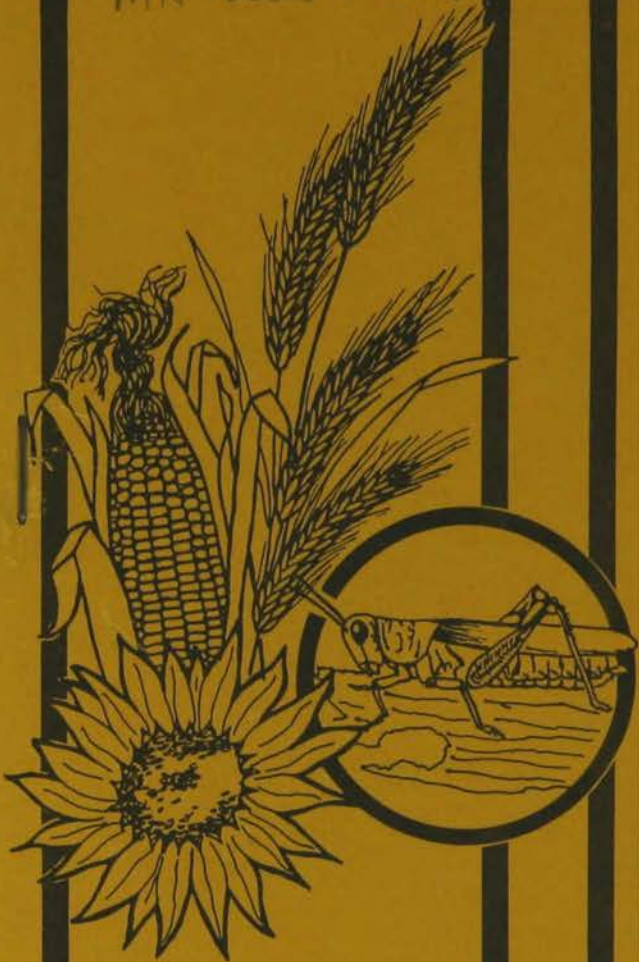
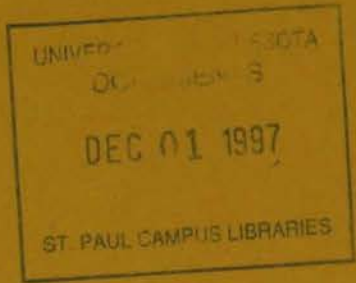


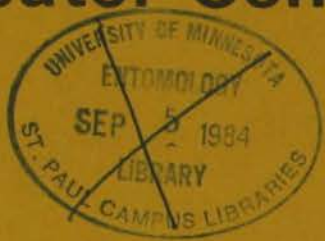
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1984 Minnesota Pesticide Applicator Conference



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

AGRICULTURAL EXTENSION SERVICE
and OFFICE OF SPECIAL PROGRAMS
UNIVERSITY OF MINNESOTA
COOPERATING WITH MINNESOTA
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PESTICIDE RECOMMENDATIONS

1984

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SUNFLOWER BEETLE

Sunflower beetle numbers in northwestern Minnesota were as high as or higher than in 1982. Infestations were also more widespread and growers were more sensitive to the defoliation following the 1982 season.

The usefulness of low insecticide dosages against sunflower beetle were initiated in 1981 with fairly extensive trials in 1982. Two additional sets of data were collected in 1983 (Table 1 and Table 2).

Table 1. Sunflower Beetle Larval Control 1983

Gerald Greene field - Norman Co.
Dave Noetzel and Ken Pazdernak, 20 July 1983

Chemical	Trade name	Rate in lbs ai/A	% control
flucythrinate	(Pay-Off)	.01	100
cypermethrin	(Cymbush)	.01	100
permethrin	(Ambush)	.025	100
fenvalerate	(Pydrin)	.025	99.7
carbofuran	(Furadan)	.5	99.7
permethrin	(Pounce)	.025	99.4
carbofuran	(Furadan)	.25	99.1
BASF 263		.5	98.8
mexacarbamate	(Zectran)	.5	98.8
thiodicarb	(Larvin)	.5	97.1
chlorpyrifos	(Lorsban)	.5	96.8
BASF 263		.25	93.9
chlorpyrifos	(Lorsban)	.25	91.9
carbaryl	(Sevin XLR)	1.5	77.7
carbaryl	(Sevin XLR)	1.0	58.9
untreated			0

Approximately 20 gallons total material per acre
40 PSI

Plots 2 rows x 25' x 4 replicates

Counts taken 72 hours post treatment

Table 2. Sunflower Beetle Larval Control 1983

Al Brusven field - Mahanomen Co.
Dave Noetzel and James Martin

Chemical	Trade name	Rate in lbs ai/A	% control
permethrin	(Ambush)	.01	99.0
carbofuran		.125	97.0
BASF 263		.125	96.0
permethrin	(Pounce)	.01	95.7
flucythrinate		.005	94.8
cypermethrin	(Cymbush)	.005	94.3
mexacarbamate		.25	92.3
cypermethrin	(Ammo)	.005	92.3
fenvalerate		.01	91.8
thiodicarb		.25	90.8
chlorpyrifos		.125	72.0
untreated			0

Approximately 20 gallons total material per acre
Applied at 40 PSI
Plots 2 rows x 25' x 4 replicates

Each trial was replicated four times with two to four rows x 25 foot plots. Survivors were counted and control expressed in percent.

The data indicates as before that with the exception of Sevin XLR in both trials and Lorsban (chlorpyrifos) at one eighth pound in trial two (Table 2) all insecticides perform exceedingly well at less than intended label rates.

Of the compounds presently labeled Lorsban at $\frac{1}{4}$ lb per acre provided good control of sunflower beetle larvae and will probably be recommended at that rate for 1984.

Products which should be labeled shortly and which performed equal to Lorsban are Pydrin and Furadan. Pydrin at 1/100 pound per acre and Furadan at 1/10 lb per acre provided control equal to or better than Lorsban at $\frac{1}{4}$ pound per acre in both 1982 and 1983.

Both first and second generation pyrethroids performed extraordinarily well against sunflower beetle larvae. Pay-Off, Cymbush and Ammo provided excellent control at 5/1000 pound of actual insecticide per acre. Control at still lower dosages remains a possibility.

We need to keep in mind, however, that these low dosages may work well only for controlling sunflower beetle larvae. We do not obtain similar efficacy at similar low dosages for the rest of the pest insect complex on sunflower. And we should not extrapolate to other crops and pests without further trials.

BANDED SUNFLOWER MOTH CONTROL

Insecticide trials against sunflower insects have been carried out at the Southwest Experiment Station at Lamberton since the middle 1970's. Originally they were intended to study sunflower moth control but non-economic levels of sunflower moth led us to examine pollinator-insecticide interactions and other pest insect reduction.

We have not had significant yield differences in these plots before the 1983 trials although consistently significant insecticide reduction of pest insects had occurred over the years. In 1983, however, sunflower seed yield differences (Table 3) were observed. The single insect present was banded sunflower moth in relatively modest numbers. In that this insect appears to be a major sunflower pest in west central and northwestern Minnesota we felt the yield data should be reported.

The study was designed to compare one and two applications of eight insecticides. The first application was made August 3 when slightly less than 30% of all plants showed male florets. The second application was made five days later with slightly more than 85% of the plants with male florets exposed.

Table 3. Sunflower seed yields with Banded sunflower moth control. Lamberton 1983. Noetzel and Ford.

Treatment	Dosage ai/A	No. of applications	Yield in pounds/acre
Supracide	0.5	2	2373
Ammo	0.04	1	2335
Lorsban	0.5	2	2328
Pounce	0.1	1	2312
Pay-Off	0.04	1	2293
Ammo	0.04	2	2292
Pydrin	0.1	2	2246
Pay-Off	0.04	2	2227
Penncap-M	0.5	2	2214
Lorsban	0.5	1	2213
Ambush	0.1	2	2194
Ambush	0.1	1	2184
Supracide	0.5	1	2180
Pounce	0.1	2	2163
Pydrin	0.1	1	2139
Untreated	-	-	1911
LSD .05			255

Sunflower seed yields in all treated plots were significantly better than untreated but not different among the insecticide treatments. This suggests that a single application of insecticide applied early in bloom may be sufficient for economic control of banded sunflower moth. At least in the dates of bloom in this experiment a second application failed to provide additional benefit.

SUNFLOWER SEED WEEVIL AND BANDED SUNFLOWER MOTH CONTROL

Several insecticides and a biological control material (Table 4) were tested against seed weevil and banded sunflower moth in sunflower near Twin Valley. Pre-treatment banded sunflower moth larval counts ranged from 10 to 30 per head and seed weevil adult counts 2 to 4 per plant. Four row x 25 foot plots were replicated 4 times and were treated once. Two dates of treatment were used for Bacillus thuringiensis. Eight out of ten plants had male florets exposed at the time of treatment.

Damaged seed was counted before the seed was cleaned and is recorded in Table 4. The samples were then cleaned and yields calculated based on clean seed.

Lorsban at 0.75 pounds per acre provided good control of both seed pests and is labeled for that use. Pounce, Pydrin, Zectran, and Furadan, although not presently labeled, also performed very well.

Bacillus thuringiensis does appear to provide some banded moth larval control and, as one would anticipate, fails to affect sunflower seed weevil populations.

It should be noted that good control of both sunflower seed weevil and banded sunflower moth were obtained when treated with 80 percent of the plants in bloom.

Table 4. Seed weevil and banded sunflower moth control. Twin Valley, Minnesota 1983. Noetzel, Holen and Pazdernak.

Treatment	Dosage ai/A	Percent of seed infested by		Total percent infested seed
		Seed weevil	Banded moth	
Pounce	0.2	3.5	1.75	5.25
Lorsban	0.75	2.75	2.75	5.5
Pydrin	0.2	2.5	5.0	7.5
Furadan	0.75	2.75	4.75	7.5
Zectran	0.75	3.0	4.75	7.75
Larvin	0.5	5.25	3.75	9.0
Ambush	0.2	5.0	6.25	11.25
Lorsban	0.5	9.0	3.25	12.25
BASF 263	0.75	6.5	5.75	12.25
Bt (6 Aug)	1 pt.	7.5	5.5	13.0
Bt (13 Aug)	1 pt.	12.0	6.0	18.0
Untreated	-	7.75	11.0	18.75

Economic value of pollinators to sunflower seed yield and oil content.

Mahmood, Furgala, and Freund. Department of Entomology
Univeristy of Minnesota

Year	Treatment	Yield in pounds of seed/acre	Average oil in percent	Price per pound seed with discounts ¹ and bonus	Gross return per acre	Increased return in dollars/acre	
						Due to higher yield and bonus or discount payment	Due to higher oil content alone
1979 ²	bagged	1587	38.3	.090	142.83	190.40	39.20
	open	3267	43.4	.102	333.23		
1980 ³	bagged	1733	46.6	.121	215.74	41.55	10.21
	open	2042	48.7	.126	257.29		
1981 ⁴	bagged	1899	39.0	.108	205.09	147.75	32.61
	open	2965	44.0	.119	352.84		

1) Discount = 2% for each 1% oil decrease below 40%
Bonus = 2% for each 1% oil increase above 40%

2) 9 hybrids; 1 open pollinated

3) 19 hybrids; 1 open pollinated

4) 20 hybrids

SEED INSECT CONTROL IN A SEED PRODUCTION FIELD

A large amount of F_1 seed is produced annually in Minnesota. This seed has a much greater economic value per pound than does commercial seed. Twenty weevil damaged seeds per plant or 1 adult weevil per plant could cause approximately five dollars damage per acre if the F_1 seed is \$.25 per pound. Also it is especially desirable for seed companies to have seed as free of insect damage as is possible so that it is appealing to the buyer.

Four compounds were compared for their effectiveness in control of banded sunflower moth (60% of damage total) and seed weevil. Plants were treated at 85% bloom. Plots were two rows x 30 feet and were replicated four times. Percent of damaged seed is reported in Table 5.

Table 5. Seed infesting insect control in hybrid seed production. Nelson field. 1983. David Noetzel and Rollyn Samuelson.

Treatment	Dosage ai/A	Average percent damaged seed
Pydrin	0.1	1.75
Supracide	0.5	3.25
Lorsban	0.5	5.0
Pounce	0.1	5.25
Untreated	-	12.75

Labeled compounds which performed superior to no treatment include Supracide and Lorsban. Both provided economic benefit in this experiment. The best performing insecticide was Pydrin at 0.1 pound ai/A. There were no differences in yield.

ARMYWORM CONTROL

A small armyworm control trial was carried out near Leonard, Minnesota in Clearwater county with the cooperation of Robert Tervola, County Extension Agent - Agriculture. Six chemicals were compared in plots 50' square, replicated five times. Plots were treated on the evening of 21 July.

Pydrin, Pounce, Pay-Off, Ammo, Lorsban, and Sevin were compared at the rates listed in Table 6. Uncorrected data is reported so that there is mortality recorded for the untreated plots. All treatments performed equally well. Of the various treatments only Sevin is presently labeled. At this time Sevin is labeled for control of armyworm in wheat only.

Table 6. Armyworm Control - Minnesota 1983. Clearwater County, Don Ophus field. David Noetzel and Robert Tervola.

Treatment	Rate in lbs ai/A	Percent mortality-24 hours
1) Pydrin	0.1	85.6
2) Pounce	0.1	100.0
3) Pay-Off	0.04	96.0
4) Ammo	0.04	100.0
5) Sevin	2.0	100.0
6) Lorsban	0.5	100.0
7) Untreated		20.0

The Department of Entomology, University of Minnesota, would like to express appreciation to the following companies for grant-in-aid support for the sunflower and small grain being reported.

American Cyanamid

Dow Chemical

FMC

ICI

Shell Chemical

Stauffer Chemical Company

CEREAL CROPS

Scab did occur on the cereal crops this year, 1983, the importance of the disease depended on area of the state and date of planting. Scab becomes an important problem when there are wet conditions or flowering. This year, the early planted crop was hardest hit by Scab. All varieties are susceptible.

