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PREDICTING NITROGEN AND MICRONUTRIENTS NEEDS BY SOIL TESTS

Charles A. Simkins, extension soils specialist

Phosphorus, potassium and soil acidity tests have long been used as a satisfactory means of predicting the economical use of lime, phosphorus, and potassium fertilizer. The work published by Roger Bray of Illinois (1948) established the relationship between soil tests and corn yields. The phosphorus and potassium soil test values and their correlation with crop yields are still valid on most soils today.

Soil tests for predicting nitrogen and micronutrient needs have developed more slowly and in the past have often been of questionable value.

Recent research has shown that certain nitrogen and micronutrient soil tests can be very helpful in making fertilizer recommendations.

Investigations in Minnesota, North Dakota, Nebraska, and Kansas have shown that a nitrate-nitrogen (NO_3-N) test made on soil samples taken to a minimum of 2 feet can be useful in determining nitrogen rates for most field crops.

The University of Minnesota has used the NO_3-N test to make nitrogen recommendations on small grain and sugarbeets in western Minnesota since 1971. Recent research would indicate that the test could also be used for corn in most regions of the state. It is rather certain that there is little likelihood of response to nitrogen fertilizer when the surface 24 inches in the soil profile contains more than 150 pounds of nitrate-nitrogen. The key to use of this test is obtaining a representative sample to a depth of 2 feet. Farmers with a special interest in a more specific means of adjusting nitrogen use are finding this test valuable.

Although soil scientists have made remarkable progress in developing soil tests for micronutrients, in the last 10 years considerable difficulty is still being experienced in calibrating tests against plant uptake and plant growth responses.

To date investigations have shown that in Minnesota on certain soils on certain plant species, certain micronutrient applications can result in significant increases in crop yields. A summary of the present situation follows:

ZINC

Deficiencies are most frequent in western and south-central Minnesota. Corn is the crop most commonly affected. Associated soil conditions include high pH, high phosphorus and often poor drainage. A reliable soil test is available--(DTPA extractant).

IRON

Deficiencies can be found in western and south-central Minnesota. Soybeans, flax, and several ornamental plants are affected. Associated soil conditions are high pH, high soluble salts. No reliable test is available.

BORON

Deficiencies occur in north-eastern and east-central Minnesota. Associated soil conditions are low organic matter and drought. No reliable test. Plant analysis is generally preferred.

COPPER

Deficiencies occur on peat soils in northern Minnesota. Copper deficiency is associated with newly farmed peat soils. Wheat, oats, and barley are crops most affected. A reliable test is being calibrated.

MAGANESE

To date no deficiencies have been reported in Minnesota.

PRACTICING SOIL TESTING

Soil testing is used to some degree in nearly all parts of the world. Its success is related to the amount and quality of research available for the calibration and interpretation of tests.

The ultimate objective of soil testing is economically sound fertilizer recommendations.

Soil testing is a program that depends on several components of good quality namely:

- Accuracy in field sampling
- Chemical analysis
- Fertilizer research
- Personal judgment

Personal judgment is especially important in today's fertilizer use. Different soils differ a great deal in production potential. The application of fertilizer nutrients cannot substitute for many of the physical and climatic limitations imposed on us.

The challenge feeding of crops is as important as the individual feeding in livestock. Crops grown on soils of different capabilities must be fertilized according to potential. The key to economical production is to know the upper limit of the soil's production potential and then fertilize and manage the crop to meet that challenge. Farmers should establish their own challenge crop feed lots to adapt new technology to their farming practices.

There are few soils farmed in Minnesota which do not require fertilizer applications for profitable crop production. On some soils excess fertilizers are being applied and environmental concerns are being faced.

The best way of determining what constitutes adequate but not excessive fertilizer use for high and efficient crop production is a sound soil testing program backed up by good quality research.

SOIL NITRATE TESTS FOR CORN

C. J. Overdahl, extension soils specialist

Field trials on corn have been conducted for several years to test the value of soil nitrate measurements in predicting nitrogen fertilizer needs.

There are some hopeful signs. In the fall of 1976 after a very dry year, for example, nitrate tests were unusually high. Corn yield increases from nitrogen in 1977 in many areas were low. Farmers who believed the test and reduced nitrogen rates saved money.

Progress in predicting nitrogen needs has been faster in western Minnesota because of low rainfall. Rainfall variation from week to week in eastern Minnesota tends to vary the availability of nitrogen. Yet, continued low rainfall during June and July causes more constant amounts of available nitrogen and makes nitrate tests better predictors of nitrogen needs. The variation is due to nitrogen release in the soil itself causing a buildup and denitrification causing a loss of nitrogen to the air.

Experiments in Martin County since 1970 show that nitrate measurements appear to relate to treatment and to corn yield response.

The tables show that there are often quite low nitrate tests (below 100) and small or no nitrogen response. The one observation that appears to hold true quite well, however, is that tests above 150 down to 2 feet seldom show nitrogen responses. Even though accurate calibration thus far is impossible a farmer can still get a clue where to reduce or omit adding nitrogen if he has tests above 150 to 2 feet depth.

Tests comparing fall and spring applications of nitrogen (not shown in the tables) sometimes show higher corn yields from fall applications than from spring treatments. These are usually on fine textured "heavy" soils frequently subject to denitrification. Nitrate tests in the spring show a slightly greater movement downward of the fall applied nitrogen compared to spring applied. Surface wetness could cause greater denitrification on the spring applied material.

Table 1. Nitrate tests from fall 1977 compared to 1978 corn yield (continuous corn)

	Annual Nitrogen Treatments/Acre Since 1970					
Test Depth	0	50	100	150	200	400
	(nitrate-N test 1977 lbs/acre)					
0-2'	40	56	56	92	104	380
0-3'	84	126	92	196	166	588
	(corn yields bu/a 1978)					
No N since 1976	101	112	115	144	141	146
No N since 1977	112	125	136	157	157	159

Table 2. Nitrate tests in southwest Minnesota counties compared to corn yield increase from nitrogen. (1977)

	Cooperator's Number											
Test Depth	1	2	3	4	5	6	7	8	9	10	11	12
	nitrate-N test lbs/acre											
0-2'	36	88	132	192	162	302	122	110	88	160	90	106
0-3'	42	124	240	328	220	398	150	166	108	232	114	166
Data by Malzer												
Yield (bu/a) increase	45	NS	NS	NS	NS	NS	NS	NS	35	NS	NS	NS

Table 3. Nitrate tests in S.W. Minnesota counties compared to corn yield increase from N. (1978)

	Cooperator's Number								
Test Depth	1	2	3	4	5	6	8	9	12
0-2'	51	50	70	50	58	61	38	71	69
0-3'	161	95	107	79	206	128	60	.03	170
Yield (bu/a) increase	21	10	NS	17	20	5*	7*	NS	NS

Data by Malzer

*=NS

Table 4. Nitrate tests in southeast Minnesota counties compared to corn yield increase from nitrogen (0-2')

<u>1977</u>

Cooperator's Number

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
nitrate-N test																		
108	153	117	81	86	54	81	244	76	115	128	63	190	106	222	156	25	118	101
yield increase bu/a																		
8	0	4	5	15	6	0	1	1	10	1	4	5	16	5	5	49	3	9

<u>1978</u>

0-2'	66	105	32	55	108	266	172	56	149*	121	175	29	110	54	98	53	156	95
0-3'	110	174	90	98	140	331	287	99	263	205	286	52	146	93	119	122	242	79
inc.	27	13	21	17	3	8	4	9	36	-5	-10	20	-1	24	8	15	4	-6

data by Simkins

*flooded

NITROGEN FERTILIZATION OF SUGARBEETS IN WEST CENTRAL MINNESOTA

R. P. Schoper, assistant extension soils specialist

Accurate prediction of nitrogen needs of sugarbeets is of prime economic importance to the sugarbeet growers of Minnesota. Sugarbeets do not have a built-in mechanism which automatically triggers sugar accumulation at a certain point in the growing season. The sugarbeet root increases in sugar only after a shortage of a primary growth factor exists such as heat units, water or essential nutrients. Of all the growth factors, the control of an essential element such as nitrogen has proven to be the most effective.

Presently two methods of predicting the proper rate of fertilizer nitrogen are available. The first is simply an estimate of nitrogen needs based on cropping history. Although this method is reasonably accurate, when a number of growing seasons are considered, it does not allow for yearly variations in residual soil nitrate-nitrogen levels. The second method is known as the nitrate-nitrogen soil test. Through this method the nitrate level in the upper two feet of the soil profile can be determined in the soil testing laboratory. This method has the advantage in prediction accuracy since it can measure the year to year variations in residual soil nitrate-nitrogen.

In 1976, 1977, and 1978 studies were conducted in west-central Minnesota to study the problem of predicting fertilizer nitrogen requirements for sugarbeets. Specific objectives of the study are: (a) to correlate residual soil nitrate levels to optimum fertilizer nitrogen rate, (b) to determine the optimum sampling depth for correlation of the nitrate-nitrogen test, (c) to observe the critical level of nitrate-nitrogen in sugarbeet petioles at various points in the growing season, and (d) to evaluate the influence of plant populations and sugarbeet varieties on nitrogen requirements.

In Tables 1-3 examples are given for comparison of the nitrate test to making recommendations based on cropping history. In all cases the nitrogen recommendation based on cropping history would be 60 pounds of nitrogen per acre. It is of interest to note that when nitrate levels are near the average for west-central Minnesota, 75 pounds per acre, both methods do an acceptable job of predicting nitrogen fertilizer needs, however, when the nitrate level is above average the prediction accuracy is improved by the use of the nitrate-nitrogen soil test.

Table 1. Effect of various rates of nitrogen on sugarbeet root yield, percentage sugar, gross sugar and recoverable sugar. Swift County, Minnesota.

Soil Nitrate Test = 78 lbs/A   Recommendation = 90 lbs N/A

Nitrogen Rate	Roots	Sugar	Gross Sugar	Recoverable Sugar
lbs/A	T/A	%	lbs/A	%
0	19.0	17.3	6578	91
50	21.4	16.6	7136	90
100	21.7	16.5	7178	90
150	22.8	15.8	7188	88
200	23.5	15.6	7316	87
Significance	*	**	NS	
BLSD (.05)	3.0	0.7	--	

Table 2. Effect of various rates of nitrogen on sugarbeet root yield, percentage sugar, gross sugar and recoverable sugar. Renville County, Minnesota.

Soil Nitrate Test = 95 lbs/A   Recommendation = 50 lbs N/A

Nitrogen Rate	Roots	Sugar	Gross Sugar	Recoverable Sugar
lbs/A	T/A	%	lbs/A	%
0	26.1	16.2	8418	90
50	27.4	15.8	8620	89
100	28.3	14.9	8442	87
150	29.9	14.6	8716	85
200	29.8	14.0	8352	83
Significance	**	**	NS	
BLSD (.05)	2.1	0.7	--	

Table 3. Effect of various rates of nitrogen on sugarbeet root yield, percentage sugar, gross sugar and recoverable sugar. Chippewa County, Minnesota.

Soil Nitrate Test = 240 lbs/A   Recommendation = 0 lbs N/A

Nitrogen Rate	Roots	Sugar	Gross Sugar	Recoverable Sugar
lbs/A	T/A	%	lbs/A	%
0	21.6	15.9	8182	87
50	21.0	16.1	8116	87
100	22.3	15.4	7766	85
150	20.6	15.2	7584	84
200	21.3	14.6	6688	83
Significance	NS	**	**	
BLSD (0.5)	--	0.7	702	

NAMES OF SOME HERBICIDES

Gerald Miller and Oliver Strand, extension agronomists

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.

Trade Name	Active Ingredient
AAtram	atrazine and propachlor
AAtrex	atrazine
Alanap	naptalam (NPA)
Amdon 10K	picloram
Amdon 101	picloram and 2,4-D
Amiben	chloramben
Asulox	asulam
Avadex	diallate
Avadex-BW	triallate
Avenge	difenzoquat
Balan	benefin
Banvel	dicamba
Banvel K	dicamba and 2,4-D
Banvel 2+2	dicamba and 2,4,5-T
Basagran	bentazon
Basalin	fluchloralin
Basfapon	dalapon
Bexton	propachlor
Betanal	phenmedipham
Betanex	desmedipham
Bladex	cyanazine
Brominal	bromoxynil
Brominal Plus	bromoxynil and MCPA
Bronate	bromoxynil and MCPA
Buctril	bromoxynil
Butoxone	2,4-DB
Butyrac 200	2,4-DB
Carbyne	barban
Cobex	dinitramine
Dacthal	DCPA
Dowpon M	dalapon
Dowpon C	dalapon and TCA
Dual	metolachlor
Dyanap	naptalam and dinoseb
Endothal	endothall
Eptam	EPTC
Eradicane	EPTC plus crop protectant
Evik	ametryne

Trade Name (continued)	Active Ingredient (continued)
Far-go	triallate
Furloe	chlorpropham
Herbicide 273	endothall
Hoelon	diclofop
Kerb	pronamide
Kleen-Krop	naptalam and dinoseb
Lasso	alachlor
Lasso II	alachlor 15-percent granules
Lexone	metribuzin
Lorox	linuron
Maloran	chlorbromuron
Modown	bifenox
MonDak	dicamba and MCPA
Milogard	propazine
Nortron	ethofumesate
Paraquat	paraquat
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
Sutan +	butylate plus crop protectant
TCA	TCA
Tenoran	chloroxuron
Tolban	profluralin
Tordon	picloram
Tordon 212, 101	picloram and 2,4-D
Treflan	trifluralin
Vernam	vernolate

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.

HERBICIDES

Gerald Miller and Oliver Strand, extension agronomists

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 University of Minnesota Extension Bulletin 400, Cultural and Chemical Weed Control in Field Crops, 1979, for additional information.

Alachlor (Lasso, Lasso II)

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

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

Time of application--Usually preemergence; preplanting for nutsedge control or with trifluralin on dry beans, can be applied just as crop is emerging, but weed control is usually better if applied before weeds emerge. 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.

Remarks--Research results show good control of annual grasses and pigweed and fair lambsquarters control. Control of other broadleafs was not consistent. Adzuki beans are very susceptible to injury from alachlor.

Formulation--Lasso--4 pounds per gallon liquid.
Lasso II--15 percent granules.

Ametryne (Evik)

Use--Annual weed control in corn.

Rate of application--1½ 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.

Formulation--80 percent wettable powder.

Atrazine (AAtrex, several private labels)

Use--Weed control in corn and sorghum and quackgrass control. Effective in controlling quackgrass with a fall and/or early spring application followed by plowing. Only corn can be planted following treatment. Used in mixtures with alachlor, linuron, metolachlor, or propachlor preemergence and with butylate preplanting on corn.

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

Time of application for weed control in corn and sorghum--Preemergence or preplant in corn and postemergence in corn and sorghum. If applied postemergence, applications before weeds are 1½ inches tall are more effective than later applications. Atrazine is cleared for use on corn up to layby-stage (about 30 inches tall) of the corn, but weed control is usually not as good on larger weeds. Addition of emulsifiable petroleum or vegetable oils has improved performance of postemergence atrazine sprays on corn. Various formulations of surfactants and detergents used with atrazine have not improved weed control as much as the use of oils.

Remarks--Susceptible crops have been injured in rotation following treated crop. To minimize injury to susceptible crops following corn, use the lowest rate consistent with good weed control; use band applications rather than broadcast applications and thoroughly till soil before planting susceptible crops. 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)

Use--Control of wild oat in small grains, flax, soybeans, sugarbeets, and sunflowers.

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 spring wheat and spring barley before the 4-leaf stage, peas before the 6-leaf stage, flax before the 12-leaf stage, and within 30 days of emergence of sugarbeets, sunflower, mustard, and soybeans.

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

Formulation--1 pound per gallon liquid.

Benefin (Balan)

Use--annual grass control in seedling legumes.

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

Time of application--Preplanting.

Remarks--Must be incorporated into the soil by disking before planting.

