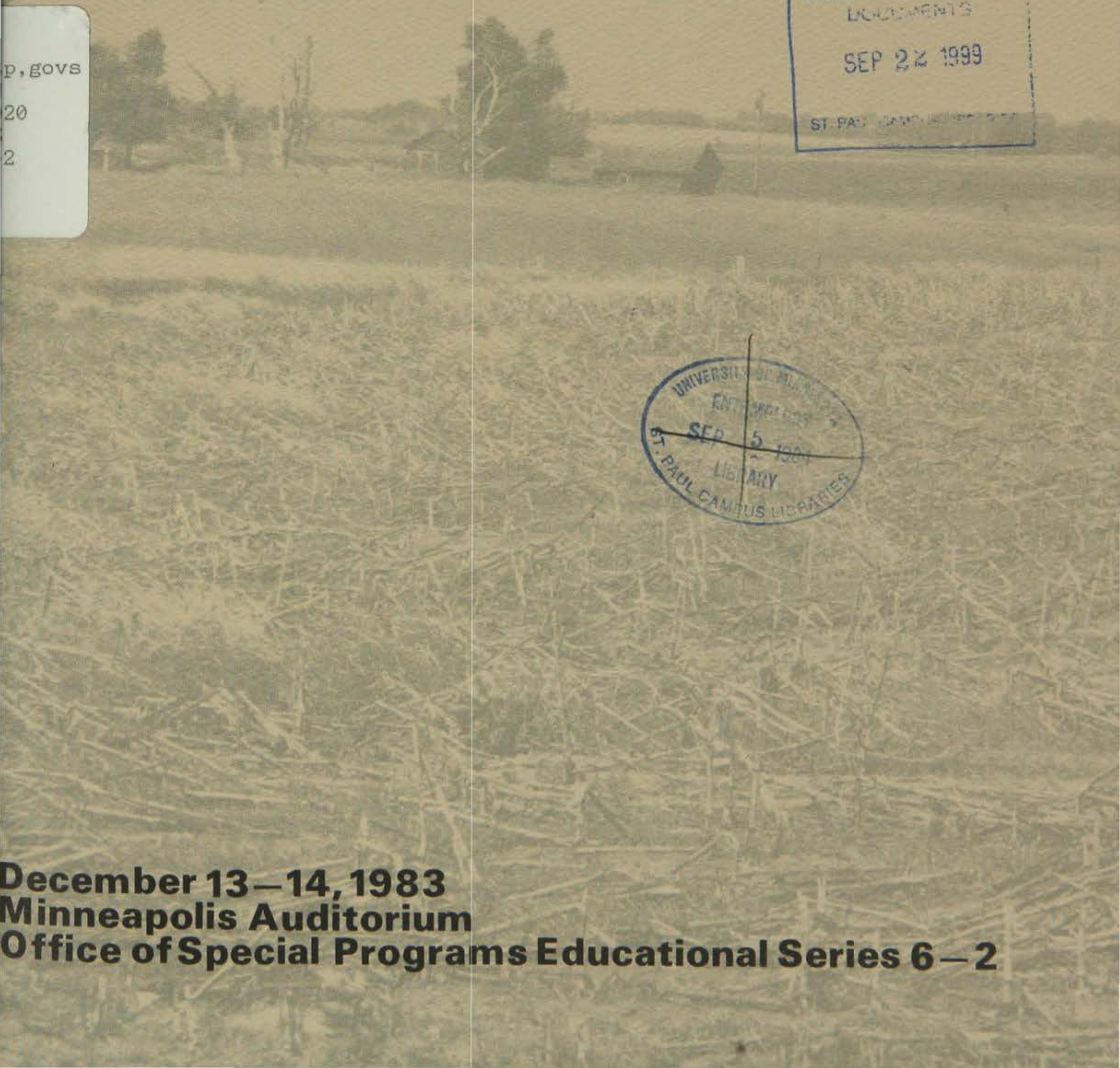
Soils, Fertilizer & Agricultural Pesticides Short Course



December 13–14, 1983
Minneapolis Auditorium
Office of Special Programs Educational Series 6–2

PROCEEDINGS

SOILS, FERTILIZER AND AGRICULTURAL PESTICIDES SHORT COURSE

December 13-14, 1983
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Presented by the
University of Minnesota
Institute of Agriculture, Forestry and Home Economics
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FERTILIZING PIK ACRES IN 1984

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The 1983 PIK program had a major impact on crop production in Minnesota. In addition to the effect on commodity prices, the PIK program will also create some changes in fertilizer management recommendations for the 1984 season.

As the 1983 PIK acres are brought back into production in 1984, it would be ideal if we could make some broad, general statements about fertilizing these acres that would fit all situations. There was, however, considerable variability in the management practices that farmers chose to use on their PIK acres. Therefore, fertilizer management suggestions for the 1984 growing season need to be modified to match these varied management practices.

In general, the acres placed in the PIK program were the problem or least productive acres on the farm. Normally these acres would need special attention with respect to fertilizer management in 1984. The fact that these acres were placed in the PIK program only serves to add a few more problems from a fertilizer management standpoint.

MANAGEMENT PRACTICES USED

Those who traveled throughout Minnesota this past summer generally agreed that the management practices used on PIK acres could be classified into 6 main groups. These are:

- Clean residue from a previous crop of corn, soybeans or small grain. Weeds were controlled with chemicals throughout the growing season.
- Weedy stubble from a previous crop of corn, soybeans or small grain. Weeds were not controlled during much of the growing season. Weeds were controlled late in the season by either tillage practices or chemical treatment.
- Small grain was planted. The crop was planted both early and late in the season. Crop was destroyed.
- Bare fallow. Weed control on these acres was accomplished by using one or more tillage practices.
- Planted to sorghum-sudan.
- Planted to soybeans.

Some of these management practices will dictate that some special attention should be given to fertilizer management in 1984.

For those farmers who planted either soybeans or small grains on their PIK acres in 1983, no changes are suggested. The fertilizer program that would normally be used in 1984 should be followed. For these fields, P and K would be applied as suggested from the results of a soil test. The N recommendations would be based on yield goal (soil nitrate test in western Minnesota) and a previous cropping history of either soybeans or small grains.

The fields where there was a substantial growth of weeds throughout the season do not present any special problem from the standpoint of fertilizer management. The N recommendations for these fields would be based on yield goal (soil nitrate test in western Minnesota) and a previous cropping history of small grains.

The use of a starter fertilizer has always been an important management tool for corn production in Minnesota. Past experiences in Minnesota and other states as well as some recent research conducted at four locations throughout the state point out the special importance of the use of a starter fertilizer for corn production on fields where bare fallow was used or where weeds were controlled throughout the growing season in the residue from a previous crop of corn, soybeans, or small grain. In South Dakota studies, the stunted early growth of corn following fallow was eliminated by the use of a starter fertilizer containing N and P.

The statements above which deal with the use of a starter fertilizer will also be appropriate for fields where weeds were controlled throughout the season and the stubble of corn, soybeans, or small grains from the previous year was not disturbed. These fields do not fit the true definition of a fallow situation. From a fertilizer management standpoint, however, these fields would resemble the fallow situation.

In areas of Minnesota where a soil test indicates a possible need for zinc fertilizer, there would be no objection to applying a small amount of zinc (about 1 lb/acre) in the starter. Remember that zinc deficiencies generally occur in western and southwestern Minnesota and are often associated with soils that have a high pH (> 7.5). It would certainly be advisable to get a soil test for zinc if there is any doubt.

The acres planted to sorghum-sudan present some special problems. It appears that most farmers who planted this crop plowed it under before the middle of September. As this relatively large amount of plant material is incorporated into the soil and starts to decompose, there is a high potential for immobilization of a significant amount of soil N. Even though decomposition takes place and there is some mineralization, it is highly probable that the amount of N that is immobilized will be larger than the amount released through mineralization. Therefore, it is anticipated that there will be some deficit of soil N when this crop is plowed under. To compensate for this anticipated deficit, it is suggested that N rates for corn be increased by 40-50 lb/acre on fields where sorghum-sudan was grown in 1983. In arriving at N recommendations for these fields, corn should be considered as the previous crop. The additional N suggested can be applied when the farmer would normally apply N in his individual fertilizer management program.

THE SOIL NITRATE TEST AS A MANAGEMENT TOOL

The soil nitrate test can be an important tool in arriving at N recommendations for corn in western Minnesota. This test will be especially important for the fields that were placed in the PIK program. This soil test is an easy way to determine if carryover N is either higher or lower than levels which are typical.

If the nitrate test shows that there are high levels of carryover N in the soil, rates of fertilizer N can be reduced for crop production in 1984. If, however, there are lower levels of carryover N in the root zone, N rates which are higher than normal may be needed to get the best yields. The sorghum-sudan may have depleted the amount of nitrate-nitrogen in soils in 1983. So, it is especially important to sample these fields in western Minnesota for residual or carryover nitrogen.

MANAGING N FERTILIZER

The grower may also want to consider some changes in the way that N is managed on PIK acres. It is obvious that weed control will be a major problem for these fields in 1984. So, some may want to consider combining their herbicide with some liquid N (weed and feed concept) as an aid in weed control. There may also be problems with the application of anhydrous ammonia where the sorghum-sudan was either disked or plowed under. Application equipment may collect some of the residue which, in turn, may cause problems with application. For these fields, a broadcast application of urea with some incorporation would be a reasonable alternative.

It should be noted that the above discussion has focused on fertilizer management for corn planted on PIK acres. If other crops are to be planted, fertilizer management presents no special problems. For other crops, fertilizer should be applied as suggested from the results of a soil test. Again, the importance of collecting soil samples from PIK acres is emphasized.

SUMMARY

As growers look ahead to fertilizing PIK acres in 1984, there are some important points to remember. These are:

1. The PIK acres were usually the least productive on the farm. They normally would need special attention. The PIK program underscores this need for attention.

2. Soil testing has always been an important management tool. The collection of soil samples is especially important for the PIK acres.

3. The use of a starter fertilizer for corn production has been widely used throughout Minnesota in the past. Experience tells us that starter fertilizer may be especially important for the bare fallow fields and the fields where crop stubble was kept free of weeds throughout the growing season.

4. Traditional N rates should be increased by 40-50 lb./acre where sorghum-sudan was planted then plowed under in 1983.

WHAT TO GROW IN 1984

by

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I. "The plans of the diligent lead to profit as surely as haste leads to poverty" Prov. 21:5

A. Major annual planning tasks of the farm manager include what to grow and how and when to price the products.

B. The what to grow decision requires knowledge of:

1. Outlook prices

2. Production costs

3. Comparative returns, including government set-asides

II. Outlook Prices

A. Short run outlook - for the upcoming market year based on fairly firm crop production estimates

1. Corn

a. PIK and drought reduced the 1983 corn crop to only 4.1 billion bushels versus 8.4 in 1982.

b. Ending carryover on October 1, 1984, is projected at only .5 billion bushels in contrast to the 3.1 on hand prior to this fall's harvest (table 1).

c. USDA price projections for corn have ranged around the $3.60 level for the current marketing year. We think this is about 30¢ too high for Minneapolis corn.