The leaf spot diseases, Tanspot and Septoria leaf blotch were as common as usual this past season. In addition, we also found leaf rust in June on many of the early planted wheat fields. With the wet conditions it was expected that the rust might develop into a problem. Most of our Spring wheat varieties have adult plant resistance, so finding rust on the young plants was not exceptional. As July dried-off and the adult plant resistance "took hold", the disease was stopped. However, there were some exceptions with the very late planted wheat, which did have rust on it at harvest.

In general the barley crop showed the value of leaf spot resistance among the different varieties. The new varieties were only slightly affected.

Disease control practices to reduce or avoid crop loss start with using good seed, as disease-free as possible, treating the seed with a seed treatment fungicide to protect it while in the soil before growth begins. As many of the leaf spotting diseases are carried over from season to season on infected plant debris, the new crop should be planted on clean ground, preferably in a rotation system not following wheat or corn. If wheat must be planted on old wheat land, the plant debris should be buried.

During the early part of the growing season, the crop should be examined for stand and evaluated for potential yield. If sufficient fertility is available, the stand is good, and the growing conditions are favorable or expected to be favorable for producing a good crop then a grower should make a decision on whether or not to utilize the fungicide leaf spot control program. This practice will only reduce or prevent the crop loss that can occur from leaf spotting diseases. Unfortunately, we do not have a system to evaluate the potential disease loss that may result from cereal scab diseases that can be applied before it is too late to make a chemical control application. Therefore, the use of this disease control practice will be based on potential yield, favorable growing conditions, past cropping experience with leaf disease and cultural practices.

In applying the fungicide to the crop it is most important that the applicator in the case of aerial application, does not use less than 5 gallons of water per acre. The application must start before heading, usually when the leaf spots do not appear to be of any consequence.

In some 1982 field trials, fungicide treatment resulted in 15% more yield than the untreated parts of the field. A grower - county agent demonstration, using a modified ground sprayer, resulted in almost 30% yield response.

Every year, observations of root rot, are reported. These below ground diseases are very difficult to evaluate because usually a complex of pathogens are involved. It has been reported that the Pythium fungus alone can account for a 15% crop loss. Knowing that there are several other fungi, which may affect the wheat plant root system we might summarize that a 20% reduction in

yield annually is not uncommon. The use of systemic fungicides in experiments for the control of leaf spot diseases suggests that other fungi in the plant may also be affected. These other fungi might well be these root rot pathogens to which we are referring to reduce or minimize yield loss caused by root rotting fungi growers should practice at least a 3 year rotation.

SUGAR BEETS

Cercospora leaf spot was again the disease of primary concern for the beet grower this year. The disease occurred from the Iowa border to Drayton, North Dakota. The severity of the disease lessened as the crop is traced to the northern areas. Within the beet growing area there were small local areas where the disease was present but did not develop into a major problem.

In general, most fungicide treatments were economically beneficial to growers. Some growers expressed concern that the disease was not as severe as it was expected to be this year. However, one must remember that every grower, scout and fieldman and neighbor was out in the field looking for the first symptoms, and more important - fungicide treatments were made on time, early, rather than late this year. There should have been less disease.

Disease control practices can and do work if no short-cuts are taken. Early detection is important, proper application is essential for chemical treatments to be beneficial. We have been extremely concerned about variety selection, fungicide selection and rightly so - however, the application technique is just as important. Some aerial application of less than 5 gallons per acre were observed, giving less than adequate disease control. The general aerial and ground applications were successful in keeping the Cercospora leaf spot disease in check this year.

POTATOES

The past season's potato disease picture was certainly a mixed bag. In a few words, yields were not too good - diseases were good and the weather was all screwed up!

Several growers got involved with ring rot. The crop experienced some ring rot in 1981, 1982 and more in 1983. This is a seedborne disease, readily spread by various types of contact contamination, which is usually the result of taking short-cuts, and the type of equipment that is used in the production of the potato crop.

Early blight was it's old self again. By the send week in July, early blight had been found in the 3 major potato growing areas. In the Hollendale area the disease developed rather slowly and did not get to 70% incidence until late August. On the Sand Plains, the disease got started the second and third week of July and increased to 10% incidence in about one week. In the Valley the disease was a few weeks behind the Sand Plains. The south end of the Valley first saw early blight about the middle of July.

Late blight was found in the northern areas of the Valley and on the Sand Plains. Very good to excellent eradication and control was obtained with Ridomil fungicide application, where used. This fungicide Ridomil, a systemic, is an excellent chemical for use to eradicate or stop late blight. However,

this fungicide does not control early blight. To protect the life of this systemic fungicide it might be best advised not to use it as a regular fungicide, use with a mixture such as the maneb-type fungicides might be the best way to use it. A new formulation Ridomil MZ should be available this year. This is a Ridomil and Mancozeb combination which should provide good foliage and tuber disease control.

Verticillium wilt is still present in most of the potato fields. This soilborne disease is causing serious crop loss, both yield and quality. Long range rotations, disease free seed, sanitation and soil fumigations are methods to reduce or control this disease. By next year we should have a method to evaluate the amount of Verticillium in the field.

SUNFLOWERS

Mildew and rust were present again this year. Also, white mold and some early dying. The seed treatment fungicide Apron should give good control for seedborne mildew.

FUNGICIDES^{1/} FOR USE ON FIELD CROPS

CEREALS

SEED 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

^{1/} There may be other seed treatment fungicides on the market that I am not aware of that are also satisfactory for treating cereal seed.

(Continued)

FUNGICIDES^{1/} FOR USE ON FIELD CROPS

CEREALS

Cereal Leaf Diseases

Dithane M-45 Manzate 200 Maneb Zineb Kocide 101	Rusts and Leaf Spots	Apply by air, using minimum of 5 gallons of water per acre; and spread-sticker per label. See label for rate and limitations.
Drayton 50% WP	- Rusts (leaf, stems, stripe) and mildew.	

POTATOES

Seed Piece Treatment

Remarks

Captan
Orthocide Plus
(Captan + Mertect)

Maneb
Polyram
Zineb
Dust Treat
(Zineb + Streptomycin)

Late Blight^{1/} and Early Blight

Bravo
Copper

See label for Rates and Limitations

Kocide 101

Difolatan
Duter (no spreader sticker)
Mancozeb

Dithane M-45
Manzate 200

Maneb

Dithane M-22
Manzate

Zineb
Polyram
Blight Out
(Polyram + Maneb)

^{1/} Ridomil MZ

Sugar Beets

Seed 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.

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

Remarks

For all fungicides 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, temperatures above 62° (optimum 75°) conditions are favorable for infection.

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 Super Tin

MBC

- Benomyl 50% Benlate

- Thiabendazole 42% Mertect

- Thiophanate-methyl 70% TOPSIN-M

NOTE: Strains of the Cercospora fungus resistant to these fungicides have been identified. These fungicides are not recommended for use in area where resistant strains occur. They may still be effective in areas where the new strain of Cercospora is 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 Mildew

Fungicides for Powdery Mildew Control

Remarks

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.

Copper

See 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

CORN

Head Smut

Head smut, *Sphacelotheca reiliana* (Kuhn) Clint, differs from common smut caused by *Ustilago maydis*, in that the head smut pathogen is primarily soilborne. The teliospores (smut spores) from the smutted tassels or ears are disseminated by wind, rain and/or harvesting equipment, overwinter in the soil and are the source for infection in succeeding corn crops. It is also believed that fields may be infested by planting seed contaminated with head smut spores. The head smut fungus infects the corn plant in the seedling stage. Once the plant is infected, symptoms are not exhibited until the tassel and/or ears are developed. The tassel and/or ear of infected plants are transformed into smut sori. Inside the sorus (small galls) are millions of dark brown to black teliospores. In addition to the teliospores are the remains of the vascular tissue of the tassel and ear. The vascular tissue appears as a "stringy mass". The head smut sorus, unlike the common smut sorus is not bounded by a distinct, persistent covering called a periderm. The head smut is found on ears and/or tassels and rarely on leaves, while the common smut sorus can be found on leaves, stalks, tassels, ears or on individual kernels of the ear.

This disease, discovered in Minnesota in 1980 has remained present in all locations - Wadena, Otter Tail, Stearns, and Todd counties. In 1981 the fields in Stearns county were all rotated to either soybeans or grain and no head smut was found, however, in 1982 corn on fields found with head smut in 1980 again had head smut present. A second location in Stearns county near Clearwater was reported in 1982 which is about 30 miles east-southeast of the previously known infestation. The incidence of head smut has remained low and has created no serious problems in 1983.

Since this disease was reported to usually produce a plant without a marketable ear, a direct yield loss and could be easily spread from place to place with equipment and/or seed and survive for many years in soil, projects were developed to: 1) screen for resistance (commercial lines 1981 and 1982, breeding lines 1982), 2) evaluate chemical treatments (seed and soil treatments 1981 and 1982) and to 3) define how long the fungus will survive in soil and infect susceptible corn lines.

Results regarding 1 & 2 were reported the last 2 years and information on natural (non-inoculated) infection was gathered in 1983. A hybrid selected from those commercial lines tested was planted in an area used for head smut research for two years. Seed was planted without inoculum into soil that was inoculated when planted in 1981 and 1982. Ears and tassels that became infected were soil incorporated with standard tillage treatments. Infection recorded October 11 averaged 3.14%. This is a large drop from the % recorded in 1981 when this hybrid was planted under inoculated conditions. Since the fungus is reported to survive for long periods in soil additional testing is planned for 1984 and 1985. Disease loss due to head smut has remained low and the continued use of resistant hybrids and rotation offer excellent methods of management. Low survival levels of the fungus in Minnesota soil may greatly reduce this disease threat.

Eyespot

This disease first reported in the U.S.A. in 1968 is most common in North Central and Northeastern states. The fungus, Kabatiella zeae survives the winter as resistant hyphae in infected corn residue. The following spring and throughout the growing season, fungal spores are produced and released during moist periods. Lower, older leaves are first infected and when wet weather or prolonged dew is present even the upper, younger leaves become infected. Observations in fields in late June indicate plants one foot high can have numerous lesions. The eyespot lesion is an oval-circular yellow spot which develops a brown or tan center with a ring of darker color and yellowish halo. When severe, the spots run together and the entire leaf dies.

Eyespot is found over a wide area in Minnesota. The relatively cool, wet early 1983 season allowed the disease to get started but dry, hot weather reduced further disease development. At Staples, Minnesota under irrigation and with inoculation eyespot reduced yields 16 Bus./A. The plot area was irrigated (11.9 inches to favor disease development.)

TABLE 1. EYESPOT DISEASE LOSS, IRRIGATED CORN, STAPLES, MINNESOTA

<u>TREATMENT</u>	<u>YIELD</u> <u>Bu/A</u>	<u>GAIN OVER CHECK</u>	
		<u>Bu/A</u>	<u>%</u>
Check	116.3	--	0
Bravo 2 Pts/A			
1 X	128.1	11.8	10.1
3 X	124.1	7.8	6.7
Dithane M-45, 2 lbs/A			
7 X	127.0	10.7	9.2
Dithane FZ, 2 lbs/A			
7 X	120.1	3.8	3.3
M-45 & RH5718F			
2 lbs and 0.25 lbs.			
7 X	110.6	-5.7	-4.9
Merck 1 lb			
2 X	132.4	16.1	13.8
Merck & M-45			
8 oz. and 1 lb			
2 X	123.4	7.1	6.1
Tilt			
25 gms ai 1 X	119.7	3.4	2.9
50 gms ai 1 X	125.8	9.5	8.2
25 gms ai 2 X	125.1	8.8	7.6
50 gms ai 2 X	132.1	15.8	13.6
Not Inoculated	132.0	15.7	13.5

Inoculated with Kabatiella zeae on 623. Placed infected millet seed in whorl at 8th leaf stage.

Corn hybrid intermediate - susceptible type.

TABLE 2. EYESPOT DISEASE LOSS, IRRIGATED CORN, STAPLES, MINNESOTA

<u>TREATMENT</u>	<u>YIELD</u> <u>Bu/A</u>	<u>LOSS</u>	
		<u>Bu/A</u>	<u>%</u>
NI + S	139.5	--	-
I + S	133.7	5.8	4.2
NI + NS	133.5	6.0	4.3
I + NS	116.7	22.8	16.3

NI = Not Inoculated, S = Sprayed 3 X with Ciba Geigy Tilt 3.6E (7/15, 7/29, 8/12) NS = Not Sprayed
 I = Inoculated Kabatiella zeae.
 Corn hybrid field tolerant type.

Corn Stalk Rot

Stalk rot is one of the most common diseases of corn in Minnesota and it occurs every year to some degree. A conspicuous symptom of stalk rot is lodging and 30-50% incidence of lodged stalks have been reported in Minnesota corn fields. On the average, a 5% yield loss occurs in the state. Yield loss is sustained from one or more of the following: 1) early plant death that results in poor grain fill and low test weights, 2) broken stalks, ear drop, and slowing down in picking corn, and 3) ear rots that frequently result from lodged corn especially in wet seasons.

Usually stalk rot is caused by a complex of several fungi and bacteria that becomes obvious in the plant as it matures. Stalk rot is often due to the combined effects one or more organisms and post flowering stresses such as leaf diseases, low light intensity (cloudy), high plant populations, wounds (hail damage, or insect injury) and wet weather. The common stalk rot diseases and fungi in Minnesota are Gibberella stalk rot - *Gibberella roseum* 'Graminearum', Fusarium stalk rot - *Fusarium moniliforme* and occasionally Diplodia stalk rot - *Diplodia maydis*, Pythium stalk rot - *Pythium* species and Bacterial stalk rot occasionally occur following heavy rains with hail.

The stalk rots common in Minnesota do not occur until several weeks after pollination. The first symptoms seen in leaves turning a dull grayish-green and the lower internodes soften and turn from green (healthy) to tan or dark brown. The stalk may be easily crushed and when split open, top to bottom, the pith tissue is soft and decayed and the vascular strands are intact. If the hybrid is susceptible, the entire plant dies and the field may appear to be frosted or suffering from drought.