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

Bentazon (Basagran)

Use--Control of most annual broad-leaved weeds, Canada thistle, and nutsedge in soybeans, corn, dry or succulent edible beans and peas.

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.

Time of application--Postemergence--Bentazon is most effective when soybeans, dry beans, snap and green beans have the first to second trifoliolate leaf and weeds are in the 2 to 4 leaf stage. Corn is tolerant at all stages, but is usually sprayed when corn has 1 to 5 leaves and weeds are no more than 2 to 6 inches tall. Peas may be treated after 3 pairs of leaves (4 nodes) are present. Do not apply to crops growing under stress such as drought or cold weather. On thistle and nutsedge a second application 10 days after the first improves control. Do not apply more than a total of 2 pounds of bentazon per acre in one crop year.

Remarks--Rain 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)

Use--Control of some annual broad-leaved weeds in soybeans. May be used alone or as a preemergence application after trifluralin, or in a 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 occurs. Grass control has been inconsistent. Do not apply after soybeans start emerging.

Formulation--80 percent wettable powder.

Bromoxynil (Brominal, Buctril)

Use--Annual broadleaf control in wheat, barley, oats, and flax. Used in mixture with MCPA ester in wheat, barley and oats.

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

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

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

Formulation--2 pounds per gallon liquid.

Butylate (Sutan +)

Use--Control of annual grasses in corn. Used in mixtures with atrazine or cyanazine for annual grass and broadleaf control.

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

Time of application--Preplanting.

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.

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

Chloramben (Amiben)

Use--Control of annual grasses and broad-leaved weeds in soybeans, sunflowers, and dry edible beans. Used in mixture with alachlor, linuron, and trifluralin.

Rate of application--Preemergence and preplanting.

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

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

Chlorbromuron (Maloran)

Use--Broadleaf and grass control in soybeans. Used in mixtures with alachlor for better grass control.

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

Time of application--Preemergence.

Remarks--Do not use on sands or soils with less than 1-percent organic matter or crop injury may occur. Works best on soils between 1 and 4 percent organic matter.

Formulation--50-percent wettable powder.

Chloroxuron (Tenoran)

Use--Control of certain annual broadleafs in soybeans.

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

Time of application--Postemergence from time of first trifoliolate leaf to layby. Weeds should be no more than 2 inches tall. Early applications are more effective.

Remarks--Most effective against lambsquarters, mustard, and pigweed. Other broadleafs are only partially controlled. Grasses are usually not controlled. Use a wetting agent with the chemical. Some soybean leaf burn and delayed growth usually follow treatment.

Formulation--50 percent wettable powder.

Chlorpropham (Furloe Chloro IPC)

Use--Annual smartweed control in soybeans.

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

Time of application--Preemergence.

Remarks--May be used preplanting in mixtures with profluralin, trifluralin or vernolate; with alachlor (Lasso) applied preemergence. Does not control weeds other than annual smartweed.

Formulation--4 pounds per gallon liquid.

Cyanazine (Bladex)

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

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

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

Remarks--Do not add petroleum oils to postemergence applications or severe corn injury may result. When applied postemergence under droughty or arid conditions, certain surfactants or emulsifiable vegetable oils may be used with the wettable powder formulation but under moist conditions, these additives may cause severe corn injury.

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

Cycloate (Ro-neet)

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

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

Time of application--Preplanting.

Remarks--Must be incorporated by disking or power rotary tiller.

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

Desmedipham (Betanex)

Use--Annual broadleaf control in sugar beets. Has given good control of pigweed, common ragweed, common lambsquarters, and wild mustard and fair control of annual smartweeds and wild buckwheat.

Rate of application--1 to 1 1/4 pounds per acre. Use no more than 1 pound per acre following EPTC or TCA.

Time of application--Early postemergence after sugar beets have at least four true leaves. Applying in late afternoon or early evening reduces injury.

Remarks--Do not apply if high temperature for the day is over 85° F.

Formulation--1.3 pounds per gallon liquid.

Dinitramine (Cobex)

Use--Annual grass control in soybeans, sunflowers, and dry beans. Also controls common lambsquarters and pigweed.

Rate of application--1/3 to 2/3 pound per acre depending on soil texture.

Time of application--Preplanting.

Remarks--Moderate crop injury has occurred. Do not use on sandy soils. Incorporate no more than 1 1/2 to 2 inches by setting disk or field cultivator 3 to 4 inches deep.

Formulation--2 pounds per gallon liquid.

2,4-D

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

Rate of application--See University of Minnesota Extension Bulletin 400 and labels. The proper rate depends on the size and kinds of weeds, weather conditions, and stage of crop growth.

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, Basfapon)

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

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

Time of application--(1) Flax and sugar beets: when grasses are not more than 2 inches tall. Postemergence until sugar beets reach 6-leaf stage, directed from 7-leaf stage until beets are 14 inches. (2) For quackgrass control, apply on growing quackgrass; plow 10 days later.

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

Formulation--74-percent water soluble powder.

2,4-DB (Butoxone, Butyrac 200)

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

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

Time of application--Postemergence when seedling legumes have 1 to 4 trifoliolate 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 3 inches tall, or over-the-top when soybeans are from 10 days before bloom to midbloom.

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

Formulation--Liquids of various concentrations.

Diallate (Avadex)

Use--Control of wild oat in barley, flax, and sugar beets.

Rate of application--1 1/4 pounds per acre on barley; 1 1/2 to 2 pounds per acre on flax and sugar beets.

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

Remarks--Quite volatile and must be incorporated soon after application. Incorporate preplanting applications with disk, cultivator, or harrow to a depth of 2 inches. In postseeding applications, incorporate chemical with two harrowings at right angles. Small grain injury has been observed, particularly with preplanting applications. 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)

Use--Postemergence control of broadleaved weeds except mustard in wheat, oats, corn, and grass pastures. Especially useful for controlling wild buckwheat and smartweed in wheat and oats. Preemergence with alachlor in corn. May be applied postemergence on corn with 2,4-D or atrazine. No oils or surfactants should be added.

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

Time of application--From 2- to 5-leaf stage of wheat and oats. Up to time corn is 2 feet tall and not within 15 days of tasseling. Application made too close to tasseling can cause barren ears when weeds are actively growing 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 to 5 percent organic matter.

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--4 pounds per gallon liquid; commercial combinations with MCPA and 2,4-D are available.

Dinfenzoquat (Avenge)

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

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

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

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

Formulation--2 pounds per gallon liquid.

Dinoseb (Premerge and others)

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

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

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

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

Formulation--Liquids of various concentrations.

Endothall (Endothal, Herbicide 273, etc.)

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

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

Time of application--Postemergence.

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

Formulation--Liquid; concentrations vary.

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

Use--Control of annual grasses and some broadleafs in sugar beets, seedling legumes, sunflowers, flax, and dry edible beans. Eradicane, but not Eptam, can be used in corn, especially for nutsedge control; gives some quackgrass control. Eradicane used in mixtures with atrazine or cyanazine on corn and Eptam with trifluralin on dry beans.

Rate of application--2 to 2 1/2 pounds per acre on sugar beets; 3 pounds per acre on seedling legumes, sunflowers, flax, and dry edible beans; 3 to 6 pounds per acre in corn.

Time of application--Preplanting.

Remarks--Must be incorporated immediately to avoid loss of chemical by volatility.

Formulation--7 or 6.7 pounds per gallon liquid; 10-percent granular.

Ethofumesate (Nortron)

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

Rate of application--1.9 to 3.75 pounds per acre.

Time of application--Preplanting or preemergence.

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

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

Glyphosate (Roundup)

Use--Non-selective control of many annual and perennial weeds before planting barley, corn, oats, sorghum, soybeans, and wheat. Spot treatment of weeds in these same crops after crop emergence, but crop will be killed or severely injured.

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

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

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

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

Field bindweed--at or beyond full bloom.

Hemp dogbane--late bud to flower stage.

Common milkweed--late bud to flower stage.

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

Formulation--3 pounds acid equivalent per gallon liquid.

Linuron (Lorox)

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

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

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

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

Formulation--50 percent wettable powder.

MCPA

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

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.

Rate of application--See University of Minnesota Extension Bulletin 400 and labels. The proper rate depends on the size and kinds of weeds, weather conditions, and stage of crop growth.

Formulation--Liquids of various concentrations.

Metolachlor (Dual)

Use--Control of annual grass, pigweed, and nutsedge in corn. Used in mixtures with atrazine (AAtrex).

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

Time of application--Preplanting, incorporated or preemergence. Preplanting is preferred for nutsedge control.

Remarks--Do not plant crops other than corn for 18 months after application.

Formulation--6 pounds per gallon liquid; 8 pounds per gallon for bulk handling.

Metribuzin (Lexone, Sencor)

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 preemergence in soybeans in mixtures with alachlor (Lasso), chloramben or paraquat; or as a preemergence treatment over preplanting trifluralin (Treflan) or profluralin (Tolban). Cleared for tank mixing with trifluralin or profluralin as a preplanting soil incorporated application.

Rate of application--3/8 to 7/8 pound per acre depending on soil texture and organic matter. 1/4 to 3/4 pound per acre with alachlor or over trifluralin. 1/4 to 1/2 pound per acre in mixtures with trifluralin, profluralin or chloramben. Use proper rate for soil conditions.

Time of application--Preplanting or preemergence.

Remarks--Early soybean stunting and necrosis have frequently occurred with this chemical. Do not use on muck or sands, sandy loams with less than 2 percent organic matter, or soils with a pH over 7.4. Certain soybean varieties Tracy and Altona, are susceptible to injury.

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

Naptalam + dinoseb (Dyanap)

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

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

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

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

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

Paraquat

Use--Contact herbicide for killing vegetation before planting or preemergence before crops emerge. Desiccant for weeds in soybeans and sunflowers (oil seed varieties only) to aid in harvesting. See label instructions for each crop.

Rate of application--1/8 to 1 pound per acre depending on use and crop. For drying weeds in soybeans--1/8 to 1/4 pound per acre; in soybeans--1/4 to 1/2 pound per acre. Use X-77 spreader with paraquat.

Time of application--Before planting or preemergence before crop emerges. As a desiccant in soybeans, apply after soybeans are mature, i.e. beans are fully developed, at least 1/2 of leaves have dropped, and remaining leaves on soybeans are turning yellow. In sunflowers, apply when heads are yellow and bracts are turning brown.

Remarks--Paraquat kills growing annual weeds and only the top growth of perennials. Paraquat is highly toxic. A small amount could be fatal if swallowed. Avoid contact with the eyes or skin and do not breath the spray mist. Follow precautions on the label.

Formulation--2 pounds per gallon liquid.

Pendimethalin (Prowl)

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.

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

Time of application--Preemergence in corn, preemergence or preplanting in soybeans.

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

Formulation--4 pounds per gallon liquid.

Phenmedipham (Betanal)

Use--Annual grass and broadleaf control in sugar beets. Does not control pigweed or wild oat.

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

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

Remarks--Applications of phenmedipham following preplanting EPTC or preemergence TCA have sometimes resulted in sugar beet injury. To reduce injury do not use more than 1 pound per acre where preplanting or preemergence herbicides have been used and do not apply when the temperature is over 85° F.

Formulation--1.3 pounds per gallon liquid.

Picloram (Tordon)

Use--One formulation (Tordon 22K) is cleared for use in a tank-mix combination with 2,4-D amine for control of certain broadleaf weeds in spring and winter wheat and barley.

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

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

Remarks--A higher rate of application, 3/8 pound per acre of picloram and 3/8 pound per acre of 2,4-D amine is cleared for use 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 only on small grain fields that will be fallowed the following year or that will be replanted to a grass or grain crop the following year. Do not use on small grain to be underseeded to a legume. Do not use on sandy soils where ground water level is within 10 feet of the soil surface.

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

Profluralin (Tolban)

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

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

Time of application--Preplanting, incorporated.

Remarks--May be mixed with metribuzin or used with overlay treatments of linuron and mixtures of naptalam and dinoseb in soybeans and may be mixed with EPTC in dry edible beans.

Formulation--4 pounds per gallon liquid.

Propachlor (Ramrod, Bexton)

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

Rate of application--3 to 5 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.

Formulation--65 percent wettable powder; 20 percent granular, 4 pounds per gallon dispersible liquid.

Pronamide (Kerb)

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.

Formulation--50 percent wettable powder.

Propazine (Milogard)

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

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

Time of application--Preemergence.

Formulation--80 percent wettable powder.

Pyrazon (Pyramin), Pyrazon and dalapon (Pyramin Plus)

Use--Control of most annual broadleafs in sugar beets. Mixture also controls annual grasses. Used alone or in mixture with dalapon or following preemergence or preplanting herbicides.

Rate of application--3.8 pounds per acre alone or with 2.2 pounds per acre of dalapon.

Time of application--Preemergence on low organic matter soils. Postemergence, before broadleafs have more than four leaves. Postemergence results have been erratic.

Remarks--Some sugar beet injury has occurred when applied after preplanting or preemergence herbicides.

Formulation--80 percent wettable powder or 31.4 percent pyrazon wettable powder with 18.5 percent dalapon powder.

<u>Silvex</u>

Use--Brush and broadleaved weed control in grass pastures.

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

Time of application--In spring after woody plants are fully leaved or when broadleaved weeds are 6 to 8 inches tall or in the rosette stage.

Remarks--Do not graze dairy animals on treated areas within 7 days to 6 weeks (see label) or slaughter meat animals within 2 weeks after application. Do not cut grass for hay during the season of treatment with silvex.

Formulation--Liquids of various concentrations.

<u>Simazine (Princep)</u>

Use--Control of grasses and broadleaved weeds in alfalfa and corn.

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

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

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

Formulation--80 percent wettable powder.

<u>TCA</u>

Use--Control of annual grasses except wild oat in sugar beets, alfalfa, sweetclover, and birdsfoot trefoil.

Rate of application--5 to 7 pounds per acre in sugar beets.

Time of application--Preemergence in sugar beets.

Formulation--Soluble powder or pellets and liquid; concentrations vary.

<u>Terbacil (Sinbar)</u>

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)

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

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 for granular formulation.

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

Remarks--Must be incorporated by two harrowings at right angles for 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. This chemical irritates skin and eyes; use caution when handling.

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

Trifluralin (Treflan)

Use--Annual grass, pigweed and common lambsquarters control in soybeans, dry edible beans, sunflowers, mustard, sugar beets, and spring wheat. Used in mixtures with metribuzin, chlorpropham or vernolate on soybeans and with EPTC on dry beans.

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 sugar beets after blocking or thinning and before new weeds come up. On spring wheat, apply immediately after planting.

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 caused slight soybean stand reduction and early soybean injury. To reduce spring wheat injury potential, plant wheat 2 to 3 inches deep, apply the chemical immediately after planting, and incorporate shallowly with a harrow operated in two different directions.

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

Vernolate (Vernam)

Use--Controls annual grass and some broadleafs in soybeans. Cleared for use in mixtures with trifluralin on soybeans. Cleared for sequential (overlay) treatments with chloramben, linuron, bentazon, and mixtures of naptalam and dinoseb.

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

Time of application--Preplanting or preemergence on soybeans.

Remarks--Should be incorporated by disking twice or using power rotary tiller. If applied preemergence, incorporate shallowly so as not to disturb seed (see label). Early soybean injury has sometimes occurred.

Formulation--7 pounds per gallon liquid and 10 percent granules.

CORN AND SOYBEAN MORPHOLOGY AND PLANT STAGING

D. R. Hicks, extension agronomist

Correct identification of stage of plant development is important in corn and soybean production. The most obvious reason for correct stage identification is for purposes of postemergence application of pesticides or growth regulators, but it is also important if one wants to monitor the progress of crop development through the season, or determine the effect on yield of a hail storm, foliar insect feeding, disease occurrence, drought, early frost, etc.

The purpose of this paper is to present the currently accepted terminology and methods of staging corn and soybean plants.

