed control and crop safety.

Chloramben is primarily a broadleaf weed herbicide, but it also has activity on many annual grasses. Application may be preplant incorporated or preemergence. Favorable weather conditions are needed to obtain good weed control.

Table 1. Suggestions for chemical weed control in sunflowers

Chemicals	Pounds per acre of active ingredient or acid equivalent broadcast <sup>1</sup>	Time of application	Environmental Protection Agency limitations on use
EPTC (Eptam)	2 to 3	Preplanting incorporation	None
trifluralin (Treflan)	½ to 1	Preplanting incorporation	None
pendimethalin (Prowl)	½ to 1½	Preplanting incorporation	Do not feed treated forage to livestock.
profluralin (Tolban)	¾ to 1	Preplanting incorporation	Do not feed treated forage to livestock.
trifluralin (Treflan)	½ to 1	Preplanting incorporation	Do not graze or feed forage.
+ chloramben (Amiben)	+2 to 3		
chloramben (Amiben)	2 to 3	Preemergence	Do not graze or feed forage.

<sup>1</sup>Use the low rate for coarse textured soils, intermediate rates for medium textured soils, and high rates for fine textured soils.

Table 2. Wild oat control in sunflowers

Chemical	Pounds per acre of active ingredient broadcast	Time of application	Environmental Protection Agency limitations on use
barban (Carbyne)	¾	When wild oat is in the two-leaf stage but within 30 days after sunflower emergence.	Do not allow livestock to graze treated fields until after harvest.

Rainfall is needed to move the herbicide into the soil for good herbicide activity when it is applied preemergence, but excessive rainfall can move chloramben below the zone of weed seed germination. This is particularly true in coarse textured (sandy) soils. Preplant incorporated applications of chloramben are more effective during dry years, but pre-emergence applications are more effective when followed by moderate to heavy rainfall. If a preemergence application of chloramben is followed by a dry period and weed seed-

lings begin to emerge, then an early shallow cultivation will result in more consistent weed control.

### WILD OAT CONTROL IN SUNFLOWERS

Tillage effectively controls many early germinating wild oat seedlings, both before and after sunflower emergence. Wild oat not controlled by tillage may be controlled with barban (table 2).

**Table 3. Effectiveness of herbicides for weed control in sunflowers<sup>1</sup>**

	Preplanting				Preemergence	Postemergence
	EPTC (Eptam)	Trifluralin (Treflan)	Profluralin (Tolban)	Pendimethalin (Prowl)	Chloramben (Amiben)	Barban (Carbyne)
Sunflower tolerance	G	G	G	G	G	G
<i>Grasses</i> —						
Green and yellow foxtail	G	G	G	G	G	N
Giant foxtail	G	G	G	G	G	N
Wild oat	F	P	P	P	P	G
<i>Broadleaves</i> —						
Pigweed sp.	F	G	G	G	G	N
Common lambsquarters	F	G	G	G	G	N
Wild mustard	P	N	N	F	F	N
Common ragweed	F	N	N	P	G	N
Smartweed sp.	P	P	P	F	G	N
Kochia	F	G	G	G	G	N
Cocklebur	P	N	N	N	P	N

<sup>1</sup>G = Good, F = Fair, P = Poor, N = No control.

**Table 4. Herbicide names and formulations used in sunflowers**

Common name	Trade name	Concentration and commercial formulations <sup>1</sup>
EPTC	Eptam	6, 7 lb/gal L, 10% G
Barban	Carbyne	1 lb/gal L
Chloramben	Amiben	2 lb/gal L, 10% G
Trifluralin	Treflan	4 lb/gal L, 5% G
Pendimethalin	Prowl	4 lb/gal L
Profluralin	Tolban	4 lb/gal L

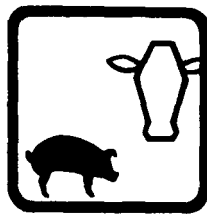
<sup>1</sup>L = Liquid, G = Granular.

#### CAUTION

*Avoid repeated and prolonged contact with all herbicides, especially direct contact with skin and eyes. Check label directions and restrictions carefully. Avoid wind drift of herbicides to susceptible crops and ornamentals.*

Trade names are used to identify herbicides. Omission of other trade names of similar herbicides is unintentional. Inclusion of a trade name does not imply endorsement, and exclusion does not imply nonapproval.

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**AGRICULTURAL CHEMICALS  
FACT SHEET No. 13-1982  
O.E. Strand and L.L. Hardman**

# Weed Control in Dry Beans

Dry beans are sensitive to weed competition. Early weed growth reduces bean yields by competing for light, moisture, and nutrients. Weeds also are likely to cause a buildup of disease and/or insect problems that may affect bean growth and development adversely. Weeds increase harvest losses and reduce bean quality. Cultivation or other tillage sometimes controls weeds adequately without the use of herbicides. However, weeds usually are not controlled adequately in the row and use of herbicides with tillage is necessary.

### How Beans Grow

Dry beans grown in Minnesota include five common bean (*Phaseolus* sp.) classes: navy, pinto, kidney, pink, and small red, as well as the adzuki bean (*Vigna* sp.). All common beans emerge by elongation of the hypocotyl (portion of the stem below the cotyledons or seed leaves), which "crooks" or arches through the soil and then straightens out with unfolding cotyledons. These common beans emerge quite rapidly (usually within 7 to 10 days) if planted in warm soil (50° F or higher) in late May or early June in Minnesota. However, earlier planting may delay emergence.

Adzuki beans, on the other hand, emerge by elongation of the epicotyl (portion of the stem above the cotyledons), and the cotyledons (seed) remain below the soil surface. Adzuki beans emerge more slowly than common beans, usually 10 to 14 days in warm soils and 15 to 20 days in cold soils. Because of the type and time required for emergence, adzuki beans are more susceptible to injury from preplanting or preemergence herbicides. For example, EPTC (Eptam), alachlor (Lasso),

or dinoseb (Premerge) can be used on common beans but should not be used on adzuki beans (table 2). Because of slower bean emergence and less early season crop competition, weed control is more critical with adzuki beans than with common beans.

### Cultivation

Before emergence, dry beans can be spike-toothed harrowed to kill emerging weeds. The weeder, rotary hoe, or flexible-tined harrow are safer to use after bean emergence than the spike-toothed harrow. More than one harrowing may be necessary.

After the beans emerge, they develop quite rapidly and progress through the cotyledon stage (or plumule stage in the adzuki bean) to the fully expanded unifoliolate leaf stage and then to the first and subsequent trifoliolate (3-part) leaves. Beans differ in canopy growth. Most navy and adzuki bean varieties are erect or "bush" type. Most pinto, pink, and small red bean varieties are prostrate vines, although bush or semi-vine types of small red and pinto are available.

Dry edible beans may be cultivated once or twice to control weeds; however, cultivation should be shallow to avoid damaging the rather shallow root systems. Cultivation or harrowing should not be done when the bean foliage is wet because bacterial diseases may be spread. Beans are hilled at the last cultivation to allow use of bean pullers. However, if beans are to be direct-combined or swathed, the last cultivation should leave the field as level as possible.

**Table 1. Effectiveness of herbicides on major weeds in dry beans<sup>1</sup>**

Weed	Preplant Incorporated				Preemergence		Postemergence
	alachlor (Lasso)	EPTC (Eptam)	trifluralin (Treflan)	profluralin (Tolban)	chloramben (Amiben)	dinoseb (several names)	bentazon (Basagran)
<b>Grasses</b>							
green foxtail	G	G	G	G	G	F	N
yellow foxtail	G	G	G	G	G	F	N
giant foxtail	G	G	G	G	F	F	N
barnyardgrass	G	G	G	G	G	F	N
wild oat	P	F	P	P	P	P	N
quackgrass*	N	P	N	N	N	N	N
<b>Broadleaves</b>							
common lambsquarters	G	F	G	G	G	G	P
pigweed	G	F	G	G	G	G	P
wild mustard	P	P	N	N	F	G	G
smartweed	P	P	P	P	G	F	G
common ragweed	P	F	N	N	G	G	G
kochia	P	F	G	G	F	G	P
velvetleaf	P	F	N	N	F	F	G
cocklebur	P	P	N	N	P	F	G
black nightshade	G	F	P	P	F	F	F
hairy nightshade	G	F	P	P	F	F	G
Canada thistle*	N	N	N	N	N	N	G

<sup>1</sup> G = good control, F = fair control, P = poor control, N = no control.

\* Glyphosate (Roundup) can be used in fields before planting dry beans and for spot treatment where these perennial weeds are a problem. See label.

**Table 2. Summary of herbicides for use on dry beans (includes navy, pinto, pink, small red, adzuki)<sup>1</sup>**

Herbicide	Lbs/A of active ingredient or acid equivalent broadcast	Time of application <sup>2</sup>	Remarks
chloramben (Amiben)	2 to 3	Pre	<i>Use lower rate on adzuki beans.</i>
EPTC (Eptam)	3 to 4	PPI	<i>Do not use on adzuki beans. Do not exceed 3 lbs/A on coarse-textured soils.</i>
trifluralin (Treflan)	1/2 to 1	PPI	<i>Use lower rates on coarse-textured soils, higher rates on medium and fine-textured soils.</i>
profluralin (Tolban)	1/2 to 1	PPI	<i>Use lower rates on coarse-textured soils, higher rates on medium and fine-textured soils.</i>
alachlor (Lasso)	2½ to 3	PPI	<i>Do not use on adzuki beans.</i>
bentazon (Basagran)	3/4 to 1	Post	<i>Beans in first trifoliate, weeds small. Use lower rate on adzuki beans.</i>
dinoseb or DNBP (Premerge, others)	9	Pre	<i>Do not use on sandy soils. May be applied at crook stage at 3 to 4½ lbs/A (see label). Do not use on adzuki beans.</i>

<sup>1</sup> For more information on herbicides for use in dry edible beans, see product labels.