Gibberella infected stalks have a pink to reddish color of pith and vascular strands. Fusarium infected stalks are difficult to distinguish from Gibberella stalk rot as the color is white to pink or salmon color. This rot also infects roots, the plant base and lower internodes. These rots progress rapidly when the plant matures and small black perithecia (Fungal reproductive structures) are formed on the stalk surface in the fall and mature next spring on Gibberella infected stalks.

Diplodia stalk rot has the same overall symptoms as Gibberella and Fusarium, but small raised black spots, pycnidia (fungal reproductive structure) are produced near the nodes. These are embedded in the rind and are not easy to scrape off. Sometimes a single stalk may be infected by several fungi and have more than one type of fruiting body present. Diplodia is not common in Minnesota.

Stalk rots are diseases of stressed corn plants and the degree of stalk rot severity is often determined by the extent of stress. Nearly all stresses such as excess of lack of moisture, nutrient deficiency or imbalance, insects (root worms and corn borers), nematodes, hail, mechanical injury to roots or stalks and loss of effective leaf area, increase stalk rot. Foliar diseases and excessive plant populations for a given hybrid will influence the degree of stalk rot. Sudden changes from very dry or wet weather before pollination to wet or very dry conditions after silking also favor stalk rot. Hybrids that are top grain producers often have relatively high losses from lodging. High grain production can cause the plant to be deficient in nutrients which cause pith cells in the stalk to die early, allowing a faster fungal

colonization. High nitrogen and low potassium levels or sudden loss of available nitrogen (denitrification or leaching) can greatly increase the incidence of stalk rot. Plant injury by nematodes, insects (corn borers and root worms) or hail also increases stalk rot. The injury may simply provide an opening for entry of stalk rot fungi and also carry the fungus into the corn plant.

Stalk rots presently cannot be completely controlled (eliminated) but damage can be reduced through use of an integrated management program. Practices to reduce stalk rot losses:

1) SELECT LODGING-RESISTANT HYBRIDS.

Full season hybrids are generally reported the more resistant to stalk rot than those that mature early. Some of this resistance is due to rapid loss of resistance mechanisms as stalk color changes from green to brown. The low incidence of Diplodia zeae in recent years is due to success in breeding stalk rot-resistant hybrids. Stalks with a thick-strong rind will resist lodging even when extensive internal decay is present.

2) PLANT SOUND, LOCALLY ADAPTED, FUNGICIDE TREATED SEED.

Fusarium species are consistently present over a wide area where corn is grown. Infection can occur at many sites in the corn plant. Planting seed without seed coat cracks and with fungicide seed treatment aids in plant establishment and slows or delays fungal infection of the seedling.

3) ADJUST PLANT POPULATION TO HYBRID, FERTILITY LEVEL, SOIL TYPE AND AVAILABLE SOIL MOISTURE.

Planting at high fertilizer rates can result in thin, spindly stalks are prone to lodging. Observe seed corn company recommendations for recommended planting rates.

4) PROVIDE BALANCED SOIL FERTILITY.

Fertilizer must be applied based on results of a reliable soil test. Adequate nitrogen levels throughout the season reduces severity of stalk rot. Where leaching or denitrification loss of nitrogen is expected, the use of nitrification inhibitor may help reduce stalk rot.

5) CONTROL WEEDS, CONTROL ROOT AND STALK-ATTACKING INSECTS USING RESISTANCE, USE RECOMMENDED CULTURAL PRACTICES AND CHEMICALS, AND MANAGE FOLIAR DISEASE.

Corn growers should follow cultural and chemical recommendations for your area. Scouting will reveal insect, weed and disease problems and may reduce unnecessary applications of pesticides. Crop rotation and/or clean plow down of refuse may reduce foliar diseases.

6) HARVEST WHEN CROP IS MATURE.

Delay in harvest can increase loss to stalk rot as resistance to Fusarium decreases rapidly with stalk color change from green to brown.

7) PRACTICE FIELD SCOUTING.

Corn growers should scout fields for stalk rots and lodging when corn grain is at 30-40% moisture. Test corn plants for stalk rot by 1) pinching the stalk below the lowest node for firmness and 2) pushing random plants 5" from the vertical at arm height. When 10% or more of the plants lodge or have soft internodes it becomes beneficial to harvest the field early to prevent potential harvest losses. When scouting also look for each plant kill which can directly reduce yields.

SOYBEAN

Downy Mildew

This disease was first reported in the U.S.A. in 1923, is present most years but seldom a serious threat to soybean production. Downy mildew causes the upper surface of new leaves to develop pale green to yellow spots of indefinite size and shape. The spots turn gray brown and on the lower leaf surface in the morning, especially if moisture is present, grey mycelium and spores can be seen. The sporangiophores release sporangia which infect new leaves. Pod infection may not be evident externally but the interior of the pods and the seed coat are encrusted with a whitish mass of mycelia and spores. Peronospora manshurica overwinters as oospores in infected leaves and on seeds. Planting oospores encrusted seeds may produce a few systemically infected seedlings, which can further spread the disease.

This disease was observed in several fields in Minnesota in 1981, 1982 and 1983. Incidence however was judged to be very low. At harvest time 1982, several samples of soybeans were observed to have seed encrusted with a white mold-downy mildew. While there are many races of downy mildew identified in the U.S.A., resistance has performed satisfactory. Treating infested seed with a fungicide should reduce seedling infection and subsequent spread. Rotation, plowing down soybean residue or rotate soybeans with a non-susceptible crop are recommended control measures.

Soybean seed from a seed lot known to have 4% encrusted seed were tested in greenhouse germination studies and field testing was done at Rosemount. Greenhouse testing of soybean seed when known to have significant levels of downy mildew on the seed revealed slower germination and greater leaf symptom expression when seed was not treated, Table 1 and 2. Stand and yield from untreated, downy mildew encrusted seed was poorer and lower when compared to seed treatments. No seed treatment benefit was observed when a clean seed lot, not known to have downy mildew, was used, Table 3.

Table 1.

Soybean emergence, St. Paul Greenhouse

Treatment	% Emergence		
	80°F		70°F
	8 Days	13 Days	13 Days
Apron	90	90	86
Captan	85	93	87
None	79	84	79

Table 2. Soybean Downy Mildew Leaf Spot Severity, St. Paul Greenhouse

Treatment	% Leaf Area Damaged*			
	Cotyledon	Unifoliate	First Trifoliate	Whole Plant
Apron	0.8	0.6	0.3	0.32
Captan	0.3	0.3	0.4	0.34
None	13.5	6.7	8.5	9.6

* at 14 days, 80°F

Table 3. Soybean Stand and Yield, Rosemount Farm

Treatment	Stand					Yield Bu/A
	5/27	6/2	6/9	6/16	6/21	
Seed with						
No Downy Mildew						
None	56	67	73	75	75	39.0
Apron 25W	68	71	76	84	84	37.6
Apron 350	60	71	75	75	75	39.1
Apron 2.66	69	73	80	86	87	40.5
Vitavax 200	66	74	76	80	80	37.6
Captan	55	74	78	83	83	40.5
Flo Pro D	54	73	77	77	77	37.4
Flo Pro T	63	77	78	84	85	38.8
PCNB	63	74	79	81	81	38.7
Seed with						
Downy Mildew						
None	58	72	74	74	74	34.4
Apron 25W	69	77	80	90	92	36.7
Apron 350	71	73	80	82	84	38.0
Apron 2.66	69	72	75	77	77	36.2
Vitavax 200	55	75	80	80	80	40.0
Captan	69	77	81	81	81	37.6
Flo Pro D	75	78	83	88	88	38.4
Flo Pro T	63	76	81	84	82	39.2
PCNB	64	81	85	85	85	38.6

* Planted 5/11/83, Stand for 13 row ft.

Seed Pathology

Fungi that cause foliar problems for soybeans can also invade and colonize soybean seed. Seed invasion before harvest can reduce yield and seed quality. Seed may be discolored, shriveled, cracked, appear white and chalky and most important: 1) germination is reduced and 2) seedling vigor is lowered. Last year downy mildew was found on several soybean seed lots. The fall of 1983 resulted in some Phomopsis infection of soybean seed. This disease, also known as pod and stem blight on the plant may reduce seed viability.

Seed may be infected without clear symptoms, while severely infected seeds are shriveled and cracked. Infected seed are a minor source of inoculum when compared to the amount of inoculum found on soybean crop residue but infected seed usually do not germinate. Infected seed that do germinate may produce diseased seedlings that are weak. Seed infection is more severe when wet weather delays harvest and especially when warm wet weather occurs before harvest.

This disease is present in Minnesota every year but in 1984 one should use high quality seed relatively free of the pathogen. Seed can be cleaned removing the badly damaged ones and thus improve seed quality. Seed treatments may reduce seedling blight, i.e. damping off and improve stand establishment. Since this disease also develops from inoculum found on crop residue, rotation away from soybean land is recommended and when suitable plowing down soybean residue aids in disease control.

Corn and Soybean Seed Treatments Registered

Fungicide ^a	Field Corn	Soybeans ^b
Captan	X	X
Captan & Maneb	X	X
Captan & Thiram	X	X
Captan & Zineb	X	X
Captan & HCB & Maneb	X	X
Captan & PCNB		X
Captan & Carboxin		X
Carboxin	X	X
Carboxin & Thiram	X	X
Dichlone	X	
Fenominosulf	X	
Herachlorobenzylne (HCB)	X	X
HCB & Maneb	X	X
Mancozeb, Maneb	X	X
Metalaxyl		X
PCNB & Etridiazol	X	X
TCMTB	X	X
Thiram	X	X
Thiram & Maneb	X	

^a Use all fungicide seed treatments according to label directions.

^b Seed treatment not normally suggested for soybean seed.

Phytophthora Root Rot

Since 1979, the year race 3 of Phytophthora megaspera (Pm) was found in Minnesota on a farm near Faribault, the continued use of race 1 resistance was in doubt. Experience and research in other states have shown that continued use of race specific resistance, i.e. race 1 resistance failed to control root rot when new Phytophthora races pathogenic to this resistance became widespread. In 1982 and in 1983 more fields in Minnesota were found with races of Phytophthora other than race 1, Chippewa, Cottonwood, Dodge, Jackson, Lyon, Meeker, Mower, Murray, Nobles, Redwood, Rock, Sibley, Steele, Watonwan Counties. (Personal Communication B. Kennedy)

Soybean growers who had Phytophthora Root Rot (PRR) problems in fields with race 1 resistant soybeans in 1983 should rotate to corn in 1984. The solution is not as simple if you plan to plant soybeans again. Race specific resistance, at least the race 1 type of resistance cannot be depended upon in fields where new races of Pm were found. Resistance did offer the best method for controlling Phytophthora. Resistant soybean varieties are not infected by races of Phytophthora to which they are resistant. Race 1 resistance was effective in Minnesota for many years and in some fields may still be a suitable method for disease management. Resistance to races 1-3 and 6-9 is available in Corsoy 79, Wells II, Vickery, and other soybean varieties. The soybean lines with multi-race resistance are more desirable in fields with new races of Pm since in 1983 less damage was found on the multi-race resistant variety Corsoy 79. However, race 4 is now identified in 3 counties (Dodge, Nobles, Redwood) that can attack this type of multi-race resistance. Isolates able to attack multi-race resistance are believed to be a small portion of the race population present in Minnesota and may even be limited to fields with severe PRR history. Multi-race resistance soybean lines should be satisfactory in most of Minnesota in the near future - until race 4 and 5 build up. The rate of development of new races is not predictable but new races ultimately do build up and resistance will no longer be effective. In Ohio, 8 years was required to render race 1 resistance useless. They believe similar build-up can be expected with other races and therefore alternatives to race specific resistance need to be considered. In Minnesota the PRR disease pressure is less severe than Ohio and I would predict rate of resistance development to be slower however, I have no Minnesota data and can only guess.

An alternate to continued use of race specific resistance and multiple race resistance is the use of highly tolerant varieties. It is predicted that 2,048 races of Pm are possible in nature. Not all of these have been found but you can see the problem becomes very large when breeders try to include resistance to all possible races. The highly tolerant soybean plant does not

respond to select races of Pm. Tolerant soybean plants have the ability to survive and yield well when infected with Phytophthora. Thus race identification and race specific resistance breeding is by-passed. Highly tolerant varieties have been effective in controlling PRR under mild to moderate disease pressure. A major weakness of tolerant varieties occurs at germination and in seedling stages, while highly tolerant varieties are reported to have little damage from PRR and yield well, they are very susceptible to seedling Phytophthora damping-off. Good stand establishment has been a serious problem from Ohio to Illinois. Replanting costs and reduced yield from delayed planting indicate tolerance alone may not be adequate for Phytophthora management. Captan and Vitavax 200 are not effective in controlling damping-off by Phytophthora. The fungicide Ridomil (Ciba-Geigy), Apion (Gustafson) has shown promise for control of PRR.

Crop production practices also can affect PRR incidence and severity. Drainage, tillage, rotation and fertilization all change levels of PRR. The proper use of production practices can lower Pm damage. This includes tiling to quickly remove excess water, deep plowing to destroy and disperse inoculum, rotation with corn to reduce inoculum and avoiding Ammonium nitrogen just prior to planting. Reduced tillage may also increase the severity of PRR as soils remain cooler and wetter in early stages when plant infection occurs. We must also remember that the fall of '82 was wet and many fields may have not been full plowed. This and wet conditions in May and June '83 may have increased soil compaction which promotes PRR.

Studies with the Phytophthora fungicide - Apion/Ridomil as a seed treatment or a granule over the row at planting time were conducted at several locations. Farmer planted soybeans with and without seed treatment at 3 locations showed little difference in stand on 7/22.