A. Corn Morphology

A corn seedling is represented by a drawing in Figure 1 which gives suggested standardized morphological terminology and other terms used to refer to the same plant parts. Regardless of whether we refer to the first internode as the cotyledon or the mesocotyl, it's important to know the plant part is the first internode.

With continued growth, the plant becomes self sufficient and does not rely on the remainder of the stored food reserves in the kernel. The cotyledon then rots as does all the plant tissue below the crown. The lower stalk development is shown in Figure 2. Internodes 2 through 5 do not elongate; internode 6 is the first internode to elongate (above node 2 because internode 1 elongates). The sheath of leaf 5 is attached to node 7, the node immediately above the first elongated internode. Recent research shows that internode 7 is the first to elongate when cool soil temperatures follow corn planting. When this occurs, corn plants in the vegetative stages between 10 leaf stage and tasseling may be understaged by one leaf stage.

B. Corn Staging

Developmental stages prior to pollination are termed vegetative stages and are identified by counting the number of leaves the plant has produced. If 10 leaves are developed on more than 50% of the plants in a field, the field is in the 10 LS (leaf stage). How a Corn Plant Develops states "the number of leaves fully emerged from the whorl (the collar is visible)" while Corn Loss Instructions states "the indicator leaf is that leaf that is 40 to 50% exposed." These methods differ in that when a leaf is 40 to 50% exposed from the whorl, the collar is not visible. However, they are relatively close because a leaf 40 to 50% exposed will be fully emerged from the whorl in 1 and at most 2 more days (normal growing conditions).

For all vegetative stages between 1 LS and 10 LS, leaves fully emerged can be counted starting with leaf number one which has a rounded tip and is the lowermost leaf on the stalk. All other leaves on the corn plant have a pointed tip.

With stem enlargement and development of aerial adventitious roots (brace roots), the lowermost 6 leaves slough from the corn plant. Soon after the 10 LS, the first leaf with the rounded tip sloughs and the developmental number of the remaining lowermost leaves cannot be determined without splitting the stalk.

For plants without the rounded tip on the lowermost leaf, the stalk is split to identify the first elongated internode. Leaf number 5 is attached to the node immediately above; with this reference point, count the number of leaves which have developed.

Vegetative stages range from emergence to 18 or 19 LS for most Minnesota adapted hybrids. Early maturing hybrids may develop 1 to 2 fewer leaves.

Reproductive stages of corn development are based on kernel development and are given in Table 1.

Table 1. Corn developmental stages and their descriptions. (from How a Corn Plant Develops and Corn Loss Instructions).

VEGETATIVE STAGES - Count number of leaves which have developed. Stages range from 1 to 19 LS.

REPRODUCTIVE STAGES:

Tassel	- Tassel fully extended. Ear shoot exposed but no silk showing. No pollen evident. 4 days in this stage.
Silked	- Silks have emerged. Tassel is shedding pollen. 4 days.
Silks brown	- Pollination almost complete. 75% of silks brown in color, but not dry to the touch. 5 days.
Pre-blister	- Silks all brown. Kernel very small 'pimple'. 4 days.
Blister	- Kernels appear as watery blisters. 4 days.
Early-milk	- Beginning of roasting ear stage. Kernels changing in color from white to yellow. 4 days.
Milk	- Prime roasting ear stage. Full yellow color. Cob maximum length. 5 days.
Late milk	- Milky fluid thickening and solids forming in base of kernels. 4 days.
Soft dough	- Past prime roasting stage. Semi-solid, but milky substance can be squeezed out. 5 days.
Early dent	- Kernels along entire ear beginning to dent. 5 days.

Table 1. (continued)

Dented	- Most all kernels dented. Kernel easily cut with fingernail. Milk in tip of some kernels. 5 days.
Nearly mature	- Hull on opposite side of embryo has a shiny hardened appearance nearly halfway to the cob (milk line). 10 days.
Mature	- Physiological maturity. Milk line has progressed to the cob. Black layer forms. Dry weight increase stops. Moisture content will be 30-35%.

Time intervals between corn developmental stages in calendar days are given in Table 2 as presented in the Iowa and Corn Loss publications. For comparison to corn development in Minnesota, calendar dates (and days to reach the developmental stage) are given for corn development as reported by the Minnesota Department of Agriculture. Dates are estimates when half the crop had reached that stage. For example, half the corn had reached pollination by July 20 in 1978. The 5 year average (1973-77) for corn development in Minnesota required 115 calendar days which is in close agreement with the total number of days presented in both the Iowa and Corn Loss schedules of corn development.

C. Soybean Morphology

Soybean seedling development and plant parts are identified in Figure 2. The cotyledons serve as the food reserve until leaves develop and the plant becomes self supporting. The unifoliolate leaves develop opposite each other; the trifoliolates develop alternately up the stem.

D. Soybean Staging

Development stages of soybeans are termed vegetative until flowering begins; thereafter referred to as reproductive. Vegetative development is based on number of fully developed leaves on the main stem. To be fully developed, the leaflet edges must be separated on the leaflets located at the next node up the stem (see Figure 6).

Stages of development and their descriptions are given in Table 3. Calendar days between the stages are given in Table 4 in comparison with calendar days for soybean development in Minnesota. For the 5 years 1973-1977, 112 days were required between soybean emergence and maturity in comparison with 128 days required by the staging sequence.

Table 2. Stages of corn development, calendar days between stages, and development for Minnesota.

		Number of Days Between Stages		Minnesota Development			
				1973-77		1978	
Stage No.	Stage Title	Iowa 1/	Corn Loss Instructions 2/	Date	Days	Date	Days
0	Emergence			5/27		5/28	
0.5	2 leaf stage (LS)	7	6				
1.0	4 LS	14	12				
1.5	6 LS	21	18				
2.0	8 LS	28	24				
2.5	10 LS	35	30				
3.0	12 LS	42	36				
3.5	14 LS	49	42				
4	16 LS	56	48				
5	Pollination	66	59	7/22	56	7/20	53
6	Blister	78	72				
7	Dough	90	89	8/22	87	8/22	86
8	Early dent	102	94	9/3	99	9/1	96
9	Full dent	114	99				
10	Physiological maturity	126	114	9/18	115	9/22	118

1/ How a Corn Plant Develops, Special Report 48, Iowa State University.

2/ Corn Loss Instructions published by National Crop Insurance Association and Crop Insurance Research Bureau.

3/ Weekly Crop-Weather Report, Minnesota Department of Agriculture.

Table 3. Soybean developmental stages and their descriptions. (Stages of Soybean Development, Spec. Rpt. 80, Iowa State University.)

Stage No.	Stage Title	Stage Description
VE	Emergence	Cotyledons above the soil surface (Figure 4).
VC	Cotyledon	Unifoliolate leaves unrolled sufficiently so the leaf edges are not touching (Figure 5).
V1	First-node	Fully developed leaves at the unifoliolate node (Figure 6).
V2	Second-node	Fully developed trifoliolate leaf at node above the unifoliolate node.
V3	Third-node	Three nodes on the main stem with fully developed leaves beginning with the unifoliolate node.
V_n	n^{th}-node	n number of nodes on the main stem with fully developed leaves beginning with the unifoliolate node.
R1	Beginning bloom	One open flower at any node on the main stem.
R2	Full bloom	Open flower at one of the two uppermost nodes on the main stem with a fully developed leaf.
R3	Beginning pod	Pod 5mm (3/16 inch) long at one of four uppermost nodes on the main stem with a fully developed leaf.
R4	Full pod	Pod 2cm (3/4 inch) long at one of the four uppermost nodes on the main stem with a fully developed leaf.
R5	Beginning seed	Seed 3mm (1/8 inch) long in a pod at one of the four uppermost nodes on the main stem with a fully developed leaf.
R6	Full seed	Pod containing a green seed that fills the pod cavity at one of the four uppermost nodes on the main stem with a fully developed leaf.
R7	Beginning maturity	One normal pod on the main stem that has reached its mature pod color.
R8	Full maturity	95% of the pods have reached their mature pod color. Five to ten days of drying weather are required after R8 before soybeans have less than 15% moisture.

Table 4. Calendar days for soybeans to progress through the developmental stages and development for soybean crop in Minnesota, 1973-77.

Stages	Number of Days[1/]	Calendar Date for Minnesota [2/]	Number of Days for Minnesota
Emergence to VC	5	Emergence 6/1	
VC to V1	5		
V1 to V2	5		
V2 to V3	5		
V3 to V4	5		
V4 to V5	5		
V5 to V6	3		
V6 to V7	3		
V7 to V8	3		
V8 to V9	3		
V9 to R1	3	Blooming 7/15	45
R1 to R2	3		
R2 to R3	10		
R3 to R4	9	Setting pods 8/3	63
R4 to R5	9		
R5 to R6	15		
R6 to R7	18	Turning yellow 9/1	92
R7 to R8	9	Mature 9/20	112

1/ Stages of Soybean Development, Spec. Rpt. 80, Iowa State University

2/ Weekly Crop-Weather Report, Minnesota Department of Agriculture.

Figure 1. Drawing of a seedling corn plant with standardized morphological terminology (Can. J. Plt. Sci. 52:1003-1006)

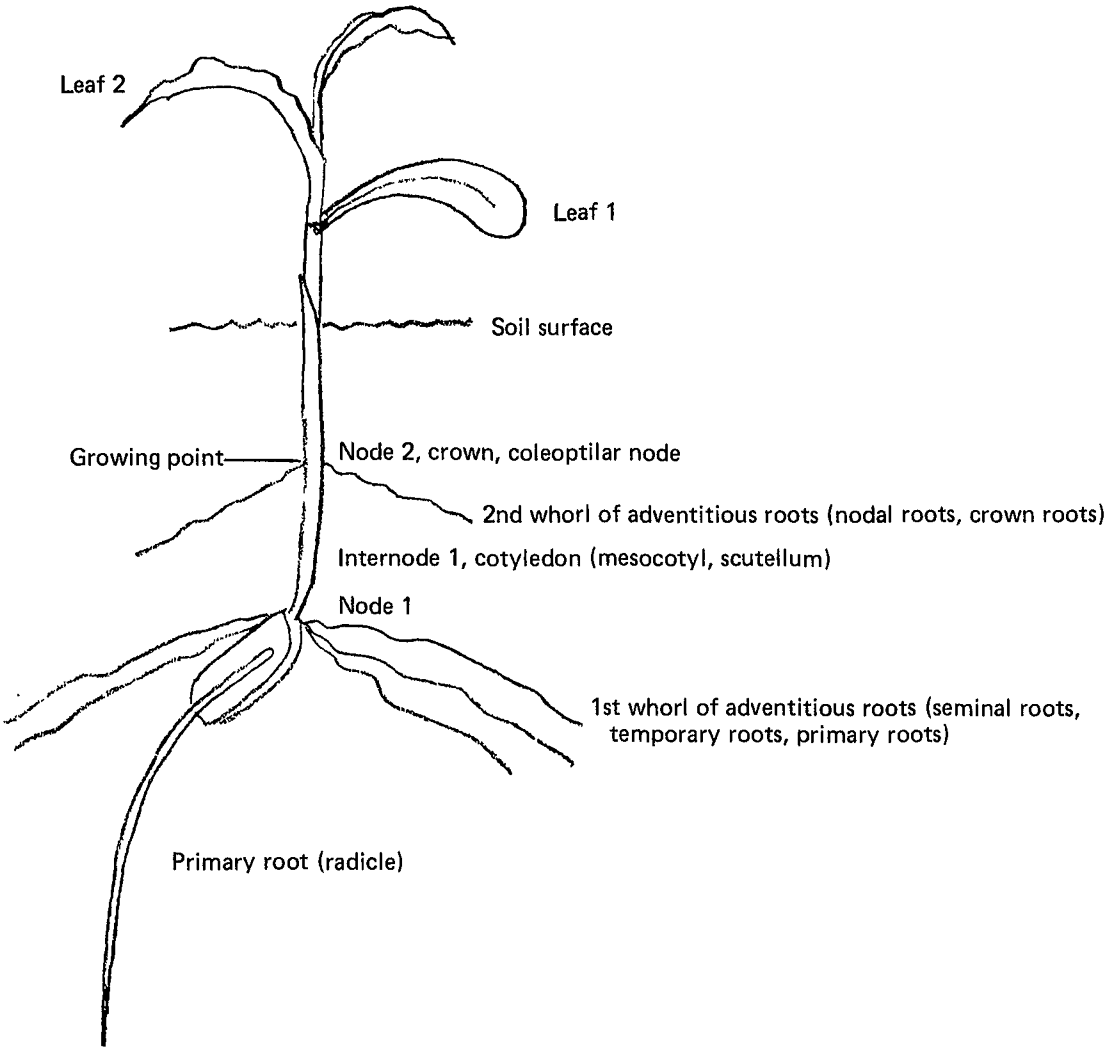
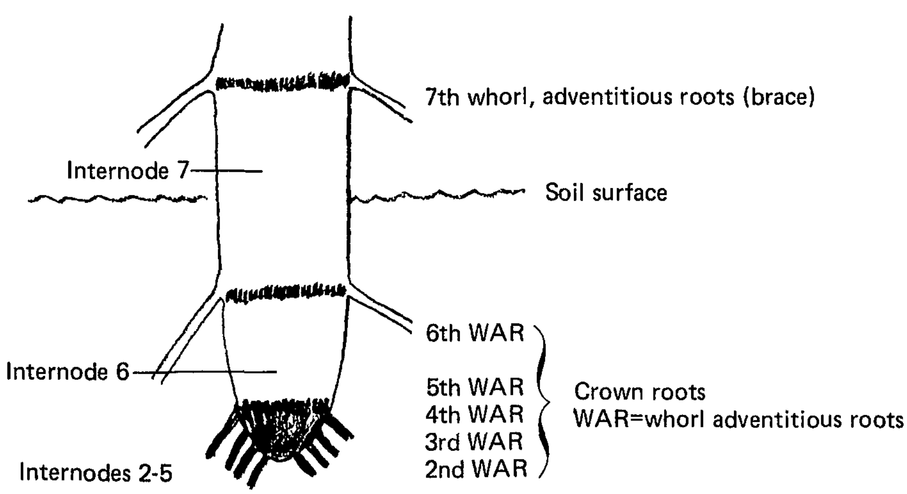


Figure 2. Drawing of a lower corn stalk showing nodal and internodal tissue and root development