2. Soybeans

a. Table 2 shows that a significant reduction is also occurring in the carryover stocks of beans because of the 1983 drought.

b. Again, our price expectations on the current crop are some 10% under the published USDA price range around the $9 level. We do, however, expect prices to again challenge the September peak before the season is over.

3. Wheat

a. The current supply/demand projections for wheat suggest little progress during this marketing year in reducing burdensome carryovers (see table 3).

b. Consequently, the wheat price is expected to remain near the level of the past 2 years.

B. Intermediate run outlook - for the next marketing year we must consider such factors as stage of production/price cycle and likely changes in world supply/demand conditions.

1. Corn

   a. Table 4 shows that carryover as a percent of annual use is a good indicator of the price level in any marketing year.

   b. Fairly regular cutbacks in the level of carryover stocks (from some unforeseen event such as drought, disease or large exports) kicks annual prices over long term averages. This stimulates increased production in subsequent years until prices again drop below production costs. This in turn encourages participation in government diversion programs until prices recover (see table 5).

   c. Past cycle patterns suggest lower corn prices on the 1984 crop. But, if a second year of drought materializes the price drop would be delayed.

2. Soybeans

   a. The price cycle in soybeans has been 3 years (table 6).

   b. Past cycles again suggest lower prices on 1984 soybeans.

3. Wheat

   a. Wheat prices are resting on government price support levels.

   b. Barring unforeseen changes in world production and demand, 1984 price levels will be determined by the government program. The current 1984 program suggests lower wheat prices in the coming year--but wheat state legislators may get this program changed in the coming months.

C. Long run outlook - for the next 3 to 5 years

Planning prices must be based on average production costs tempered by expected government programs.

1. Corn

   a. Current production cost levels and government programs lead me to a suggested long range planning price of $2.90 for corn, Minneapolis basis (table 7).

   b. Current concerns over the high cost of government subsidies to agriculture suggest that the real price of corn will not increase unless world supply/demand conditions change enough to significantly increase export demand.

2. Soybeans

   a. Given the normal ratio of soybean/corn prices, beans should average $6.75 to $7.00 if corn averages just under $3.00.

   b. With current bean prices over this level, expanded bean acreage and weakening prices can be expected during the next 2 years.

3. Wheat

   a. Minneapolis wheat prices are expected to remain near current levels over the next several years.

   b. Current wheat legislation suggests no price increases, but this could be changed.

III. Production Costs

A. Corn

1. USDA estimates that cash operating expenses per acre for annual inputs such as fertilizer, chemicals, custom operations, fuel and repairs actually declined about 4% for corn in 1983 (see table 8).

2. Sharply increased corn acreage plus higher corn prices will push up demand and price on most inputs in 1984. Therefore, expenses will likely be back at least to 1982 levels--and higher for those who did not take advantage of fall price discounts.

B. Soybeans And Wheat

1. Because of the lower level of annual inputs per acre for soybeans and wheat, their production costs remained about the same in 1983 as in 1982.

2. Again, acreage expansion and higher grain price levels in 1984 will result in both higher input prices and higher levels of input use on beans and wheat.

IV. Comparative Returns

A. Projections made a year ago suggested that beans would outperform corn and wheat in most areas of Minnesota in 1983. Farm records will likely show a greater than expected advantage to beans because 1983 bean yields held up better than corn yields.

B. Using current price expectation for the 1984 crop, beans again budget out higher returns than corn--especially in southwestern Minnesota.

C. Wheat appears to be the lowest return choice of these three crops--even in northwestern Minnesota.

D. Not growing wheat or corn (government program participation) appears to be the most profitable alternative for farms with realistic base and yield assignments.

   1. The analysis results shown in table 9 suggest that, although highly criticized, the 1984 wheat program should attract a high level of participation.

   2. The analysis results shown in table 10 suggest that the expected farm price of corn would have to exceed $2.70 per bushel before the operator facing the assumptions listed at the top of the table should consider staying out of the 1984 corn program.

TABLE 1. USDA U.S. SUPPLY/DEMAND: CORN

	--1981-82--	--1982-83--	--1983-84--
	--MILLION BUSHELS--		
SUPPLY			
BEGINNING STOCKS	1,034	2,286	3140
PRODUCTION	8,202	8,397	4121
TOTAL SUPPLY	9,236	10,683	7262
DISAPPEARANCE			
FEED	4,173	4772	3925
FOOD/IND/SEED	811	902	950
TOTAL DOMESTIC	4,984	5674	4875
EXPORTS	1,967	1870	1875
TOTAL USE	6,951	7544	6750
ENDING STOCKS	2,286	3140	512
AVG. FARM PRICE, U.S.	250	$2.65	3.40-3.80

TABLE 2. USDA U.S. SUPPLY/DEMAND: SOYBEANS

	--1981-82--	--1982-83--	--1983-84--
		--MILLION BUSHELS--	
SUPPLY			
BEGINNING STOCKS	318	266	387
PRODUCTION	2,000	2,230	1537
TOTAL SUPPLY	2,318	2,500	1924
DISAPPEARANCE			
CRUSH	1,030	1108	975
EXPORT	929	905	720
SEED/FEED	70	—	73
RESIDUAL	23	—	16
TOTAL	2,052	2109	1784
ENDING STOCKS	266	387	140
AVG. FARM PRICE, U.S.	605	5.65	8.50-9.50

TABLE 3. USDA U.S. SUPPLY/DEMAND: WHEAT

	--1981-82--	--1982-83--	--1983-84--
		--MILLION BUSHELS--	
SUPPLY			
BEGINNING STOCKS	992	1,164	1543
PRODUCTION	2,799	2,816	2408
TOTAL SUPPLY	3,791	3,980	3954
DISAPPEARANCE			
FOOD	712	615	} 730
SEED	100	97	
FEED	42	216	350
EXPORTS	1,773	1,511	1400
TOTAL USE	2,627	2,439	2480
ENDING STOCKS	1,164	1,541	1474
AVG. FARM PRICE	$3.65	$3.53	3.60

TABLE 4. AVERAGE U.S. CORN PRICES BY MARKETING YEAR AND ENDING CORN CARRYOVER AS A PERCENT OF TOTAL USE

MARKETING YEAR	CARRYOVER AS PERCENT OF USE	U.S. AVERAGE PRICE
1971-72	22	$1.08
1972-73	12	1.60
1973-74	8	2.55
1974-75	7	3.02
1975-76	7	2.54
1976-77	15	2.15
1977-78	18	2.02
1978-79	18	2.25
1979-80	21	2.52
1980-81	14	3.11
1981-82	33	2.50
1982-83	47	2.65
1983-84	7	3.30

TABLE 5. CORN PRICE "CYCLES"

PRICES RECEIVED FOR CORN - MINNESOTA

	LOW YEAR*	FOLLOWING YEARS			
1972-76	1.50	2.48	2.92**	2.50	2.03
1977-81	1.90	2.08	2.26	2.85**	2.33
1982-	2.15	2.85	? **		

* STARTING WITH 1972; CORN PRICES WERE AT GENERALLY LOWER LEVELS PRIOR TO THIS.

** HIGH YEAR

TABLE 6

WORTHINGTON, MINNESOTA

SOYBEAN PRICES - CONS. COOP

(YEARLY HIGHS)

	HIGH YEAR	2ND YEAR	3RD YEAR
1974 - 76	8.70 (EST)	6.66	6.85
1977 - 79	9.80	6.83	7.47
1980 - 82	8.41	7.60	6.22
1983 -	9.00		

TABLE 7. FARM PLANNING PRICES

projected by
Agricultural Economists, University of Minnesota

	Unit	1 Year Planning Price 10/1/83 to 10/1/84: Mpls.	My Locality 2/	Long Range Planning Prices 1/: Mpls.	My Local Farm Price 2/
CROPS					
Corn	bu.	$ 3.10		$ 2.90	
Oats	bu.	2.00		1.70	
Wheat, 13% protein	bu.	4.20		4.20	
Soybeans	bu.	8.25		6.85	
Barley, all	bu.	2.70		2.60	
Sunflowers	cwt.	13.00		11.00	
		Local		Local	
Mixed hay	ton	$30-70		$40-60	
Alfalfa hay	ton	40-90		50-80	
Straw, grain	ton	40-70		40-70	
LIVESTOCK		Terminals		Terminals	
Hogs	cwt.	$47.00		$49.00	
Feeder pigs, 40 pounds	head	35.00		44.00	
Hog feeding margin/cwt. gain 3/	cwt.	42.00		38.00	
Choice steer calves	cwt.	65.00		72.00	
Beef cow herd sales 4/	cow	250.00		260.00	
Choice yearling steers	cwt.	62.00		66.00	
Choice slaughter steers	cwt.	62.00		65.00	
Beef feeding margin/cwt. gain 3/					
Calves	cwt. of	62.00		60.00	
Yearlings	gain	65.00		62.00	
Slaughter lambs	cwt.	55.00		60.00	
PRODUCE		Local		Local	
Milk, grade A, 3.5% butterfat	cwt.	12.00-12.50		12.00-12.50	
Milk, grade B	cwt.	11.75-12.25		11.70-12.20	
Eggs	doz.	.63-.68		.60-.65	
Wool (with incentive)	lb.	1.35		1.35	

1/ Long range planning prices do not include any allowance for future inflation. They are based on current cost structures and include government "target price" payments which in some years may require "set aside" acres. Future inflation may increase both costs and commodity prices above these levels. If future inflation is included in cost projections, it should also be added to these planning prices.

2/ Adjust terminal price as necessary for normal locational differentials when selecting a local planning price. Thus, a long-range planning price of $2.65 might be appropriate in the surplus corn areas of southern Minnesota compared to $3.00 for the deficit areas of north central Minnesota. Since a terminal market does not exist for some commodities (hay and milk) we suggest a probable range in outstate market prices.

3/ The hog and beef feeding margins are determined by subtracting the purchase cost of a feeder from the sale receipts of one finished animal and dividing by the cwt. of gain.

4/ Assumes average sales per cow of: steer calf - 180 lbs., heifer calf - 100 lbs., cow - 170 lbs.