<sup>2</sup> Pre = preemergence, PPI = preplant incorporation, Post = postemergence.

### Herbicides

For effective weed control in dry edible beans, any weeds present should be identified, and the best herbicide or herbicide combination should be selected (tables 1 and 2). For preplanting incorporation, several herbicides are available that give good annual grass control and fair-to-good control of some annual broadleaves. These herbicides are EPTC (Eptam), trifluralin (Treflan), profluralin (Tolban), and alachlor (Lasso). Thorough incorporation requires two tillage operations at right angles, with most tillage implements.

Two herbicides, chloramben (Amiben) and dinoseb or DNBP (several trade names), are available for preemergence use to control a wide range of annual broadleaf weeds with fair-to-good control of some annual grasses. If sufficient rainfall does not occur within 7 days after applying chloramben, use a shallow cultivation to kill germinating weeds and incorporate the herbicide. If rain is not expected, chloramben may be incorporated shallowly (1 to 2 inches deep) right after application. Dinoseb may be applied at a lower rate as the beans are emerging and up to the crook stage (table 2). Bentazon (Basagran) for broadleaf weed control is applied when weeds are small and after beans reach the first trifoliate leaf stage. The effectiveness of bentazon is much reduced after broadleaf weeds become larger than the 6 to 8 leaf stage (or more than 6 inches tall). Use the higher rate of bentazon for larger weeds up to the size limit specified for the species. See label.

### Summary

A weed control program should be based on the kind of beans, the weed species in the field, the soil type, the type of tillage, and any irrigation. Herbicide costs and expected bean yields also should be considered. If perennial or other weeds that cannot be controlled by tillage or a labeled herbicide are present, a more competitive crop than beans should be planted. Total weed control is neither probable nor necessary. However, adequate weed control, especially for the first 3 to 4 weeks, is required for profitable dry bean production.

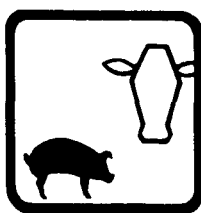
**Table 3. Herbicide names and formulations**

Common Name	Trade name	Concentration <sup>1</sup>
alachlor	Lasso	4 lb/gal L
bentazon	Basagran	4 lb/gal L
chloramben	Amiben	2 lb/gal L, 10% G
dinoseb (DNBP)	Premerge, others	1, 3, 5 lb/gal L, 10% G
EPTC	Eptam	7 lb/gal, 10% G
profluralin	Tolban	4 lb/gal L
trifluralin	Treflan	4 lb/gal L, 5% G

<sup>1</sup> L = liquid, G = granular.

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AGRICULTURAL CHEMICALS  
FACT SHEET No. 14-1981  
O.E. STRAND and D.L. WYSE

## Weed Control in Established Alfalfa and Other Forage Legumes

Minnesota has approximately three million acres of alfalfa, alfalfa-grass mixtures, or other forage legumes that are used primarily as livestock feed. Approximately one-third of these "hay-crop" acres are reestablished each year, partly because weeds take over and the stands become unproductive or produce low quality feed. Controlling weeds in forage crops does not always increase total dry matter production; however, most weeds are less palatable and provide a less dependable feed supply than adapted forage species. Controlling weeds usually results in improved forage quality and higher protein levels if good forage production practices also are used. Weed control also may prolong the productive life of the alfalfa stand by preventing competitive weeds such as quackgrass from crowding out the alfalfa.

Alfalfa often has been suggested as a rotational crop to help control certain problem weeds. Established stands of forage legumes can compete effectively with many weeds. If alfalfa is to compete well with weeds, however, it is important to establish a stand of at least 20 plants per square foot in the seedling year by using effective establishment practices. Then good management practices should be followed to maintain a competitive forage stand.

Many weeds in established legumes can be controlled by harvesting the crop before the weeds flower in order to prevent weed seed formation and dispersal. If weeds "go to seed" before the legume is ready for harvest, the forage should be ensiled, if possible. Fermentation in the silo kills many weed seeds.

### Cultural Practices for Weed Control in Forages

1. Before seeding alfalfa or other forage legumes, apply lime and fertilizer according to soil test needs.
2. Seed adapted varieties at the proper depth into a firm, level seed bed to help ensure good germination and seedling survival.
3. Use a timely and proven method of forage legume seeding and establishment. Direct seeding in the spring with an herbicide(s) or in the late summer without an herbicide has produced better legume stands than spring seeding with a companion crop.
4. Maintain a cutting/grazing schedule that allows adequate regrowth and recovery of the stand, consistent with the need for harvesting good quality forage.

### Herbicides for Weed Control in Established Forage Legumes

Many of the biennial or perennial broadleaf weeds that are troublesome in alfalfa are deep rooted and similar to alfalfa in growth habit. These weeds are difficult to control with herbicides without injury to the alfalfa. On the other hand,

quackgrass and other grass weeds that invade alfalfa are shallow rooted and are morphologically different enough from alfalfa so that control with herbicides is more feasible. However, the herbicides that control quackgrass also injure or kill most perennial forage grasses as well as the weedy grasses.

There is a rather limited number of herbicides available to control weeds in established alfalfa (table 1). These are simazine (Princep), metribuzin (Sencor/Lexone), terbacil (Sinbar), pronamide (Kerb), 2,4-DB (Butyrac, Butoxone), and certain formulations of MCPA. All of these except 2,4-DB are cleared for use only when the alfalfa is dormant or after the last cutting in the fall (see table 1) and all may cause alfalfa injury. Simazine should not be used on sands, loamy sands, or other coarse textured soils, or on soils where the soil pH is higher than 7.5. Metribuzin (Sencor/Lexone) may be used at varying rates on alfalfa/grass mixtures to control some broadleaf weeds and the amount of grass in the stand. Terbacil (Sinbar) should not be used on sand, loamy sand, gravelly soils, or soils with less than 1 percent organic matter, or crop injury may result.

All three of these herbicides (simazine, metribuzin, and terbacil) should be used only on alfalfa stands established for at least one year. Pronamide (Kerb) will control annual grasses and suppress quackgrass the following year, when applied in fall, if soil moisture conditions are favorable. Some formulations of MCPA are cleared for fall application (when alfalfa is dormant) to control certain winter annual, biennial, or perennial weeds whose "winter rosettes" are still actively growing. There is considerable potential for alfalfa injury, however, 2,4-DB (Butyrac/Butoxone) is effective for control of only a few broadleaf weeds if applied when the weeds are small (one to three inches tall). 2,4-DB should be applied only when daytime temperatures range between 40° and 90° F.

Some troublesome perennial weeds cannot be adequately controlled with herbicides in established alfalfa or other forage legumes. Many of these weeds, however, can be controlled with glyphosate (Roundup), see table 2, prior to seeding the legumes.

For effective control, glyphosate must be applied as a spray on at least 6 to 8 inches of topgrowth of actively growing perennial weeds. The field may be tilled and seeded three or more days later. Because individual weed species differ in their response to various herbicides, the first step in effective weed control with herbicides is to identify the weed problem(s). Then select the best herbicide or herbicide combination to use (tables 1 and 2). Refer to and follow herbicide labels for more information.



**Table 1. Herbicides for weed control in established alfalfa and other forage legumes.**

Crop(s)	Herbicide	Pounds per acre of active ingredient or acid equivalent broadcast	Time of application	Remarks	Environmental Protection Agency limitations on crop use
Alfalfa <sup>1</sup>	Simazine (Princep)	0.8 to 1.6	Fall, after last cutting. Prior to soil freeze-up.	May injure alfalfa. May carry over to injure next year's crop if other than corn.	Do not graze for 30 days or cut hay for 60 days after treatment.
Alfalfa <sup>1</sup>	Metribuzin (Sencor/Lexone)	0.35 to 1.0	Late fall or early spring when alfalfa is dormant.	May injure alfalfa.	Do not graze or harvest within 28 days of treatment.
Alfalfa <sup>1</sup>	Terbacil (Sinbar)	0.25 to 0.75	Late fall or early spring when alfalfa is dormant.	May injure alfalfa. Do not plant other crops within 2 years after treatment.	None
Alfalfa, clover, birdsfoot trefoil, or crown-vetch	Pronamide (Kerb)	1.0 to 2.0	Fall, when soil temperatures are less than 60° F. but before freeze-up.	May injure alfalfa.	Do not graze or harvest alfalfa within 25 to 45 days after treatment, depending on rate used. Do not graze or harvest other forage legumes for 120 days after treatment. See label.
Alfalfa	2,4-DB amine	0.5 to 1.5	When annual broad-leaf weeds are 1 to 3 inches tall (2 to 5 leaves).	May injure alfalfa.	Do not graze within 60 days or cut hay within 30 days of treatment.
Alfalfa	2,4-DB ester	0.5 to 1.0		May injure alfalfa.	
Alfalfa	MCPA <sup>2</sup>	1/4 to 1/2	Fall, after last cutting, when alfalfa is dormant.	Treat when temperatures are higher than 40° F. May injure alfalfa.	None

<sup>1</sup> Alfalfa should be established for one year or more.