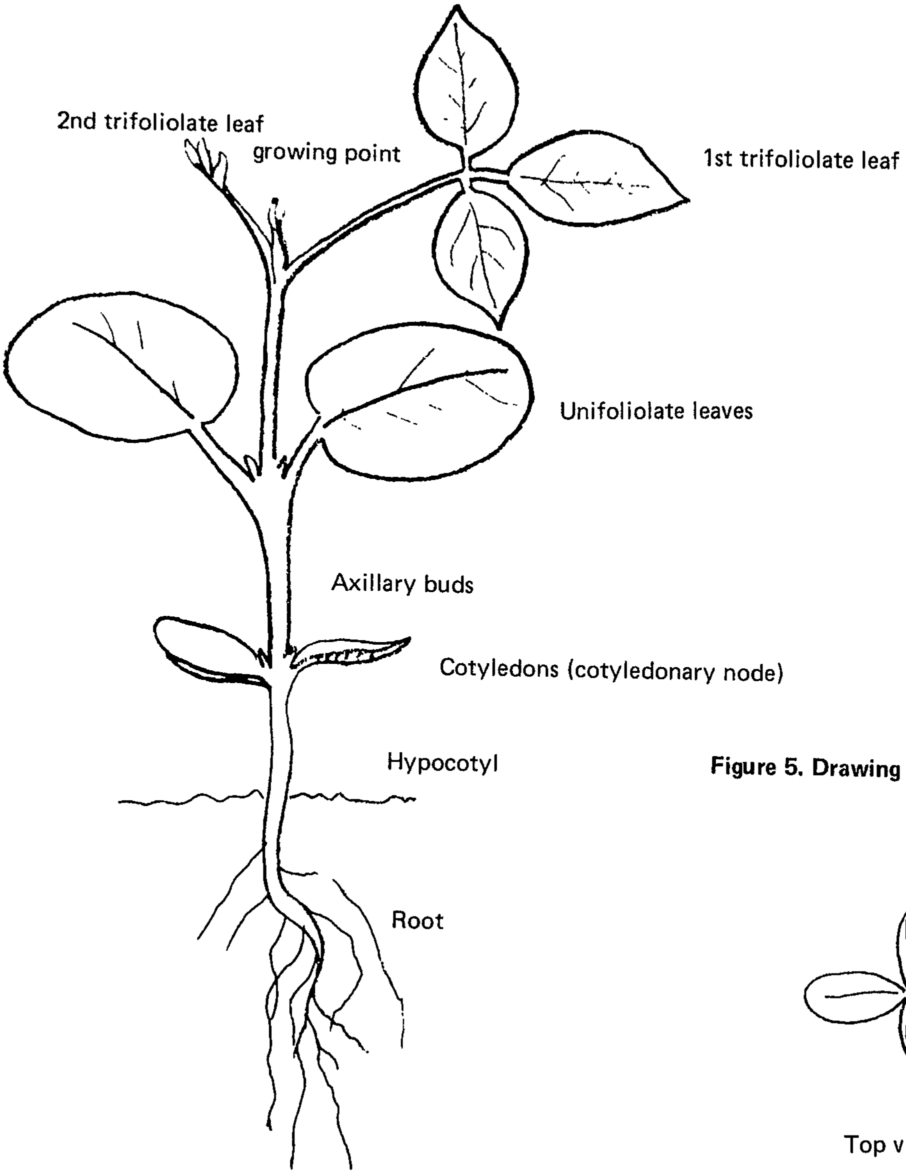


Figure 3. Soybean seedling morphology

Figure 5. Drawing of a VC staged soybean plant

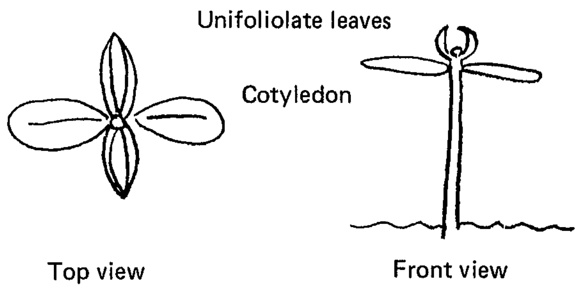


Figure 4. Drawing of VE staged soybean plant

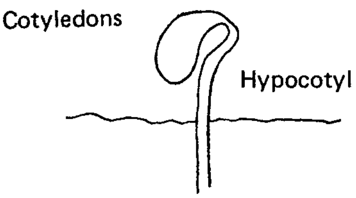
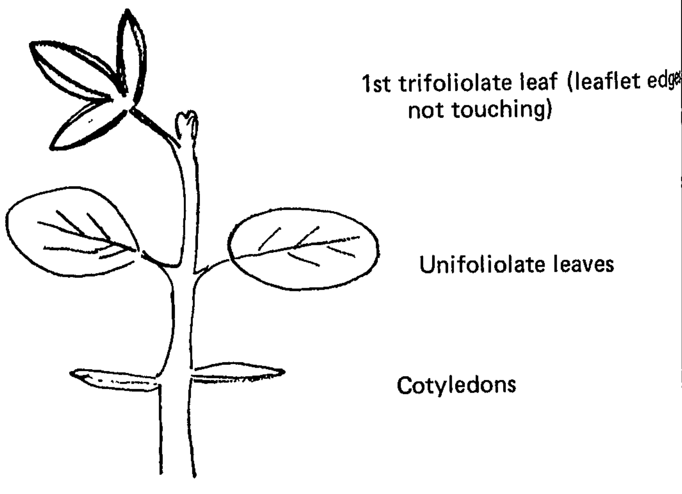


Figure 6. Drawing of V1 staged soybean plant



CORN AND SOYBEAN WEED CONTROL DEMONSTRATION RESULTS 1978

Gerald R. Miller, extension agronomist

Table 1 to 8 summarize results of weed control demonstrations conducted by Minnesota county extension directors and extension specialists. These data are the average results from a large number of trials on various soil types and under different weather conditions. They may assist in making a general comparison of herbicides, but for information on herbicides, rates, and methods of use for specific situations, refer to University of Minnesota Extension Bulletin 400, Cultural and Chemical Weed Control in Field Crops.

Chemicals were applied on 1/100-acre plots either preplanting and incorporated (before planting and disked in), preemergence (after crop planted but before crop or weed emergence), or postemergence (after crop and weeds emerged) as specified in the tables. Preemergence treatments were not incorporated. All chemicals were applied as sprays with a knapsack sprayer. One-half of each plot was cultivated once or twice as needed, the other half was left uncultivated. Several check plots with no chemical applied were left in each trial.

Early postemergence treatments in corn were applied when weeds were about 1-1/2 inches tall. Preplanting treatments were usually incorporated by disking. In combination treatments with trifluralin (Treflan), the trifluralin was applied preplanting and disked, then the other chemicals were applied preemergence after planting; bentazon (Basagran) was applied postemergence when soybeans were in the first trifoliolate leaf stage.

Weed control was visually evaluated 3 to 8 weeks after chemicals were applied (early evaluations). Control is rated "good" if more than 75 percent of the weeds were controlled, "fair" if 50 to 75 percent of the weeds were controlled, and "poor" if less than 50 percent of the weeds were controlled. "Grasses" in the tables refers to annual grasses such as foxtails, barnyardgrass, and crabgrass. "Broadleafs" refers to annual broad-leaved weeds such as pigweeds, lambsquarters, smartweeds, ragweeds, cocklebur, velvetleaf, wild mustard, etc. Perennial weeds such as Canada thistle and quackgrass were not included in the evaluations.

Tables 1 and 2 summarize early evaluations of herbicides that have been included for 2 or more years. These results are from uncultivated plots. Tables 3 to 6 are 1978 results. Each table specifies uncultivated or cultivated. Tables 7 and 8 show the frequency and degree of crop injury from the treatments over 6 years, 1973 to 1978.

Table 1. Corn Weed Control Demonstration Results, Several Year Summary. Early Evaluations, Uncultivated.

Chemical	Pounds per acre A.I. or A.E.* broadcast	Years in trials	Number of trials		Percent of trials in each class					
					Grasses			Broadleaf weeds		
			Grasses	Broadleaf weeds	Good	Fair	Poor	Good	Fair	Poor
Preemergence										
Propachlor (Ramrod,Bexton)	5	1965-73,75-78	410	399	81	12	7	44	25	31
Pendimethalin (Prowl)	2	1976-78	54	51	58	37	5	58	24	18
Atrazine (AAtrex)	3	1959-78	764	733	76	16	8	88	8	4
Cyanazine (Bladex)	3	1969-78	210	203	81	14	5	77	13	10
Alachlor (Lasso)	3	1969-78	210	203	86	10	4	51	20	29
Metolachlor (Dual)	3	1977-78	35	33	74	6	20	43	30	27
Atrazine + pendimethalin	1-1/2 + 1-1/2	1976-78	55	53	73	20	7	85	10	5
Cyanazine + pendimethalin	2 + 1-1/2	1976-78	55	52	77	16	7	79	15	6
Atrazine + propachlor	1-1/2 + 3	1969-78	296	301	83	14	3	86	8	6
Alachlor + dicamba (Banvel)	2 + 1/2	1972-78	130	124	88	6	6	89	5	6
Atrazine + alachlor	1-1/2 + 2	1970-78	178	171	91	8	1	92	6	2
Atrazine + metolachlor	1-1/2 + 2	1977-78	35	33	83	11	6	55	15	30
Cyanazine + alachlor	2 + 2	1974-78	98	95	88	10	2	85	10	5
Alachlor + linuron (Lorox)	2 + 1-1/2	1970-75	120	114	94	5	1	88	6	6
Propachlor + linuron	3 + 1-1/2	1968-73	152	148	88	9	3	78	14	9
Postemergence										
Atrazine	3	1961-67	398	374	73	14	13	87	7	6
Atrazine + oil	2 + 1-1/2 gpa	1966-78	367	358	85	9	6	95	4	1
Atrazine + surfactant	2 + 1 pt.	1968-69,71-77	178	175	60	30	10	95	4	1
Cyanazine	2	1973-78	104	99	72	12	16	90	3	7

* A.I. = active ingredient

A.E. = acid equivalent

Table 2. Soybean Weed Control Demonstration Results, Several Year Summary, Early Evaluations, Uncultivated.

Chemical	Pounds per acre A.I. or A.E.* broadcast	Years in trials	Number of trials: Grasses	Number of trials: Broadleaf weeds	Percent of trials in each class: Grasses Good	Grasses Fair	Grasses Poor	Broadleaf weeds Good	Broadleaf weeds Fair	Broadleaf weeds Poor
Preplant and Disked In										
Dinitramine (Cobex)	5/8	1972-78	89	87	80	13	7	64	26	9
Trifluralin (Treflan)	1	1965-78	240	230	87	10	3	61	24	15
Profluralin (Tolban)	1	1973-77	69	65	82	13	5	54	35	11
Fluchloralin (Basalin)	1-1/2	1976-77	26	24	88	8	4	79	9	12
Pendimethalin (Prowl)	1-1/2	1977-78	26	25	96	4	0	77	20	3
Preplanting + Preemergence										
Trifluralin + linuron	3/4 + 1-1/2	1970-78	129	124	90	7	3	90	6	4
Trifluralin + chloramben	3/4 + 2	1971-78	111	107	94	5	1	91	7	2
Trifluralin + metribuzin	3/4 + 1/2	1974-78	68	65	94	4	2	95	3	2
Trifluralin + bifenox	3/4 + 2	1975-78	49	47	96	2	2	89	9	2
Preemergence										
Chloramben (Amiben)	3	1959-78	511	493	75	16	9	76	16	8
Alachlor (Lasso)	3	1969-78	167	163	89	7	4	62	23	15
Linuron (Lorox)	2	1962-75	381	368	53	25	22	68	18	14
Bifenox (Modown)	2	1975-76	27	26	33	33	33	65	19	16
Metribuzin (Sencor,Lexone)	5/8	1972-78	100	98	70	16	14	80	10	10
Alachlor + linuron	2 + 1-1/2	1971-76,78	103	105	87	11	2	85	6	9
Alachlor + dinoseb (Premerge)	2-1/2 + 4-1/2	1973-77	76	73	88	10	2	76	13	11
Alachlor + metribuzin	2 + 1/2	1974-78	74	71	95	4	1	93	3	4
Alachlor + bifenox	2-1/2 + 2	1976-78	39	37	90	5	5	92	5	3
Alachlor + chloramben	2 + 2	1976-78	40	38	90	8	2	87	10	3
Preemergence + Postemergence										
Alachlor, pre + bentazon (Basagran), post	3 + 3/4	1973-77	70	65	87	7	6	88	7	5

* A.I. = active ingredient

A.E. = acid equivalent

Table 3. 1978 Corn Weed Control Demonstration Results. Early Evaluations. Uncultivated.

Chemical	Pounds per acre A.I. or A.E.* broadcast	Number of trials: Grasses	Number of trials: Broadleaf weeds	Percent of trials with each degree of control — Grasses: Under 50%	Grasses: 50-75%	Grasses: 75-85%	Grasses: 85-95%	Grasses: Over 95%	Broadleaf Weeds: Under 50%	Broadleaf Weeds: 50-75%	Broadleaf Weeds: 75-85%	Broadleaf Weeds: 85-95%	Broadleaf Weeds: Over 95%
Preplant and Disked In													
Alachlor + atrazine	2 + 1-1/2	11	9	9	9	27	37	18	0	0	11	33	56
Metolachlor + atrazine	2 + 1-1/2	11	9	9	18	18	27	28	0	0	11	44	45
Alachlor + cyanazine	2 + 2	11	9	9	9	18	46	18	0	0	22	22	56
Preemergence													
Propachlor (Ramrod,Bexton)	5	15	13	20	20	46	7	7	0	8	0	38	54
Pendimethalin (Prowl)	2	15	12	7	27	46	13	7	0	17	42	25	16
Atrazine (AAtrex)	3	15	13	20	20	46	7	7	0	8	0	38	54
Cyanazine (Bladex)	3	15	13	13	7	27	33	20	8	8	23	23	38
Alachlor (Lasso)	3	15	13	13	13	20	14	40	31	23	15	15	16
Metolachlor (Dual)	3	15	13	33	0	20	27	20	31	38	8	15	8
Pendimethalin + atrazine	1-1/2+1-1/2	15	13	13	33	7	20	27	0	0	23	38	39
Pendimethalin+cyanazine	1-1/2 + 2	15	13	13	20	20	13	34	0	0	54	0	46
Atrazine + propachlor	1-1/2 + 3	15	13	0	20	20	27	33	0	0	23	38	39
Dicamba(Banvel)+alachlor	1-1/2 + 2	15	13	13	0	33	20	34	0	8	23	31	38
Atrazine + alachlor	1-1/2 + 2	15	13	0	27	0	33	40	0	0	23	38	39
Atrazine + metolachlor	1-1/2 + 2	15	13	0	13	20	27	40	0	0	39	15	46
Cyanazine + alachlor	2 + 2	15	13	0	13	7	27	53	0	0	46	8	46
Postemergence													
Atrazine + oil	2 + 1-1/2	15	13	0	13	13	34	40	0	0	8	31	61
Cyanazine	2	15	13	7	7	33	20	33	0	0	15	54	31
Preemergence + Postemergence													
Alachlor, pre + bentazon (Basagran), post	3 + 1	14	13	7	14	29	7	43	0	0	31	23	46
Alachlor, pre + 2,4-D amine (Formula 40),post	3 + 3/8	13	11	31	0	8	38	23	18	0	18	27	37

* A.I. = active ingredient

A.E. = acid equivalent

Table 4. 1978 Corn Weed Control Demonstration Results. Early Evaluations, Cultivated.

Chemical	Pounds per acre A.I. or A.E.* broadcast	Number of trials		Percent of trials with each degree of control									
				Grasses					Broadleaf weeds				
		Grasses	Broadleaf weeds	Under 50%	50-75%	75-85%	85-95%	Over 95%	Under 50%	50-75%	75-85%	85-95%	Over 95%
Preplant and Disked In													
Alachlor + atrazine	2 + 1-1/2	5	3	0	0	40	0	60	0	0	0	0	100
Metolachlor + atrazine	2 + 1-1/2	5	3	0	20	20	0	60	0	0	0	0	100
Alachlor + cyanazine	2 + 2	5	3	20	0	20	0	60	0	0	0	0	100
Preemergence													
Propachlor (Ramrod, Bexton)	5	10	8	20	10	30	20	20	0	12	50	38	0
Pendimethalin (Prowl)	2	9	6	0	22	56	11	11	17	0	33	33	17
Atrazine (AAtrex)	3	10	8	20	20	10	30	20	12	0	0	38	50
Cyanazine (Bladex)	3	9	7	22	11	11	34	22	0	0	28	29	43
Alachlor (Lasso)	3	10	8	10	10	20	20	40	0	0	50	12	38
Metolachlor (Dual)	3	10	8	10	20	30	30	10	37	0	38	0	25
Pendimethalin+atrazine	1-1/2 + 1-1/2	10	8	0	0	50	30	20	0	0	0	50	50
Pendimethalin+cyanazine	1-1/2 + 2	9	7	11	22	11	22	34	0	0	28	29	43
Atrazine + propachlor	1-1/2 + 3	9	7	0	0	33	45	22	0	0	0	57	43
Dicamba(Banvel)+alachlor	1/2 + 2	10	8	10	10	10	10	60	0	0	0	13	87
Atrazine + alachlor	1-1/2 + 2	10	8	0	0	10	40	50	0	0	0	25	75
Atrazine + metolachlor	1-1/2 + 2	10	8	0	0	20	60	20	0	0	12	25	63
Cyanazine + alachlor	2 + 2	10	8	0	0	10	50	40	0	0	0	50	50
Postemergence													
Atrazine + oil	2 + 1-1/2	10	8	0	10	0	30	60	0	12	0	25	63
Cyanazine	2	10	7	10	0	10	20	60	0	0	0	43	57
Preemergence + Postemergence													
Alachlor, pre + bentazon (Basagran), post	3 + 1	10	8	22	11	11	34	22	0	0	28	29	43
Alachlor, pre + 2,4-D amine (Formula 40), post	3 + 3/8	10	8	10	10	20	20	40	12	0	0	50	38

* A.I. = active ingredient

A.E. = acid equivalent

Table 5. 1978 Soybean Weed Control Demonstration Results. Early Evaluations, Uncultivated.