TABLE 8. PRODUCTION COSTS AND RETURNS FOR U.S. CROPS, 1982-1983[1]

	Corn		Wheat		Soybeans	
	1982	1983	1982	1983	1982	1983
Total cash receipts	245.51	268.09	115.93	142.20	163.61	175.30
	$/planted acre					
Cash expenses						
Variable[2]	132.55	128.06	50.32	49.47	58.52	58.48
Fixed[3]	77.24	78.49	35.12	35.89	48.39	49.49
Total	209.79	206.55	85.44	85.36	106.91	107.98
Receipts less cash expenses	35.72	61.52	30.49	56.84	56.70	67.32
Capital replacement	31.66	34.72	22.44	24.61	24.11	26.44
Receipts less cash expenses & replacement	4.06	26.80	8.05	32.23	32.59	40.88
Economic costs						
Variable expenses[2]	132.55	128.06	50.32	49.47	58.52	58.48
General farm overhead	16.40	16.73	7.66	7.97	10.07	10.34
Taxes and insurance	16.59	19.45	7.68	9.00	11.64	13.65
Capital replacement	31.66	34.72	22.44	24.61	24.11	26.44
Allocating returns to owned inputs						
Operating capital (equity)	6.03	5.75	3.14	3.05	3.19	3.15
Other nonland capital	12.19	13.20	8.18	8.85	8.88	9.61
Land	75.93	74.94	40.42	39.89	64.44	63.60
Labor[4]	15.43	15.89	10.89	11.22	16.75	17.25
Residual to management and risk	-61.27	-40.67	-34.80	-11.86	-33.99	-27.22
Net returns to owned inputs	48.31	105.95	27.83	51.15	59.27	66.39
	$/bushel or bale					
Price	2.14	3.15	3.39	3.60	5.13	7.04
	bushels or pounds					
Yield per acre	114.64	85.10	32.56	39.50	31.91	24.90

1 Data for additional crops are available on request from the author.

2 Includes seed, fertilizer, lime, chemicals, custom operations, fuel and lubrication, repairs, drying, purchased irrigation water, management fees, storage and interest paid on operating capital.

3 Includes taxes and insurance, general overhead, and interest paid on land and nonland capital.

4 Includes hired labor (a cash expense) and unpaid labor; they could not be separately identified given available survey data.

TABLE 9. THE 1984 WHEAT PROGRAM

WHEAT PIK-SHOULD I PARTICIPATE?

VARIABLE PRODUCTION COSTS/ACRE	BASE WHEAT YIELD	NON-PARTICIPATION	30% ARP	ARP + 20% PIK
$75	40	$75	$81	$81
55	40	95	95	91
75	32	77	75	72

ASSUMES VARIABLE COSTS PER DIVERTED ACRE OF $12; EXPECTED ACTUAL WHEAT YIELDS OF 42, 43 AND 44, FOR NON-PARTICIPATION, ARP, AND ARP AND PIK, RESPECTIVELY; AND A $3.75 MARKET PRICE ON 1984 WHEAT (EVERY 10¢ INCREASE IN MARKET PRICE REDUCES THE ADVANTAGE OF PARTICIPATION BY $1 PER ACRE). IF PRICING IS DONE ON MINNESOTA WHEAT DURING THE USUAL OCTOBER-NOVEMBER PEAK, A PRICE OF $3.65 TO $3.75 IS CONSISTENT WITH U.S. AVERAGE PRICE OF $3.50 DURING THE JULY-NOVEMBER PERIOD

TABLE 10

COMPARISON OF PARTICIPATION AND NON-PARTICIPATION IN THE 1984 FEED GRAIN

ASSUMPTIONS

LOAN RATE (LOCAL)	2.45	PERRY FALES
DEFICIENCY PAYMENT (MAXIMUM)	.48	AREA EXTENSION
BASE YIELD (ASCS)	105.00	FARM MANAGEMENT
MARKET PRICE (FIRST 5 MO. OF MARKET YR.)	2.60	LAMBERTON, MN
CASH COSTS PER ACRE	100.00	NOVEMBER 1, 198
A.C.R. COSTS PER ACRE	20.00	
EXPECTED YIELD PER ACRE	110.00	

PERCENT PROGRAM PARTICIPATION	0 %	10 %
RETURNS OVER CASH EXPENSES	186.00	196.59
PAYMENT PER ACRE SET-A-SIDE		311.85
EXPECTED YIELD	110.00	110.00
EXPECTED MARKET PRICE	2.60	2.60
PORTION OF BASE ACRE PLANTED	1.00	.90
LOAN OR MARKET RECEIPTS/BASE ACRE	286.00	257.40
EXPECTED DEFICIENCY PAYMENT PER ACRE		.33
BASE YIELD (ASCS)		105.00
PORTION OF BASE ACRE PLANTED		.90
DEFICIENCY PAYMENT PER BASE ACRE		31.19
TOTAL GROSS INCOME/BASE ACRE	286.00	288.59
EXPENSES:		
CASH COSTS PER ACRE	100.00	100.00
PORTION OF BASE ACRE PLANTED	1.00	.90
GROSS EXPENSE/BASE ACRE	100.00	90.00
SET ASIDE COST PER BASE ACRE		20.00
PORTION OF BASE ACRE SET ASIDE		.10
SET ASIDE COST PER BASE ACRE		2.00
TOTAL CASH OPERATING EXPENSES	100.00	92.00
RETURNS LESS CASH OPERATING EXPENSES	186.00	196.59
MARKET PRICE NEEDED TO EQUAL PARTICIPATION		
	2.70	

EFFECTS OF CROP RESIDUE ON CORN-SOYBEAN ROTATIONS

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Plant residues affect soil water content and soil temperature when residues are left on the soil surface. Corn and soybean residue left on the soil surface tend to result in soils with lower temperatures and higher water contents than soils which have a bare surface. Under field conditions corn residues tend to have the greater impact on soil conditions simply due to the greater quantity of plant residues associated with the corn crop.

Plant residues, in addition to affecting crop growth through their effect on soil temperature and water content, may contain substances which inhibit plant growth when these substances are absorbed. This phenomenon, termed allelopathy, depends upon: 1) the type of residue serving as the source of growth inhibiting substance(s); 2) the plant type growing in the presence of the residue; and 3) the environmental condition under which the residue-plant interaction occurs. Certain plant residues, sorghum for example, release compounds which have much stronger effects on plant growth than other residues. Also certain plant species are more sensitive to these substances than other species.

Corn and soybeans dominate row crop production in this region. The bulk of these crops are grown in a crop rotation, although some continuous corn exists. The potential for corn residue to inhibit soybean growth, soybean residue to inhibit corn growth, and corn residue to inhibit corn growth through allelopathic effects thus warrants consideration. Under laboratory conditions, soybeans appear to be sensitive to substances found in water soluble extracts of fresh, unweathered corn or soybean residues. Initial research indicates early corn growth can be inhibited by soybean residue substances under laboratory conditions. Corn residue also shows a significant potential to affect early corn plant growth. Growth inhibition due to these effects have not been conclusively verified in the field.

The most dramatic effects of residue inhibition occur with root growth. The effects on early plant growth are more dramatic when residues come into direct contact with the planted seed or emerging radicle (root) of a germinating seed. Rainfall and temperature conditions which promote residue weathering and/or residue leaching tend to minimize allelopathic effects on early crop growth. Later planted crops such as soybeans are less likely to be inhibited by allelopathic substances from the residue of the previous crop than earlier planted crops such as corn.

A NITROGEN STORY WITH DIFFERENT TILLAGE SYSTEMS

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A considerable amount of emphasis and a large number of questions are being generated regarding the use of conservation tillage systems for corn and soybean production. The concerns related to conservation tillage may range from weed control, insect problems, variety selection, and potential diseases to fertilizer management of which nitrogen is one component. In many cases confusion related to recommendations for conservation tillage systems may develop. In part, some of this confusion comes about when we try to define the term "conservation tillage". The term "conservation tillage", as it implies, could be any tillage technique or combination of techniques ranging from the traditional moldboard plow system to the extreme case of absolute no-till. Likewise a description of the tillage technique utilized is frequently not adequate to describe the impact of those operations on the soil and residue cover.

Should I Be Interested in Conservation Tillage?

In most situations the answer to this question is yes. However, when a producer makes a major change in his primary tillage system he should be prepared to make additional changes in his management program to make that system work effectively for him. In most cases, however, the advantages associated with conservation tillage far outweigh the necessary changes in the management system. The first obvious advantage of conservation tillage is the reduced power demands and/or faster more timely tillage operations. The major reason to consider conservation tillage is, however, related to the potential for reduced wind and water erosion that might take place from the soil surface. In drier regions of the state, conservation tillage may conserve moisture and result in less crop stress than might otherwise develop under conventional tillage.

What Happens to My Nitrogen Under Conservation Tillage?

Before we answer this question it is important to examine what changes are taking place in the soil environment under a conservation tillage system. This should aid in evaluating what will happen to the soil and fertilizer nitrogen. One of the major things that conservation tillage is supposed to do is to leave more crop residue on the soil surface. In most cases, depending on the extent of this cover, this residue will serve as a mulch. As might be expected the net effect of such residue will be to keep the soil cooler and wetter than what might be expected under conventional moldboard plow systems. The bulk density or compactness of the soil may also increase under a conservation tillage system. Current speculation, however, would suggest that it is the effect of the residue or mulch that is responsible for creating a different crop production environment.

The question then arises again: What happens to my nitrogen under conservation tillage? The answer: The same reactions that take place with nitrogen under a moldboard plow system also take place under conservation tillage BUT they probably take place at different rates and the net effect may be different. There are many potential nitrogen reactions that may take place, but the ones of interest that appear to become important in conservation tillage systems include mineralization, immobilization, nitrification, denitrification, leaching surface volatilization. A brief definition of each is in order before we proceed:

mineralization - release of plant available inorganic forms of a nutrient from organic molecules

immobilization - assimilation of inorganic nutrients into organic combinations

nitrification - conversion of ammonium (NH_4+-N) to nitrite (NO_2-N) and nitrate (NO_3-N)

denitrification - reduction of NO_2^- or NO_3^- to a volatile gas, usually N_2O or N_2 (nitrogen loss)

leaching - downward movement of NO_3^--N below the crop rooting zone (nitrogen loss)

surface volatilization - loss of ammonia (NH_3^--N) from the soil surface - may occur due to urea losses or improper anhydrous ammonia application (nitrogen loss).

It is interesting to note that all of the above reactions or processes except for the last two are either directly or indirectly involved with microbiological activity. Any process which might affect the microbiological population will influence the nitrogen transformations and nitrogen availability.

What would we expect with these reactions and processes if we go from moldboard plow to a conservation tillage system?

mineralization - lower soil temperatures, less mixing of residues with the soil - therefore probably less nitrogen available to the next crop from the residues and organic matter breakdown under conservation tillage.

immobilization - higher surface residue, microbiological populations concentrated closer to the soil surface - therefore higher rates of immobilization with surface applied N fertilizers.

nitrification - cooler soil temperatures, reduced aeration - therefore, slower rates of nitrification.

denitrification - higher soil bulk density, wetter soil environment - increased denitrification; lower soil temperatures, decreased rate of nitrification - reduced denitrification - therefore net reaction - uncertain.

leaching - wetter soil - increased leaching; reduced mineralization and nitrification - decreased leaching - therefore net reaction - uncertain depending on the timing and magnitude of the leaching event(s)

surface volatilization - losses of ammonia from urea increase with surface applications to a soil with a high pH or high residue cover - therefore these types of losses would be exptected to increase with conservation tillage. Losses of anhydrous ammonia due to improper application can take place under any tillage system.

Considering the above possibilities let us examine some of the more recent research information in Minnesota. Table 1 presents the grain yields obtained at Lamberton, MN 1982 with three different tillage systems, five nitrogen rates and two different hybrids.