<sup>2</sup> Certain formulations only, see label.

**Table 2. Effectiveness of herbicides on major weeds in established alfalfa.<sup>1</sup>**

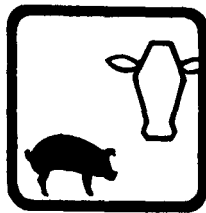
	Simazine	Metribuzin	Terbacil	Pronamide	2,4-DB	MCPA	Glyphosate
Alfalfa tolerance	F	F	F	G	F	P	N
<b>Grasses</b>							
Quackgrass	F	P	P	G	N	N	G
Wirestem muhly	F	P	P	G	N	N	G
<b>Broadleaves</b>							
White cockle	F	F	F	N	P	P	G
Hoary alyssum	F	P	P	N	P	P	G
Common dandelion	P	F	F	N	P	P	G
Curly dock	P	F	P	N	P	P	G
Yellow rocket	F	F	F	N	P	F	G
Field pennycress	G	G	G	P	G	G	G
Shepherd's-purse	G	G	G	P	G	G	G
Oxeye daisy	P	P	P	N	N	P	F
Narrowleaf hawkbeard	P	P	P	N	N	P	F
Orange hawkweed	P	P	P	N	N	P	F
Hempnettle	N	N	N	N	N	N	F
Hemp dogbane	P	P	P	N	N	P	F
Spotted knapweed	F	F	F	P	F	P	G
Virginia pepperweed	G	G	G	P	G	G	G
Perennial sowthistle	P	N	N	N	P	P	G
Tansy	N	N	N	N	N	N	F
Canada thistle	P	P	P	N	P	P	G
Bull thistle	F	F	F	P	F	F	G

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

<sup>1</sup> Effectiveness ratings apply if herbicide is used according to label recommendations as to rate, time of application, etc., and if favorable temperature and moisture conditions prevail.

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AGRICULTURAL CHEMICALS  
FACT SHEET No. 15  
OLIVER E. STRAND

Broadleaf weeds, many of them on the noxious weed list and several of them poisonous to livestock, infest considerable grass pasture acreage in Minnesota. These broadleaf weeds are generally less palatable, less nutritious, lower yielding, and are less dependable as a forage supply for livestock than the desirable grass or legume pasture species that they replace.

**Kinds of Pasture Weeds**

Most pasture weed species are perennial in growth habit or life span (will live for several years) and spread by underground rhizomes (stems) or rootstocks in addition to spreading by seed. These perennial weeds are not easily controlled by mowing because regrowth occurs from the underground perennial plant parts.

Some troublesome pasture weeds are biennial in growth habit. These spread entirely by seed but require two years to complete their life cycle. The first year they produce a rosette of basal leaves and a vigorous tap root system. The second year they produce flowers and seeds and then die. Many of these weeds are also difficult to control by mowing because during the first year they do not have an erect stem. By the second year they have developed an extensive root system with large food reserves that enables the plant to regrow several times if mowed off.

## Broadleaf Weed Control in Grass Pastures

There are also a few annual weeds that infest grass pastures. These weeds grow from seed each year and die after producing flowers and seeds. They may be summer annuals that germinate in the spring and die in the fall; or they may be winter annuals that germinate in the fall, live over winter, and produce flowers and seed in the spring or early summer before they die. Some of these weeds can be readily controlled by mowing, but unless they are clipped very close to the ground, they also may recover and regrow to produce seed.

**Herbicides for Use in Grass Pastures**

There are three herbicides presently available for broadleaf weed and brush control in grass pastures (table 1). These herbicides are:

1. 2,4-D (available under several trade names)
2. MCPA (available under several trade names)
3. dicamba (Banvel)
4. combinations of the above

These herbicides control some weeds but not others. Therefore, the first step in effective pasture weed control is to identify the weeds and be aware of their growth habit or life span (table 2). Then selection and timely use of the best herbicide or herbicide combination (tables 1 & 2)—together with

Table 1. Herbicides for weed control in grass pastures.

Chemicals	Pounds per acre of acid equivalent or active ingredient/A	Time of application	Remarks	Environmental Protection Agency registration limitations on use
2,4-D	½ to 2	Before bud stage of weeds, preferably when perennial weeds are 6 to 10 inches tall and growing rapidly or when biennials are in rosette stage. 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, dicamba, or mixtures of these for woody plant control. Esters or oil soluble amine formulations are more effective than amines on many weed species and are less affected by rainfall or dew.	Do not graze dairy animals on treated areas within 7 to 14 days after application of 2,4-D. See label. Do not cut 2,4-D treated grass for hay for 30 days.
MCPA	¼ to 2	When woody plants are fully leaved.	Avoid drift to susceptible broadleaf crops, especially soybeans, dry beans, sunflowers, and sugar beets.	Do not graze dairy animals on dicamba treated pastures for 7 to 21 days after these rates of application. See label.
Dicamba (Banvel)	½ to 1			
Dicamba + 2,4-D	1/3 to ¼ + 1 to 2			

**Table 2. Susceptibility of common pasture weeds to herbicides (weeds preceded by an asterisk may be poisonous to livestock).**

Weed name	Life span of weed	Susceptibility to herbicide <sup>1</sup>		
		2,4-D	MCPA	Dicamba
Alyssum, hoary	perennial	F	F	F
Aster sp.	perennial	F	F	G
*Bracken fern	perennial	P	P	F
Burdock, common	biennial	E	E	E
*Buttercup sp.	perennial	F	E	G
Daisy, oxeye	perennial	F	F	F
Dandelion, common	perennial	E	E	E
Dock, curly	perennial	G	F	G
Goldenrod sp.	perennial	F	F	G
Hawksbeard sp.	annual or biennial	P	P	F
*Hawkweed sp.	perennial	F	P	F
*Hemp	annual	E	E	E
Horseweed	annual	F	F	F
Knapweed, spotted	biennial	F	E	G
Kochia	annual	E	G	G
*Milkweed, common	perennial	P	N	F
Mullein, common	biennial	P	P	F
Nettle, stinging	perennial	G	F	F
Pennycress, field	annual	E	E	F
Plantain sp.	perennial	E	E	G
Ragweed, common	annual	E	E	E
Sorrel, red	perennial	N	N	G
*Snakeroot, white	perennial	F	F	G
Sowthistle, perennial	perennial	F	F	G
*Spurge, leafy	perennial	P	N	F
Tansy	perennial	F	N	G
Thistle, Canada	perennial	F	F	G
Thistle, bull	biennial	E	E	E
Thistle, musk	biennial	G	F	G
Thistle, plumelless	biennial	G	F	G
Thistle, Russian	annual	G	G	G
Toadflax, yellow	perennial	N	N	P
*Waterhemlock, spotted	perennial	G	F	F
Wormwood, absinth	perennial	F	P	G
Yarrow, common	perennial	F	P	F

<sup>1</sup>E = excellent, G = good, F = fair, P = poor, N = no control. (Ratings apply if recommended rate and time of application of herbicide is used and optimum temperature and growing conditions prevail.) References: USDA Farmer's Bulletin 2183, Revised 1975, "Using Phenoxy Herbicides Effectively;" Pasture Weed Control Demonstration and Research Results, Agricultural Extension Service, University of Minnesota; and herbicide labels.

other good pasture management practices such as fertilizer use, rotational grazing, clipping herbicide resistant weeds, and periodic clipping of ungrazed forage—will gradually reduce weed problems and improve grass pasture stands and yields.

Many years of research data and practical farmer use have shown that these herbicides are not harmful to livestock when applied on pasture grass and weeds at recommended usage rates following label restrictions. Because applied herbicides may make toxic weeds more palatable to livestock, however, livestock should be excluded from the sprayed area for 7 to 10 days after treatment if poisonous plants are present. Follow grazing restrictions and safety precautions as prescribed on the label for the specific herbicide used.

### Time of Application of Herbicides

Annual and biennial weeds are easiest to control with herbicides early in the first year of growth—after they have germinated and leafed out, but when they are still small. Biennial and winter annual weeds also may be effectively controlled with herbicides in the fall of the seedling year when they are in the rosette stage. Perennial weeds that arise from a parent root-

stock or underground rhizome, on the other hand, are best controlled with herbicides when they are at least 6 to 8 inches tall but before the bloom stage. During this growth stage, the perennial weeds are large enough to intercept an adequate amount of foliar herbicide to translocate enough into the root system to kill the weed. Also during this growth stage, translocation (of sugars produced in the leaves) is from leaf shoot to root rather than from root to shoot, which favors movement of the herbicide into the perennial root system and makes root kill more likely.