Chemical	Pounds per acre A.I. or A.E.* broadcast	Number of trials		Percent of trials with each degree of control									
				Grasses					Broadleaf weeds				
		Grasses	Broadleaf weeds	Under 50%	50-75%	75-85%	85-95%	Over 95%	Under 50%	50-75%	75-85%	85-95%	Over 95%
Preplant and Disked In													
Dinitramine (Cobex)	5/8	11	11	0	0	36	54	9	0	27	18	37	18
Trifluralin (Treflan)	1-1/4	11	11	0	0	9	54	36	9	27	9	46	9
Profluralin (Tolban)	1	11	11	0	0	9	63	27	0	18	18	55	9
Fluchloralin (Basalin)	1-1/4	11	11	9	0	18	18	55	9	9	18	37	27
Pendimethalin (Prowl)	1-1/2	11	11	0	0	46	18	36	0	27	46	9	18
Preplanting + Preemergence													
Trifluralin + linuron	3/4 + 1-1/2	11	11	0	0	27	9	64	0	9	9	0	82
Trifluralin + chloramben	3/4 + 2	11	11	0	0	9	18	73	0	0	27	0	73
Trifluralin + metribuzin	3/4 + 1/2	11	11	0	9	9	18	64	0	0	18	9	73
Trifluralin + bifenox	3/4 + 2	11	11	0	0	27	18	55	0	9	9	18	55
Preemergence													
Chloramben (Amiben)	3	12	11	17	8	17	25	33	9	9	27	27	28
Alachlor (Lasso)	3	12	12	0	0	25	17	58	8	42	17	17	16
Metribuzin (Sencor, Lexone)	5/8	11	11	27	9	9	18	37	9	0	0	27	64
Alachlor+bifenox(Modown)	2-1/2 + 2	12	12	9	0	33	33	25	0	0	17	25	58
Alachlor + chloramben	2 + 2	12	12	0	8	0	42	50	0	8	8	17	67
Alachlor + metribuzin	2 + 1/2	11	12	0	0	9	27	64	0	0	8	8	84
Alachlor + linuron(Lorox)	2 + 1/2	12	12	0	8	8	25	59	0	0	0	33	67
Preemergence + Postemergence													
Alachlor, pre + bentazon (Basagran), post	3 + 1	12	12	0	8	8	34	50	0	0	25	8	67

* A.I. = active ingredient

A.E. = acid equivalent

Table 6. 1978 Soybean Weed Control Demonstration Results. Early Evaluations, Cultivated.

Chemical	Pounds A.I. or A.E.* broadcast	Number of trials: Grasses	Number of trials: Broadleaf weeds	Percent of trials with each degree of control: Grasses Under 50%	Grasses 50-75%	Grasses 75-85%	Grasses 85-95%	Grasses Over 95%	Broadleaf weeds Under 50%	Broadleaf weeds 50-75%	Broadleaf weeds 75-85%	Broadleaf weeds 85-95%	Broadleaf weeds Over 95%
Preplant and Disked In													
Dinitramine (Cobex)	5/8	6	5	0	0	17	66	17	0	0	0	80	20
Trifluralin (Treflan)	1-1/4	6	6	0	0	0	67	33	0	0	0	83	17
Profluralin (Tolban)	1-1/4	6	6	0	0	0	83	17	0	0	0	83	17
Fluchloralin (Basalin)	1-1/4	6	6	17	0	0	50	33	16	17	0	50	17
Pendimethalin (Prowl)	1-1/2	6	5	0	0	33	50	17	0	0	60	0	40
Preplanting + Preemergence													
Trifluralin + linuron	3/4 + 1-1/2	6	5	0	0	0	33	67	0	0	20	0	80
Trifluralin + chloramben	3/4 + 2	6	5	0	0	0	33	67	0	0	0	20	80
Trifluralin + metribuzin	3/4 + 1/2	6	5	0	0	17	17	66	0	0	0	40	60
Trifluralin + bifenox	3/4 + 2	6	5	0	16	17	17	50	0	0	0	40	60
Preemergence													
Chloramben (Amiben)	3	8	6	13	25	37	0	25	0	0	66	17	17
Alachlor (Lasso)	3	8	7	0	0	13	37	50	0	14	14	29	43
Metribuzin (Sencor, Lexone)	5/8	8	7	12	25	13	37	13	0	0	0	43	57
Alachlor+bifenox(Modown)	2-1/2 + 2	8	7	0	0	25	13	62	0	0	0	43	57
Alachlor + chloramben	2 + 2	8	7	0	0	13	37	50	0	0	0	43	57
Alachlor + metribuzin	2 + 1/2	8	7	0	0	0	37	63	0	0	0	14	86
Alachlor + linuron(Lorox)	2 + 1-1/2	8	7	0	0	25	37	38	0	0	0	43	57
Preemergence + Postemergence													
Alachlor, pre + bentazon (Basagran), post	3 + 1	8	7	0	0	12	25	63	0	0	0	29	71

* A.I. = active ingredient

A.E. = acid equivalent

Table 7. Crop Injury Evaluations in Corn Weed Control Demonstrations, 1973-78.

Chemical	Pounds per acre A.I. or A.E.* broadcast	Years in trials	Number of trials	Number of trials with each degree of injury				Percent of trials with each degree of injury			
				None	Slight	Moderate	Severe	None	Slight	Moderate	Severe
Preplant and Disked In											
Alachlor + atrazine	2 + 1-1/2	1978	12	12	0	0	0	100	0	0	0
Metolachlor + atrazine	2 + 1-1/2	1978	12	12	0	0	0	100	0	0	0
Alachlor + cyanazine	2 + 2	1978	12	12	0	0	0	100	0	0	0
Preemergence											
Propachlor (Ramrod, Bexton)	5	1973, 75-78	84	83	1	0	0	99	1	0	0
Pendimethalin (Prowl)	2	1976-78	50	45	3	1	1	90	6	2	2
Atrazine (AAtrex)	3	1973-78	108	107	1	0	0	99	1	0	0
Cyanazine (Bladex)	3	1973-78	109	103	3	2	1	94	3	2	1
Alachlor (Lasso)	3	1973-78	108	103	4	1	0	95	4	1	0
Metolachlor (Dual)	3	1977-78	32	27	4	1	0	84	13	3	0
Atrazine + pendimethalin	1-1/2 + 1-1/2	1976-78	52	47	2	0	3	90	4	0	5
Cyanazine + pendimethalin	2 + 1-1/2	1976-78	51	44	3	2	2	86	6	4	4
Atrazine + propachlor	1-1/2 + 3	1973-78	107	101	5	1	0	94	5	1	0
Alachlor + dicamba (Banvel)	2 + 1/2	1973-78	109	102	6	1	0	94	5	1	0
Atrazine + alachlor	1-1/2 + 2	1973-78	107	104	3	0	0	97	3	0	0
Atrazine + metolachlor	1-1/2 + 2	1977-78	34	30	4	0	0	88	12	0	0
Cyanazine + alachlor	2 + 2	1974-78	94	87	5	1	1	93	5	1	1
Alachlor + linuron (Lorox)	2 + 1-1/2	1973-75	57	55	1	1	0	96	2	2	0
Postemergence											
Atrazine + oil	2 + 1-1/2 gpa	1973-78	106	95	9	2	0	90	8	2	0
Atrazine + surfactant	2 + 1 pt	1973-77	94	87	7	0	0	93	7	0	0
Cyanazine	2	1973-78	107	99	7	0	1	93	6	0	1
Preemergence + Postemergence											
Alachlor, pre + bentazon (Basagran), post	3 + 1	1978	12	11	1	0	0	90	10	0	0
Alachlor, pre + 2,4-D amine (Formula 40), post	3 + 3/8	1978	10	9	0	1	0	90	0	10	0

* A.I = active ingredient

A.E = acid equivalent

Table 8. Crop Injury Evaluations in Soybean Weed Control Demonstrations, 1973-78.

Chemical	Pounds per acre A.I. or A.E.* broadcast	Years in trials	Number of trials	Number of trials with each degree of injury				Percent of trials with each degree of injury			
				None	Slight	Moderate	Severe	None	Slight	Moderate	Severe
Preplant and Disked In											
Dinitramine (Cobex)	5/8	1973-78	83	61	10	8	4	73	12	10	5
Trifluralin (Treflan)	1	1973-78	82	73	5	4	0	89	6	5	0
Profluralin (Tolban)	1	1973-77	71	66	3	2	0	93	4	3	0
Profluralin	1-1/4	1978	12	10	1	1	0	84	8	8	
Fluchloralin (Basalin)	1-1/2	1976-77	28	26	0	1	1	92	0	4	4
Fluchloralin	1-1/4	1978	12	12	0	0	0	100	0	0	0
Pendimethalin (Prowl)	1-1/2	1977-78	27	19	6	0	2	70	22	0	8
Preplanting + Preemergence											
Trifluralin + linuron	3/4 + 1-1/2	1973-78	81	68	9	4	0	84	11	5	0
Trifluralin + chloramben	3/4 + 2	1973-78	84	73	4	6	1	87	5	7	1
Trifluralin + metribuzin	3/4 + 1/2	1974-78	71	47	12	11	1	66	17	16	1
Trifluralin + bifenox	3/4 + 2	1975-78	52	30	10	9	3	58	19	17	6
Preemergence											
Chloramben (Amiben)	3	1973-78	89	79	8	2	0	89	9	2	0
Alachlor (Lasso)	3	1973-78	90	85	4	1	0	95	4	1	0
Linuron (Lorox)	2	1973-75	44	39	4	0	1	89	9	0	2
Bifenox (Modown)	2	1975-76	28	17	3	5	3	61	11	18	11
Metribuzin (Sencor, Lexone)	5/8	1973-78	90	48	20	13	9	53	22	15	10
Alachlor + linuron	2 + 1-1/2	1973-76, 78	72	66	5	0	1	92	7	0	1
Alachlor + dinoseb (Premerge)	2-1/2 + 4-1/2	1973-77	77	72	4	1	0	94	5	1	0
Alachlor + metribuzin	2 + 1/2	1974-78	77	51	14	6	6	66	18	8	8
Alachlor + bifenox	2-1/2 + 2	1976-78	41	23	2	12	4	56	5	29	10
Alachlor + chloramben	2 + 2	1976-78	42	38	3	1	0	91	7	2	0
Preemergence + postemergence											
Alachlor + bentazon (Basagran)	3 + 3/4	1973-77	70	64	5	0	1	92	7	0	1
Alachlor + bentazon	3 + 1	1978	13	12	1	0	0	92	8	0	0

* A.I. = active ingredient

A.E. = acid equivalent

CEREAL GRAINS

Howard L. Bissonnette, extension plant pathologist

Wheat - Barley - Oats

Seed Treatment

Planting good quality disease-free seed in a well-prepared seedbed when the soil is warm and moist would eliminate the need for most seed treatment. However, these ideal conditions usually do not occur, so seed treatment is needed to protect the seed from pathogenic organisms on the seed and in the soil.

The non-use of a seed treatment program by cereal crop growers has resulted in important crop losses the past two growing seasons. Covered smut of oats and semi-loose smut of barley, easily controlled by seed treatment fungicides, are the seedborne diseases that caused the crop losses. These losses include the loss of the oat variety Froker and the barley variety Manker.

Much of the 1978 wheat crop in the southern half of the state was infected with scab. This disease will show up next spring as seedling blight. Seed treatment will not give 100% control but it will increase the stand of scab infected seed.

Seed treatment will usually increase the stand and yield.

Several chemicals for use as dusts or slurries are now available as seed treatment fungicides. During the last few years of field testing these new chemicals have appeared favorable. For rates of application be sure to check the label.

Seed treatment chemicals are also available as drill-box treatments. When used as directed, this type of treatment is effective in preventing damping-off and seedling blight.

Where wireworms may be a problem, the addition of a suitable insecticide or combination product is desirable.

Growers planning to use their own barley crop for seeding the 1979 crop should have it tested for loose smut.

An embryo test for loose smut detection may be obtained through the State Department of Agriculture. Send about 1 pint of seed representative of the lot to:

Division of Plant Industry
670 State Office Building
St. Paul, Minnesota 55155

There is a $5 per sample charge which should accompany the sample. Make checks payable to the Minnesota State Treasurer.

Chemicals available to treat* wheat--barley--oats

Common name	Trade names	Bunt control	Seedling blight control	Remarks
Captan	Captan Orthocide Evershield (several other names)		G	Combination with maneb or zineb for bunt control
Captan-HCB	Ortho seed protectant	G	G	
Carboxin	Vitavax			For the control of loose smut
Carboxin + thiram	Vitavax 200 Evershield	F	F	For bunt, seedling blight and loose smut control
Maneb	AGSCO DB Green AGSCO DB Yellow cover-up Granol NM	F	G	DB Green + Granol NM are combined with Lindane
Maneb HCB	Granox NM	G	G	
PCNB	Terra-coat LT2	G	F	
	Terra-coat L205	G	F	Combined with Terrozole
	Terra-coat SD205	G	F	Combined with Terrozole
Polyram		F	G	
TCMTB	Busan (cover-up L)	G	F	
Thiram	Arasan-75	F	G	
	Evershield Thiram	F	G	

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

F = control fair
G = control good

Cereal Diseases

Rusts

During the last couple of years the population of both the stem rust and leaf rust fungus has been changing. These fungi are living organisms and as such have the ability to hybridize and thus produce new races of the organisms.

In the present wheat breeding programs there are 19 genes for resistance to stem rust. In the field populations of stem rust we have identified races of stem rust with virulence to all of these 19 genes. Two races of stem rust can attack 16 of these genes for resistance.

Although these populations are present in nature, we do not expect an epidemic such as occurred in the early 1950's with race 15B. However, such a possibility does exist. The development of an epidemic depends on many factors: e.g., weather, variety, extent of area devoted to a variety, presence of virulent races of rust, development of rust in the winter wheat area, etc.

Leaf rust was found on late season Era wheat in northern Minnesota. We have not received information as to which race is involved. However, this occurrence of leaf rust should alert growers to the potential hazard. During the 1979 growing season growers and the agricultural business community should be on the watch for leaf rust.

If leaf rust is seen early, before heading, it can be controlled with fungicides (see Leaf Disease Control with Fungicides on following pages).

Leaf Spot

Cereal leaf spot diseases (Septoria leaf spot, leaf rust, and others) are controllable with foliar applications of fungicides. Leaf rust is again showing up as a serious leaf disease on wheat and barley. This occurrence might be associated with planting more wheat, especially winter wheat, susceptible varieties, and new races of the rust fungus. The knowledge that these diseases are present and do cause crop loss is the first step toward eliminating crop losses. Now that the significance of such plant diseases is known, farmers and agribusinessmen should be able to produce these cereal crops without a 20 to 30 percent loss. It can and is being done.

Bacterial leaf spot was found on wheat in several areas. The disease was usually limited to small areas in fields, and may be more pronounced on some of the winter wheat varieties. Two bacteria, Xanthomonas spp. and Pseudomonas spp. were found on diseased plants. Recently, these bacteria have been reported as a disease problem in South Dakota. The bacteria cause a severe linear leaf spot that usually kills the leaf. There is no evidence that the fungicides used for leaf spot control this.