Table 1. Grain yields as influenced by tillage, N rate, and hybrid - Lamberton, MN - 1982[1]

			Grain Yield					
N Rate[2]			Mod Ridge Till		Fall Chisel		Fall Plow	
Preplant	Side	Total	Hyb 1	Hyb 2	Hyb 1	Hyb 2	Hyb 1	Hyb 2
- - - - - - #/a - - - - -			- - - - - - - - - - - - -bu/a- - - - - - - - - - - -					
0	0	17	53	46	73	60	96	94
40	0	57	82	81	93	86	106	108
40	32	89	102	102	107	112	122	133
80	32	129	122	124	126	126	127	134
80	63	161	127	135	126	127	134	138

[1]data from A. Olness - USDA-ARS - Morris, MN
[2]17 #N/a applied as a starter

Particular attention should be directed to the grain yields obtained under differing tillage systems when no nitrogen was applied. The lower yields obtained with the more conservation-like tillage systems are probably reflecting the reduced mineralization that we might expect with large quantities of surface residue. As nitrogen rates increased, much of this differential was reduced, but it appears that a higher quantity of nitrogen was needed with the conservation tillage systems to obtain results similar to the conventional tillage. In this case it took about 40 #N/a more under a modified ridge till system to achieve comparable results with the fall plow treatment.

Preliminary research results of Waseca (Table 2) evaluating the leaching N loss potential under no till and moldboard plow suggest that the no till may be subject to increased leaching losses.

Table 2. Influence of tillage on tile flow N concentration and grain yield. Waseca, MN - 1982.[1]

Tillage System	tile flow	NO_3-N	grain yield
	acre-in	mg/L	bu/a
Moldboard plow	1.10	5.0	146
no till	1.75	6.2	144

[1]Data of G. Randall Southern Expt. Station - Waseca

Results indicate more tile flow and a slighly higher concentration of nitrate-N with no till. The grain yields with the two tillage systems were similar. Conditions were very dry at Waseca in July and August of 1982 so tile line losses are those that were experienced between October and December.

Additional research locations were established on a silt loam soil in Goodhue County (S.E. MN) and a coarse textured irrigated soil in Sherburne Co. (E.C. MN) to further examine nitrogen management with differing tillage systems. Separate experiments at each location were designed to characterize nitrogen response, nitrogen loss and use of nitrification inhibitors, as well as application methods for products such as 28% N solution which contain urea nitrogen. The following tables present the yield results from two of the tillage systems utilized at each location.

Table 3. Influence of N rate, tillage, nitrification inhibitors and timing of N application on grain yield at two locations.

	Grain Yield					
	no till			chisel		
N[1] Rate	Sp[2]	Sp+NI	Sd	Sp	Sp+NI	Sd
#/a	- - - - - - - - - - - bu/a - - - - - - - - - - -					
	Silt loam - Goodhue Co.[3]					
0	78			72		
75	131	123	115	139	134	150
150	132	136	127	140	140	137
300	137	133	115	134	140	134
	Loamy sand - Sherburne Co.					
0	38			47		
75	62	103		68	110	
150	104	115		141	136	
300	141	136		150	152	

[1]applied as anhydrous ammonia
[2]sp = spring, Sp+NI = spring + nitrification (average of N-Serve + Dwell), sd = sidedressed
[3]data of Moncrief, Malzer, Swan, and True

The nitrogen response obtained on the silt loam soil was restricted to the first 75# N/a applied. The lack of a positive response to either a nitrification inhibitor or sidedressed N application would suggest that nitrogen losses through leaching and/or denitrification were minimal at this location in 1983. The yields obtained with similar nitrogen treatments were not influenced by tillage.

Leaching losses of nitrogen at the Sherburne County location were severe in 1983. An eight inch precipitation event in mid-June was effective in removing large quantities of nitrate nitrogen from the crop rooting zone. The large amount of leaching produced yields lower than might be expected and provided relatively large yield increases due to nitrification inhibitors especially at the lower nitrogen rates. No till treatments at close to recommended N rates (150 #N/a) produced lower yields than those obtained with chisel plow treatments, thus indicating that increased rates of N would be needed under no till to obtain comparable yields.

To examine the importance of surface volatilization of urea containing fertilizers additional experiments were established at each of the preceding locations. Applications of 28% N solution were made at three rates in three different methods of application across the different tillage systems. The methods included a broadcast surface spray, injected, and a surface dribble application. The grain yields from these locations are presented in Table 4.

Table 4. Effect of N rate, tillage and method of 28% N solution application on grain yield at two locations.[1]

N Rate	No Till Spray	No Till Inject	No Till Dribble	Chisel Spray	Chisel Inject	Chisel Dribble
	Grain Yield - 15.5% moisture					
#/a	-bu/a-					
	Silt loam - Goodhue Co.					
0	78	78	78	77	77	77
75	122	112	117	124	114	110
150	136	146	126	139	140	146
300	138	126	133	138	132	128
	Loamy sand - Sherburne Co.					
0	35	35	35	47	47	47
75	38	66	42	54	54	57
150	43	58	47	65	122	73
300	53	114	115	78	147	140

[1]Data of Malzer, Rehm and Moncrief

Relatively few differences were obtained on the silt loam soil due to method of 28% N solution application. The lack of differences due to method of application can at least be practically explained with a rainfall event about 48 hours after N application. This precipitation would have incorporated all methods of application and thus allowed very little time for surface volatilization to take place. As with the anhydrous ammonia treatments (Table 3) nitrogen responses as influenced by tillage on the silt loam soil in 1983 were minimal.

By comparison, yield differences due to method of 28% N solution application and tillage were very dramatic at the Sherburne Co. site. Yield reductions were very severe with both tillage systems when 28% N solution was applied as surface spray application. Even with 300 #N/a applied as a broadcast application yield results would suggest that over 90% of the fertilizer N was either lost or unavailable for plant uptake. The surface dribble application was better than surface, and the injected treatment was superior to dribble. As a general rule, yields were higher in the chisel plow treatments than with the no till (treatment for treatment). It should be recalled that leaching was a severe problem at this site in 1983. The poor performance of the surface applications cannot be explained however, because of leaching. The most obvious conclusion would suggest that substantial quantities of N were either lost through surface volatilization (ammonia from urea) or was immobilized by the surface residue or both.

<u>Summary</u>: It is obvious in looking at the results from tillage-nitrogen research that our standard N recommendations should change as we grade into conservation tillage systems. It appears that the tillage systems which leave high amounts of residue on the soil surface will probably require increased rates of nitrogen fertilizer application. The residue may also have a major impact on the methods of nitrogen application (especially urea or urea containing products). Just as we can find experimental results

which may create some real management concerns with conservation tillage we can also find results which make conservation tillage (even no till) look very good. It therefore becomes very apparent that a great deal more research will be necessary to predict accurately the correct nitrogen management procedures for conservation tillage systems.

IS MORE P AND K NEEDED WITH CONSERVATION TILLAGE?

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INTRODUCTION AND DEFINITIONS

Conservation tillage, as the name implies, is any tillage practice that provides protection from wind and water erosion and conserves soil moisture. Because of the myriad of regional and even local terms describing such practices it becomes necessary to begin any paper with a set of definitions. A useful dichotomous scheme for tillage definition subdivides all primary tillage into the following two major groups: full width and strip tillage. Full width systems include: moldboard and chisel plows, plowing discs, and more recently paraplows. These implements leave the soil in a loose condition (soil moisture at the time of tillage is more critical for the latter three) after tillage and incorporate applied P and K to varying degrees. Strip tillage is usually combined with the planting operation and can be further divided into wide and narrow strip tillage. Wide strip tillage usually results in tilling about one third of the row area (8-12 inches) and leaves the remainder with little disturbance and most of the previous year's crop residue. A subsequent cultivation can be used for building ridges. Common forms of this category include: till plant, ridge till, intertill, and rotary tillage. Narrow strip tillage results in a much more narrow tilled strip, usually two to four inches. This is done with rippled or fluted coulters on special planters or drills. Common names for this category include no till, and zero till. Strip tillage results in more dense soil in zones where there is no tillage and also incorporates applied P and K to varying degrees.

TILLAGE EFFECTS ON P AND K AVAILABILITY

Availability of soil P and K is dependent on soil factors and plant factors. Physical soil properties such as temperature, moisture, aeration, and the spacial distribution of P and K can affect crop availability. Plant properties such as root distribution, root metabolism (effects on active uptake), and nutrient requirements can also affect availability. In many instances these soil and plant properties interact and are affected by tillage. Lower soil temperatures and aeration would have a detrimental effect. Higher soil moisture would provide a beneficial effect. So the question is what is the net effect of changes due to tillage?

Many researchers have documented the vertical stratification of immobile nutrients such as P and K with conservation tillage (Randall, 1980; Shear and Moscher, 1969; Triplett and Van Doren, 1969; Fink and Wesley, 1974; Griffith et al. 1977; and Ellis and House, 1980). This is not surprising considering the mobility of these nutrients in a soil system. Most researchers in humid areas report no difference in availability of P due to tillage (Singh et al. 1966; Estes, 1972; Fink and Wesley, 1974; Triplett and Van Doren, 1969; Belcher and Ragland, 1972; Moschler et al. 1975; Kang and

Yunusa, 1977; and Moncrief, 1981). The most common explanation given to account for availability of stratified P in the upper soil is an increase in root activity in this region due to higher moisture content. However, if the surface soil dried out, roots would be inactive, and nutrients in the dried soil temporarily would not be available. The following data of Bauer cited by Munson (1982) illustrates such a case with wheat. Varying incorporation of 300 lbs P_2O_5/A on a low P site in North Dakota was accomplished with three tillage treatments.

Narrow strip (No Tillage)	Disc	Moldboard
------------- Wheat yield bu/A (2 yr. average) -------------		
13.8	16.2	32.7

The response to incorporated P is no doubt a result of dry upper soil a substantial portion of the growing season.

The research literature is more evenly split on tillage effects on K availability. Stanford et al. (1973) cited a study finding K equally available, and three more where K was more available to corn with narrow strip (no till) tillage. Other investigators found similar results (Estes, 1972; Fink and Wesley, 1974; Moschler and Martens, 1975; and Moschler et al. 1975). In the north central corn belt most researchers have found K availability reduced with conservation tillage (Schulte, 1975, 1980; Griffith, 1974; Moncrief, 1981; Moncrief and Randall, 1982; Moncrief and Swan, 1983; and Bower, 1945). It is noteworthy that on soils exhibiting this tillage induced deficiency, modest amounts of row applied fertilizer effectively overcame it (Lawton, 1946; Schulte, 1980; and Moncrief, 1981). When various types of placement are evaluated in the northern corn belt, row application at planting is superior for both P and K (Rehm, 1982; Ghodrati and Schulte, 1983; Wolkouski and Schulte, 1982).