### Grass Pasture Improvement Recommendations

1. Evaluate the pasture area to determine yield improvement potential. Consider soil type, land capability, fertility level, and potential soil moisture supply. Do not attempt to improve "poor risk" pasture areas that are too wet, too droughty, too rocky, or otherwise unsuitable.
2. Identify weeds and select best herbicide or herbicide combination for control.
3. Take a representative soil sample from the pasture area. Have soil tested and apply phosphate and potash fertilizer according to need. If the grass stand is adequate, apply an increment of approximately 50 pounds of actual nitrogen (150 pounds of ammonium nitrate or equivalent) early in the spring. If rainfall is adequate, apply one or more additional increments of nitrogen as needed during the growing season to stimulate growth of additional grass. The use of fertilizer will make the grass more productive and more vigorous so that it will compete better with the weeds.
4. Apply herbicide(s) when predominant perennial pasture weeds are 6 to 8 inches tall but before bloom. Allow woody plants to become fully leaved out before spraying. More than one application of an herbicide may be needed for control. Early fall treatment of some biennials or fall retreatment of the regrowth of some perennials may be more effective than spring treatment.
5. Identify and avoid grazing areas where poisonous pasture weeds predominate until these weeds have been killed by herbicides.
6. Manage the pasture to favor the grass and help control the weeds. Allow grass to attain 5 to 6 inches of top growth before grazing the area. Use sufficient grazing pressure to utilize the grass rapidly before it matures. Rotate cattle to another pasture area to allow the grass 3 to 4 weeks recovery time after grazing. Clip grazed pasture areas to control escaped weeds and promote uniform regrowth of grass. Spread cattle droppings if needed.

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AGRICULTURAL CHEMICALS  
FACT SHEET No. 16-1981  
O.E. STRAND and N.P. MARTIN

## Establishing Forage Legumes with Herbicides

Each year Minnesota farmers establish nearly one million acres of alfalfa and legume-grass mixtures for livestock feed. Most of this acreage is seeded with a companion crop such as oats, wheat, or flax. A companion crop is used to help crowd out weeds that otherwise would compete excessively with the forage legumes. However, this companion or "nurse" crop also competes with the forage legumes and often reduces the forage stand.

Most of the companion crop acres are harvested as grain for a cash crop, or the straw is used for bedding and the grain for livestock feed. When the companion crop is allowed to grow to maturity, competition for light, water, and nutrients becomes severe and often kills or reduces the vigor of many forage legume seedlings and reduces forage yields. In Minnesota, most small grain companion crop acres are cut and swathed before combining to allow further drying. If rain delays combining, windrows often mat down over the forage legume seedlings and smother them. Also, the companion crop tends to shatter before or during combining, and thick stands of volunteer grain provide further competition for young forage seedlings.

Seedling legumes generally are poor competitors with weeds. If the seeding is done in the spring, annual grasses such as the foxtails and annual broadleaf weeds such as pigweed and common lambsquarters usually compete aggressively with the legumes. Unless the field is comparatively weed free or unless repeated tillage is used to kill seedling weeds prior to seeding, a herbicide usually is needed.

### Direct Seeding

Seeding alfalfa or other forage legumes alone in early spring with herbicides to control annual weeds is a relatively new method of legume establishment called "direct seeding." With this method there is little or no competition to the forage legumes, and better stands and higher yields are possible in the seeding year and subsequent years.

If alfalfa or other forage legumes are direct-seeded with a herbicide, no forage grasses can be included in the mixture or they will be injured or killed. Direct seeding of alfalfa should not be attempted on steep slopes or other soils where wind or water erosion is a problem. On these sites, a companion crop will give more soil protection and can be used, but it should be harvested as forage before the grain matures.

There are four herbicides cleared for use to control annual grass and broadleaf weeds in direct-seeded forage legumes. These are: EPTC (Eptam), benefin (Balan), and profluralin (Tolban), all preplant incorporated herbicides that will control most annual grass weeds and a few annual broadleaves, and 2,4-DB (Butyrac, Butoxone), which will control many annual broadleaf weeds when applied early postemergence (see table).

Annual grass weeds such as green, yellow, or giant foxtail usually compete more severely with forage legume seedlings than do broadleaf weeds. Therefore, one of the preplant incorporated herbicides should be used to control grass weeds and increase seeding year forage legume yields.

### Selecting a Herbicide

All three of the preplant incorporated herbicides can injure the forage legume seedlings if used at excessive rates for the soil type. Use the lower labeled rate on coarse- and medium-textured soils and the higher rate on fine-textured soils. These herbicides should be thoroughly incorporated into the top two to three inches of soil (see table).

EPTC is the most water soluble of the three, more subject to loss by leaching, and more likely to cause legume seedling injury under irrigation or high rainfall conditions, especially on coarse-textured soils. However, EPTC requires less soil moisture to activate the herbicide and has performed somewhat better under low rainfall conditions. EPTC also has given fair control of a few more broadleaf weeds such as common ragweed, which benefin or profluralin does not control.

### Controlling Perennial Weeds

If perennial weeds are a problem in a field to be seeded to forage legumes, these weeds should be controlled prior to seeding. Herbicides, tillage, or a combination of both can be used. Once forage legumes are seeded, perennial weeds are difficult to control without injury to the crop.

Perennial broadleaf weeds such as Canada thistle, perennial sowthistle, or field bindweed can be treated the fall prior to seeding with 2,4-D, dicamba (Banvel), or a combination of the two. For best results, spraying should be done before a killing frost when the weeds still are growing and temperatures are higher than 50°F. Before seeding pure alfalfa stands, glyphosate (Roundup) can be used to control perennial weeds such as quackgrass or Canada thistle either fall or spring prior to seeding. Spray when there is at least four to six inches of leaf canopy, and allow one week after treatment before tillage and seeding.

### Comparing Advantages and Disadvantages

Direct seeding has several advantages over establishing forage legumes with a companion crop. They include: less competition for legumes, thus better forage stands (especially true for birdsfoot trefoil); more high protein can be harvested per acre in the seeding year; less risk of weeds taking over the stand; and no establishment costs for companion crop.

Disadvantages include: less erosion control with legumes than with grass and legume mixture; no straw for bedding and no grain for potential cash crop; can only seed pure stands of legumes, not legume and grass mixtures; and seeding costs may be higher (herbicide cost).

## Keys to Successful Direct Seeding

Seed in the spring as soon as a good seedbed can be prepared. Alfalfa and red clover can be seeded earlier than birdsfoot trefoil. Birdsfoot trefoil is slower to germinate and has less seedling vigor. For alfalfa or red clover, usual seeding dates are April 15 to May 1 in southern Minnesota and May 1 to May 15 in northern Minnesota. Seeding of birdsfoot trefoil is often delayed two to three weeks after alfalfa or red clover.

Select an adapted, disease resistant species or cultivar. Seed 15 pounds of alfalfa, 14 pounds of red clover, or 10 pounds of birdsfoot trefoil per acre. Red clover and birdsfoot trefoil will tolerate poorly drained soil conditions better than alfalfa. If alfalfa is to be planted on poorly drained soils it is important to select a phytophthora resistant variety.

Apply corrective phosphate and potash, according to soil test needs, before secondary tillage. Apply lime to correct acid soil to a pH 6.8 for alfalfa and 6.0 for red clover and birdsfoot trefoil. Red clover and birdsfoot trefoil require less phosphate and potash than alfalfa. Yearly maintenance applications of phosphate and potash are needed on most soils to keep the stand productive.

Select one of the three preplant, incorporated herbicides — EPTC (Eptam), benefin (Balan), or profluralin (Tolban) — for annual grass weed control. Use the rate recommended for the soil type and apply and incorporate according to the herbicide label. It is best to apply and incorporate the herbicide three to five days before seeding.

Seed at the proper depth, ¼ to ½ inches, into a firm, level seedbed to help ensure seed germination and good seedling emergence.

Scattered annual broadleaf weeds will not compete seriously with forage legumes and likely will be killed by the first cutting. However, if annual broadleaf weeds become a serious problem, apply 2,4-DB (Butyrac, Butoxone) according to label directions when the forage legumes have two to four trifoliolate leaves and when weeds are small.

Harvest the first cutting of alfalfa in the bud to first bloom stage (usually 60 to 70 days after seeding). Birdsfoot trefoil can be cut 80 to 90 days after seeding. Two or three cuts of alfalfa are possible during the seeding year when seeded early and if rainfall is normal.

If the forage legume is seeded in mid to late summer, annual weeds are much less of a problem and seeding without a herbicide is usually possible. If the field is known to be weedy, however, one of the preplant, incorporated herbicides should be used to help reduce weed competition. The seeding should be done by early to mid-August to ensure good root establishment before a killing frost occurs.

Control perennial weeds with herbicides, tillage, or a combination of these prior to establishment.

Insect and disease problems need to be identified and controlled using recommended practices.

### Herbicides for direct seeding of forage legumes.

Crop(s)	Herbicide	Rate lbs/A	Time of Application	Remarks	EPA Limitations on use
Alfalfa; red or alsike clover; sweetclover; birdsfoot trefoil	EPTC	2 to 4	Preplanting incorporation	Incorporate immediately after application.	None
Alfalfa; red, alsike, or ladino clover; birdsfoot trefoil	benefin (Balan)	1 1/8 to 1 1/2	Preplanting incorporation	Incorporate as soon as possible within 8 hours after application.	None
Alfalfa only	profluralin (Tolban)	1/2 to 1	Preplanting incorporation	Incorporate as soon as possible within 4 hours.	None
Alfalfa; red, alsike, or ladino clover; birdsfoot trefoil (amine)	2,4-DB (Butyrac, Butoxone)	1/2 to 1 1/2 (amine)	When legumes have 2 to 4 trifoliolates and weeds are small	Use lower rates for weeds less than 1 inch tall; higher rates for weeds 2 to 3 inches tall.	Do not graze or feed treated crop within 60 days after application.
Alfalfa; birdsfoot trefoil (ester)		1/2 to 1 (ester)			

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**AGRONOMY**

**FACT SHEET No. 35—Revised 1982**

**O.E. STRAND and R. BEHRENS**

# Identification and Control of Wild Proso Millet

Wild proso millet (*Panicum miliaceum* L.) was first identified as a serious weed problem in Minnesota in 1970. Since then it has been found in 41 Minnesota counties ranging from Dakota and Chisago in the east to Lincoln, Lac Qui Parle, and Wilkin in the west. Found mainly in corn and soybean fields, wild proso millet is a prolific seed producer and a vigorous competitor in row crops.