Root Rots

Root rots were very prominent in the 1978 wheat crop in west central Minnesota. The symptoms most easily seen are: dying plants early in the season, after heading, patches of short plants, and plants nearing maturity with a grayish color. By removing the plants from the soil you will usually find that the crown is dark colored and rotted. Roots will be discolored and lacking.

Head Disease

Scab caused very severe loss on wheat in west central Minnesota. Scab is usually present in this area but was very severe due to excessive rain and dew after heading. The fungus that causes scab of wheat also causes stock rot of corn!

Control of Cereal Diseases

With the potential threats to the cereal grain crop, plant pathologists have intensified their efforts to predict potential disease hazards in advance of actual crop damage. New fungicides, especially materials of a systemic nature, are being studied for their properties in controlling the rust fungi.

Some very promising results have been obtained, especially for the control of leaf rust; however, the particular fungicide does not have registration at this time.

As for the other cereal leaf diseases, Septoria and Helminthosporium, good results have been obtained in controlling such diseases with the dithiocarbamate fungicides. The dithiocarbamate fungicides do offer some protection against rust.

All of the presently grown varieties of wheat are susceptible to the leaf spotting diseases. There are definite varietal differences. The semidwarf varieties are more susceptible to Septoria leaf spot than the older tall varieties. Septoria leaf spot may become more of a disease loss factor with these varieties, as has already happened in other parts of the world.

The use of fungicides and the agricultural aircraft to apply them is a very important tool in the protection of potential yields of quality cereal grains.

For disease control practice, see the following chart:

Cereal Leaf Disease Control With Fungicides

	Wheat	Barley
1st application	Early heading - 1/4 of plants starting to head	5 days to 1 week before heading (head can be felt in the boot)
2nd application	10 days after first application	10 days after first application
Chemicals	Dithane M-45 Manzate 200 Zineb Kocide 101	Dithane M-45 Manzate 200 Kocide 101

Spreader-sticker - 3/4 to 1 oz./acre

Cereal Leaf Disease Control With Fungicides (continued)

Rates	All chemicals - 1-1/2 to 2 pounds of formulation per acre each application
Method	At present only aerial application has been worked out. A minimum of 5 gallons of water per acre must be applied. The aircraft must have the proper equipment and develop a uniform spray pattern.

Sugar Beets

Cercospora Leaf Spot

The 1978 season brought back our old friend Cercospora leaf spot. Leaf spot was found throughout the Renville area. The first symptoms were found in early August.

Many growers lost control of the disease because they tried to stretch out their fungicide applications.

All plant leaves are susceptible. As new foliage is produced it must be protected when the disease is present in the area, if a susceptible variety is being grown.

Fungicides 1/ for Leaf Spot Control

Benlate
Dithane M-45
Duter
Fixed coppers (Kocide 101)
Manzate 200
Mertect
Polyram

1/ Similar materials may be sold under different local names.

Powdery Mildew

Mildew occurred late in the season. Where fungicide was applied the disease was controlled with one application.

The mildew fungus depends on moist conditions, high humidity, not necessarily rain, and cool night temperatures. The conditions become ideal when the plants develop large leaves that cover the row. Light rains and cool nights provide conditions for dew formation. These conditions usually occur by late July.

Early infections may be difficult to detect. The first symptoms will be a very slight fungal growth on the surface of the leaf. The surface mycelium will have a whitish or gray color. As the disease progresses the mycelium will cover the whole leaf surface. Eventually (approximately 3 weeks), the leaves will yellow and die. The fungus produces conidia spores in the leaf surface, which may be the source of secondary spread of the disease.

If this disease gets started in mid-season and is not controlled, a grower may experience measurable yield reduction and low sugar content.

Mildew can be successfully controlled with fungicides. Early detection is important. Once the disease is established in the understory of leaves, it becomes difficult to get the fungicide to the fungus. Fungicides may be applied by aircraft, high volume ground sprayers, and dusters. Sulfur, applied as a liquid spray, has provided the best control in research plots in California (see following list for other fungicides).

Fungicides of Powdery Mildew Control
Mixture

Benomyl
Duter
Mertect
Sulfur

Potatoes

Poor quality seed, poorly stored, treated improperly, and planted in cold soil resulted in some very poor stands. Seed piece decay may be caused by a variety of fungi and/or bacteria. Chemical seed treatment together with proper seed handling will reduce the loss caused by the seed piece decay organisms.

Good Potato Seed Handling

1. Before planting, warm seed at 60° - 70° F 1-1/2 to 2 weeks.

2. Do not handle seed until warm.

3. Plant cut seed immediately in warm (50° F) moist soil.

4. If cut seed must be held: store in well-ventilated area for suberization at 60° - 70° F with a relative humidity of 85 percent. Hold for 1 week; then lower temperature to 50° - 60° F.

Fungicides for Use on Potatoes

Seed piece treatment	Blight and foliage disease
captan	Bravo
maneb	Copper (Iocide 101)
Polyram	Difolatan
zineb	Dithane M-45
zineb + 100 ppm streptomycin	Duter (no spreader-sticker)
	Maneb
	Manzate 200

Rhizoctonia

PCNB - emulsifiable concentrate	Polyram
(Broadcast-or in-furrow application)	A spreader-sticker should be used for better distribution and retention of the chemical if advised on the label.

The application of fungicides to potato plants with a low volume weed sprayer will not give adequate disease protection. Likewise, dust application with poor equipment will not protect the plant from disease. Use the proper equipment that has been calibrated in the correct manner or don't waste your time and money.

Early Blight

Early blight seems to be more pronounced each year. This is very possible due to shorter crop rotation systems.

In the demonstration trials at Grand Forks in 1978, two applications of fungicide increased the yield by 60 cwt of U.S. No. 1 potatoes over the untreated check.

Verticillium Wilt and/or Nematodes

Wilt and nematodes have been identified in several areas where potatoes are grown. Wilt by itself is enough of a problem, however, when nematodes are also present the disease situation is bad.

Soil fumigation appears to be the only way out of this problem, until resistant varieties are available. In addition to standard fumigation practices, some of the new systemic insecticides such as "Temik" have shown very good control on nematodes, and may be a useful tool in this respect in addition to its insecticides properties.

Sunflowers

As the sunflower crop moves into new areas of the state new plant disease problems may be expected to develop. There are several serious diseases that may occur on sunflowers, e.g., white mold, Verticillium wilt, downy mildew, rust, and Phoma spot. White mold and Verticillium wilt are soilborne disease problems. At this time crop rotation is the best method of avoiding them. Mildew usually is introduced with the seed but after continuous cropping may become soilborne.

A new disease, stalk rot, was found again this past season. This disease may be caused by a Fusarium fungus. We do not know if this is the same Fusarium that causes stalk rot of corn or Fusarium wilt of potatoes.

Several commercial varieties of sunflowers have various amounts of resistance to some of these diseases. This resistance is not immunity; it means that in a disease situation more plants will survive or produce, compared with a nonresistant variety.

Fungicides

Chemicals used to control plant diseases are called fungicides. These chemicals, for the most part, are protectants. The chemical, when applied to a plant part, protects the plant from infection. The fungicide action takes place on the plant part surface. In contrast, a few of the newer fungicides are systemic. The chemical, when applied to the plant may be absorbed and translocated within the plant. The fungicide activity may take place on the plant surface or at some internal infection site.

Because more field crops are being treated with fungicides, more people are dealing with these chemicals and should be aware of the toxic nature of fungicides.

TOXICITY OF FUNGICIDES

Toxicity ratings of pesticides. Pesticides are generally categorized according to acute oral toxicity (the toxicity when taken by mouth), but because users may absorb a significant quantity of the pesticide through their skin, dermal toxicity (toxicity when absorbed through the skin) is of equal or greater practical importance.

LD_{50} values (see terminology section) generally show relative toxicities among the chemicals and are not truly representative of effects on humans, especially since they are usually obtained on rats. Actual toxicities do not constitute the only hazards associated with the exposure to the chemicals. For instance, a chemical with low toxicity may be hazardous due to concentration, high volatility, or careless use.

LD_{50} depends upon body weight. A child's body requires less chemical than does an adult to have a toxic effect. LD_{50} also is proportional to the percent of active ingredient. A material only 50 percent active requires twice as much to produce a toxic effect as 100 percent pure material.

The lower the LD_{50} value, the greater the toxicity. A common standard for comparison is aspirin, which has an LD_{50} of 1,200 mg/kg and is considered slightly toxic.

The following table illustrates the various toxicity classes

Oral Toxicity		Dermal (Skin) Toxicity	
LD_{50} -mg/kg	Toxicity Class	LD_{50}-mg/kg	Toxicity Class
1-50	Highly Toxic	1-200	Severe
50-500	Moderately Toxic	200-2,000	Moderate
500-5,000	Low Toxicity	2,000-20,000	Mild
Over 5,000	Very low Toxicity	Over 20,000	Very Mild

Low and very low orders of toxicity are generally considered to be of low hazard.

The toxicity of various fungicides is shown in the following table.

Toxicity of various fungicides

CHEMICAL	Use*	Toxicity: Oral LD_{50}-mg/kg	Toxicity: Skin Reaction	Potential oral lethal dose for 180 lb human	Relative persistence+
Actidione	See cycloheximide				
Arasan	See thiram				
Benlate	See Benomyl				
benomyl	F	9,590	Mild	28.8 oz	I
Bravo W 75	F	>3,750	Mild	11.2 oz	I
captan	F, ST	9,000-15,000	Mild	27.0 oz	I
carboxin	ST	3,200-3,820	Mild	9.6 oz	I
chlorine	See sodium hypochlorite				
copper sulfate	F	300	Mild	0.9 oz	I
cycloheximide	F	2	Severe	0.0056 oz	?
Daconil 2787	See Bravo W 75				
Difolatan	F	4,600-6,200	Severe	13.8 oz	I
Dithane M-22	See maneb				
Dithane M-45	See zinc ion maneb				
Dithane Z-78	See zineb				
Du-ter	F	108	Mild	0.3 oz	I
copper	F	3,000-6,000	Mild	9.0 oz	I
formaldehyde	D, ST	800	Moderate	2.4 oz	N
Hyamine 2389	See quaternary ammonium				
Kocide 101	See copper				
Kocide 404	See copper				
maneb	ST, F	6,750-7,500	Moderate	20.2 oz	I
Manzate D	See maneb				
Manzate 200	See zinc ion maneb				
Mertect 360	See thiabendazole				
Mist-O-Matic	See phenyl mercury acetate				
Orthocide	See captan				
Oxy Cop 8L	See copper				
Parzate D	See zineb				
PCNB	ST, S	1,200-2,000	Moderate	3.6 oz	P
phenyl mercury acetate	ST	40	Severe	0.12 oz	P
Polyram	ST, F	6,400	Mild	19.2 oz	I
quaternary ammonium	D	390	Mild	1.17 oz	?
sodium hypochlorite	D	Moderate	Moderate	--------	N
streptomycin	ST, F	9,000	Moderate	27.0 oz	N
Terra-Coat	See PCNB and Terrazole				
Terraclor	See PCNB				
Terrazole	ST	2,000	?	6.0 oz	?
thiabendazole	F	3,100	?	9.3 oz	I
thiram	ST	780	Severe	2.3 oz	I
Vitavax	See carboxin				
zinc ion maneb	ST, F	>8,000	Mild	24.0 oz	I
zineb	ST, F	>5,200	Moderate	15.6 oz	I

* D = disinfectant, ST = seed treatment, F = foliar spray, S = soil treatment.

+ P = persistent - lasting through current growing season, I = moderately persistent - lasting a week to several months, N = nonpersistent - lasting a few days to several weeks.

Soil Fumigants--How to Apply[1]

The objective of soil fumigation is to place a chemical in the soil where it can effectively form gases which disperse throughout the spaces between soil particles, killing nematodes and fungi. The gases disperse sideways and upwards, principally, eventually escaping through the soil surface to the atmosphere. Nematodes and fungi are virtually impossible to eradicate from field soils by soil fumigation because:

1) The nematodes and fungi may be inside small soil aggregates or small pieces of plant residue or other organic matter and be protected from the lethal gas of the fumigant. Small soil aggregates or pieces of organic matter may be present in small numbers even in soils well-prepared for soil fumigation.

2) The nematodes and fungi may be below the depth of penetration of the gases.

3) The rapid dissipation of the gases from the soil surface may keep the gas concentration in the upper one to two inches of the soil, below the lethal point.

Soil Preparation, Temperature, Moisture, Sealing

Soil fumigation must be done properly if satisfactory results are to be obtained. Planning is necessary; soil fumigation done on "the spur of the moment" is often unsuccessful. Because of the soil temperature and soil moisture requirements, soil fumigation is most often done in the late summer and fall after the crops are off.

Soil Condition

The major reason for the failure of soil fumigation is the improper preparation of the soil. Prepare the soil to seed bed condition by deep plowing followed by disking or rototilling. Most fumigants are not effective below an established plow sole thus the sole should be tilled to the depth of desired fumigation. Application depth is usually 8 inches. The soil should be free of lumps, clods, and undecomposed organic matter. Cover crops should be plowed down early enough to allow for good decomposition of the organic matter. If necessary, irrigate and add nitrogen to hasten decomposition. Soil should be fumigated before manure, sawdust or other organic materials are applied.

Soil Temperature

Most materials are more effective at the high temperatures. An extremely high soil temperature (above 80° F) is not desirable since the fumigants form gases and evaporate too quickly for effective control of nematodes and fungi. At low soil temperature (below 45° F) the fumigants may only partially form a gas resulting in limited diffusion.

1/ Adapted from Oregon Plant Disease Handbook 1975, p. 76.

Soil Moisture

Fumigants are not fully effective in very dry or very wet soil. Soil moisture should be slightly below field capacity for sandy soils and between 50 and 75 percent of field capacity in heavier soils. Soil is usually at the proper moisture level for fumigation when it barely retain its shape after being squeezed in the palm of the hand.

Soil Surface Seal

The rapid evaporation and dispersion of gases from the soil surface make it difficult to build up a lethal concentration of the fumigant gases in the top 2 inches of soil. "Sealing" the surface to reduce the gas losses from the soil surface should be done immediately after fumigation. If a large area is being fumigated, "seal" as the job progresses, do not wait until the whole area is fumigated before sealing. There are two ways of sealing:

1) Packing the soil with cultipacker, roller, weighted plank, etc.

2) Sprinkling the surface with 1/2 inch of water. After sealing, the soil should be left undisturbed for the time specified by the manufacturer, then aerated with a disc or harrow to aid the final escape of the fumigant.

Application Equipment--Power Drawn

Chisel applicator: The chisel applicator is probably the most common device used for large scale fumigation. The fumigants are applied behind chisels spaced 8 to 12 inches apart through a fluid system pressured by a gear-driven pump, or compressed air.

Plow-sole applicator: The plow-sole applicator is designed to place the fumigant in the bottom of the furrow just ahead of the plow, where it is immediately covered with soil. Most plow-sole applicators rely on a gravity flow to move the fumigant through the fluid system. The use of constant-flow tank will greatly increase the accuracy of the amount of material used per acre.

Blade applicator: The blade applicator, developed at Oregon State University, injects the soil with a continuous sheet of the fumigant in contrast to the narrow band of the other applicators. The injection boom, mounted in a protected recess beneath the blade, sprays the fumigant into the soil as it breaks over the rear edge of the blade. Before using a blade injector, the surface of the soil, previously worked into a seed bed condition, should be firmed with a roller or float to provide traction, and to aid in movement of the soil over the blade.