Plants Per foot of Row

Location	Treated	No Treatment
1	5.6	5.3
2	7.6	8.3
3	8.3	7.7

At one location, #2 at harvest time plants were collected for analysis. Pods and seeds per plant were determined. Plant stand at harvest (9/27) was nearly the same as found on 7/22. Total seed, seed weight and pods per plant did not vary greatly.

	Treated	No Treatment
#Seed	2547	2569
Seed wt Total	390.4 gms	390.7 gms
#Pods	1078	1090
#Seed/Pod	2.36	2.36
#Seed/Plant	62.12	57.09
#Plants/ft	7.7	8.4

No improvement in yield or stand was observed when resistant soybeans were planted. Disease pressure in these fields was low and the race specific resistance of the soybean was adequate.

At another location where a race that can attack Corsoy 79 was found, early stand was improved. Yield difference due to treatment was improved. Corsoy, (a susceptible variety) stand early and late and yield was increased when seed was treated and/or granules were applied.

<u>Treatments</u>	<u>Stand (Plants/ft)</u>		<u>Yield Bu/A</u>
	7/1	8/19	
Corsoy 79			
Seed only	4.3	4.4	36.1
Ridomil Granule			
3 or ai/1000 Row H	4.9	4.5	41.4
6 or ai/1000 Row H	5.0	4.7	38.1
Apion Seed Treatment			
2.66 FL	4.7	4.0	40.3
350 L	4.8	4.2	32.8
Apion Seed Treatment (350L) and Ridomil Granule			
3 or ai/1,000 row ft	4.8	4.9	38.8
6 or ai/1,000 row ft	4.7	4.2	39.3
Corsoy			
Seed only	3.8	3.1	24.4
Ridomil Granule			
3 or ai/1000 row ft	4.0	3.7	29.8
6 or ai/1000 row ft	4.1	3.5	35.2
Apion Seed/Treatment			
25W	4.5	4.2	32.5
2.66 FL	4.3	3.2	33.3
Apion Seed Treatment (2.66FL) and Ridomil Granule			
3 or ai/1,000 row ft	4.5	4.2	36.2
6 or ai/1,000 row ft	5.7	4.3	39.1

TABLE I.

CHEMICALS FOR DISEASE CONTROL IN DRY BEANS

<u>CHEMICAL</u>	<u>LABELED USE*</u>	<u>RATE</u>	<u>COMPANY</u>
<u>Foliar Sprays</u>			
<u>Fungus Diseases</u>			
Bravo 500	rust, Anthracnose, downy mildew	2-3 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, downy mildew	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.

Table 1. Cont.

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.

* 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. A mixture with bentazon (Basogran) is labeled. This mixture will control more species of weeds than either chemical alone.

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

Time of application--Postemergence; acifluorfen effectively controls most annual 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. The 2S formulation includes a surfactant. The 2L formulation does not contain a surfactant. Follow the label instructions for adding a surfactant or oil concentrate.

Alachlor (Lasso, Lasso II) - Monsanto

Use--Annual grass and nutsedge control in corn, dry beans, potatoes, sunflowers and soybeans; some broadleaf control. Use in preemergence mixtures with atrazine, cyanazine, dicamba, simazine, or linuron on corn; with linuron, chlorpropham, bifenoxy, 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, 2 to 3 pounds per acre on dry beans, and 3 to 4 pounds per acre on sunflowers 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. Preplanting or preemergence applications may be applied with fertilizer solutions.

Remarks--Research results show good control of annual grasses, nutsedge, 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--2.5 + 1.5 pounds per gallon dispersible liquid.

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 (Section 18) label in 6 North-west Minnesota counties in 1983 to control wild oat and to suppress foxtail and wild buckwheat in flax. CAUTION: As of November 1, 1983, asulam is not cleared for use on flax but label clearance is expected for 1984. The flax variety "Flor" has been injured by asulam in recent tests and will be restricted on the label.

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, sorghum, and proso millet. 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 3.0 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. (4) Weed control in proso millet: 1/2 to 2 pounds per acre.

Time of application for weed control in corn and sorghum--Preemergence or pre-plant in corn and postemergence in corn and sorghum before grasses are 1-1/2 inches or broadleaf weeds are 4 inches tall. Atrazine is cleared for use on corn up to layby-stage (about 30 inches tall) of the corn. 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. Apply preplanting or preemergence for weed control in proso millet.

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) - Velsicol

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. Do not spray when plants are wet with dew or rain. Spray only when crop is actively growing and not under stress.

Formulation--2 pounds 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. May be mixed with fluid fertilizers.

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; a mixture with acifluorfen (Blazer) is labeled.

Rate of application--3/4 to 1-1/2 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.

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, Brominal-4E, Buctril) - Union Carbide, Rhone-Poulenc

Use--Annual broadleaf control in corn, wheat, barley, oats, rye, flax, and newly planted grasses for sod and seed production. 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 corn is less than 6 inches tall. When flax is 2 to 8 inches tall. Early applications more effective on weeds. Treat broadleaves before the 5-leaf stage. Do not treat flax in humid weather or when temperature is over 80°F.

Remarks--Controls wild buckwheat and smartweed better than MCPA or 2,4-D. Does not control perennials. Injures legumes. Some small grain and corn leaf burn has occurred at higher rates.

Formulation--2 or 4 pounds per gallon liquid. Formulations of 2 or 3 pounds per gallon of bromoxynil + 2 or 3 pounds per gallon of MCPA ester are available (Brominal Plus, Brominal 3+3, Bronate).

Butylate (Sutan +) - Stauffer

Use--Control of annual grasses and nutsedge 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, 4.8 pounds butylate plus .2 pounds atrazine per gallon liquid (Sutazine).

Chloramben (Amiben) - Union Carbide

Use--Preplanting and preemergence 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 trifoliolate leaf stage. Chloramben is labeled for tank mixing with trifluralin, fluchloralin, pendimethalin, vernolate, linuron, alachlor, dinoseb, metribuzin, metolachlor, and 2,4-DB.

Rate of application--1.8 to 2.7 pounds per acre preplanting on preemergence; 2-1/4 to 2.7 pounds per acre postemergence. For wild proso millet control, chloramben may be applied preplant incorporated at 1.8 to 2.7 lb/A followed by a postemergence application of 1.8 to 2.7 lb/A, when soybeans are in the cotyledon to second trifoliolate stage, but before emergence of wild proso millet.

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. Chloramben may be applied early postemergence from the cracking to second trifoliolate stage of soybeans.

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 0.9 to 1.8 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--1.8 pounds per gallon liquid; 10 percent granule; 75 percent DS (dry soluble)

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.

Chlorsulfuron (Glean) - DuPont

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

Time of application--Preemergence or postemergence, but early postemergence use of chlorsulfuron plus a surfactant appears to be the most effective method of application in Minnesota.

Remarks--Chlorsulfuron is a very active herbicide. Rates of 1/8 to 1/2 ounce/A of the 75 percent dry flowable formulation are effective in controlling many common small grain weeds. Chlorsulfuron may persist in high pH soils and cause injury to broadleaf crops following in the rotation. Chlorsulfuron is not labeled for use in soils with a pH above 7.5. A test strip of rotational crops must be successfully grown to maturity in the year prior to the production year. See label before using.

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

Cyanazine (Bladex) - Shell

Use--Annual grass and broadleaf control in corn. Preemergence with atrazine, paraquat, 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--1.25 to 4.75 pounds per acre depending on soil texture and organic matter, 0.6 to 3.0 pounds per acre with alachlor, butylate, EPTC (Eradicane), or metolachlor.

Time of application--Preplanting, preemergence, or postemergence on corn through the 4-leaf stage and before weeds exceed 1-1/2 inches. For postemergence, use only the 80 percent wettable powder or 90 percent dry flowable, 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, 15 percent granule, 90 percent dry flowable water dispersible granule.

Cycloate (Ro-neet) - Stauffer

Use--Annual grass, nutsedge, and broadleaf control in sugarbeets.

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

Time of application--Preplanting; fall or spring.

Remarks--Must be incorporated immediately and thoroughly, tillage tool should be operated 4 to 6 inches deep to incorporate to a depth of 2 to 3 inches.

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 sugarbeets. Quackgrass control in the fall before planting corn; potatoes, dry beans, or sugarbeets in the spring.

Rate of application--(1) Flax: 3/4 pound per acre. May be tank-mixed with 1/4 pound per acre of MCPA on flax. (2) Sugarbeets: 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 sugarbeets: when grasses are not more than 2 inches tall. Postemergence until sugarbeets 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.

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.

2,4-DB is labeled for postemergence use with naptalam and as directed sprays with linuron and metribuzin.

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 grazing 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 sugarbeets, 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 sugarbeets 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 sugarbeet injury. To reduce injury do not use more than 1 pound per acre where preplanting or pre-emergence 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 sugarbeet injury and improved weed control compared to a single application at the full rate. Rainfall within 6 hours after spraying may reduce weed control.

Formulation--1.3 pounds per gallon liquid.

Diallate (Avadex) - Monsanto

Use--Control of wild oat in alfalfa, barley, flax, sugarbeets, 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 sugarbeets; postseeding (pre-emergence) on barley. Fall application is a possibility before sugarbeets. 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; 1/4 to 1/2 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 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, wheat, and barley, 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 trifoliate 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 bromoxynil), 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. Do not apply more than one application of diclofop in a growing season.

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.

Diethatyl (Antor)

Use--Control of pigweed and some annual grasses in sugarbeets.

Rate of application--4 to 6 pounds per acre.

Rate of application--Preplanting incorporation.

Remarks--Shallow incorporation (1 to 2 inch) gives best results.

Formulation--4 lbs. per gallon liquid.

Difenzoquat (Avenge) - American Cyanamid

Use--Controls wild oat in barley, winter wheat, Era, Butte, Kitt, Solar, Cateau, Walera, Probrand 711, Olaf and Fortuna spring wheat, and all varieties of durum wheat except Lakota, Wascana, Vic and Edmore. Significant injury can occur from the use of difenzoquat on some spring wheat varieties including Alex, Bonanza, Lark, Len, Waldron and others.

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

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 or MCPA amine or ester, bromoxynil or a mixture of MCPA and bromoxynil. Do not apply mixture of difenzoquat and 2,4-D until the crop is 6 inches tall or until after the crop is well tillered. 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) - Vertac

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

Endothall (Endothal, Herbicide 273) - Pennwalt

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

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

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

Remarks--Excessive injury, especially to very small sugarbeets, 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); EPTC plus crop protectant plus extender (Eradicane Extra) - Stauffer

Use--EPTC: Control of annual grasses, nutsedge and some broadleaves in sugarbeet

potatoes, seedling alfalfa, birdsfoot trefoil, clovers, sunflowers, flax, and dry edible beans except adzuki beans. EPTC can be mixed with trifluralin (Treflan) on dry beans. "Eradicane" or "Eradicane Extra" 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 or fluchloralin on dry beans and sunflowers, and with chloramben on sunflowers (except that mixtures with fluchloralin should not be used on adzuki beans).

Rate of application--EPTC: 2 to 3 pounds per acre on sugarbeets 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 or Eradicane Extra: 3 to 6 pounds per acre in corn.

Time of application--Preplanting in spring or previous fall.

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. Perennial grasses must be turned under and chopped thoroughly prior to treatment. Effectiveness declines with repeated annual use due to more rapid degradation by soil microorganisms.

Formulation--Eptam: 7 pounds per gallon liquid; 10 percent granular; Eradicane: 6.7 pounds per gallon liquid; Eradicane Extra: 6 pounds per gallon liquid.

Ethofumesate (Nortron) - Fisons

Use--Control of some annual broadleaves and grassy weeds in sugarbeets. 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. Sugarbeet 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.

Fluazifop (Fusilade) - ICI

Use--Control of grassy annual and perennial weeds in soybeans.

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

Time of application--Early postemergence when grass weeds are 2 to 8 inches tall.

Remarks--Fluazifop has given excellent control of most annual grasses including volunteer corn, foxtails, wild proso millet and woolly cupgrass in soybeans. The chemical also controls perennial grasses. An oil concentrate is used with the spray mixture. Avoid spray drift onto corn.

Formulation--4 pounds per gallon liquid.

Fluchloralin (Basalin) - BASF

Use--Annual grass, pigweed, and common lambsquarters control in soybeans, sunflowers, and most dry edible beans except adzukis. Labeled for tank-mix with metribuzin in soybeans. Can be tank-mixed with EPTC (Eptam) for most dry beans except adzukis and flat-podded beans.

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. May be applied with liquid or dry fertilizers.

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, forage legumes and grasses, oats, potatoes, sorghum, soybeans, sugarbeets, wheat, and many vegetable crops. 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 to 3 pounds per acre depending on time of application and weed species (see label).

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 pipe-wick applicators in soybeans. Volunteer corn control has been acceptable with all of these applicators.

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.

Hexazinone (Velpar) - DuPont

Use--Weed control in established alfalfa.

Rate of application--0.45 to 1.35 pounds per acre. Use the lower rates (0.45 to 0.90 pounds per acre) on coarse textured soils low in organic matter and the higher rates (0.90 to 1.35 pounds per acre) for medium and fine textured soils and soils high in organic matter.

Time of application--In the fall after alfalfa becomes dormant or in the spring before new growth begins.

Remarks--Treat only stands of alfalfa established for one year or more. Do not use on seedling alfalfa or on alfalfa-grass mixtures or other mixed stands. Hexazinone may injure alfalfa if excessive rates or overlaps occur. Also injury may result from the occurrence of excessive rainfall or too much irrigation water within a week or two after application.

Formulation--90 percent water soluble powder.

Linuron (Lorox) - DuPont

Use--Preemergence weed control in corn, sorghum 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 replanting 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. May be tank-mixed with dalapon on flax at 1/4 pound per acre plus 3/4 pound per acre of dalapon. 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, soybeans, dry beans and potatoes. Used in mixtures with atrazine, cyanazine, simazine, or dicamba in corn or with metribuzin, linuron, naptalam + dinoseb, chloramben, chlorpropham, trifluralin or dinoseb in soybeans. For minimum tillage corn in mixtures with glyphosate, paraquat, atrazine, or simazine and for 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.