Cultivated proso millet (*Panicum miliaceum* L.), also called "Hog Millet," is grown as a feed grain and bird seed crop in Minnesota and in several other states. Since it is similar to oats or barley in feed value, in some countries of the world proso millet is used as human food.

The exact origin of wild proso millet is unknown. Some evidence exists that it may have come from Asia or central Europe, or it may have developed a weedy growth habit over time from one of the many cultivated varieties. Wild proso millet resembles the seed and panicle type of an old proso millet variety, "Crown," which was grown widely in Minnesota in the 1940s and 1950s. One farmer in Stevens County, Minnesota, reported that he had observed wild proso millet in several patches on his farm since the 1930s when he purchased seed and grew a mixed millet emergency hay crop on his farm.

**DESCRIPTION AND TAXONOMY OF WILD PROSO MILLET**

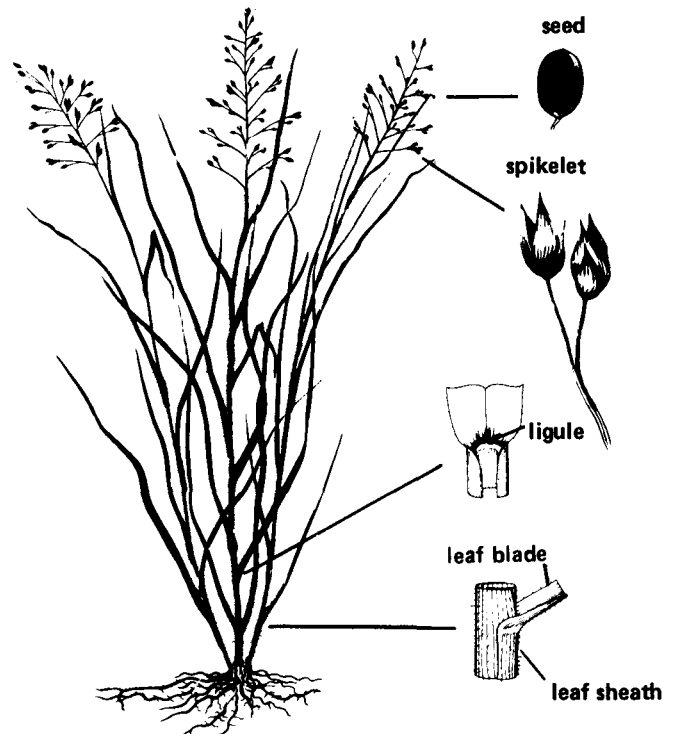
Wild proso millet is a very competitive branching annual that grows from seed each year. It is erect in growth habit, growing from 2 to 6 feet tall, but some culms (stems) may be decumbent (prostrate) at the base. It has leaf blades that range from smooth to somewhat hairy on both surfaces and from 1/2 to 3/4 inch wide. The leaf sheaths (which encircle the stems) are round, split, and have long, spreading hairs. The ligule (projection at base of leaf blade) is a dense fringe of hairs fused at the base and approximately 2 mm. long. Each culm is topped by a spreading panicle 6 to 12 inches wide, which often is not fully extended from the leaf sheath. The spikelets, composed of the seed and surrounding glumes, are 4 to 5 mm. long, ovate, pointed at the tip, and strongly nerved with 7 to 9 nerves. There is one fertile floret (seed) per spikelet with a hardened lemma and palea (hulls) and the caryopsis, or grain, within. The seed is smooth and shiny, olive-brown to brownish-black in color at maturity, and approximately 2 1/2 to 3 mm. long by 1 1/2 to 2mm. wide with definite nerves or veins visible on the surface.

Wild proso millet is in the *Panicaceae* (millet) tribe of the grass family, closely related to the corn and sorghum tribes. These three tribes make up one subfamily of the grasses as classified by A.S. Hitchcock, a noted authority on grasses, in *Manual of the Grasses of the United States*. Like corn, the first internode of wild proso millet elongates during emergence,

permitting this weedy grass to germinate from depths of 2 or more inches in the soil. The readily identifiable seed of wild proso millet usually does not deteriorate after germination. If the plant is carefully removed from the soil, the seed often can be found among the roots to aid in identification of the plant. Also like corn, wild proso millet is tolerant of atrazine and has been increasing rapidly in areas where atrazine has been used widely as the principal corn herbicide.

Unlike cultivated proso millet, the wild strain has definite weedy characteristics. Several panicles are produced on each plant, some from the axils of the upper leaves that ripen later than the terminal inflorescence over a several-week period. Seed production usually continues until a killing frost stops plant growth in the fall. The seed is easily shed from the plant when mature and normally does not germinate in the fall but remains dormant over winter to germinate the following spring. Wild proso millet produces a large quantity of seed per plant. It is common to find 500 or more seeds per square foot in infested areas. The seed is spread easily by harvesting equipment, especially in sweet corn production fields (where it has been spreading rapidly).

**Wild proso millet (*Panicum miliaceum* L.).**





# Weed Control in Small Grains

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This folder summarizes herbicide treatments for controlling weeds in small grains. For additional information refer to herbicide labels.

## Spring Wheat, Durum Wheat, Oats, and Barley

If small grain is not underseeded with a legume, more herbicides and higher rates may be used (see tables 1 and 3).

## Winter Wheat and Rye

For winter wheat and rye apply all weed control chemicals except triallate in the spring only. Apply triallate in either fall or spring (see table 3).

## Consider Effectiveness and Tolerance

Accurately identify the weed problem and then select the most effective herbicide (see table 4). Consider crop tolerance as well as effectiveness, however (see table 5). See table 6 for common names and trade names of herbicides and their formulations.

## Caution

Avoid repeated and prolonged contact with all herbicides, especially direct contact with skin and eyes. Check label directions and restrictions. Avoid wind drift of herbicides to susceptible crops and ornamentals.



Wild mustard and wild buckwheat control in wheat requires a combination of herbicides.

**Table 1. Suggestions for chemical weed control in spring-sown small grains not underseeded with a legume**

Chemicals <sup>1</sup>	Pounds per acre of acid equivalent or active ingredient broadcast	Time of application	Remarks	Environmental Protection Agency limitations on use
<i>Spring or durum wheat or barley</i>				
2, 4-D amine	¼ to ⅓	After tillering to early boot.	For broadleaves. Amine less injurious to crop.	Do not graze for 2 weeks after treatment.
2, 4-D ester	⅓ to ½			
MCPA amine	¼ to ⅓	Two-leaf to early boot.		None
MCPA ester	⅓ to ½			
bromoxynil	¼ to ½	Two-leaf to early boot.	For broadleaves. Best control when weeds are small. Bromoxynil is effective on smartweeds and wild buckwheat. Mixture may be tank-mixed with diclofop.	Do not graze for 30 days after treatment.
bromoxynil and MPCA esters	¼ + ¼			