INTERPRETATION OF SOIL TESTS

When applied P and K are not uniformly mixed within the surface soil, special considerations are necessary when interpreting soil tests. The distribution of soil K due to tillage from a study in Goodhue County, Minnesota is shown in Table 1. This table reflects distribution after two years of K application at the rates indicated. The K distribution in the control plots reflect the past tillage history (chisel plowing). With chisel plowing K is fairly well distributed in the top four inches. Most is in the top two inches without tillage. It is interesting to note that soil K appears to be increasing below two inches without tillage, suggesting mobility with a steep gradient. Other researchers have shown K movement with steep gradients on fine textured soils (Wallingford, 1974; and Murphy, 1983). This movement tends to mitigate potential positional availability problems.

More accurate fertilizer recommendations can be made if the buffering capacity of a particular soil is taken into consideration. This allows prediction of soil test change with a given application of P or K. In a

Wisconsin study of ten soils (Kussow, 1983) it took from 2.7 to 10.7 lbs P_2O_5/A to change the soil test one unit and from 2.5 to 5.8 lbs K_2O/A for potassium. These data reflect complete mixing. With less mixing associated with conservation tillage these numbers would be decreased for a given soil. Tillage effects of the Goodhue County study are shown in Table 2. With a given application of K the soil test (0-6 inch sample) is higher without tillage. With soils that fix K it would appear that there is advantage with reducing mixing of applied fertilizer. This would serve to minimize fixation and increase recovery. A major factor which would determine the benefit of this is timeliness of precipitation. If the upper region of the soil is moist enough of the time to permit plant exploitation of soil K, this would actually be a benefit of conservation tillage.

A unique problem with interpretation is encountered with a ridge-till system. During cultivation to build ridges soil P and K are moved into the row area. During planting the ridge is scalped and thrown between the rows. When and where does one soil sample with this system? If samples are taken between the row after ridging soil test P and K values are misleadingly low. If the row area is sampled they are high. Essentially one would be sampling the top three inches twice (three inches of soil moved into ridge and three inches below). Sampling between the row at this time is actually 3-9 inch layer. Results from a sampling study at Waseca, Minnesota with this system are shown in Tables 3 and 4 for soil P and K, respectively. Large differences due to position relative to the row are apparent after ridging. After planting but before ridging there is not much variability. Based on these data it would appear that the best time to sample with a ridge till system is after planting but before ridging.

THE MINNESOTA SITUATION

Minnesota is unique in several respects. There is a wide range in native soil P and K levels. This is illustrated by subsoil P and K levels (figure 1). It is also a transition zone from woods to prairie and corn to small grain because of the east-west rainfall gradient across the state (figure 2). The north-south temperature gradient also defines the northern border of corn. What does this have to do with P and K needs with conservation tillage? If you are located on a low P soil and in a dry zone (less than 16 inches May-Sept.), phosphorus becomes important in your fertility program. Phosphorus is always important in starter fertilizer and starter fertilizer is always important with conservation tillage. To minimize the probability of P being limiting in this situation be sure soil test P is medium to high and use row applied P for corn and small grains. If possible set fertilizer openers on your planter as deep as possible to keep the band in moist soil. If you are located on a low K soil an analogous recommendation can be made for K. If you are located on a low to medium K soil in the higher rainfall area potassium is important in your fertility program but surface applied K without incorporation is less important. On these soils the data suggest that a high soil K level with row applied K will eliminate any tillage induced deficiencies (most probable with strip tillage-no till or ridge till). Analyses of P and K in starter fertilizer should be more balanced.

CONCLUSIONS*

1. Conservation tillage extremes (strip tillage-no till and ridge till) can induce reductions in availability of soil K on medium to low K soils.

2. In dry areas of Minnesota P or K stratification may pose positional availability problems. In higher rainfall areas stratification is probably not a problem in most years.

3. Soil P levels should be corrected to medium to high on natively low P soils and row applied P emphasized in starter fertilizer. Starter P or K should be placed as deep as practical with planter or drill in low rainfall areas (below the seed if possible).

4. Soil K levels should be corrected to high levels in natively medium to low K soils and applied K balanced with P in starter fertilizer.

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* Medium to high soil P and K is defined as 20-40 and 200-300 for P and K, respectively.

Table 1. The effect of tillage on K (ppm) distribution
(Moncrief and Swan, 1983)

	Depth (cm)	Applied K (kg/ha) 0	224	448
No Till	0 - 5	86	255	350
	5 - 10	65	88	135
	10 - 15	59	65	82
Chisel	0 - 5	87	167	249
	5 - 10	77	123	179
	10 - 15	70	70	102

Table 2. The effect of tillage on the change in soil test K (ppm) after potassium application
(Moncrief and Swan, 1983)

		Applied K (kg/ha) 0	224	448
No Till	before appl.	71	80	102
	after appl.	65	125	176
	change	-6	+45	+74
Chisel	before appl.	69	76	108
	after appl.	72	112	153
	change	+3	+36	+45

Table 3. The effect of ridging and planting on distribution of soil P (Randall, 1983)

	After Ridging		After Planting	
	Phosphorus (ppm)			
Depth	In Row	Between	In Row	Between
0-2	68	33	49	40
2-4	42	19	22	24
4-6	20	13	13	17
6-9	12	7	8	10

Table 4. The effect of ridging and planting on distribution of soil K (Randall, 1983)

	After Ridging		After Planting	
	Potassium (ppm)			
Depth	In Row	Between	In Row	Between
0-2	295	241	337	341
2-4	216	157	190	221
4-6	154	125	151	150
6-9	118	115	124	139

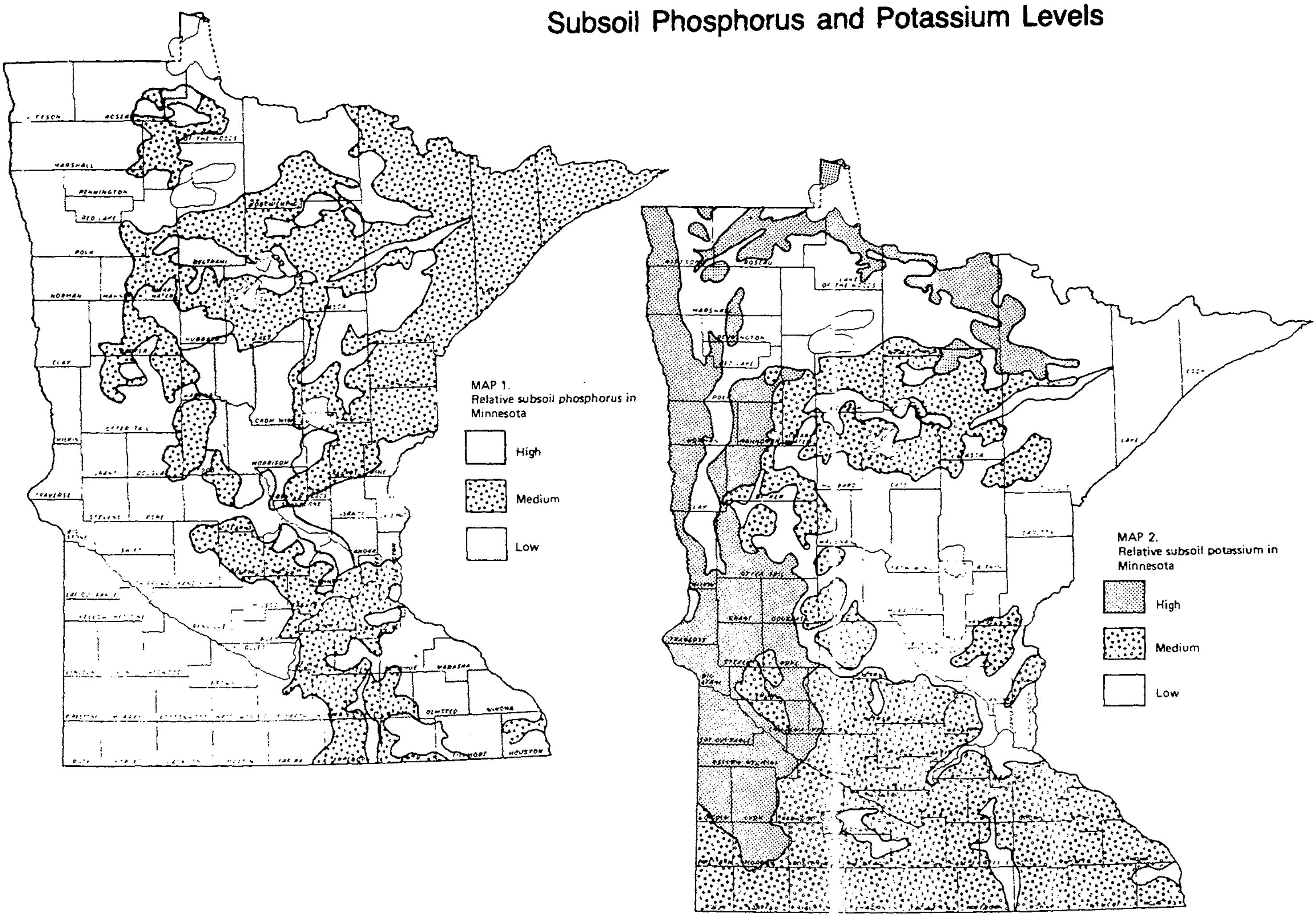

Figure 1. Subsoil P and K levels in Minnesota soils.

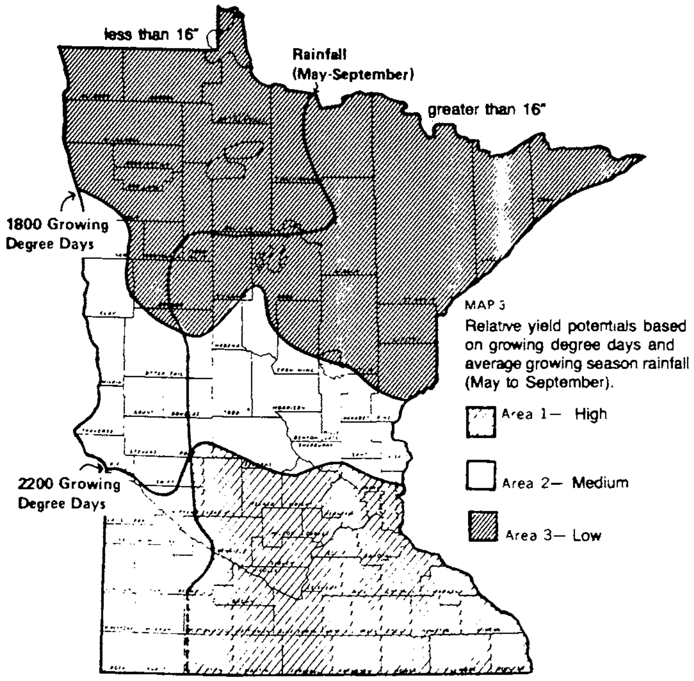

Figure 2. Growing season precipitation and growing degree days in Minnesota.

LITERATURE CITED

Belcher, C. R. and Ragland, J. L. 1972. Phosphorus absorption by sod-planted corn from surface applied phosphorus. Agron. J. 64: 754-756.

Bower, C. A., Browning, G. M., and Norton R. A. 1945. Comparative effects of plowing and other methods of seedbed preparation on nutrient element deficiencies in corn. Soil Sci. Soc. Am. Proc. 9: 142-146.