Formulation--8 pounds per gallon liquid, 25 percent granule and 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 broadleafs than grasses. Can be used on soybeans in mixtures with

alachlor, metolachlor, chloramben, glyphosate, paraquat, trifluralin, fluchloralin, or pendimethalin.

Rate of application--Soybeans: 3/8 to 7/8 pound per acre depending on soil texture and organic matter. 1/8 to 3/4 pound per acre in mixtures. 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, preemergence or a combination of preplanting and 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. Metribuzin may be applied on dry fertilizers or with liquid fertilizers.

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

Naptalam (Alanap-L) - Uniroyal

Use--Postemergence control of annual broad-leaved weeds (cocklebur, giant ragweed, volunteer sunflower, wild mustard) in soybeans. Used in combination with 2,4-DB.

Rate of application--1 to 1-1/2 pounds per acre of naptalam plus 3/64 to 1/16 pound per acre of 2,4-DB. Use a nonionic surfactant with the mixture.

Time of application--When soybeans are about 18 inches tall (7-10 days before bloom through mid-bloom).

Remarks--This treatment is primarily to control large (12 inches) broadleaved weeds that have escaped earlier control. There is some risk of soybean injury. Do not apply to drought stressed soybeans. Rain within 6 hours after application will reduce effectiveness.

Formulation--2 pounds per gallon liquid.

Naptalam + dinoseb (Dyanap) - Uniroyal

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

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 or metolachlor. 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 preemergence 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 (Paraquat, Gramoxone) - 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. Preplanting incorporated alone or with chloramben on sunflowers.

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

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; preemergence or preplanting in soybeans; pendimethalin alone or mixed with atrazine may be applied postemergence incorporated on corn from 4 inches tall to last cultivation; preplant incorporated on sunflowers.

Remarks--Do not use on soils containing less than 1-1/2 percent organic matter, nor on peat or muck. 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 and sunflowers, 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 or ester or MCPA amine for control of certain broadleaf weeds in spring and winter wheat and barley. All formulations may be used on non-crop-land, except do not use near rivers, lakes or other water supplies. Two formulations (Tordon 22K and Tordon 2K) may be used on grass pastures in Minnesota on a special local need label.

Rate of application--A tank-mix combination of 1/4 ounce picloram (1 fluid ounce of Tordon 22K) and 1/4 pound 2,4-D amine or ester or MCPA amine for wheat and barley, 1/2 to 2 pounds per acre in grass pastures.

Time of application--Postemergence, when wheat or barley is in the 4 to 6-leaf stage and weeds are small; postemergence in grass pastures when perennial broadleaf weeds are 6 to 8 inches tall but before bloom.

Remarks--A higher rate of application, 3/8 ounce per acre of picloram and 3/8 pound per acre of 2,4-D amine or ester or MCPA 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. Picloram is a restricted use pesticide and can be applied only by a certified applicator. Adhere to all label requirements for safe use of this herbicide.

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

Propachlor (Ramrod) - Monsanto

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--20 percent granular, 4 pounds per gallon dispersible liquid, or Ramrod/atrazine, 3 + 1 pounds per gallon dispersible liquid.

Propanil (Stampede) - Rohm and Haas

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

Rate of application--1-1/8 to 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 4 leaf stage. Use higher rate on 4-leaf grasses and more tolerant broad-leaves.

Remarks--Do not apply propanil beyond the 5 leaf stage of HRS wheat or at rates of more than 1-1/2 pounds per acre or beyond the four leaf stage of durum wheat or rates higher than 1.13 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. Do not apply if frost is expected within 24 hours or when temperatures are above 85°F, especially with drying winds.

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° 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.

Remarks--Corn may be planted in rotation 12 months after treatment. Other crops should not be planted for 18 months following treatment. Do not use in sand or loamy sand soils.

Formulation--80 percent wettable powder.

Pyrazon (Pyramin) - BASF

Use--Control of most annual broadleaves in sugarbeets. Has been more effective on medium to coarse textured soils with less than 5 percent organic matter. May be applied preemergence with TCA.

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

Time of application--Preemergence or preplanting incorporated; postemergence when sugarbeets have two expanded true leaves and before weeds have more than 2 to 4 true leaves.

Remarks--A rain shortly after application is necessary for best results. Incorporation usually improves weed control. Do not use on sands or loamy sands as crop injury may occur; do not use preemergence on peat or muck soils.

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

Sethoxydim (Poast) - BASF

Use--Control of grassy weeds in soybeans.

Rate of application--0.1 to 0.5 pounds per acre. High rate for perennial grasses.

Time of application--Early emergence.

Remarks--Sethoxydim gives excellent control of most annual grassy weeds including volunteer corn, foxtails, wild proso millet and woolly cupgrass in soybeans. In addition, sethoxydim gives good suppression or control of several perennial grass weeds such as quackgrass and wirestem muhly. An oil concentrate is used with the spray mixture. Avoid spray drift onto corn.

Formulation--1.53 pounds per gallon 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. Fall or spring on well established, dormant birdsfoot trefoil.

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.

Ethfluralin (Sonalan) - Elanco

Use--Annual grass, pigweed, common lambsquarters control and partial control of eastern black nightshade in soybeans.

Rate of application--0.56 to 1.3 pounds per acre.

Time of application--Preplanting incorporation.

Remarks--Must be incorporated in the soil. Do not graze or feed forage.

Formulation--3 pounds per gallon liquid.

TCA - Hopkins

Use--Control of annual grasses except wild oat in sugarbeets.

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 postseeding for barley (postseeding preferred). Fall incorporated or surface applications are possibilities. See label for details.

Remarks--Must be incorporated by two harrowings at right angles for postseeding 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. May be tank-mixed with trifluralin for spring postseeding application for wheat and barley. This chemical irritates skin and eyes; use caution when handling.

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

Tridiphane (Tandem) - Dow

Use--Combined with Atrazine plus oil or Bladex for postemergence control of small annual grasses in corn.

Rate--0.5 pounds per acre.

Time of application--Early postemergence.

Remarks--Tandem may increase the effectiveness of Atrazine and Bladex on annual grasses up to 3 inches tall. Full clearance or an EUP expected for 1984 season.

Formulation--4 pounds per gallon liquid.

Trifluralin (Treflan) - Elanco

Use--Annual grass, pigweed and common lambsquarters control in soybeans, dry edible beans including adzuki beans, sunflowers, mustard, sugarbeets, and spring wheat. Used in mixtures with chloramben, metribuzin, chlorpropham or vernolate on soybeans; with chloramben and EPTC on dry beans; and with triallate on spring wheat and barley.

Rate of application--1/2 to 1 pound per acre, depending on soil type. Use lower rates on coarse-textured soils and higher rates on finer-textured soils. On spring wheat, the rates are 1/2 to 3/4 pound per acre.

Time of application--Preplanting on soybeans, dry edible beans, mustard and sunflowers; postemergence on 2 to 6 inch sugarbeets after blocking or thinning and before new weeds come up. On spring wheat and barley, apply immediately after planting or the previous fall just before freezeup.

Remarks--Must be incorporated into the soil soon after application. Proper incorporation of preplanting applications can be accomplished by disking field twice, once in each direction, immediately after applying chemical. This chemical sometimes causes slight soybean stand reduction and early soybean injury. To reduce spring wheat injury potential, plant wheat 2 to 3 inches deep, apply the chemical and incorporate shallowly with a harrow operated in two different directions. Can be applied with fluid or dry bulk fertilizer.

Formulation--4 pounds per gallon liquid; 5 percent granular.

Vernolate (Vernam) - Stauffer

Use--Controls annual grasses and some broadleaves in soybeans. Cleared for use in mixtures with trifluralin, fluchloralin, and chloramben in soybeans. Cleared for sequential (overlay) treatments with chlorpropham, linuron, bentazon, and naptalam + dinoseb.

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

Time of application--Preplant incorporated; incorporate immediately.

Remarks--Vernolate must be incorporated immediately after application to prevent loss by volatilization. Incorporation should be done by disking twice or by using a power rotary tiller. Early soybean injury has sometimes occurred. Can be applied with fluid or dry bulk fertilizer.

Formulation--7 pounds per gallon liquid; 10 percent granular.

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
Amidon 101	picloram and 2,4-D
Amiben	chloramben
Asulox	asulam
Avadex	diallate
Avadex-BW	triallate
Avenge	difenzoquat
Balan	benefin
Banvel	dicamba
Banvel II	dicamba
Basagran	bentazon
Basalin	fluchloralin
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	endothall
Eptam	EPTC
Eradicane	EPTC plus crop protectant
Eradicane Extra	EPTC plus crop protectant plus extender
Evik	ametryne
Far-go	triallate
Furloe	chlorpropham
Fusilade	fluzifop

<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 (BAS-9052)
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
Sonalan	ethal fluralin
Stampede	propanil
Sutan +	butylate plus crop protectant
Sutazine	butylate plus crop protectant plus atrazine
Tandem	tridiphane
TCA	TCA
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.

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	Incorporate for nutsedge. May shallow incorporate for annual weeds.	None
	atrazine	1 to 3	Preplanting, preemer- gence or early post- emergence	Atrazine may injure crops the following year	Do not graze or feed for- age for 21 days after treatment
	EPTC with protectant (Eradicane) or EPTC + protectant + extender (Eradicane Extra)	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)	4 to 6	Preemergence		None
	cyanazine (Bladex)	1.25 to 4.75 } 2 }	Preplanting Preemergence Early postemergence (80 W or 90 DF only).	Do not use on sandy soils. Use oil or surfac- tant postemergence under arid conditions only.	None
	atrazine and alachlor	1 to 2+ 1½ to 2½	Preplanting or preemergence		Do not graze or feed for- age for 21 days after treatment.
	atrazine and metolachlor (Bicep or tank mix)	1 to 3+ 1¼ to 3	Preplanting or preemergence		
	cyanazine and alachlor	0.6 to 3 2 to 2½	Preplanting or preemergence	Do not use on sandy soils.	None
	cyanazine and metolachlor	0.6 to 3 1.25 to 2.5	Preplanting or preemergence	Do not use on sand or on loamy sand with less than 1% organic matter.	None
	dicamba (Banvel) + alachlor	½ - 2 to 2½	Preemergence	Use only on medium or fine textured soils with more than 3% 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 (Sutazine or tank mix)	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. None
	cyanazine and butylate	0.6 to 3 + 3 to 4	Preplanting incorporation		
	atrazine and EPTC (Eradicane, Eradicane Extra)	1 to 1½ + 3 to 4	Preplanting incorporation	Do not use on corn seedstock.	None
	cyanazine and EPTC (Eradicane)	0.6 to 3 + 3 to 4	Preplanting incorporation	Do not use on corn seedstock.	None
	atrazine and propachlor	1 to 1½ + 2 to 3¼	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 } ⅓ 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	½ to 1	Corn over 3 feet	Spray base of stalks only.	
	2,4-D ester	⅓ to ⅓			
	dicamba (Banvel)	⅓ to 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.
	dicamba-2,4-D amine	⅓ - ¼			
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.	
bromoxynil	¼ to ½	Postemergence before weeds 6 inches and corn 14 inches.			
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)	1½ to 1½ } 2 to 3 } ½ to 1 }	Preplanting incorporation	Alfalfa only	None
	EPTC (Eptam)				None
	profluralin (Tolban)				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	½ to 1½	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.
	2,4-DB ester	½ to 1			
	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)				
	pronamide (Kerb)	1 to 2	Fall	May injure alfalfa	Do not graze or harvest alfalfa within 25 to 45 days after application.
hexazinone (Velpar)	0.45 to 1.35	Fall or spring when alfalfa is dormant	May injure alfalfa	Do not graze or feed treated forage within 30 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 MCPA only at low rates, if legumes are present. Use 2,4-D, dicamba, picloram, or mixture of these for woody plant control. Avoid drift, especially of dicamba or picloram to susceptible crops, particularly soybeans and sunflowers. Read label precautions before using picloram.	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. Do not graze or feed forage for two weeks after application of picloram.
	MCPA	¼ to 2			
	dicamba (Banvel)	½ to 1			
	picloram (Tordon 22K & 2K)	½ to 2			
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
	fluchloralin (Basafin)	½ to 1	Preplant incorporation	Do not use on adzuki beans.	None
	alachlor (Lasso)	2½ to 3	Preplant incorporation	Do not use on adzuki beans.	None
	metolachlor (Dual)	1½ to 3	Preplant incorporation or Preemergence	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
		2½ to 3½	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			
	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 in spring or fall	For grass weeds and some annual broadleaves. Similar performance to EPTC but less injury.	None
	diethatyl (Antor)	4 to 6	Preplanting incorporation	For pigweed and some annual grasses	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)	3/8 to 1/2	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 (Furloc Chloro IPC)	2 to 3	Preplant incorporation or preemergence	For smartweed control	None
	diclofop (Hoelon)	3/4 to 1 1/4	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	1/2 to 2 1/2	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 1/2 percent	None
	metolachlor (Dual)	1 1/2 to 3	Preplant incorporation or preemergence	Incorporate for nutsedge control	Do not graze or feed soybean hay or forage.
	metribuzin (Sencor Lexone)	1/4 to 3/4	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)	1/2 to 1 1/2	Preplant incorporation	Must be incorporated	Do not graze or feed forage
	pendimethalin (Prowl)	1/2 to 1 1/2	Preplant incorporation	Incorporate	None
	trifluralin (Treflan)	1/2 to 1	Preplant incorporation	Must be incorporated	None
	vernolate (Vernam)	2 to 3	Preplant incorporation	Incorporate immediately	None
	bentazon (Basagran)	3/4 to 1 1/2	Early postemergence (soybeans in first trifoliolate, weeds less than 2 inches and 4 true leaves).	Controls most annual broadleaves, Canada thistle, nutsedge	None
ethal fluralin (Sonalan)	0.56 to 1.3	Preplant incorporation	Partial control of eastern black nightshade	Do not graze or feed forage.	