**Table 1. (cont.) Suggestions for chemical weed control in spring-sown small grains not underseeded with a legume**

Chemicals <sup>1</sup>	Pounds per acre of acid equivalent or active ingredient broadcast	Time of application	Remarks	Environmental Protection Agency limitations on use
picloram and 2, 4-D amine	$\frac{1}{64}$ to $\frac{3}{128}$ + $\frac{1}{4}$ to $\frac{3}{8}$	Four-leaf to early boot.	Picloram may persist in the soil to harm most broadleaf crops the following year. See label.	None
trilalate	1 to $1\frac{1}{4}$ (wheat) $1\frac{1}{4}$ to $1\frac{1}{2}$ (barley)	Preemergence, spring (wheat). Preplanting or preemergence, fall or spring (barley).	For wild oat control. Must be incorporated into soil. Use higher rates for granules, lower rates for liquid. Liquid may be tank-mixed with trifluralin on spring wheat or barley.	Do not graze livestock on treated areas.
barban	$\frac{1}{4}$ to $\frac{3}{8}$	When wild oat is in two-leaf stage. Two sequential applications at $\frac{1}{4}$ lb/A each or one "late" application of up to $\frac{1}{2}$ lb/A permitted. See label.	For wild oat control. Do not spray after crop is in the four-leaf stage. Use high rate on wild oat populations over 50 plants/sq. ft. and on semi-dwarf wheats.	Do not graze treated fields until after harvest.
difenzoquat	$\frac{5}{8}$ to 1	When wild oat is in three- to five-leaf stage.	For wild oat control. Use higher rates for higher density stands of wild oat. May be tank-mixed with MCPA and/or bromoxynil and with 2, 4-D.	Do not graze treated fields or cut for silage. Grain and straw can be fed. Use only on barley, and on durum wheat and spring wheat varieties listed on the label.
diclofop	$\frac{3}{4}$ to $1\frac{1}{4}$ (wheat) $\frac{3}{4}$ to 1 (barley)	One- to four-leaf stage of grass weeds (wheat). One- to three-leaf stage of grass weeds (barley).	For annual grass weeds including wild oat. Use high rate for larger weeds. Only tank mix with bromoxynil. Do not apply other broadleaf herbicides within one week of diclofop application.	Do not graze treated areas or harvest forage from treated fields prior to grain harvest.
trifluralin	$\frac{1}{2}$ to $\frac{3}{4}$	Postplanting incorporation.	Improper application may result in crop injury. See label. Liquid formulation may be tank mixed with trilalate.	None
<i>Spring or durum wheat or oats</i>				
dicamba and MCPA	$\frac{1}{8}$ + $\frac{1}{4}$	Two- to five-leaf stage.	Dicamba is effective on wild buckwheat or smartweeds.	Do not graze or feed forage to dairy animals prior to crop maturity.
<i>Spring wheat</i>				
propanil	$1\frac{1}{2}$	Three- to five-leaf stage of wheat.	For annual grasses and certain broadleaves. May cause temporary leaf injury or a slight delay in maturity.	Do not graze treated crop or cut for green chop feed.
propanil + MCPA isooctyl ester	$1\frac{1}{8}$ + $\frac{1}{4}$	Two- to four-leaf stage of grass weeds.		
<i>Oats</i>				
2, 4-D amine	$\frac{1}{4}$ to $\frac{1}{2}$	Six-leaf to early boot.	MCPA less injurious to crop.	Do not graze for 2 weeks after treatment.
MCPA amine	$\frac{1}{4}$ to $\frac{3}{8}$	Two-leaf to early boot.	Bromoxynil for smartweeds and wild buckwheat.	None
MCPA ester	$\frac{1}{8}$ to $\frac{1}{2}$			None
bromoxynil	$\frac{1}{4}$ to $\frac{3}{8}$			Do not graze for 30 days after treatment.

<sup>1</sup>See table 6 for trade names of herbicides and their formulations.

**Table 2. Suggestions for chemical weed control in spring-sown small grains underseeded with a legume**

Chemicals	Pounds per acre of acid equivalent broadcast	Time of application	Remarks	Environmental Protection Agency limitations on use
<i>Spring-sown wheat, oats, and barley</i>				
2, 4-D or MCPA amine	$\frac{1}{8}$ to $\frac{1}{4}$	Six-leaf to early boot stage of small grain. Not before clover is 2 inches tall.	Legumes injured, canopy of crop or weeds reduces injury. Do not use on sweet clover.	Do not graze dairy animals on treated areas for 14 days after application of 2, 4-D.
diallate	$1\frac{1}{4}$	Incorporate into the soil after planting but before emergence.	For wild oat control in barley underseeded to a legume.	None

**Table 3. Suggestions for weed control in winter wheat and rye**

Chemicals	Pounds per acre of acid equivalent broadcast	Time of application	Remarks	Environmental Protection Agency limitations on use
<i>Winter wheat or rye</i>				
2, 4-D amine	1/4 to 3/4 } 1/4 to 1/2 } 1/4 to 3/4 }	In spring, after grain is fully tillered, but before boot stage.	For broadleaves	Do not graze for 2 weeks after treatment with 2, 4-D. None for MCPA.
2, 4-D ester				
MCPA amine or ester				
bromoxynil	1/4 to 1/2 } 1/4 + 1/4 }	After wheat is fully tillered to boot stage.	For broadleaves	Do not forage or graze for 30 days after treatment with bromoxynil.
bromoxynil + MCPA ester				
<i>Winter wheat only</i>				
dicamba + 2, 4-D amine	1/8 + 1/4 to 3/8 } 1/8 + 1/4 to 3/8 }	After winter dormancy until wheat begins to joint.	For broadleaves	Do not graze dicamba treated fields or harvest for dairy feed prior to crop maturity.
dicamba + MCPA amine				
diclofop	3/4 to 1 1/4	When grass weeds are in the one- to four-leaf stage.	For annual grass control. May be tank-mixed with bromoxynil.	Do not graze treated fields or harvest treated forage prior to grain harvest.
difenzoquat	5/8 to 1	When wild oat is in three- to five-leaf stage.	For wild oat control.	Do not graze treated fields or cut for silage. Grain and straw can be fed.
triallate	1 1/4 (liquid) 1 1/4 to 1 1/2 (granules)	Must be incorporated into soil after application. See label.	For wild oat control.	Do not graze livestock on treated areas.
barban	1/4 to 3/8	When wild oat is in two-leaf stage.	For wild oat control. Use high rate for wild oat populations over 50 plants/sq. ft. Sequential applications may be made if necessary. See label.	Do not graze treated fields until after harvest.
picloram + 2, 4-D amine	1/64 to 3/128 + 1/4 to 3/8	Four-leaf to early boot.	For broadleaf weeds. May persist in the soil. Use only where a grass or grain crop will be planted the following year; one application per year.	None

**Table 4. Effectiveness of herbicides on major weeds in small grains**

	Small grains											
	trifluralin (Treflan)	triallate (Far-go)	diallate (Avadex)	2, 4-D amine or ester	MCPA amine or ester	bromoxynil (Brominal/Buctril)	dicamba (Banvel)	picloram (Tordon 22K)	barban (Carbyne)	difenzoquat (Avenge)	diclofop (Hoelon)	propanil (Stampede)
<i>Grasses</i>												
Green foxtail	G	N	N	N	N	N	N	N	N	N	G	G
Yellow foxtail	G	N	N	N	N	N	N	N	N	N	F	G
Barnyard grass	G	N	N	N	N	N	N	N	N	N	G	G
Wild oat	P	G	G	N	N	N	N	N	G	G	G	P
<i>Broadleaves</i>												
Wild mustard	N	N	N	G	G	F	P	P	N	N	N	F
Wild buckwheat	P	N	N	F	F	G	G	G	N	N	N	G
Lambsquarters	G	N	N	G	G	G	G	F	N	N	N	G
Pigweed	G	N	N	G	G	G	G	F	N	N	N	G
Smartweed (annuals)	P	N	N	F	F	G	G	F	N	N	N	P
Common ragweed	N	N	N	G	G	G	G	F	N	N	N	P
Giant ragweed	N	N	N	G	G	G	G	F	N	N	N	P
Kochia	P	N	N	G	G	G	G	F	N	N	N	F
Marshelder	P	N	N	G	G	G	G	F	N	N	N	P
Canada thistle	N	N	N	F	F	N	G	P	N	N	N	N
Perennial sowthistle	N	N	N	F	F	N	G	P	N	N	N	N

G = good; F = fair; P = poor; N = no control

Effectiveness ratings apply if herbicide is used according to label recommendations as to rate, time of application, etc., and if favorable temperature and moisture conditions prevail.

**Table 5. Crop tolerance and herbicide clearance<sup>1</sup>**

Herbicides	Oats	Wheat	Barley	Rye
2, 4-D amine	F	G	G	G
2, 4-D ester	P	F	G	F
MCPA amine	G	G	G	G
MCPA ester	G	G	G	G
bromoxynil	G	G	G	G
dicamba	G	F	P	—
triallate	—	G	G	—
diallate	—	F	F	—
barban	—	F	F	—
difenzoquat	—	*	G	—
trifluralin	—	F	F	—
picloram	—	G	G	—
propanil	—	F	—	—
diclofop	—	G	G	—

<sup>1</sup>P = poor, F = fair, G = good, — = not cleared for use.

\*Good tolerance on winter wheat, and on spring wheat and durum wheat varieties listed on the label. Not cleared for use on other spring wheat varieties. See label.

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**Table 6. Herbicide names and formulations used in small grains**

Common name	Trade name	Concentration and commercial formulation <sup>1</sup>
barban	Carbyne	1 lb/gal L
bromoxynil	Buctril, Brominal	2 lb/gal L
bromoxynil and MCPA	Bronate, Brominal Plus	2 lb/gal MCPA + 2 lb/gal bromoxynil L
diallate	Avadex	4 lb/gal L 10% G
dicamba and MCPA	MonDak Banvel M	1.25 lb/gal dicamba + 2.50 lb/gal MCPA L
difenzoquat	Avenge	2 lb/gal L
MCPA	Several, mixtures	See product label.
triallate	Far-go, Avadex-BW	4 lb/gal L 10% G
2, 4-D	Several	See product label.
trifluralin	Treflan	4 lb/gal L
picloram	Tordon 22K	20 lb/gal L
propanil	Stampede	3 lb/gal L
diclofop	Hoelon	3 lb/gal L

<sup>1</sup>G = granular, L = liquid.

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# Cultural and Chemical Weed Control in Soybeans

GERALD R. MILLER and OLIVER E. STRAND  
extension agronomists

Weeds can be most effectively controlled in soybeans with a well-planned program that involves a thorough analysis of the field situation and use of a combination of cultural practices and appropriate herbicides. The most effective weed control system depends on the kinds of weeds in the field, soil characteristics, tillage practices, crop rotation, and soybean row width.

Weeds are vigorous competitors with soybeans. Weeds usually germinate and emerge with the soybeans, so the soybeans cannot get ahead of the weeds. Soybeans are relatively short and susceptible to shading from taller weeds. Weeds also compete with soybeans for nutrients and water. Since soybeans are especially sensitive to moisture deficiencies in late summer, a few large weeds can severely reduce yields. Nearly complete weed control must be accomplished within three to four weeks after emergence of the soybeans in order to avoid yield losses due to early emerging weeds.