Ellis, F. B. and House, K. R. 1980-81. Effects of cultivation on the distribution of nutrients in the soil and the uptake of nitrogen and phosphorus by spring barley and winter weat on three soil types. Soil & Tillage Research 1: 35-46.

Estes, G. O. 1972. Elemental composition of maize grown under no-till and conventional tillage. Agron. J. 64: 733-735.

Fink, R. J. and Wesley, D. 1974. Corn yield as affected by fertilization and tillage system. Agron. J. 66: 70-71.

Ghodrati, M. and Schulte, E. E. 1983. Effect of broadcast N and soil test P and K on response to corn to row N, P, and K. Paper presented at the North Central Extension-Industry Soil Fertility Workshop. Bridgeton, MO.

Griffith, R. G., Mannering, J. V., and Moldenhauer, E. C. 1977. Conservation tillage in the eastern corn belt. J. Soil Water Conserv. 32: 20-28.

Kang, B. T., and Yunusa, M. 1977. Effect of tillage methods and phosphorus fertilization on maize in the humid tropics. Agron. J. 69: 291-294.

Kussow, W. R. 1983. Implications of phosphorus and potassium buffering in Wisconsin soils. Proc. 1983 Fertilizer, Aglime and Pest Management Conf. Madison, WI.

Lawton, K. 1946. The influence of soil aeration on the growth and absorption of nutrients by corn plants. Soil Sci. Soc. Am. Proc. 10: 263-268.

Moncrief, J. F. 1981. The effect of tillage on soil physical properties and the availability of nitrogen, phosphorus, and potassium to corn (Zea mays L.) Ph.D. thesis. Univ. of Wisconsin. Madison, WI.

Moncrief, J. F., and Randall G. W. 1982. Do fertilizer recommendations change with changes in tillage? Soils, Fertilizer & Ag. Pesticides Short Course Proc. Univ. of MN. St. Paul, MN.

Moncrief, J. F., and Swan, J. B. 1983. The effect of tillage on the distribution and availability of applied K to corn in southeastern Minnesota. Paper presented at the North Central Extension-Industry Soil Fertility Workshop. Bridgeton, MO.

Moschler, W. W., Martens, D. C., and Shear, G. M. 1975. Residual fertility in soil continuously field cropped to corn by conventional tillage and no tillage methods. Agron. J. 67: 45-48.

Moschler, W. W., and Martens, D. C. 1975. Nitrogen, phosphorus, and potassium requirements in no-tillage and conventionally tilled corn. Soil Sci. Soc. Am. Proc. 39: 886-891.

Munson, R. D. 1982. Interactions are critical for top production. In: Proceedings of 1982 Fertilizer Aglime and Pest Management Conf. Madison, WI.

Murphy, L. C. 1983. Phosphorus and potassium movement in soils: is it important? Paper presented at North Central Extension-Industry Fertility Workshop. Bridgeton, MO.

Randall, G. W. 1980. Reduced tillage: Impact on soil fertility needs. Illinois Fertilizer Conference Proceedings, Fertilizer and Chemical Assoc. Univ. of Illinois, Urbana-Cahmpagne, IL.

Rehm, G. 1982. Phosphate placement for corn in the western corn belt. Paper presented at the North Central Extension-Industry Fertility Workshop. Bridgeton, MO.

Schulte, E. E. 1975. Fertility-disease-tillage interaction in corn. Proc. 1975 Fertilizer and Aglime Conf. 14: 58-66.

Schulte, E. E. 1980. Effectiveness of row fertilizer in Wisconsin. Proc. 1980 Fertilizer, Aglime and Pest Management Conf. 19: 113-121. Madison, WI.

Shear, G. M., and Moschler, W. W. 1969. Continuous corn by no-tillage and conventional tillage methods - a six year comparison. Agron. J. 61: 524-526.

Singh, T. A., Thomas, G. W., Moschler, W. W., and Martens, D. C. 1966. Phosphorus uptake by corn (Zea mays L.) under no tillage and conventional practices. Agron. J. 58: 147-148.

Stanford, G., Bennett, O. L., and Hower, J. F. 1973. Conservation tillage practices and nutrient availability. p 54-62. In Conservation Tillage: The Proceedings of a National Conference. Soil Conser. Soc. of Am. Ankeny, IA.

Triplett, G. B., and Van Doren, D. M. 1969. Nitrogen, phosphorus and potassium fertilization of untilled maize. Agron. J. 61: 637-639.

Wallingford, G. W. 1974. Effects of solid and liquid beef feedlot wastes on soil characteristics and on growth and composition of corn forage. Ph.D. thesis. Kansas State University.

Wolkowski, R. P., and Schulte, E. E. 1982. Response of corn to row fertilizer P and K application. Proc. 1982 Fertilizer, Aglime and Pest Management Conf. Madison, WI.

PROFIT TILLAGE

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My wife Diana and I farm around 1000 acres of rowcrop in Jones Co. Iowa. Our soils are in the Kenyon-Clyde soil association, gently rolling, ranging from 3 - 6% slope, some heavy low ground, some sandy knolls with considerable risk of erosion. I have always been looking for lower cost methods of producing corn and soybeans.that also hold soil erosion losses to acceptable limits.

I started chisel plowing and planting in corn stalk residue in 1967. I t worked well till we had problems with leaf dieases which we blamed on crop residue and went back to plowing. In 1970everyone found out that the leaf dieases were caused by "T" cytoplasm in the seed corn so we went on with chiseling and disk and plant. In 1975 after a series of wet and late springs I purchased a six row 36 inch Buffalo till planter and cultivator and started into the ridge till system. Since then the system has evolved rather than been changed. Problems that have arisen are solved and I don't plan to ever go back to the plow.

In 1977 I put together a low cost high speed stalk chopper consisting of Lilistcn chopper modules mounted on a toolbar. I converted the Buffalo planter to plateless with John Deere seed boxes and insecticide hoppers. At this time we broadcast our P and K, used a liquid starter with the planter and broadcast herbicide as we planted. This program worked reasonable well b but we weren't setting any yield records. In 1979 we evolved into a new era by going to a John Deere 7000 pulltype planter with a mechanized dry fertilizer system. We pull an Enurgro Olson fertilizer cart which holds five tons of dry fertilizer. The tongue of the cart is an auger and we can fill the fertilizer boxes on the planter as we plant. We have reduced the total amount of P and K used annually and have not broadcast and fertilizer for five years. We use a cold blend of half DAP and half 0-0-60. During this period we have not experienced any yield reductions but on the contrary have had the highest farm averages ever and have won some yield contests.

I'm a firm beliverer that deep applied side dress anhydrous ammonia is the most effective and efficient method to provide nitrogen for corn in ridge till and no-till systems. I have side dressed all of my corn with a three knife applicator, one knife between each pair of rows, for the past eight years. I have two tubes on each knife to allow for heavy rates at high speeds. (7 or 8 MPH) I drive in the same track and take the same six rows as I plant. Side dress nitrogen seems to provide consistant high yields for ridge till systems.

I have done a lot of banding of herbicides as a cost control measure. Lasso banded directly behind the planter gives consistant good grass control in the row whether it rains or not. My current favorite herbicide treatment for corn is Lasso banded at planting time followed bya post-emergent application of two pounds of Bladex 80W broadcast. The Lasso keeps the grassout of the row and the Bladex takes out all broadleafs abd some years controls the grass between the rows well enough that only the ridge rebuilding cultivation at layby time is necessary. For soybeans I am going to use an early preplant application of herbicide such as Bladex to keep down all early weed growtn. Banded Lasso will be used at planting time and spot treatments of post-emergent herbicides will be used for some broadleaf weeds.

One feature of my system is that it has developed into a controlled traffic pattern to aid in reducing compaction problems. the stalk chopper, the planter, the cultivator and the side dress operation all drive in the same track. The only time any other row space is driven is during harvest when the drive wheels of the combine run on different areas. Even our tractor and augur cart are set in 72" tread so they run in the same track as all the spring operations take.

One area of increasing interest is interplanting of corn and soybeans in the same field. I have one farm with has light soils, long slopes and many rocky areas. It had been in continous corn and during 1976, a very dry year, very poor yields were experienced. During that year corn after soybeans yielded thirty or forty bushels per acre more than corn after corn. Due to erosion considerations I didn't want to put the whole farm in soybeans at one time so since I was ridge planting I planned to rotate the field out of continous corn by planting 12 and 24 row strips of corn and soybeans. About this same time I read articles by Dr. Keeth Whigham at Iowa State University stating that higher net returns per acre were possible from interplanting due to higher corn yields from border row effect more than offsetting any yield reduction in soybeans due to shading. In 1978 I planted about 100 acres of 12 and 24 row corn and soybean strips plus a small plot of 6and 6. The 6 and 6 worked well and I rapidly expanded to nearly half my acres of this pattern by 1981 and 1982. The most yield response, 25 or more additional bushels of corn per acre, comes during the best growing seasons. Some care must be taken to work out the fertilizer and herbicide programs. Overall weed contool is more difficult with this pattern. During 1982 I had some serious common stalk borer problems caused by grassey weeds which developed when I didn't get the final cultivation and ridges built during the summer of 1981. It now appears that I can control these stalk borers by using Pydrin with a post-emergent herbicide. I plan now to substantially increase my area of corn and soybean interplanting. My advice to others interesting in tyying this would be to select a low weed pressure field, hopefully orient the rows North and South and develope compatable herbicide, fertilizer and equipment procedures.

Ridge till systems dramatically cut production costs without reducing output. Most ridge till users talk in terms of saving 30 dollars or more per acre. On many farms that adds up to a lot of money. However by the adoption of banding of all P and K and the side dressing of ammonia substantially more can be saved per acre. Additional innovations such as the interplanting of corn and soybeans can further increase output without increasing production costs. So in summary the system I use has really turned into a profit tillage program and has made the past few years the most profitable I have ever had.

WHAT ELSE WILL RAISE CORN & SOYBEAN YIELDS?

Wallace W. Nelson, Superintendent
Southwest Experiment Station
Lamberton, Minnesota

WEATHER - *Nicer Than Normal*

In the center of a continent, weather is the single most important factor. To have a normal year is very abnormal. Minnesota is the northern edge of the corn and soybean belt because of temperature; western edge because of moisture. Almost everything we do then must be to enhance the weather we get to our advantage. To do this we must be as optimal with all our production inputs and practices to fit your other soil conditions. In other words, fine tune the system and put it together with timeliness.

KNOW YOUR SOIL - *Treated Well*

The origin of your soil can make a difference how you treat it and fertilize it. Know your parent material, texture, organic matter and slope. You need to leave it better than you found it.

NITROGEN - *Keep it Available*

Need to have the nitrogen available when the plants need it. Need to understand use of N and where it is available. Do not need to spoon feed except under special conditions and should have enough available for plant use regardless of the weather.

PLANTS - *Adaptable to Soil, Population*

Plant populations must be able to take advantage of the weather and make maximum yields. The varieties must be adaptable to the soils they are planted on.