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	1/5	Postemergence directed	For cocklebur control	Do not harvest within 60 days after application
Winter wheat	2,4-D amine 2,4-D ester MCPA	1/4 to 3/4 1/4 to 1/2 1/4 to 3/4	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	1/8 + 1/4 to 3/8			
	dicamba + 2,4-D amine	1/8 + 1/4 to 3/8			
	bromoxynil bromoxynil + MCPA ester	1/4 to 1/2 1/4 + 1/4	Wheat fully tillered to boot stage	For broadleaves	Do not forage or graze for 30 days after treatment with bromoxynil.
	diclofop	3/4 to 1 1/4 (wheat) 3/4 to 1 (barley)			
	picloram and 2,4-D amine	1/64 to 3/128 + 1/4 to 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
Rye	2,4-D amine 2,4-D ester MCPA amine or ester	1/4 to 3/4 1/4 to 1/2 1/4 to 3/4	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	1 1/2	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 graze treated crop or cut for green chop feed.
	propanil + MCPA iso-octyl ester	1 1/8 + 1/4	2 to 4 leaf stage or grass weeds	Do not use on fields previously treated or to be treated this year with organophosphorus or carbamate insecticides.	
Spring wheat or barley	2,4-D amine 2,4-D ester	1/4 to 3/8 1/6 to 1/2	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	1/4 to 3/8 1/6 to 1/2	Two leaf to early boot	May injure legumes.	None
	trifluralin (Treflan)	1/2 to 3/4	Postplanting incorporation in spring or preplanting incorporated in fall prior to spring seeding.	Improper application may result in crop injury. May be tank-mixed with triallate in spring, not in fall.	None
	Chlorsulfuron	1/96 to 1/32	Preemergence or Postemergence	For broadleaves and grasses. Follow label directions to avoid carry-over injury to sensitive crop.	

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 unseeded legumes.	Do not forage or graze for 30 days after treatment
	bromoxynil (Brominal, Buctrit)	$\frac{1}{4}$ 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 $\frac{3}{128} + \frac{1}{4}$ 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	$\frac{1}{8} + \frac{1}{4}$	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 $\frac{3}{8}$ $\frac{1}{8}$ 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.
	trifluralin	$\frac{1}{2}$ to 1	Preplanting incorporation	Fall application only For annual grasses	None
Alfalfa and clover in small grains	Some formulations of 2,4-D amine or MCPA amine (See label)	$\frac{1}{8}$ 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.
	alachlor	2 to 4	Preplanting incorporation or preemergence		None
	EPTC (Eptam)	2 to 3	Preplanting incorporation	Fall or Spring Application	None
	trifluralin (Treflan)	$\frac{1}{2}$ to 1	Preplanting incorporation		None
	fluchloralin (Basalin)	$\frac{3}{4}$ to $1\frac{1}{2}$	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.
	pendimethalin + chloramben	$\frac{3}{4}$ to $1\frac{1}{4} + 2$	Preplanting incorporation		Do not feed treated forage to livestock.
	trifluralin + EPTC	$\frac{1}{2}$ to 1 + 2	Preplanting incorporation		None
	EPTC + Chloramben	2 to 3 + 1 to 2	Preplanting incorporation		Do not graze or feed forage.

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	1/2	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)	1/8 to 1/4		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)	1 1/2	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)	3/4 to 1 each time-two applications or 1 to 1 1/2 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	1/2	Bud to bloom		See crop
	glyphosate (Roundup)	2 1/4 to 3 3/4	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	3/8 to 1/2	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	1/2	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	See crop
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
Yellow Nutsedge	bentazon (Basagran)	¾ to 1	6- to 8-inch nutsedge Repeat 7 to 10 days later.	For soybeans or corn Split applications usually better.	See crop
Quackgrass	dalapon (Dowpon)	11	Fall	Foliage application, plow 1 or 2 weeks later. May plant corn, dry beans, some varieties of potatoes, sugarbeets next spring.	Do not graze treated areas in year treated.
	EPTC (Eradicane)	6	Preplanting incorporated	For more consistent control, apply glyphosate or atrazine in the fall followed by EPTC in the Spring.	
Quackgrass Wirestem muhly (muhlenbergia)	atrazine	2 to 4	Spring or fall Split application in fall and spring preferred.	Use low rate on sandy soils. Only corn can be grown the year after treatment.	See corn.
	glyphosate (Roundup)	¾ to 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.	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	Preplanting or preemergence, fall or spring	Rate for sugarbeets.	None
	diallate (Avadex)	1½ to 2 (liquid)			
	diallate (Avadex)	1½		Rate for corn	
	triallate (Far-go)	1 to 1¼ (wheat) 1¼ to 1½ (barley)	Preplanting or preemergence fall or spring.	Must be incorporated into soil, except late fall granules.	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 corn¹

	Preplanting						Preemergence								Postemergence						
	Alachlor (Lasso)	Metolachlor (Dual)	Butylate (Sutant+)	EPTC (Eradicane, Extra)	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)	Pendimethalin (Prowl)	Bromoxynil (Brominal, Buctril)
<i>Corn tolerance—</i>	G	G	G	G	F	G	G	G	F	G	F	G	F	F	F	G	G	F	G	F	G
<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	N
Green foxtail	G	G	G	G	G	G	G	G	P	G	F	G	F	G	N	N	G	G	N	F	N
Yellow foxtail	G	G	G	G	G	G	G	G	P	G	F	G	F	G	N	N	G	G	N	F	N
Barnyardgrass	G	G	G	G	F	F	G	F	P	G	F	F	F	F	N	N	F	F	N	F	N
Crabgrass	G	G	G	G	F	P	G	P	P	G	F	G	F	F	N	N	P	F	N	F	N
Panicum	G	G	G	G	F	P	G	P	P	G	F	F	G	F	N	N	P	F	N	F	N
Nutsedge	G	G	G	G	P	P	F	P	N	F	N	F	P	P	N	N	F	P	G	N	N
Quackgrass	N	N	N	F	P	P	N	G	N	N	N	N	N	P	N	N	G	P	N	N	N
Woolly cupgrass	G	G	F	G	P	P	G	P	P	G	F	F	P	P	N	N	F	F	N	F	N
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	F	N
Wild oat	P	P	F	F	F	G	P	G	N	P	F	P	G	F	N	N	G	F	N	F	N
Sandbur	F	F	G	G	F	F	F	F	P	F	G	P	—	F	P	P	P	—	P	G	N
<i>Broadleaves—</i>																					
Buffalo bur	P	P	F	G	P	P	P	P	P	P	P	P	P	P	P	P	G	F	P	P	—
Cocklebur	N	N	P	P	F	F	N	F	F	N	P	P	P	F	G	G	G	F	G	P	G
Kochia	P	P	P	F	G	G	P	G	F	P	F	P	F	G	F	G	G	G	—	F	G
Lambsquarters	F/P	F/P	P	F/G	G	G	F/P	G	G	F/P	F	P	G	G	G	G	G	G	F	F	G
Mustard	P	P	P	P	G	G	P	G	G	P	P	P	G	G	G	F	G	G	G	P	G
Pigweed	G	G	F	F	F	G	G	G	G	G	F	F	G	F	G	G	G	F	P	F	G
Ragweed	P	P	P	F	G	G	P	G	G	P	P	P	G	G	G	G	G	G	G	P	G
Smartweed	P	P	P	P	G	G	P	G	G	P	F	P	F	G	P	G	G	G	G	F	G
Velvetleaf	P	P	F	F	F	F	P	F	F	P	F	P	F	F	G	G	F	F/G	G	F	G
Wild sunflower	P	P	P	P	F	F	P	F	F	P	P	P	P	F	F	G	G	F/G	G	P	G
Canada thistle	N	N	N	N	P	P	N	P	N	N	N	N	N	P	F	G	F	P	F	N	N
Jerusalem artichoke	N	N	N	N	P	P	N	P	P	N	N	N	P	P	G	G	P	P	P	N	N
American germander	N	N	P	F	P	P	N	P	P	N	N	N	P	P	P	P	G	F	P	N	N
E. black nightshade	F	F	P	P	G	G	G	G	F	G	P	P	P	G	F	F	G	G	P	P	—

¹ G = Good, F = Fair, P = Poor, N = None

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)	Trifluralin (Treflan)	Vernolate (Vernam)	Alachlor (Lasso)	Chloramben (Amiben)	Chlorpropham (Furibc Chloro IPC)	Naptalam (Alanap-L)	Dinoseb (Premerge)	Linuron (Lorox)	Metolachlor (Dual)	Metribuzin (Sencor or Lexone)	Acifluorfen (Blazer)	Bentazon (Basagran)	2,4-DB (Butoxone or Butyrac 200)	Diclofop (Hoelon)	Dinoseb (Premerge)	Naptalam (Alanap L)	Fluzifop (Fusilade)	Sethoxydim (Poast)
Soybean tolerance	G	G	F	G	F	F	F	F	G	G	G	P	G	F	G	F	F	G	P	G	P	G	G	G
Grasses																								
Giant foxtail	G	G	G	G	F	G	G	G	G	G	P	P	P	F	G	F	P	G	P	G	P	G	G	G
Green foxtail	G	G	G	G	F	G	G	G	G	G	P	P	P	F	G	F	P	G	P	G	P	G	G	G
Yellow foxtail	G	G	G	G	F	G	G	G	G	G	P	P	P	F	G	F	P	G	P	G	P	G	G	G
Barnyardgrass	G	G	G	G	F	G	G	G	G	G	P	P	P	F	G	F	P	G	P	G	P	G	G	G
Wild proso millet	G	G	G	G	F	G	G	G	G	G	P	P	P	F	G	F	P	G	P	G	P	G	G	G
Nutsedge	G	G	G	G	F	G	G	G	G	G	P	P	P	F	G	F	P	G	P	G	P	G	G	G
Woolly cup grass	G	G	G	G	F	G	G	G	G	G	P	P	P	F	G	F	P	G	P	G	P	G	G	G
Quackgrass	N	N	G	F	P	G	G	F	N	G	Z	P	P	P	Z	F	Z	Z	Z	Z	P	P	F	F
Sandbur	F	P	G	F	P	G	G	G	F	P	I	P	P	P	F	P	G	P	P	P	P	P	I	I
Broadleaves																								
Eastern Black nightshade	F	F	P	F	P	P	P	P	G	G	P	P	P	P	P	P	G	F	P	Z	G	P	Z	Z
Hairy nightshade	F	F	P	F	P	P	P	P	G	G	P	P	P	P	P	P	G	F	P	Z	G	P	Z	Z
Cocklebur	F	F	P	F	P	P	P	P	G	G	P	P	P	P	P	P	G	F	P	Z	G	P	Z	Z
Kochia	F	F	P	F	P	P	P	P	G	G	P	P	P	P	P	P	G	F	P	Z	G	P	Z	Z
Lambsquarters	F/P	F	G	F	P	P	P	P	F	P	P	P	P	P	P	P	P	F	P	Z	G	P	Z	Z
Mustard	F	F	P	F	P	P	P	P	G	G	P	P	P	P	P	P	G	F	P	Z	G	P	Z	Z
Pigweed	F	F	P	F	P	P	P	P	G	G	P	P	P	P	P	P	G	F	P	Z	G	P	Z	Z
Common ragweed	F	F	P	F	P	P	P	P	G	G	P	P	P	P	P	P	G	F	P	Z	G	P	Z	Z
Giant ragweed	F	F	P	F	P	P	P	P	G	G	P	P	P	P	P	P	G	F	P	Z	G	P	Z	Z
Smartweed	F	F	P	F	P	P	P	P	G	G	P	P	P	P	P	P	G	F	P	Z	G	P	Z	Z
Velvetleaf	F	F	P	F	P	P	P	P	G	G	P	P	P	P	P	P	G	F	P	Z	G	P	Z	Z
Venice mallow	F	F	P	F	P	P	P	P	G	G	P	P	P	P	P	P	G	F	P	Z	G	P	Z	Z
Wild sunflower	F	F	P	F	P	P	P	P	G	G	P	P	P	P	P	P	G	F	P	Z	G	P	Z	Z
Canada Thistle	N	N	N	N	P	N	N	N	Z	Z	P	P	P	P	P	P	F	G	P	Z	G	P	Z	Z

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				
	Diethylal (Antor)	Cycloate (Flo-neel)	Diallate (Avadex)	EPTC (Eptam)	Ethionnesate (Noriton)	Pyrazon (Pyramin)	TCA	Barban (Carbyne)	Dalapon (Dowpon, Bastapon)	Endothal (Herbicide 273)	Desmedipham (Betanex)	Desmedipham + Phenmedipham (Betamix)
Sugar beet tolerance	G	G	G	F	G	G	G	G	F	F	F	F
Grasses												
Giant foxtail	F/G	G	U	G	G	U	G	U	G	U	U	U
Green foxtail	F/G	G	U	G	G	U	G	U	G	U	U	U
Yellow foxtail	F/G	G	U	G	U	U	G	U	G	U	U	U
Barnyardgrass	P/F	G	U	G	U	U	G	U	G	U	U	U
Wild oat	P/F	U	G	U	U	U	U	G	U	U	U	U
Broadleaves												
Common ragweed	P	U	U	U	U	U	U	U	U	U	G	G
Lambsquarters	U	U	U	U	U	U	U	U	U	U	G	G
Marshelder	U	U	U	U	U	U	U	U	U	U	U	U
Pigweed	G	U	U	U	G	U	U	U	U	U	U	U
Smartweed	U	U	U	U	U	U	U	U	U	U	U	U
Wild buckwheat	U	U	U	U	U	U	U	U	U	U	U	U
Wild mustard	U	U	U	U	U	U	U	U	U	U	G	G
Volunteer sunflower	U	U	U	U	U	U	U	U	U	U	U	U
Kochia	U	U	U	U	U	U	U	U	U	U	U	U
Common cocklebur	U	U	U	U	U	U	U	U	U	U	U	U