## Cultural Practices

Several cultural practices aid weed control in soybeans. Seedbed preparation immediately prior to planting will kill weeds that have germinated. Killing these weeds is important in obtaining good results from preemergence herbicides. Preemergence herbicides need to be moved into the soil by rainfall before weed seeds germinate. A rotary hoe, harrow, or cultivator should be used to control weeds that germinate as soon as weeds appear at the soil surface.

## Herbicides

A herbicide or herbicide combination should be selected on the basis of the weed species in the field (table 1), performance, soil texture, pH of the soil, amount of organic matter in the soil, soybean tolerance, crop rotation, tillage practices, and economics. Field conditions that affect a herbicide's performance or limit its usefulness must be considered. Dry soil, heavy rain after application, surface trash, or a poor seedbed may reduce weed control. Cultivation practices and postemergence herbicide applications should be used when necessary to supplement soil applied herbicides.

Herbicide mixtures are used to overcome the 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. See table 2 for labeled tank-mixes of herbicides suggested for use in Minnesota. Only those mixtures that have been field tested under local conditions should be used. The use of some mixtures may result in poor weed control or crop injury.

The correct herbicide rate must be used to obtain good weed control and to minimize soybean injury. Herbicide rates must be adjusted for soil texture, percent organic matter, soil pH, kinds of weeds, potential for soil residue, and whether the herbicide is to be used alone or in combination. See table 3 for herbicide rate ranges. Always consult herbicide labels for specific rates. Only chemicals that are cleared by the Environmental Protection Agency for the specific use intended should be used.

## Preplant Incorporated Applications

Fluchloralin (Basalin), pendimethalin (Prowl), profluralin (Tolban), trifluralin (Treflan), or vernolate (Vernam) are suggested for preplant incorporated use in soybeans. These herbicides have provided good control of annual grasses, pigweed, and common lambsquarters. Vernolate and pendimethalin have also controlled velvetleaf and vernolate controls nutsedge and Venice mallow.

Proper herbicide application and favorable soil conditions are necessary for optimum herbicide performance. The soil should be moist, but not wet, to ensure maximum mixing of herbicide and soil during preplant herbicide incorporation. To provide good control, adequate moisture is needed at the point where the emerging weed seedling contacts the herbicide.

Good incorporation thoroughly mixes the herbicide with 2-3 inches of soil. Incorporate the herbicide twice with a disk, field cultivator with sweep shovels, or similar implement, or once with a power driven rotary tiller. The second incorporation should be carried out at a right angle to the direction of the first incorporation. This is needed to ensure thorough mixing of the herbicide with the soil. Observe label instructions for proper equipment depth and operation speed. Under ideal soil conditions, adequate incorporation may be accomplished with one trip using multiple implements.

To prevent herbicide loss by evaporation, vernolate must be incorporated immediately after application and should not be applied to a wet soil surface. Consult specific labels to determine the maximum time period allowed between application and incorporation of other herbicides.

Fluchloralin, pendimethalin, profluralin, and trifluralin may persist more than one year in some soils under dry or cold conditions. Sensitive crops such as corn, small grains, grain sorghum, or sugarbeets can be affected the following year. Plowing with a moldboard plow reduces the potential for crop injury from residues of these herbicides compared to reduced tillage systems that do not include moldboard plowing.

## Preplant Incorporated or Preemergence Applications

Several herbicides including alachlor (Lasso), chloramben (Amiben), metolachlor (Dual), and metribuzin (Sencor or Lexone) are suggested for use either preplant incorporated or preemergence. These herbicides may be left on the soil surface or incorporated with one or two tillage operations. Preplant incorporated applications of these herbicides into moist soil are more effective during years when rainfall to activate preemergence applications does not occur; however, preemergence applications provide more effective weed control when adequate rainfall does occur. If weed seedlings begin to emerge following a preemergence application, then an early harrowing, rotary hoeing, or shallow cultivation will result in more effective weed control.

Alachlor and metolachlor control annual grasses, nutsedge, redroot pigweed, and nightshade. Control of other broadleaf weeds has been erratic. Preplant

**Table 1. Effectiveness of herbicides on major weeds in soybeans.**

	Preplant incorporated										Preemergence							Postemergence							
	Alachlor (Lasso)	Chloramben (Amiben)	Fluchloralin (Basalin)	Metolachlor (Dual)	Metribuzin (Sencor or Lexone)	Pendimethalin (Prowl)	Profluralin (Tolban)	Trifluralin (Treflan)	Vernolate (Vernam)	Alachlor (Lasso)	Bifenox (Modown)	Chloramben (Amiben)	Chlorpropham (Furloe Chloro IPC)	Naptalam + Dinoseb (Dyanap)	Linuron (Lorox)	Metolachlor (Dual)	Metribuzin (Sencor or Lexone)	Oxyfluorfen (Goal)	Acifluorfen (Blazer)	Bentazon (Basagran)	2,4-DB (Butoxone or Butyrac 200)	Diclofop (Hoelon)	Dinoseb (Premerge)	Naptalam (Alanap L)	Naptalam + dinoseb (Dyanap)
	G	G	F/G	G	F	F/G	F/G	F/G	F	G	P	G	G	P	F	G	F	—	F	G	P	G	P	G	F
<b>Grasses</b>																									
Giant foxtail	G	G	G	G	F	G	G	G	G	G	P	F/G	P	P	F	G	F	P	P	Z	Z	Z	G	P	P
Green foxtail	G	G	G	G	F	G	G	G	G	G	P	F/G	P	P	F	G	F	P	P	Z	Z	Z	G	P	P
Yellow foxtail	G	G	G	G	F	G	G	G	G	G	P	F/G	P	P	F	G	F	P	P	Z	Z	Z	G	P	P
Barnyardgrass	G	G	G	G	F	G	G	G	G	G	P	F/G	P	P	F	G	F	P	P	Z	Z	Z	G	P	P
Wild proso millet	F	F	F	F	P	F	F	F	F	F	P	F	P	P	F	F	P	P	P	Z	Z	Z	P	P	P
Nutsedge	G	P	N	G	P	N	N	N	G	F	P	N	P	P	F	P	P	P	P	G	Z	P	P	P	P
<b>Broadleaves</b>																									
Black nightshade	F	F	P	F	P	P	P	P	P	G	F	G	P	—	P	G	P	G	F	F	P	Z	Z	G	—
Hairy nightshade	F	F	F	F	P	P	P	P	P	G	F	G	P	—	P	G	P	G	F	F	P	Z	Z	G	—
Cocklebur	P	P	Z	Z	F	Z	Z	Z	P	Z	P	P	P	—	P	Z	F	P	G	F	F	Z	Z	F	—
Kochia	F	G	G	P	G	G	G	G	—	P	P	G	P	—	P	P	G	P	—	F	F	Z	Z	F	—
Lambsquarters	F	G	G	P	G	G	G	G	—	P	P	G	P	—	P	P	G	P	—	F	F	Z	Z	F	—
Mustard	P	F	P	P	G	Z	Z	Z	F	P	P	G	P	—	P	P	G	F	G	F	F	Z	Z	—	—
Pigweed	G	G	G	G	G	G	G	Z	P	G	P	G	P	—	P	P	G	F	G	F	F	Z	Z	—	—
Common ragweed	P	G	Z	P	F	Z	Z	Z	P	P	P	G	P	—	P	P	G	F	G	F	F	Z	Z	—	—
Giant ragweed	P	F	Z	P	G	Z	Z	Z	P	P	P	G	P	—	P	P	G	F	G	F	F	Z	Z	—	—
Smartweed	P	G	P	P	G	F	P	P	P	P	G	G	P	—	P	P	G	F	G	F	F	Z	Z	—	—
Velvetleaf	P	F	Z	P	F	F	Z	Z	P	P	P	G	P	—	P	P	G	F	G	F	F	Z	Z	—	—
Venice mallow	P	G	Z	P	F	P	Z	Z	P	P	—	P	P	—	P	P	—	—	G	F	F	Z	Z	—	—
Wild sunflower	P	P	N	P	F	Z	Z	Z	P	P	—	P	P	—	P	P	—	F/G	G	P	Z	Z	F	—	—

G = good; F = fair; P = poor; N = no control; — = insufficient information.

**Table 2. Labeled tank mixes<sup>1</sup> of suggested incorporated and preemergence herbicides for soybeans.**

	Alachlor (Lasso)	Chloramben (Amiben)	Chlorpropham (Furloe Chloro IPC)	Fluchloralin (Basalin)	Linuron (Lorox)	Metolachlor (Dual)	Metribuzin (Sencor or Lexone)	Pendimethalin (Prowl)	Profluralin (Tolban)	Trifluralin (Treflan)	Vernolate (Vernam)
Alachlor (Lasso)	—	L	L	—	L	—	L	—	—	—	—
Chloramben (Amiben)	L	—	—	—	—	L	L	—	—	—	L
Chlorpropham (Furloe Chloro IPC)	L	—	—	—	—	—	—	—	L	L	L
Fluchloralin (Basalin)	—	—	—	—	—	—	—	—	—	—	—
Linuron (Lorox)	L	L	—	—	—	L	L	L	L	—	—
Metolachlor (Dual)	—	L	—	—	—	L	L	—	—	—	—
Metribuzin (Sencor or Lexone)	L	L	—	L	L	L	—	—	—	—	—
Pendimethalin (Prowl)	—	—	—	—	—	—	L	—	—	—	—
Profluralin (Tolban)	—	—	—	—	—	—	—	L	—	—	—
Trifluralin (Treflan)	—	L	—	—	—	—	—	—	L	—	—
Vernolate (Vernam)	—	L	L	L	—	—	—	—	—	—	—

<sup>1</sup>See table 1 for effectiveness of herbicides on major weeds and table 3 for additional use information.