TILLAGE - *For a Purpose*

Tillage is only performed to enable production of the crops to be produced. Thus all tillage should be done only if it has a purpose and fits your management plan. Be a Pro-Tiller.

PRO | DUCTIVE
FITABLE
FESSIONAL
ENVIRONMENTAL
FICIENT
GRESSIVE
SCRIPTION
SPER | TILLAGE

TIMELINESS - *Don't Remember last Year*

If you are always remembering what it was like last year and just reacting to that you will always be a year behind with your management. Normally plant as soon by the calendar as field conditions permit.

SOYBEAN MANAGEMENT TILLAGE* 1982 - 83

Lamberton, Mn.

Date of Planting	Row Spacing 10 inch	30 inch	Ave.
Early (5/6)	47.6	43.8	45.6
Late (5/24)	45.7	42.2	43.9
Average	46.6	43.0	44.8

* Average of 4 tillage systems

Also do all the other operations as soon as it's time so leave a wider window to get it done in.

MANAGEMENT - *The Best of You*

There is no magic formula or word for better yields. It's knowing your soils, equipment, time and skills and putting them together each year to give your crops the best opportunity for the weather we get. Take advantage of every opportunity as early as you can to put together a total management system. This is managing several years ahead and creating opportunities rather than only correcting problems.

BEAN LEAF BEETLE AND YELLOW WOOLLYBEAR CONTROL IN SOYBEAN

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Bean leaf beetles are a late season pest of soybean in Minnesota. They damage soybean by feeding first on the foliage followed by pod feeding. The bean leaf beetle does not eat the seed itself; however, the bean directly beneath the feeding scar on the pod is often attacked by fungi. Peak bean leaf beetle numbers generally occur from middle to late August and the earliest planted fields are the ones most likely to sustain damage.

Table I. Control of the bean leaf beetle 1983. Southern Agricultural Experiment Station, Waseca, MN. David Ragsdale and James Loughran.

Treatment and lb ai/acre		Corrected percent control of the bean leaf beetle 1 day and 5 days after treatment	
		1 day	5 days
Check		-	-
Guthion 2S	0.125	75.1	88.1
Guthion 2S	0.25	89.3	89.3
Pydrin 2.4EC	0.05	65.4	65.6
Pydrin 2.4EC	0.1	73.5	81.3
Sevin 80S	0.5	93.2	86.8
Sevin 80S	1.0	91.2	94.4
Sevin XLR	1.0	86.4	94.9

All treatments significantly reduced bean leaf beetle numbers when compared to the check. Control with Pydrin was only fair with the lower rate being significantly poorer than the other treatments.

The first known outbreak of yellow woollybears on soybean in Minnesota caused considerable defoliation in parts of southern Minnesota 1983. Damage was confined to late season foliage feeding. Insecticide trials were conducted to determine efficacy of several insecticides at the Rosemount Experiment Station, Rosemount, MN.

Table II. Control of the yellow woolly bear caterpillar. 1983. Rosemount Experiment Station, Rosemount, MN. Whitney Cranshaw, David Ragsdale and James Loughran.

Treatment and lb ai/acre			Average number of live caterpillars in the center of two 24 ft rows three days after treatment	Percent Control
Check			33.7	-
Lorsban	4EC	0.25	2.0	94.1
malathion	25WP	1.0	27.7	17.8
Pounce	3.2EC	0.05	2.7	92.1
Pydrin	2.4EC	0.05	4.3	87.1
Sevin	80S	1.0	28.3	15.8

Only Lorsban, Pounce and Pydrin controlled the yellow woolly bear with complete failure of malathion and Sevin 80S.

ASTER LEAFHOPPER AND ASTER YELLOWS CONTROL IN CARROT

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Three insecticides were evaluated to determine their effects on the aster leafhopper and its transmission of aster yellows to two carrot cultivars. The insecticide trials were conducted at the Rosemount Experiment Station in 1983. Two carrot cultivars Scarlet Nantes (aster yellows resistant) and Nantes Coreless (aster yellow susceptible), were planted on June 2. The plots were surrounded by lettuce which remained untreated to provided a continuous source of aster leafhoppers and aster yellows. Spray applications were applied biweekly from June 30 to August 4 and weekly from August 4 to August 25. Plots were sampled for aster leafhoppers 1 and 3 or 7 days after insecticides were applied. On August 11 plants showing aster yellows symptoms (yellow to red foliage) were counted. Yields were taken on September 28 and the number of plants showing aster yellows symptoms (hairy roots) were counted.

Table I. Control of aster leafhoppers. 1983. Rosemount Experiment Station, Rosemount, MN. Ragsdale, Radcliffe, and Loughran.

Treatment and lb ai/acre		Mean no. of aster leafhoppers in 25 sweeps			
		Biweekly Application*		Weekly Application**	
		1 day	3 days	1 day	7 days
Check		142.1	151.0	89.6	92.9
malathion 25WP	1.0	12.4	112.0	52.0	64.1
Pydrin 2.4EC	0.05	4.8	29.9	11.0	22.4
Pydrin 2.4EC	0.1	4.5	20.7	5.4	9.8
Pydrin 2.4EC	0.2	2.0	11.2	2.6	5.7
Sevin XLR	1.0	4.8	31.8	8.4	30.0

* Biweekly treatments were applied from June 30 through August 4.
** Weekly treatments were applied from August 4 through August 25.

All spray applications significantly reduced aster leafhoppers 24 h after treatment. Pydrin and Sevin XLR continued to suppress aster leafhoppers 3 and 7 days after treatment.

Table II. Aster yellows infection rates and yields. 1983. Rosemount Experiment Station, Rosemount, MN. Ragsdale, Radcliffe, and Loughran.

Treatment and lb ai/acre		No. of Aster Yellows infected plants per 40 feet of row*	Yield lb per 40 feet of row**
Check		45.4	60.1
malathion 25WP	1.0	31.0	80.1
Pydrin 2.4EC	0.05	15.9	70.4
Pydrin 2.4EC	0.1	14.9	81.8
Pydrin 2.4EC	0.2	9.9	81.3
Sevin XLR	1.0	18.8	68.4

* Counts from both cultivars were combined.
** Yield is the combined weight of both cultivars.

Aster yellows infection was significantly reduced in all treated plots from that occurring in the check. Pydrin and Sevin XLR were significantly better than malathion in reducing the incidence of aster yellows. Yields in all treated plots were significantly greater than the check. Malathion and the two higher rates of Pydrin had the greatest yield in spite of the elevated number of aster yellows infected plants in the malathion plots. The low rate of Pydrin and Sevin XLR had yields which were significantly lower than the other treatments.

AGRICULTURAL EXTENSION AND AGRI-BUSINESS

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Farmers are faced with an increasingly complex technology in their production, management and marketing practices. These technologies are not only more complex but are changing more rapidly. This trend is likely to continue as we benefit from genetic engineering, growth regulators, computer programs, etc. The capacity of a farmer to adopt new technology quickly and effectively is becoming the basis for survival. Competitive advantage is often gained now through innovative new technology rather than more and harder work as in the past. The differential capacity of farmers to effectively adopt technology and manage is illustrated by the wide range of economic situations now present among farmers during these economically difficult times. Most successful farmers have learned to depend on others for part of their technical expertise. The question we are dealing with is "who will provide the expertise to supply the information that is so vital in a rapidly changing agriculture."

Extension has been in this role of providing information to farmers for many years since the passage of the Smith-Lever Act of 1914 and even before. This legislation established funding "to aid in diffusing among people of the United States useful and practical information on subjects relating to agriculture and to encourage adoption of the same." Our close association with Land Grant Universities has provided sound information based on research of the Experiment Stations and USDA.

The Agricultural Extension Service is committed to maintaining and strengthening agriculture in this state. Extension programs in agriculture are part of a cooperative arrangement in at least three respects. First, financial support and program direction come from federal, state and county sources. Secondly, within the University a strong cooperative relationship exists in the Land Grant concept of research, teaching and extension. Thirdly, Extension and the University are part of the agricultural structure that includes producers, industry, agri-business and government agencies. Minnesota Agricultural Extension Service contributed to the agricultural sector within these cooperative relationships for 70 years and is continually assessing and changing its role as agriculture changes.

Extension has based its programs on sound educational principles. These included involvement of local people, identification of local needs, local evaluation of new technology and providing competent, well trained resource people at the local level.

Extension resources devoted to agriculture are invested primarily (85%) in professional staff. There are approximately 70 full-time-equivalent (FTE) agriculturally trained professional staff at the county level in Minnesota. Staffing varies from 0.5 to 2 FTE's per county in agriculture. There are approximately 20 Area Extension Agents in agriculture working in specialized program efforts such as crops, soils, crop pest management, farm management, marketing, potatoes and horticulture. We have approximately 75 FTE faculty in state specialist positions. These specialists are highly competent Ph.D. professionals in academic departments of the Colleges of Agriculture and Veterinary Medicine.

But Extension has never had the resources to work one-on-one nor to provide individualized services to very many producers. Therefore, Extension methods have used processes that educated people to make decisions rather than making the decisions for them. With the increasing complexity of agricultural technology and larger farms, it has become possible for farmers to hire others to provide individualized services. Many farmers have been doing this for years in areas like veterinary medicine, soil testing, marketing services, etc. More recently, the area of management services has developed rapidly.

Production supply firms and agricultural cooperatives provide highly trained technical people who help farmers with technical information that has previously come primarily through extension agents from university research. An increasing number of agricultural consultants now provide information and research services. The input supply companies have done additional research, often drawing upon the basic research done at the University. Companies develop new products and are in the forefront about farm application of their new products and equipment. This continuing trend toward high technology agriculture based on products from industry has changed the role of Extension and the sources of information for farmers.

In the past Extension has assumed that individual farm managers sought the best information they could get, then proceeded to make most decisions independently and on their own. Extension thus tried to provide the appropriate education/information for such decisions. Increasingly we find, due to size, complexity and potential consequence of error, that individual producers are seeking to contract or hire various management services. Here enters the grower organization and/or the private crop consultant.

Extension is still faced with demands from farmers and related industry or consumer clientele to provide direct educational/information programs. But Extension must face up to the question of where our limited resources can be most effectively used, particularly in sorting educational and service roles. We must also use approaches that make use of others for a multiplier effect. A balance of direct producer education and working through training and support of private consultants or grower groups is sought. There are four important considerations in determining Extension's responsibility versus the private consultant regarding providing information:

1. Expectations of producers that Extension should serve their local needs on a continuing basis.
2. Areas of state where private consultants do not exist.
3. Small or low resource farms that can't affort to hire consulting services and likewise may not be profitable consulting firm's clients.
4. Need for agricultural systems information among all farmers to maintain a profitable and sustainable agriculture.

Minnesota Extension has a very positive posture in working with grower organizations and private consultants. With the introduction of new technology, extension has a responsibility for <u>creating awareness, developing interest, establishing trial programs, developmental testing and research, evaluating results and encouraging adoption</u>. Extension has a continuing responsibility for organization, education, demonstration and further technology development.