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)	chloroxuron (Glean)	MCPA amine/ester	bromoxynil	dalapon (Dowpon)	barban (Carbyne)	diallate (Avadex)	EPTC (Eptam)	trifluralin (Treflan)	
<u>Crop Tolerance</u>	F	F	F	G	G	G	F	F	F	F	F	F	G	F	G	F	G	G	F	F	
<u>Grasses</u>																					
Green foxtail.....	G	N	N	N	N	N	N	N	N	N	G	G	G	N	N	G	N	N	G	G	
Yellow foxtail.....	G	N	N	N	N	N	N	N	N	N	F	G	G	N	N	G	N	N	G	G	
Barnyardgrass	G	N	N	N	N	N	N	N	N	N	G	G	G	N	N	G	N	N	G	G	
Wild oat	P	G	G	N	N	N	N	N	G	G	G	P	P	N	N	F	G	G	F	P	
<u>Broadleaves</u>																					
Wild mustard	N	N	N	G	G	F	P	P	N	N	N	F	G	G	F	N	N	N	P	N	
Wild buckwheat	P	N	N	F	F	G	G	G	N	N	N	G	G	F	G	N	N	N	P	P	
Lambsquarters	G	N	N	G	G	G	G	F	N	N	N	G	G	G	G	N	N	N	F	G	
Pigweed	G	N	N	G	G	G	G	F	N	N	N	G	G	G	G	N	N	N	F	G	
Smartweed (annuals)	P	N	N	F	F	G	G	P	N	N	N	P	G	F	G	N	N	N	P	P	
Common ragweed	N	N	N	G	G	G	G	F	N	N	N	P	G	G	G	N	N	N	F	N	
Giant ragweed	N	N	N	G	G	G	G	F	N	N	N	P	G	G	G	N	N	N	P	N	
Kochia	P	N	N	G	G	G	G	F	N	N	N	F	G	G	G	N	N	N	P	P	
Marshelder	P	N	N	G	G	G	G	F	N	N	N	P	G	G	G	N	N	N	P	P	
Canada thistle	N	N	N	F	F	N	G	P	N	N	N	N	F	F	N	N	N	N	N	N	
Perennial sowthistle	N	N	N	F	F	N	G	P	N	N	N	N	F	F	N	N	N	N	N	N	

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

1/ Effectiveness and crop tolerance 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 EXTENSION SERVICE
UNIVERSITY OF MINNESOTA - U.S. DEPARTMENT OF AGRICULTURE (Revised)
INSTITUTE OF AGRICULTURE, FORESTRY AND HOME ECONOMICS
ST. PAUL, MINNESOTA 55108

PW-18

Weed and Brush Control Along Roadside, Drainage
Ditches, and Other Rights-of-Way

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Weeds and brush along roadsides and rights-of-way must be controlled to protect the large investment in these public utilities and to protect the public who use them. If not controlled, weeds and brush restrict visibility at road intersections and at highway warning signs, and markers may grow up to interfere with telephone and electric power lines, choke out and fill in drainageways, may become a fire hazard in certain areas and become "weed nurseries" to propagate troublesome weeds that can spread to adjoining cropland. In addition, poisonous plants, such as poison ivy, and pollen-bearing plants, such as ragweed, may be public health hazards if not controlled. Noxious weeds and brush in these right-of-way areas should be controlled, but complete vegetation control is usually not desired because of erosion and aesthetic considerations. A yearly or periodic application of 2,4-D or one of the related phenoxy herbicides, or combinations of these, will control most of the troublesome broadleaf weeds and brush without killing the grasses and desirable native broadleaves (forbs). "Spot treatment", or spraying only where patches of noxious weeds and brush occur, is recommended. Grasses and forbs will be favored by the lack of broadleaf competition. Encouragement of the grasses and forbs in these areas provides erosion control and wildlife cover and also improves the appearance of the roadway. Grasses are fibrous rooted and hold the soil better on steep slopes than the more tap-rooted broadleaf

weeds. Also, most grasses do not grow as tall as broadleaf weeds or brush and usually require only one clipping each year along roadside shoulders to maintain proper visibility and safety and to prevent excessive drifting of snow in roadways.

Methods of weed and brush control

Weeds and small brush can be controlled by periodic mowing. However, two or more mowings are often required to keep weeds down and to prevent weed seed formation. Brush mowed off will resprout from the base, will become thicker, and repeated cutting is necessary for control. With high costs of labor, fuel and machine repairs, mowing of highways and other rights-of-way is becoming extremely expensive. Also, mowing early enough to prevent weed seed formation endangers nesting birds and their eggs and young, and cripples and kills other wildlife species.

The use of a phenoxy herbicide such as 2,4-D, on the other hand, can be applied from the roadway to adjoining roadsides and ditch banks with little danger of smashed clutches of eggs or crippled or killed birds and wildlife. The herbicide can be applied early in the season (usually sometime in June) in time to kill weeds or prevent weed seed formation. A follow-up mowing along the roadside after nesting season and after grasses are mature will reduce snow pileup in the roadway during the winter months. The use of a herbicide on a "spot treatment" basis to control patches of noxious weeds and troublesome brush is also much less expensive and less time consuming than mowing. Phenoxy herbicides may also be applied in early fall.

Minnesota Noxious Weed Law

Nine weeds are designated as noxious weeds in the state of Minnesota. This means these weeds are deemed by the Commissioner of Agriculture to

be injurious to public health, public roads, crops, livestock or other property. In addition, there are 47 weeds on a secondary weed list in the state. The Minnesota Commissioner of Agriculture may, without further hearing, take a weed or weeds from this secondary list and add it to the noxious weed list on a county basis if: (1) a majority of township boards and city mayors in a county file a petition requesting this addition, (2) the petition is approved by the County Board of Commissioners, and, (3) the Commissioner of Agriculture deems the weed or weeds to be a problem.

The land owner, his agent, or the public official in charge of the land, if it is public land, is responsible to see that noxious weeds growing thereon are controlled. Weed control is generally understood to mean preventing weeds from going to seed. Weeds not adequately controlled can be ordered destroyed or eradicated. Destroying or eradicating weeds refers to "complete killing of weeds, both the top growth and underground propagating parts of such weeds". If weeds are not controlled, an official notice may be served on the owner or the public officer in charge. This notice may be served by the local weed inspector (township officers or municipal mayor or president), by the County Agricultural Inspector, the district inspector, the state supervisor, or by the State Commissioner of Agriculture. The official notice (Form #1) must contain the following information:

- 1) Kinds of weeds
- 2) How to destroy or eradicate these weeds
- 3) The number of days allowed to comply with the notice
- 4) Signature of local or County Agricultural Inspector

The nine weeds on the noxious weed list in Minnesota are (1) four

herbaceous perennials: Canada thistle, perennial sowthistle, field bindweed and leafy spurge; (2) three biennials: bull thistle, musk thistle and plumeless thistle; (3) one annual: wild hemp and (4) one woody perennial: poison ivy. In addition to these noxious weeds, the Minnesota Department of Transportation lists ragweed species and common dandelion as additional weeds to be controlled along public highways to improve the roadside environment for human health considerations.

Selection of herbicides for use along roadsides, ditch banks or other rights-of-way (non-cropland)

1. 2,4-D

2,4-D is a phenoxy or chloro-phenoxy herbicide that is formulated as an amine, oil-soluble amine or low-volatile ester. It is usually the first choice of an herbicide for broadleaf weed control along rights-of-way because it is effective on a large number of weed species, is relatively low in cost and is usually readily available. These 2,4-D formulations are low in volatility and are less hazardous to use than the more volatile formulations. Highly volatile formulations, such as butyl ester of 2,4-D, should not be used for right-of-way spraying.

2,4-D will also control some woody species, including aspen (poplar), willow and boxelder. However, ash, maple, oak and several other common woody species are resistant to 2,4-D. If mixed brush species are present, 2,4-D can be mixed with another herbicide, such as 2,4-DP, to control a wide variety of broadleaf weeds and brush. 2,4-D may be used along drainage ditch banks or adjacent to home yards. However, when using 2,4-D or any herbicide used for vegetation control along rights-of-way, precautions must be taken to avoid wind drift to susceptible broadleaf crops,

trees, ornamentals or other desirable plants. Drift hazard can be reduced by using low sprayer pressure, preferably no more than 30 to 40 psi (pounds per square inch), using a higher gallonage of water per acre and larger nozzles, by not spraying on windy days, or by using an invert emulsion or spray-thickening agent. 2,4-D is rapidly broken down on plant foliage and in the soil, and is not considered a persistent herbicide. For example, 2,4-D may be used on grass pasture if a 7 to 14 day waiting period is observed before grazing dairy cattle on treated areas. Beef cattle should be removed from freshly treated areas for 7 days before slaughter. Check the product label closely for specific limitations.

2. 2,4-DP

2,4-DP is a phenoxy compound closely related to 2,4-D, except it has a propionic acid side chain instead of an acetic acid side chain, like 2,4-D. 2,4-DP may be used alone, or in combination with 2,4-D to control many 2,4-D resistant broadleaf weed or brush species. 2,4-DP is not cleared for use on pastures, but may be used along drainage ditch banks and on non-cropland areas. The herbicide is not considered persistent and will break down within a few weeks of application.

3. Picloram (Tordon, Amdon)

Picloram is formulated as a 2 lb/gal liquid or as either a 10 percent or 2 percent granule or bead. Picloram is a very persistent broadleaf weed and woody plant killer that can be used along roadsides and other rights-of-way to kill phenoxy-resistant weeds or brush. It should not be used along drainage ditches or along streams, lakes, ponds or water runoff areas. Picloram is cleared for spot treatment and broadcast use in grass pastures in Minnesota for the control of 2,4-D resistant broadleaf

weeds and brush. Picloram is useful for spot treatment of deep rooted perennials such as leafy spurge, or hard-to-kill woody and fern species such as ash and bracken fern. Because of its longer persistence in soil as compared to 2,4-D and other phenoxy herbicides, and because many broadleaf crops and ornamental plants, including trees and shrubs, are very susceptible to injury from picloram, great care should be taken to avoid drift or misapplication to non-target areas. Picloram has been designated as a restricted use pesticide by the Environmental Protection Agency, and most formulations can only be applied by a certified applicator. Refer to the product label for additional information.

4. MCPA

MCPA is a phenoxy herbicide that is formulated as an amine, an ester or a sodium salt. It is normally not used for roadside or other rights-of-way spraying, but could be used to control certain broadleaf weed or brush species such as spotted knapweed, buttercup, burcucumber, or honeysuckle on which it is more effective than 2,4-D, or it could be used at low rates to control susceptible broadleaf weeds without serious injury to legumes. MCPA is cleared for use on grass pastures with no limitation on use and is non-persistent.

5. MCPP (mecoprop)

MCPP is another phenoxy herbicide closely related to MCPA, except it has a propionic acid side chain instead of the acetic acid side chain of MCPA. MCPP may be used alone or in combination with 2,4-D and/or dicamba (Banvel) for the control of 2,4-D or MCPA resistant broadleaf weeds or brush. MCPP alone, and in various combinations, is cleared for use on lawns and other turf areas, and on non-cropland, but is not yet cleared for use on grass pastures in Minnesota. However, additional clearances are being sought and are expected shortly.

6. Dicamba (Banvel)

Dicamba is labelled for use along roadsides, but because of the great sensitivity of soybeans and most other legume and broadleaf crops and woody plants to dicamba, this herbicide should not be used to spray roadsides and other rights-of-way that are in the vicinity of susceptible broadleaf field crops, ornamentals, trees and vegetable or fruit crops. Dicamba may be used in combination with 2,4-D to control a broad spectrum of broadleaf weeds and brush where the drift hazard is not a problem. Dicamba is also formulated as a granule, which greatly reduces the drift hazard. However, dicamba is very water soluble, and high rates should not be used along ditches carrying water. Dicamba may be used in grass pastures for broadleaf weed control and has a limitation to exclude dairy cattle from grazing treated areas for 7 days after application of 1/2 lb or 21 days after application of 1 lb of dicamba. For use of higher rates, see product label.

Note: Before any weeds can be sprayed or otherwise controlled in public waters (rivers, lakes, streams) in the state of Minnesota, a permit must be secured from the Department of Natural Resources, Centennial Office Building, St. Paul, MN.

Mowing roadsides for forage use

In some areas, farmers wish to mow the roadside once or twice each season and harvest the forage as feed for livestock. This practice is particularly desirable to the landowner on wide roadways and medians where past use of herbicides has eliminated most of the broadleaf weeds and brush. Where this practice is common, highway crews should not spray these areas prior to mowing, or if spraying is necessary, they can spot spray with a herbicide such as 2,4-D so the forage can be harvested for

hay after a two week waiting period. If certain poisonous broadleaf weeds such as waterhemlock or bracken fern are present, the farmer should be alerted to the possibility of livestock poisoning from these weeds, and if present, poisonous plants should be controlled with herbicides prior to harvest, or harvesting these areas should be delayed until after chemical treatment and required waiting period. Farmer mowing of the roadway and utilization of this unused resource as livestock feed is looked upon as a benefit to both the farmer and the municipality and is encouraged in some areas. However, regular mowing may destroy the area for wildlife food and cover. Therefore, a system of partial or rotational mowing of an area is desirable, with some sections of roadside being left unmowed each year for wildlife utilization.

Types of herbicides

Herbicides such as 2,4-D and 2,4-DP are called "selective herbicides" because they will selectively control broadleaf weeds with little or no injury to the grasses. Also, they will selectively control deciduous (broadleaf) woody plants with little or no injury to evergreen (coniferous or needle-bearing) trees. Many selective herbicides, however, may become non-selective if the usage is increased over the recommended amount.

Another group of herbicides is called "non-selective herbicides". Non-selective herbicides are chemicals that "burn off" or kill all vegetation and may leave the soil non-productive (barren) for a year or more. Some of these complete vegetation control chemicals may be needed around highway guardrails, signs, and around buildings or industrial sites to eliminate fire hazards or to reduce hand labor weed control efforts.