Soil Fumigants

Trade name--manufacturer	Active ingredient	Uses
Chloropicrin Chlor-o-pic Great Lakes Chemical Company Picfume Dow Chemical Company	trichloronitromethane	fungicide soil inseticide nematicide herbicide
Methyl bromide plus Chloropicrin combinations Dowfume M-33 Trizone Dow Chemical Company Path-o-fume Trifume 2 plus 2 Nor-Am Agricultural Products, Inc. Terr-o-gas (Several different mixtures) Terrogel Great Lakes Chemical Company Mumfume Pathofume B Trifume Neil McLean Company	Chloropicrin plus methyl bromide mixtures	fungicide nematicide insecticide
DD Shell Chemical Company Vidden D Dow Chemical Company	dichloropropene dichloropropene	nematicide soil insecticide herbicide
Telone II Dow Chemical Company Telone C.	dichloropropene (DD + Chloropicrin) Plus 17% Chloropicrin	nematicide fungicide soil insecticide herbicide
DD and Chloropicrin Terr-o-cide 15 D Terr-o-cide 30 D Great Lakes Chemical Company	1,3 dichloropropene 1,2 dichloropropene Chloropicrin	insecticide fungicide
DD-pic Shell Chemical Company Telone C Dow Chemical Company		
Vapam Stauffer Chemical Company	sodium methyl dithiocarbamate	fungicide soil insecticide herbicide
Vorlex Nor-Am Agricultural Products, Inc.	methyl isothiocyanate and chlorinated C_3 hydrocarbons including 1,3 dichloropropene	fungicide nematicide herbicide insecticide

SOYBEAN CYST NEMATODE AND CORN LEAF DISEASES

Herbert G. Johnson, extension plant pathologist

Soybean Cyst Nematode--The first infestation of soybean cyst nematode (SCN) was found in a field in south central Minnesota near the Iowa border in September 1978. Soil samples were obtained from 25 more locations in the vicinity of the first location. Nine of these samples contained SCN, and one of them was 7 miles from the first location. Additional soil sampling has been done, but the status of those samples is not available at the time of this writing. Small numbers of SCN that can increase over a period of years may be present in other parts of the soybean growing area at this time.

Field Symptoms--Soybean plants that are damaged by the SCN are stunted, yellow, and unthrifty. The area of a field that is affected will generally be oval shaped with the long dimension in line with the primary direction of field tillage and cultivation. The size of the affected area is variable from several feet in diameter to covering entire fields. High and low areas of a field are not important except for the movement of the nematode from high to low areas by erosion. Some of this description would also fit iron chlorosis of soybeans. Iron chlorosis is more confined to low areas or the borders of low areas. Yellow leaves from iron chlorosis have green color along the veins and yellow between the veins. The similarity of the two will cause some confusion. Soil sampling and testing is the only reliable method for verifying SCN. In both cases, unthrifty plant growth is likely to result in excessive weed growth in the affected areas. The actual cysts of nematode are attached to soybean roots; however, they are small and should not be considered a reliable symptom for field diagnosis.

Damage--The actual damage the nematode does to the soybean plant is through feeding on roots. This results in varying degrees of damage depending on the numbers of nematodes. Nodules for nitrogen fixation are destroyed which results in nitrogen deficiency that accounts for much of the yellow leaf symptom. Root deterioration also causes a general reduction of absorption of other nutrients and water. Yield reduction of 30-80 percent has been found in affected parts of fields in other states.

Spread of SCN--The spread of the nematode from one area to another, from field to field, and within a field is caused by the movement of infested soil. Soil on machinery is probably the major factor in this spread. Soil in seed may contain nematodes which can account for some long distance spread. Migratory birds and wind blown soil and crop refuse are factors also.

Development of an infestation in a field--One of the just described means of spread is responsible for the initial deposit of the nematode in a field. The early years of the infestation often go unnoticed. The rate of buildup will depend on the frequency of soybean crops and other susceptible crops and possibly some weeds. The nematodes will move only a few inches per year, but tillage equipment moves the infested soil and accelerates spread. In one instance where corn and soybeans were grown on a field in alternate years, the first three crops of soybeans were not suspected of being damaged. The fourth crop showed noticeable damage and the fifth crop had 15-20 acres severely damaged.

Control--

1. Take sanitary precautions to delay the initial movement of nematodes into fields. Preventing the movement of machinery from infested fields or fields of unknown infestation to a clean field is the most important factor.

2. Know the status of fields with regard to the SCN. As long as a field is free of the nematode, the high-yielding but susceptible varieties of soybeans can be grown successfully.

3. If the SCN is known to be present:

   a) Reduce the frequency of soybean crops and other host crops as they become known to 3 to 5 years. Corn, cereals, sunflowers, sugar beets, potatoes, and grass crops are nonhosts. All legumes are not known as to host status and should be avoided if possible. Snap beans are known hosts and dry beans are likely hosts.

   b) The University of Minnesota Agricultural Experiment Station does not have a recommended SCN-resistant variety at this time. At this time our recommended varieties should be grown, but fields of known infestation should be avoided or soybean crops spaced out 3 to 5 years to avoid a nematode buildup. Varieties from other areas that are resistant, but are not adapted to Minnesota's latitude are not recommended. The relatively small area of known infestation in Minnesota indicates that present recommended varieties will be successful on most fields for many years. The SCN, as with many other disease-causing agents, is made-up of several races that have different capabilities in attacking different kinds of crop resistance. The race or races of nematodes present in Minnesota are believed to be races 3 or 4 or both. The Minnesota soybean breeding program has plant material that is resistant to race 3 but not to race 4. Resistance to race 4 is available in some other states and can be brought into the program. Additional races may be identified in the future.

   c) Maintain a good level of potash and phosphorus in the soil. Root damage by the SCN tends to accentuate soil nutrient deficiencies.

Soil testing for SCN--Soil samples should be taken from suspected parts of soybean fields. Collect the soil from the row area of the plants. The sample should be taken to a depth of 8-10 inches and 8 to 10 soil samples should be taken to make up the final sample. A total of about one pint of soil is needed for the test. Two laboratories are available in Minnesota to do the test:

1. Minnesota Department of Agriculture Greenhouse
   830 West 6th Street
   Shakopee, Minnesota 55379

   Samples for this test may be moist or dry. There is no charge.

2. Plant Nematology Laboratory
   Department of Plant Pathology
   University of Minnesota
   St. Paul, Minnesota 55108

   Samples for this test must be moist, preferably sent in a plastic bag. Additional information is given with this test such as population of lesion nematodes that affect corn. There is a $3 charge for this test. Checks are to be made out to University of Minnesota.

Corn Leaf Diseases--Three corn leaf diseases were present in Minnesota in 1978, but little damage was done. Eyespot is potentially the most serious on the basis of past experience. This disease was first identified in Minnesota about 1968 and that same year a few fields had most of the corn leaves killed by about the middle of August. Since then eyespot has been less serious and has been found only occasionally in the last several years. In 1977 eyespot built up in one field of irrigated corn and caused some yield reduction. In 1978 this disease was found in many fields in central, east central and southeast Minnesota. Usually it either started too late or built up too slowly to cause yield reduction. The question now concerns the status of this disease in the 1979 crop and crops of other future years. This is a fungus disease and the fungus overwinters on crop refuse. When another crop of corn follows a diseased crop, there is a good chance of early infection starting in that crop. Minimum tillage, which leaves a large amount of leaves on the surface, increases the chances of early and heavy infection. Corn is the only susceptible crop to this disease so a different crop would greatly reduce the problem. Secondary spread of the fungus from the first infection is wind-borne but this would be later. Some corn hybrids are more resistant than others so where this is known the damage can be reduced.

Holcus leaf spot, the bacterial leaf disease of corn, has always been a minor disease in this area and can be found in practically all fields. In 1978 in southwestern Minnesota this disease was quite severe in a few fields. Four or five leaves about two-thirds of the way up the plant were about 50-70 percent covered with spots of this disease. Apparently there was a period of weather conditions that were usually favorably for this disease. Several hybrids were affected, but yield reduction was doubtful.

Corn rust was present in most fields, but appeared not to be damaging.

A REVIEW OF REBUTTABLE PRESUMPTION AGAINST REGISTRATION

(RPAR)

Howard Deer, assistant extension entomologist and
Phillip K. Harein, extension entomologist

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) provides the Environmental Protection Agency (EPA) with authority to regulate pesticides. Section 6 provides for the suspension and/or cancellation of pesticides. This section also serves as the basis for the RPAR process.

Prior to the formation of EPA in 1970 a "Notice of Intent" to cancel a pesticide was issued when it was determined that the pesticide was hazardous. Registrants could then request a public hearing. Most frequently, the industry conceded and the product(s) was removed from the market without long administrative procedures being invoked.

More recently, from 1971 to 1975, Notices of Intent to cancel were issued when "there was reasonable question as to safety". Since it was "a reasonable question," almost all actions were automatically thrown into the public hearing mode, e.g., aldrin, chlordane, DDT.

The current procedure, 1976 to present, for reaching a regulatory decision on pesticide registration is RPAR. The 1975 amendments to FIFRA state that, in determining whether or not to issue a Notice of Intent to cancel, the Administrator of EPA shall include the impact of such action on production and prices of agricultural commodities, retail food, and otherwise on the agricultural economy. He shall also provide the Secretary of Agriculture with a copy of such notice and an analysis of such impact on the agricultural economy.

The RPAR process, then, is a regulatory mechanism created to gather further information on the risks, benefits and exposure of pesticides when it is determined that certain risk factors have been exceeded and that cancellation of the material is feasible. However, the issuance of an RPAR is not a prejudgement toward cancellation. The final outcome may be re-registration, cancellation of some or all uses, or other regulatory options such as restriction of use such as the need for protective clothing, longer re-entry periods, modified applications methods or times, etc.

The RPAR process begins when it is determined that any of the risk criteria outlined in the regulations are met or exceeded. Any person, agency, business, or association may place a chemical on RPAR candidate status by calling attention to appropriate risk information.

Risk criteria (or triggers) fall into three general categories:

1. Acute toxicity by the dermal or inhalation route,
2. Chronic toxicity, including the various "genecities", such as oncogenic (tumor formation), mutagenic (genetic damage), teratogenic (birth defects), or other related effects, and
3. Impacts on non-target avian, aquatic and mammalian species.

The risk of triggers are not a measurement of hazard. Hazard is a function of risk and exposure. A product may have a potent risk trigger, but if the exposure by appropriate use is minimal or non-existent, then there is little or no hazard.

If the risk criteria is met or exceeded, then an RPAR notice is issued in the Federal Register. After issuance of an RPAR notice the risk-rebuttal period begins.

There is a regulatory time limit (105 days) for submitting trigger rebuttal information. Risk rebuttal is normally provided by the pesticide industry, but rebuttals may be submitted by anyone.

The next period is a risk/benefit analysis. Risks are primarily provided by EPA, benefits by USDA through the RPAR process. Benefits are accumulated via national pesticide assessment teams. The Technical Advisory Group (TAG) of USDA recommends, concurs, and then clears the various personnel to serve on the team. The Environmental Quality Activities Office obtains EPA participation and the Joint USDA/STATE/EPA team commences its activities in the collection of benefits. This team is not charged with nor should it address the validity of the toxicological risk data.

If EPA determines that some sort of cancellation action will be taken, then a more formal process of receiving comments from USDA is required. The EPA Administrator must furnish the Secretary with the proposed order and impact analysis 60 days prior to sending it to the Registrant, or otherwise making the notice public. The Secretary then has 30 days to make comments on the proposed order.

If cancellation still proceeds, then the registrant or other interested parties still have the normal avenues of Public Hearing and Judicial Review open to them.

In summary, the RPAR process consists of a pre-RPAR review period where risk criteria are examined followed by a determination whether or not to issue an RPAR notice in the Federal Register. If an RPAR notice is issued then a risk/benefit analysis is conducted by EPA and USDA. The next period is review of the risk/benefit analysis followed by a decision to re-register or to enter the pesticide into some form of cancellation action. If cancellation action is to take place, the avenues of Public Hearing and Judicial Review are available to interested parties.

The following pesticides have had RPAR notices issued in the Federal Register:

Baam (Amitraz)
Benomyl (Benlate)
BHC (Benzene Hexachloride)
Cadmium and Derivatives
Chlorobenzilate (Akar)
Chloroform
Coal Tar (Wood Preservative Uses)
Creosote (Wood Preservative Uses)
DBCP (Dibromochloropropane)
Diallate (Avadex)
Dimethoate (Cygon)
EBDC's (Amobam, Mancozeb, Maneb, Metiram, Nabam, Zineb)
Endrin
Ethylene Dibromide (EDB)
Ethylene Oxide (ETO)
Inorganic Arsenicals (Wood Preservative Uses)
Kepone
Lindane
Maleic Hydrazide (MH)
PCNB (Pentachloronitrobenzene, Quintozene)
Pentachlorophenol (PCP) (Wood Preservative Uses)
Pronamide (Kerb)
Strychnine/Strychnine Sulfate
1080/1081
2,4,5-T
Thiophanate Methyl
Toxaphene
2,4,5-Trichlorophenol (2,4,5-TCP)

The following pesticides are being considered for RPAR review:

Amitrole (Weedazol)
Asbestos
Cacodylic Acid and Salts (Ansar, Phytar)
Captafol
Captan
Carbaryl (Sevin)
Carbon Tetrachloride
Daminozide (Alar)
DCPA (Dacthal)
Dichlorobenzene
1,3-Dichloropropene (Telone II)
Dichlorvos (DDVP, Vapona)
DEF
Dimilin
Dinoseb (Premerge)
Epichlorohydrin
EPN
Erbon (related to 2,4,5-T)
Folpet (Phaltan)
Hexachlorobenzene (HCB)
8-Hydroxyquinoline (Tumex)
Inorganic Arsenicals
Maleic Anhydride
Merphos (Folex)
Methanearsonates (MSMA, DSMA, MAMA, etc.)
Mexacarbate (Zectran)
Monuron (Telvar)
10,10'OIxtbisphenoxarsine
Paraquat
Pentachlorophenol (PCP) and Derivatives
Perchloroethylene
Perthane
Phosphorus Paste
Piperonyl Butoxide (Synergist)
Probe
Propham
Ronnel (related to 2,4,5-T)
Rotenone
Silvex (related to 2,4,5-T)
Triallate (Avadex BW, Far-Go)
Tribromosalan
Trichloroethylene
Trichlorofon (Dipterex, Dylox)
Trifluralin (Treflan)

REPORT ON THE MINNESOTA STORED-GRAIN INSECT SURVEY

Alan V. Barak, research associate, Department of Entomology,
Fisheries and Wildlife

and

Phillip K. Harein, extension entomologist

A project was initiated in 1977 at Waseca and Granite Falls with the objective of providing current information on the status of farm-stored grains in Minnesota. The program will be expanded in 1979 statewide to develop a large scale program pending agreements of cooperation with the Area Vocational Technical Institutes (AVTI). The farm management instructors at each AVTI will be asked to organize a network of student samplers to provide data on various aspects of the quantity and quality of farm-stored grains. A computer program will be used to correlate various factors which affect grain condition.

Some of the more common and abundant insects found in stored corn and wheat to date follow:

1. Flat and rusty grain beetles
2. Foreign grain beetle
3. Red flour beetle
4. Indian meal moth
5. Saw-toothed grain beetle
6. Larger black flour beetle

These species have usually been considered as secondary insect pests since they do not develop inside the whole kernel. They remain outside the kernel feeding on dockage and broken kernels or the germ of whole kernels.

7. The granary weevils, maize weevils and the lesser grain borer are considered primary pests since their larvae usually develop inside sound kernels.

The survey to date indicates that the insect species considered to be the most serious are not common, but instead the "minor" pests species have the greatest population and widest distribution. Data from Waseca County, during the 1977 crop year, show the flat grain beetles and the foreign grain beetle are the dominant species. The saw-toothed grain beetle and rice weevil are found only in 3 of 47 farm storages sampled. The lesser grain borer was not found.

Data collected from grain samples supplied by six county elevators also show a similar pattern of insect species infesting shelled-corn. Based on our experiences, alleged reports of "weevils" in grains brought to elevators are due to the inability to properly identify insect species.

Also contributing to the problem at the local elevator is failure to even detect insect populations. Of 47 elevator samples which contained insects, 44 came from one elevator which reported that 75 percent of the loads brought in had insects.