L = labeled; — = unlabeled

**Table 3. Suggested herbicides for weed control in soybeans.**

Chemicals	Formulation(s)	Pounds per acre of active ingredient or acid equivalent broadcast	Application time(s)	Remarks	Environmental Protection Agency registration limitations on crop use
Fluchloralin (Basalin)	4 lb/gal L	½ to 1½	Preplant incorp.	Must be incorporated	Do not graze or feed forage
Pendimethalin (Prowl)	4 lb/gal L	½ to 1½	Preplant incorp.	Incorporate to reduce crop injury	None
Profluralin (Tolban)	4 lb/gal L	½ to 1½	Preplant incorp.	Must be incorporated	None
Trifluralin (Treflan)	4 lb/gal L	½ to 1	Preplant incorp.	Must be incorporated	None
Vernolate (Vernam)	7 lb/gal L	2 to 3	Preplant incorp.	Incorporate immediately	None
Alachlor (Lasso)	4 lb/gal L 15% G	2 to 4	Preplant incorp. or preemergence	Incorporate for nutsedge control May shallow incorporate for annual weeds	None
Chloramben (Amiben)	2 lb/gal L 10% G	3	Preplant incorp. or preemergence		None
Chlorpropham (Furloe Chloro IPC)	4 lb/gal L 10% G	2 to 3	Preplant incorp. or preemergence	For smartweed control	None
Metolachlor (Dual)	8 lb/gal L	1½ to 3	Preplant incorp. or preemergence	Incorporate for nutsedge control	None
Metribuzin (Sencor, Lexone)	4 lb/gal L 50% WP 75% DF	¼ to ¾	Preplant incorp. or preemergence	Increased soybean injury potential at high use rates. Use in combinations at lower rates. See label for soil use restrictions. Soybean injury may occur on alkaline soils, sandy soils and where atrazine residues are present.	None
Linuron (Lorox)	50% WP	½ to 2½	Preemergence	Increased soybean injury potential at high use rates. Use in combinations at lower rates. Do not use on soils with organic matter higher than 5 percent or lower than ½ percent	None
Acifluorfen (Blazer)	2 lb/gal L	¾ to ½	Early postemergence (soybeans in first trifoliolate, weeds less than 2 inches tall and 4 true leaves)	Controls many annual broadleaves, including black nightshade	Do not graze or use soybean hay or forage
Bentazon (Basagran)	4 lb/gal L	¾ to 1½	Early postemergence (see label)	Controls most annual broadleaves, Canada thistle, nutsedge	
2,4-DB amine	2 lb/gal L	½	Postemergence directed	For cocklebur control	Do not harvest within 60 days after application
Diclofop (Hoelon)	3 lb/gal L	¾ to 1¼	Early postemergence when soybeans are between the first and sixth trifoliolate leaf stage, before annual grasses exceed 4 leaves, before volunteer corn exceeds 10 inches	Controls many annual grasses, any volunteer corn	Do not graze or use soybean hay or forage

<sup>1</sup>G = granular; L = liquid; WP = wettable powder; DF = dry flowable.

incorporation of alachlor or metolachlor has resulted in more consistent yellow nutsedge control than preemergence applications.

Chloramben controls many annual broadleaved and grass weeds on a wide range of soils when sufficient rainfall occurs before weeds emerge. Crop tolerance is good on a wide range of soils and under high pH conditions. Excessive rainfall can move chloramben below the zone of weed seed germination, resulting in poor weed control, or the rainfall can move it near the germinating crop seeds, resulting in crop injury. This is particularly true in coarse textured (sandy) soils.

Metribuzin has provided good control of several common hard-to-control broadleaf weeds, but it has marginal crop safety. Potential crop injury can be decreased by using reduced rates of metribuzin with another herbicide. Metribuzin should not be used under the following circumstances: See the label for restrictions on various soils and soybean varieties. Soybean injury is more likely on alkaline soils, sandy soils, where atrazine residues are present, or if used with vernolate.

Chlorpropham (Furloe Chloro IPC) applied preplant incorporated or preemergence has given good control of annual smartweed species. Soybeans have good tolerance to chlorpropham.

Pendimethalin (Prowl) applied preemergence to soybean has controlled annual grasses and certain broadleaved weeds; however, callusing and brittleness of soybean stems has occurred. Incorporation of pendimethalin has increased the control of many weeds and reduced soybean injury.

Bifenox (Modown) applied preemergence has provided fair to good control of some annual broadleaf weeds including pigweed, common lambsquarters, and annual smartweeds. Soybean tolerance to bifenox is limited. Severe malformation and stunting of young soybeans has occurred. Bifenox may be incorporated; however, if it is, incorporation should be shallow. Incorporation of bifenox has resulted in reduced crop injury and reduced weed control.

## Preemergence Applications

Preemergence applications of linuron (Lorox) controls annual broadleaved weeds and some grasses in soybeans. Linuron is best suited for medium textured soils with 4 percent organic matter or less. Weed control has been inconsistent on fine-textured soils with high organic matter content. Soybean injury may occur on sandy low organic matter soils. Potential crop injury can be decreased by using reduced rates of linuron with another herbicide.

Oxyfluorfen (Goal) is a preemergence herbicide that controls pigweed, mustard, lambsquarters, and nightshade. Grass control has been inconsistent and soybean tolerance is limited. Early injury to young soybeans often has occurred, and incorporation has reduced its effectiveness. Oxyfluorfen is labeled only for soybeans grown in no-tillage fields. It may be mixed with alachlor.

## Postemergence

Acifluorfen (Blazer) and bentazon (Basagran) are suggested for postemergence broadleaf weed control in soybeans. The herbicide used should be determined by the weed species in the field. The leaf stage and size of the weeds at the time of herbicide application are critical for consistent control with either herbicide. Applications made to weeds larger than the maximum labeled leaf stage may result in inconsistent, partial, or only temporary control. Observe label limits concerning the maximum leaf stage of specific weeds.

Acifluorfen can be applied once (early postemergence) during a season to control broadleaf weeds in soybeans, including pigweed, wild mustard, Pennsylvania smartweed,

common ragweed, giant ragweed, black nightshade, and buffalobur. Application must be made before the weed exceeds the maximum labeled leaf stage. Later treatment will result only in temporary control. Weeds treated beyond the labeled leaf stage may regrow from surviving roots and stems.

Temporary speckling, yellowing, and crinkling of treated soybean leaves may result from oxyfluorfen application. Hot, humid weather and active growth at application will increase possible crop injury and the herbicide's effectiveness. Do not apply acifluorfen to soybeans under stress.

Bentazon can be applied early postemergence to control several broadleaf weeds including volunteer sunflower, common cocklebur, velvetleaf, common lambsquarters, common ragweed, and wild mustard. A split application should be used to control Canada thistle, yellow nutsedge, and annual broadleaved weeds that continue to germinate throughout the growing season. The addition of oil concentrate may improve weed control, but soybean injury may increase.

Diclofop (Hoelon) is suggested for postemergence annual grass and volunteer corn control in soybeans. Wild oat, giant foxtail, green foxtail, and barnyardgrass should be treated before they exceed the four-leaf stage. Yellow foxtail should be treated before it reaches the three-leaf stage for good results. The full label rate of diclofop should be used when the annual grass is at or near the maximum leaf stage for treatment. Volunteer corn should be sprayed with diclofop when the largest corn plants reach 10 inches in height. This delay allows corn sprouting later to emerge before the application is made. All volunteer corn plants in a clump must be sprayed to obtain complete control with diclofop. Do not tank mix diclofop with any other product or apply any other product within seven days of a diclofop application because diclofop may be deactivated by other pesticides.

Dinoseb (Premerge) or a mixture of naptalam plus dinoseb (Dyanap) applied at the crook-stage of soybeans has given fair broadleaf weed control, but serious soybean injury has sometimes occurred. Applications made after the second trifoliolate leaf stage of the soybeans have resulted in inconsistent weed control and crop injury.

Barban (Carbyne) can be used as a postemergence treatment for wild oat control in soybeans. Application should be made when most of the wild oat plants are in the two-leaf stage. Do not apply later than 30 days after soybean emergence.

2,4-DB amine (Butoxone, Butyrac 200) is labeled for postemergence control of common cocklebur in soybeans. Weed control is less satisfactory and the potential for crop injury greater when 2,4-DB is used than when other postemergence broadleaf herbicides are used.

BAS 9052 0 H (Poast) is a promising new postemergence herbicide for soybeans. In experiments, the chemical has controlled annual and perennial grasses. Soybeans have good tolerance. BAS 9052 does not control broad-leaved weeds. An oil concentrate added to the spray improves performance. The chemical will be available in limited quantities in 1982 under an experimental use permit.

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