Herbicides may be classed as to their type of applications. Foliarly applied herbicides such as 2,4-D, or paraquat must be applied to the foliage

and are not effective by soil uptake at the rates commonly used. Other herbicides, such as bromacil or simazine, are taken up mainly through the soil and do not need to have plant foliage present when the application is made. Herbicides may also be classified as to their mode of action. A contact herbicide, such as paraquat, kills above ground plant tissue only and does not translocate into the root system. 2,4-D is a good example of another type of herbicide - a "translocated herbicide". It moves into the root system from the foliage. These translocated herbicides will kill perennial weeds and brush. A contact herbicide will not. Herbicides may also be classed as residual and non-residual chemicals. Most herbicides used along roadsides, such as 2,4-D and 2,4-DP, are non-residual chemicals because they break down rapidly and are not a threat to the environment. Some herbicides, such as the soil-sterilants already mentioned, are considered residual chemicals and may persist for several years in the soil. Most of the residual herbicides used are low in water solubility and, therefore, do not move readily in the environment.

Selection of the best herbicides or herbicide combination

There are two primary considerations in selecting a herbicide for weed and brush control along highways or other rights-of-way. The first consideration may be safety to non-target plants and other organisms, including the applicator. The second and equally important consideration is performance or effectiveness of the herbicide.

Crops, trees and other broad-leaved plants adjacent to rights-of-way may be injured by herbicides in two main ways, (1) wind drift of the herbicide as it is being applied or (2) vapor drift, by volatility of certain formulations of a herbicide after application, which is evaporation of the herbicide into the air (especially troublesome on hot days) and subsequent drift

of these vapors to sensitive plants, which can happen two or three days or more after application. Wind drift can be minimized by using low sprayer pressure, using higher gallonage nozzles, and by not spraying when the wind exceeds 5 to 10 miles per hour. In addition, invert emulsions (water-in-oil droplets rather than oil-in-water), which have the consistency of mayonnaise on application, can be used to reduce or prevent wind drift. Spray thickening agents of various kinds can also be used to reduce drift potential. Volatility can be minimized by choosing a low-volatile ester rather than a high-volatile ester formulation, or by using an amine, oil-soluble amine or soluble salt formulation of the herbicide. The amine and soluble salt formulations are not volatile enough to cause a vapor drift hazard. Safety to the applicator may be accomplished by strict adherence to label precautions and safe equipment operating procedures.

Effective herbicide performance is dependent on proper identification of the weed or brush species to be controlled and subsequent selection of the herbicide or herbicide combination that is most effective in controlling those species. Refer to USDA Farmer's Bulletin No. 2183, "Using Phenoxy Herbicides Effectively", to the herbicide label or to this publication (Table 1) to determine the best herbicide for a particular weed problem.

Time of application of herbicides

For best results, foliarly applied herbicides such as 2,4-D should be applied when perennial weeds are 6 to 8 inches tall and up to bud stage. Brush should be fully leaved out and growing rapidly. Perennial weeds should normally not be sprayed early in the spring when they are 2 to 3 inches tall or less because not enough spray will usually be retained on the foliage to kill the root. Also, early spring translocation of nutrients from root to shoot to initiate early spring top growth does

not enhance maximum translocation of herbicide from shoot to root. Herbicides may also be applied in the fall up until frost, but if perennial weeds are mature or nearing maturity and seed production has occurred, it is more effective to mow perennial weeds and then spray the regrowth when it is 6 to 8 inches tall. Application of herbicides in the fall, when crops and gardens are nearing maturity, will often result in much less injury to non-target plants.

Summary of principal considerations for spraying rights-of-way with herbicides

1. Identify weeds and brush to be controlled.
2. Select best herbicide or combination of herbicides for control.
(Tables 1, 2, 3 or 4)
3. Select a low-volatile ester, amine or soluble salt formulation to reduce or eliminate the danger of herbicide volatility.
4. Determine sprayer output per acre or per unit area (using linear feet of miles of roadway sprayed x width of area sprayed and measurement of water used to spray this area).
5. Put the right amount of herbicide concentrate in the tank for each tankful.
6. Use low pressure (no more than 30 to 50 psi).
7. Don't spray when the wind speed is excessive (preferably not over 5 miles per hour). Use an invert emulsion or spray thickening agent to reduce drift, if necessary. Avoid applications of herbicide to non-target plants.
8. Spray early in the season (usually early June) when perennial weeds are 6 to 8 inches tall, before bud stage, and when brush is fully leaved out, or in the fall when perennial weeds have active new growth.

- (Weeds kill easier when they are actively growing, and danger to susceptible crops will be less if spraying is done early in the season).
9. Don't spill herbicide on clothing or skin, follow safety precautions listed on label.
 10. Do not use picloram (Tordon) or high rates of dicamba (Banvel) along drainage or irrigation ditches or along streams, lakes, or other open water.
 11. Keep a complete record of spraying operations, recording chemical used, weather and wind conditions at time of spraying, date sprayed, etc.

Application of herbicides along rights-of-way

There are two principal methods of herbicide application used along rights-of-way. First, and perhaps the most common, is the use of a broadjet or gun type nozzle that makes use of considerable pressure, usually more than 50 pounds per square inch, to direct the spray at the weeds and brush to be controlled. This method utilizes relatively large gallonages of 50 to 200 gallons of water per acre and wets the foliage to the point of run-off. The spray is prepared by mixing the desired quantity of herbicide concentrate in the estimated gallonage of spray to be applied. A more accurate estimation can be made of sprayer output by measuring a roadside or right-of-way area, then computing the acreage involved (43,560 sq ft = 1 acre), spraying it with water only, and determining the gallonage applied per acre. Then the proper amount of herbicide concentrate can be put in the tank for the size of batch being mixed.

The second method of spraying rights-of-way is using a boom on either ground or aerial equipment. The boom type sprayer delivers a much more accurate and uniform spray pattern, gives better coverage of plant foliage,

and can utilize smaller gallonages of water (as little as 15 to 20 gallons per acre will give adequate coverage in many cases). When using ground equipment, the height of the boom must be adjusted to give a uniform spray pattern, and all nozzles should be checked to make sure they are delivering a uniform rate. The sprayer should be calibrated by determining sprayer output per acre or by linear feet of right-of-way sprayed and then putting the proper amount of spray concentrated in the tank for the gallonage of spray being delivered per unit area.

Right-of-way spraying examples

1. Suppose you are to operate a broadjet sprayer to apply herbicides along a road right-of-way. There is mixed hardwood brush, Canada thistle and other broad-leaved weeds to be controlled. You have been asked to apply a mixture of 2,4-D and 2,4-DP at 1 lb of each component per acre. The label on the product states that there are 2 lbs of 2,4-D and 2 lbs of 2,4-DP acid equivalent per gallon. The label also states that the material is a low-volatile ester formulation and an emulsifiable concentrate in liquid form.

Question 1 - How much product, as it comes from the container, should you apply per acre? _____

2. You wish to calibrate your sprayer to determine approximate sprayer output per acre. There is a 320 gallon tank on the sprayer graduated in 10 gallon increments. You wish to mix a full batch of spray each time you fill. You fill the spray tank with water in preparation for a test run. You measure off a distance of 330 feet on the roadway and determine that the width of the area to be sprayed on each side, of the roadway is approximately one rod (16.5 feet). From a "running start" at a sprayer pressure of 40 pounds per square inch (psi) and

at uniform speed, spray the foliage on one side of the roadway for the 330 feet distance just as you would if you were using the herbicide. Spray to the point of runoff, moving the nozzle gun smoothly and uniformly to achieve good coverage of the weeds and brush to be controlled. Then you refill the tank, and by measuring the amount needed you determine that you used 10 gallons of water to cover the test area. There are 43,560 square feet/acre.

Question 2 - What fraction of an acre did you spray? _____

Question 3 - What gallonage are you applying per acre? _____

Question 4 - How many acres can you spray per tankful? _____

There are 5,280 feet per mile.

Question 5 - How many miles of roadway (spraying both sides) can you spray per tankful? _____

Answers: 1) 1/2 gallon; 2) 1/8 acre; 3) 80 gpa; 4) 4 acres; 5) 1 mile.

Table 1. Susceptibility of noxious and other undesirable weeds and brush to phenoxy herbicides^{1/}

Plant	Life cycle	2,4-D	2,4-DP
Field bindweed	Perennial	Fair	Fair
Leafy spurge	Perennial	Poor	Fair
Canada thistle	Perennial	Fair	Fair
Perennial sowthistle	Perennial	Fair	Fair
Bull thistle	Biennial	Excellent	Excellent
Musk thistle	Biennial	Good	Good
Plumeless thistle	Biennial	Good	Good
Hemp	Annual	Good	Good
Poison ivy	Woody perennial	Fair	Good
Common ragweed	Annual	Excellent	Excellent
Giant ragweed	Annual	Excellent	Excellent
Common dandelion	Perennial	Excellent	Excellent
Ground Ivy (Creeping Charlie)	Perennial	Fair	Good
Common chickweed	Annual	Fair	Good
Waterhemlock	Perennial	Good	Good
Ash	Woody perennial	None	Poor
Boxelder	Woody perennial	Good	Good
Buckbrush	Woody perennial	Good	Good
Elm	Woody perennial	Poor	Fair
Aspen (poplar)	Woody perennial	Fair	Fair-Good
Oak	Woody perennial	Poor	Fair-Good
Willow	Woody perennial	Good	Good
Maple	Woody perennial	Poor	Fair

^{1/} Adapted from Farmer's Bulletin No. 2183 USDA, Using Phenoxy Herbicides Effectively, and from research trials.

Table 2. Summary of herbicides for broadleaf weed and brush control on roadsides and drainage ditch banks.

Chemical	lb/A	Time of application	Precautions
<u>For thistles and other broadleaf weeds</u>			
2,4-D amine or L.V. ester	2	When perennial broadleaf weeds are 6 to 10 inches tall and before bud stage or in the fall on active new weed growth.	Use low pressure (30 - 40 psi). Avoid drift. 2,4-D may be used along drainage ditches. Glean should not be used near water or drainage ditches.
Chlorsulfuron (Glean)	1/4 oz-2 oz/acre		
<u>For broadleaf weeds and 2,4-D resistant brush</u>			
2,4-DP	2	When brush is fully leaved out and before bud stage of broadleaf weeds or in the fall on active new weed growth.	Avoid drift. May be used along drainage ditch banks.
2,4-D + 2,4-DP	1 + 1		
MCPP (mecoprop)	2		
2,4-D + MCPP + dicamba (Trimec-352)	2 + 1 + 0.2		
2,4-D + MCPP + dicamba (Trimec 4-41)	1.88 + 2 + 0.5		
Triclopyr (Garlon)	1 to 3	When brush is fully leaved out and before bud stage of broadleaf weeds or in the fall on active new weed growth.	Do not use along drainage ditch banks.
Triclopyr + 2,4-D	1 to 2 + 2 to 4		
Triclopyr + picloram + 2,4-D	1 + 1/2 + 2		
<u>For spot treatment of 2,4-D resistant broadleaf weeds or brush</u>			
Picloram (Tordon, Amdon)	1/2 to 1	When brush is fully leaved out and before bud stage of broadleaf weeds or in the fall on active new weed growth.	Picloram is a persistent and water soluble herbicide. (Restricted use material.) Do not use these herbicides along drainage ditch banks or along streams, lakes or water supplies. Avoid drift to non-target broadleaf plants.
Picloram + 2,4-D (Amdon 101 Tordon 101)	1/2 + 1		
Dicamba + 2,4-D (Banvel 720)	1 + 2		
<u>Brush control</u>			
Fosamine (Krenite)	6 to 12	Apply during the 2 month period prior to fall leaf coloration.	May be used on drainage ditch banks.

Table 3. Chemicals for temporary or short-term vegetation control (non-cropland, fence rows, highway guardrails, parking lots, building sites, etc.).

Grasses and cattails	Broadleafs	Grasses and broadleafs
dalapon (Dowpon M) (Basfapon)	2,4-D	paraquat ^{1/}
TCA	2,4-DP	amitrole
dalapon and TCA (Dowpon C)	MCPP	amitrole - T
	picloram (Tordon, Amdon) ^{1,2/}	glyphosate (Roundup)
	MCPA	ammonium-sulfamate (Ammate)
	dicamba (Banvel) ^{2/}	
	2,4,5-T or Silvex ^{3/}	

^{1/} Restricted use herbicide. May be applied only by a certified applicator.

^{2/} Water soluble compounds. Use with caution around desirable broadleaf plants, trees and shrubs.

^{3/} May still be used on certain non-cropland sites such as airports, fencelines not adjacent to pasture, lumber yards, refineries, storage areas, tank farms or industrial sites (not otherwise included in suspended uses).

Table 4. Chemicals for long-term vegetation control (non-selective) (non-crop-land, fence rows, highway guardrails, parking lots, building sites, etc.)

Broadleaf and Grass Control

sulfomethuron methyl (Oust)
*bromacil (Hyvar-X, Hyvar-XL)
diuron (Karmex)
diuron/bromacil (Krovar, liquid; Bromex granules)
simazine (Princep)
atrazine (AAtrex, atrazine)
prometone (Pramitol)
simazine and amitrol (Amizine)
*AMS (Ammonium sulfamate) Ammate
borates
sodium chlorate
borax and 2,4-D (D.B. Granular)
*hexazinone (Velpar)
*tebuthiuron (Spike - available as wettable powder or pellets)

* May also be used for spot treatment of brush species. However, these materials must be used with caution because the roots of desirable trees or shrubs may pick up and translocate these materials.

Table 5. Cut stump treatment of brush and trees.

2,4-D + 2,4-DP + penetrating agent (Weedone CB) - apply undiluted
Dicamba (Banvel CST) - apply undiluted
Dicamba + 2,4-D + oil or diesel fuel as carrier
Picloram (Tordon 101R, Tordon RTU) - apply undiluted
Ammonium sulfamate (Ammate) - apply as crystals or water base spray
Triclopyr (Garlon) - apply undiluted or mix with diesel fuel

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