Data collected at the farm level show the probably cause of heavy infestation:

- Too many bins are filled beyond capacity, making proper inspection, treatment, and aeration difficult.

- Rarely were aeration fans in operation even though temperatures of the grain indicated heating and moisture migration was taking place.

- Although most bins were pre-cleaned before new grain was introduced, rarely if ever were protectants applied to the bin or grain.

Grains stored under such conditions are subject to infestation and have a high risk of spoilage. Many of the insect species found survive best in "out of condition" grain and this appears to be the main contributing factor. Such grain not only had the greatest numbers of insects but also the greatest variety.

Losses are difficult to assess on the farm level since marketing practices vary widely. However, costs of treatments, moving of grain, cleaning of grain and fumigations due to insect presence can be calculated. The cost of the fumigant is $12-$20 per 1,000 bushels. Nonchemical alternative methods can be practiced, especially when one considers the species present. Fumigation is usually only necessary if weevils or lesser grain borers are the primary infestors, especially if the grain cannot be cleaned or moved and treated with a residual insecticide. Also, fumigation is not likely to succeed in overfilled, out of condition or heating bins and is even more difficult in flat storages or partially filled bins.

The following conclusions resulted:

1. Adequate preventive measures are not being taken.

2. Storage practices favor the environmental conditions suitable for insect development.

3. Improper identification of species may result in wasteful, dangerous, and unworkable methods of control.

4. Failure to detect substantial infestations contributes to the problems further along marketing channels.

SUNFLOWER INSECTS 1978

David M. Noetzel, extension entomologist

A. Seasonal Summary

Pest insect numbers in sunflowers were generally reduced in 1978. Lower numbers of stem weevils, sunflower moth, and seed weevils suggest that some environmental factor other than acreage affects those insects in a similar manner. Cutworms (primarily darksided cutworm) and sunflower midge numbers increased in 1978.

Losses due to cutworms were the greatest in 10 years. Fields were damaged statewide, but major replanting took place in west central Minnesota where in excess of 20 percent of the acreage was destroyed. A series of trials (Section B - Cutworm Control) comparing a number of new insecticides with the presently labeled toxaphene were carried out.

Sunflower midge damage was somewhat increased over 1977. Noticeable injury occurred in the Wheaton to Breckenridge area and in the Warren vicinity. These were both areas of heavy May and June rainfall.

Stem weevils were so low in numbers they were difficult to find. Most of the sunflower stalk breakage in 1978 was not related to their presence and/or abundance.

Some have asked questions about the relationship of "premature ripening" disease to stem weevil presence. There is no data showing such relationship and indeed many fields were free of weevil injury yet had from 16 to 100 percent infected stalks due to "premature ripening" in 1978.

Sunflower moth adult numbers were very low with just occasional observations of larvae. A certain age group (e.g., planting date) of sunflowers contained what little infestation there was. This shortened oviposition period has now been observed both in 1977 and 1978 in Minnesota.

Seed weevil abundance was also greatly reduced. The few fields which contained infestations were sampled in order to attempt to relate larval damage to the seed yield decrease. Random samples were taken from four infested fields. Seed weights per 100 seeds as field sampled were taken and the weights (i.e., reduction due to larval feeding) recorded. Then 100 undamaged seeds were weighed, and the percent reduction was based on these latter weights.

Relationship of percent seed weevil damage and percent yield reduction.

Field no.	Percent damaged seed	Percent yield reduction for each 10% of damaged seed
1	8	5.41
2	13	3.32
3	23	1.09
4	34	2.35
From ND (1977 progress report)	16	2.47
Average		2.93

The data suggest that there may be a variation in percent yield reduction with constant infestations due to variety or some other factor. This merits further examination before definitive thresholds are established.

B. Cutworm Control

The major insect problem in sunflowers the past three years, and probably since sunflowers became extensively grown in the upper midwest, has been cutworms. The Minnesota areages destroyed by cutworms during 1975-1978 were estimated to be at least 15,000, 5,000, 56,000 and 110,000, respectively. Replanting costs were about $5 per acre replanted. Control needs were estimated to be an acreage equal to that destroyed each year at an estimated treatment cost also of $5 per acre. Losses thus were estimated to be $150,000, $50,000, $560,000 and $1,100,000 per respective year. This is an annual average loss of nearly one-half million dollars.

Toxaphene, the only insecticide presently labeled for cutworm control in sunflowers, has performed rather erratically over the years. A more dependable insecticide for cutworm control is an important industry need.

The extensive cutworm outbreak in 1978 [primarily the darksided cutworm, Euxoa messoria (Harris)] provided the opportunity to compare presently available insecticides with some potential materials for cutworm control.

All of the reported information is from 6 row x 30 foot plots with treatments randomly arranged and replicated four times. We did not have time to obtain quantitative samples of cutworms but did determine that the darksided cutworm was the dominant species. The cutworm populations as indicated by the percent stand reductions were moderate.

Both granules and sprays were applied in the morning in a 10-12 inch band over the row. Granules were not worked in until the normal cultivation of the field took place. Sprays were applied by hand at the rate of 20 gallons of total material per acre.

Cutworm control: Westberg field--Hoffman, Minnesota.

Chemical formulation and rate (AI/A)	Percent reduction in plant stand
Pydrin spray (0.2 lb)	3
Sevin bait (1 lb)*	4
Lorsban spray (1½ lb)	4
Mocap granules (1 lb)	9
Toxaphene spray (1½ lb)	13
Nematak granules (1½ lb)	16
Check	10
Check	11

*5% Sevin in apple pomace

Cutworm control: Sellin field--Buffalo, Minnesota.

Chemical formulation and rate (AI/A)	Percent reduction in plant stand
Sevin bait (1 lb)	7
Pydrin spray (0.2 lb)	10
Lorsban spray (1½ lb)	12
Check	33

Cutworm control: Rob Holland field--Clearwater, Minnesota.

Chemical formulation and rate (AI/A)	Percent change in plant stand
Lorsban spray (3 lb)	+11
Pydrin spray (0.2 lb)	+6
Toxaphene spray (2 lb)	+4
Sevin bait (1 lb)	+2
Lorsban spray (1½ lb)	+1
Mocap granular (1 lb)	0
Nematak (1½ lb)	-2
Check	-1

Pydrin, Lorsban, and Sevin bait at the rates used performed about equally well. Granular applications were less effective than sprays or bait. Toxaphene was only slightly superior to no treatment at all. It would appear that Lorsban or Pydrin spray and Sevin bait are excellent candidates for consideration in future cutworm control in sunflower.

C. Seed Weevil Control

Although populations of sunflower seed weevils (Smicronyx fulvus and S. sordidus) were dramatically reduced in 1978 as compared to 1977 a few fields in the Clinton, Graceville, Beardsley area did have numbers sufficient to cause grower concern. Preliminary control experiments were carried out in 1977 which showed that a single application of ½ pound per acre of methidathion (Supracide) reduced the number of seeds infested by weevil larvae by nearly 60 percent.

A similar trial was carried out in 1978. Adult weevil counts reached a total of 17 per plant (total of both species and both sexes) when nearly all plants in the field had some florets in bloom (i.e., 100 percent bloom). Seed infestation levels in the untreated area were 31 percent and 7.6 percent in the treated. This was a statistically significant reduction.

Sunflower seed weevil (Smicronyx fulvus & S. sordidus) control and related yield reductions; a preliminary study.

Treated			Untreated		
Plot No.	% Seeds infested	Wt in gms/ 100 seeds	Plot No.	% Seeds infested	Wt in gms/ 100 seeds
1	2	4.39	1	31	3.71
2	3	3.42	2	34	4.34
3	27	4.58	3	33	4.35
4	4	4.04	4	19	4.06
5	2	4.48	5	38	3.89
Average	7.6	4.18	Average	31.0	4.07

Plot data did not show any yield differences nor even a clear trend with the amount of seed injury observed. We then took weights per 100 seeds from treated vs. untreated areas and found about a 2.5 percent yield difference. This too was not significant at the 10 percent level.

Yield reduction in sunflowers due to seed weevil activity does not appear to be very great. Methidathion (Supracide) is acceptably effective against the two weevil species. However, treatment for weevil control will have to take place during the early period of sunflower bloom. Because insect pollination is still necessary for most hybrids and oil content is increased as a consequence of pollinator activity, it's desirable to avoid insecticide applications while the sunflower is in bloom.

PESTICIDE REGULATIONS REVIEW

J. A. Lofgren, extension entomologist

A. The last Congress further amended the amended FIFRA in the following major areas:

1. Much of the pesticide enforcement activities will be delegated to the states.
2. Guidelines for Sec. 24c, Special Local Needs, registrations were changed so that state registrations are less complicated.
3. Interpretations of "Use Inconsistent with the Label" are relaxed to permit more flexibility in uses such as rates and frequency less than those listed on the label and applications against pests not listed on the label.
4. A provision for conditional labeling which will help bridge the gap until products can be re-registered.
5. Methods of applications are legal unless specifically prohibited, e.g. aerial application.
6. Mixtures with fertilizer unless prohibited.

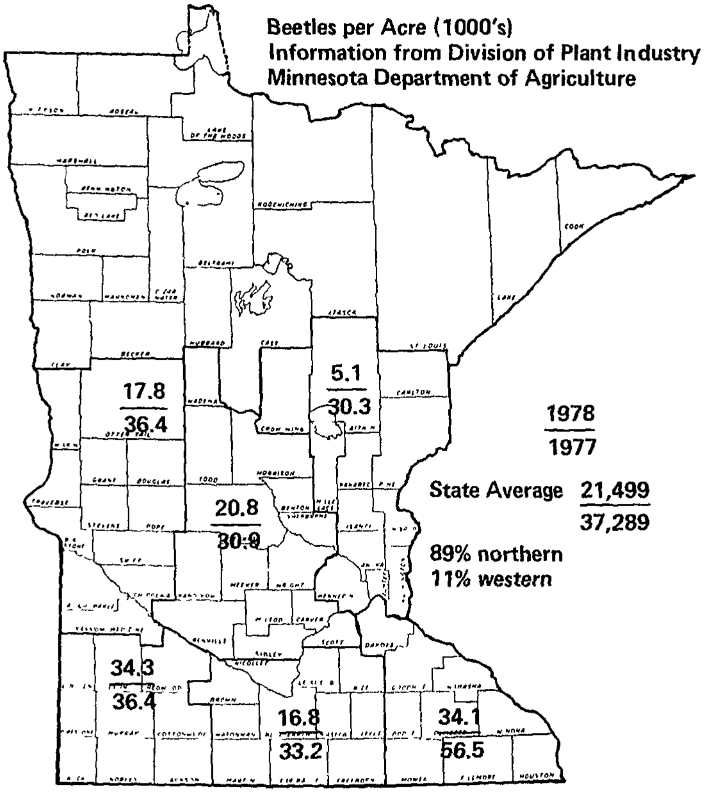
B. Classification procedures have not produced any additional restricted uses, so it is not likely that restricted use labeling will be required for any more pesticides before the start of the 1979 crop season because of the time lag between date of classification and date of required restricted-use labeling.

C. Upon adoption of Rules under the Minnesota Pesticide Control Law of 1976 the EPA gave final approval for the Minnesota State Plan for Pesticide Applicator Certification.

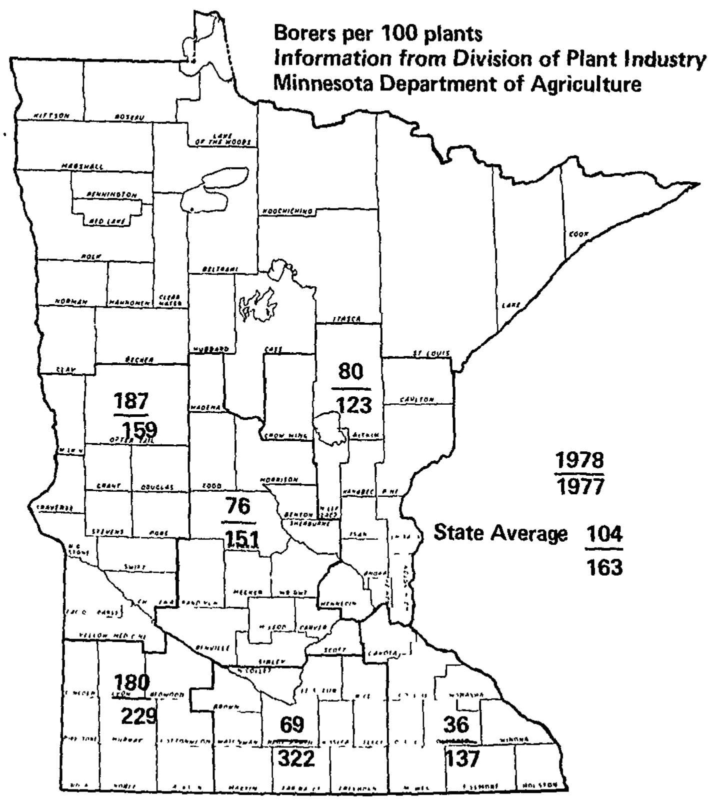
1. The state rules contain a section dealing with state restricted use pesticides. Those pesticides restricted in Minnesota include the arsenical herbicides, zinc phosphide, 1080, 1081 and lindane. Lindane is a widely used insecticide for livestock pest control and in seed treatments. Farmers must be certified to use these in addition to the EPA restricted use materials.
2. Dealers handling state or EPA restricted use pesticides must be licensed by the Minnesota Department of Agriculture.

   Applicators, or their agents, must sign the certification form at the time of each purchase of a restricted use product.
3. Reciprocal agreements may be entered into with other states.

CORN ROOTWORM ADULT SURVEY 1978



EUROPEAN CORN BORER FALL SURVEY



CORN ROOTWORM CONTROL TRIALS 1978

Southern Experiment Station, Waseca, MN

John A. Lofgren and William Lueschen

Planted May 17, Basal treatments June 26

Treatment (product per 1000 ft. of row except where noted)			Average root damage rating (1-6)	Average yield (Bu/A)
Amaze	20G	6 oz./1000 ft.	2.0	147
Nem A Tak	15G	8 oz.	2.1	136
Counter	15G	8 oz.	2.1	141
Thimet	15G	8 oz.	2.1	145
Mocap	6E	6 lb. AI/A ppi	2.2	138
Dyfonate	20G	6 oz.	2.3	149
Furadan	10G	12 oz.	2.3	150
Mocap	10G	12 oz.	2.4	141
Counter	15G	8 oz. in furrow	2.4	142
Furadan	4F	2.5 fl. oz. Basal	2.5	136
Lorsban	15G	8 oz.	2.8	146
Amaze	20G	6 oz. Basal	3.4	133
Furadan	10G	12 oz. Basal	3.4	138
Check			3.6	131

Furadan History Field

Amaze	20G	6 oz.	2.0	138
Counter	15G	8 oz.	2.1	141
Check			3.3	133
Furadan	10G	12 oz.	3.7	136
NC 6897	10G	12 oz.	3.9	137

Southwest Experiment Station, Lamberton, MN

John A. Lofgren and Harland Ford

Planted May 16, Basal treatments June 21

Amaze	20G	6 oz.	1.6	121
Counter	15G	8 oz.	1.6	124
Furadan	10G	12 oz.	1.6	126
Amaze	20G	6 oz. Basal	1.8	131
Counter	15G	8 oz. Basal	1.8	127
Furadan	10G	12 oz. Basal	1.8	121
Lorsban	15G	8 oz.	1.8	125
Thimet	15G	8 oz.	1.8	125
Dotan	10G	12 oz.	1.9	129
Mocap	10G	12 oz.	1.9	124
Counter	15G	8 oz. in furrow	2.0	120
Furadan	4F	2.5 fl. oz. Basal	2.0	125
Thimet	15G	8 oz. Basal	2.0	127
Dyfonate	20G	6 oz.	2.4	129
Check			2.3	113