The relationship of Extension and private consultants should be mutually supportive. Both groups have highly trained people with access to research information. Both have limited time and resources. Private consultants should expect access to a sound technical base via Extension. They should receive from Extension an excellent continuing education service. Extension should also assume the risk of piloting new technology. Private consultants and organizations can be expected to provide services to growers, field data, and resources to support Extension programs. We are in a relationship of dependence as well as support. Private organizations can help extend the capacity of Extension, to get out information and assist farm people in reaching their goals. Extension's role should be centered on the development and testing of technologies relating to farm services, to adaptive and demonstrational research relating to the concepts of specialized farm services, to evaluate in an educational framework the information and products provided by specialized farm services. Finally, the primary role of Extension is to provide access to the appropriate technology base for those offering the services whether they have been nurtured by Extension or whether they are independent entities.

Another aspect that Extension can deal with is the matter of the broad based, societal concerns. A business or service enterprise is most often based on the profit motive. Some of the kinds of service that may be offered to farmers have issues that need to be considered in the broader off-farm community or societal setting. Environmental issues, safety, and product quality are aspects having an educational component that Extension can and should deal with in their relation to specialized farm services.

CHEMICAL CONTROL OF WHITE MOLD ON PINTO BEANS

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

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

Benlate and Topsin-M have provided good chemical control of white mold when applied at lable rates.

Researchers results with these and other chemicals indicate that for maximum results timing is very important. The timing recommendations however may be somewhat confusing as they will vary from one part of the county to another. Michigan results indicate that one spray at mid-bloom is satisfactory in most cases with a second application 7-10 days later depending on disease pressure and disease history. Recommendations from Idaho indicate that one application of Benlate (50W) or Topsin M-70W were successful when one application was made when 100% of the plants had at least one open blossom. Nebraska results indicate good disease control using one application of these chemicals when 80-100% of the plants have one or more flowers and small pods ¼"inches long. Regardless of the varying time recommendations, however, all agree that adequate coverage is extremely important. Sufficient water must be used to provide thorough coverage of blossoms, stems and beans, especially those closest to the soil surface. Ground applications are better than air applications to achieve this. Ground applications during early bloom (before rows close and wheel damage would be minimum) applied at 20-40 gal acre at 60 lbs. pressure using flat fan nozzles banded on the top with drop nozzles between the rows pointing toward the plants on each side the row has shown good results. Second applications (when the canopy is full) should be made with broadest cone nozzles 40-60% gal/acre and 150 lbs. pressure in order to penatrate the canopy. Wide rows every few feet would help accommodate equipment and minimize wheel damage. Air applications should be from a low altitude, using a minimum of 5 gallons of water/acre. Studies at Idaho have shown that applications of Benlate 50W and Topsin M-70W have been successful in controlling white mold in dry beans when applied through a sprinkler irrigation system. Maximum disease control and yields were obtained with one application at the time when 100% of the plants had one open blossom. Yield increases due to the spray program decreased with applications later in the growing season and when infected plants were already present.

Tests were run at Staples, Minnesota on a plot which had a history of severe white mold infections on previous crops of dry edible beans. Respective Pinto bean (Var 144) plots under irrigation in a randomized block design (3 reps) were sprayed with either Topsin M-4F, Topsin M-70WP, Benlate, Ronilan, Tilt or Rohm & Haas-5781F. (Table 1). Different spray regimes were incorporated to assess returning for spray programs starting at various stages of plant stage and disease development, (Table 1). Each spray was broadcast (ground application) with D-13 cone nozzles using 60 gal/acre at 180 lbs. pressure.

Topsin M,4F and 70WP, Benlate 50W and Ronilan were most effective in controlling the disease with a corresponding increase in yields (Table 1). Benlate 50W, with 2 sprays was significantly more effective than Topsin M with 2 sprays on the same schedule. However, it was not significantly different than the Topsin M applied 3 weeks after the first pod was ¼" long (Table 1).

The Topsin M 70WP treatments were not significantly different which would indiciate that under the disease pressure which existed in 1983 (above average temperature in July and August, below average rainfall with dry days with a normal September) the later treatments, on the average did just as well as the earlier ones whether or not one or two applications were applied.

The Ronilan FL at 1 lb./acre yielded significantly better than when applied at .75 lb./acre.

On the basis of the above experiment and the recommendations from other states the recommendations for Minnesota are to apply either Benlate or Topsin M to the crop within 2 weeks of when the first pod is ¼" long with a second application only when a wetter than normal August to harvest is predicted. Use ground application when possible or airplane with 5 gallons or more of water. Injecting into on irrigation system should be used where lable permits.

Ronilan FL is a promising fungicide for use on dry beans and registration for this purpose is now in progress. Tilt and Rohm and Haas 5781F are not registered for use on dry beans and should not be used for the control of white mold.

Table I. Yield and white mold disease readings resulting from the use of chemicals to control white mold on Pinto beans.

Chemical	time of spray application	Ave. Yield lbs/A	% wilted Plants Aug 23	% Diseased Plant at Harvest
Topsin M, 4F 1.05 qt. Prod/A	1st Spray 1 wk. after first pod ¼" long 2nd spray 2 wks. later.	1601[a]	13[ab]	31[a]
Benlate, 50W 2 lb/acre	1st spray 1wk. after first pods ¼" long 2nd spray 2wks. later.	1565[ab]	6[b]	33[abc]
Ronilan FL 1 lb. ai/A	1st spray 3 wks after first pod ¼" long 2nd spray 2 wks later	1368[abc]	30[b]	65[abcde]
Ronilan FL 1 lb. ai/A	1st spray 1 wk. after first pod ¼" long 2nd spray 2 wks later	1345[abcd]	8[a]	42[abcd]
Topsin M70WP 1.5 lb. Prod./A.	One spray 3 wks. after first pods ¼" long	1295[abcde]	31[b]	61[abcde]
Ronilan FL .75 lb ai/A	1st spray 1 wk after first pod ¼" long 2nd spray 2 wks later	1223[cdef]	17[ab]	32[ab]
Topsin M70WP 1.5 lb Prod/A	1st spray 1 wk. after first pod ¼" long 2nd spray 2 wks later	1131[cdef]	25[ab]	70[abcde]
Tilt 3.6 E 70g ai/A	1st spray 1 wk after first pods ¼" long 2nd spray 2 wks later	1101[cdef]	63[c]	94[f]
Topsin M, 70 WP 1.5 lb. prod/A	One spray 1 wk after first pods ¼" long	1088[cdef]	20[ab]	67[abcde]
Rohm & Haas 5781F .25 lb. ai/A	1st spray 1 wk. after first Pods ¼" long 2nd spray 2 weeks later	1063[def]	63[c]	90[f]
Ronilan FL .75 lb ai/A	1st spray 3 wks after first pods ¼" long 2nd spray 2 wks later	1053[ef]	33[b]	76[ef]
Check	No treatment	968[f]	73[c]	89[f]

Means in a column followed by the same letter are not significantly different from each other (LSD P=0.05)

THE CHANGING SCENE: PHYTOPHTHORA ROOT ROT OF SOYBEANS IN MINNESOTA

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In 1983, numerous reports came in concerning occurrence of Phytophthora root rot in Minnesota soybeans which were supposedly resistant to this disease. Laboratory isolations were made from diseased plants and Phytophthora race 3 was identified by innoculating a series of differential soybean varieties in the greenhouse. This constitutes widespread occurrence of a new race of this fungus in 1983 and many of our varieties that were resistant to race 1 are susceptible to race 3.

In the early 50's a significant root rot disease situation in soybeans developed in Canada and shortly thereafter was observed in the eastern soybean belt of the U.S. The fungus Phytophthora magasperma had made its appearance and a series of studies were begun on factors related to its epidemiology. It was quickly recognized as a disease that would probably persist and increase as the crop was planted more widely. In 1964, root rot disease was found in a commercial field near Mankato, Minnesota; by then there were several soybean varieties already developed elsewhere that were resistant to the fungus.

Jean Lambert, Dick Cooper (Plant breeders in the U of M Agronomy Dept.) and I were careful to avoid over emphasis of the existing economic importance of Phytophthora in Minnesota at the time as its occurrence was exceedingly limited. However, we knew that eventually we would have to deal with it and we would also be obliged to deal with the different races of this fungus that would inevitably follow as the years went by.

Race 1, the original race that occurred in Canada and the U.S., began to change rapidly and within 10 years or so farmers in the eastern sections of the soybean belt no longer could count on protection via race 1 resistant varieties. In Minnesota, we predicted many years could go by without the same magnitude of threat. However, we made available soybean varieties that were resistant to race 1 and recommended judicious use of them, - we encouraged usage only when there was a real probability that Phytophthora might occur. Conditions we considered important were wet and poorly drained soil, compacted soils, and history of Phytophthora occurrence. In this way, we hoped to prolong the useful life to resistant varieties by delaying natural development of additional races of the fungus that could attack them.

In 1979, we were called to a farm near Faribault, Minnesota where race 1 resistant variety was being grown and where Phytophthora had caused significant damage. It turned out to be race 3. Following this occurrence, we became more conservative in predicting the longevity of race 1 resistant varieties in Minnesota. Still, race 1 resistance appeared to protect soybeans over the vast plantings in the state during the following years and only occasionally could we locate an example or report of susceptibility of those varieties resistant to race 1. Late in the 1982 season, we found root rot in two fields planted to varieties that were supposedly resistant to race 1 and one field was devastated. We arranged for plot work on the seriously affected field during the 1983 season and alerted colleagues to watch for occurrence of Phytophthora in 1983.

We had a wet fall in 1982*: For the last 4 months of the year, every month had higher than average rainfall for Central (5.5 inches above the 30 year average), Southwest (5.4 inches above normal), South Central (6.6 inches above normal) and Southeast Minnesota (7.5 inches above normal). Then in the spring of 1983, a similar thing happened - Central Minnesota had 2.1 inches of rainfall above normal during March through June, Southwest was 3.3 inches above, and Southeast was 1.3 above. If we consider just May and June, the months that we think are more critical for the infectious stage of Phytophthora - the differences were even greater all across the southern part of Minnesota. Also, during the planting season, temperatures were about four degrees colder than normal.

In accordance with predictions, the disease developed more severely than normal during the 1983 season and isolation from samples from an assortment of varieties resistant to race 1 revealed that race 3 predominated, but races 4 and 6 were also present. Since we suspect that perhaps 90 percent of the Minnesota plantings are resistant to race 1, it is not surprising that those soybeans coming down with Phytophthora this year were infected with something other than race 1. In nature the fungus can move from one location to another in water and soil; it is not seedborne, thus a grower does not come up with Phytophora in his field by planting seeds grown in some other field.

The strategy for controlling Phytophthora in the future is not clear cut. Resistant soybeans, at least the types of race specific resistance we have had in the past, have a limited useful life since the fungus changed on its own and when confronted (pressured?) by massive plantings of resistant soybeans it invariably comes up with a new race that will attack that resistance. The fungus is exceedingly variable and there is evidence that a whole array of variants (races) exist in the environment. The widespread use of race specific resistance increases the speed of change once the resistant variety is released and widely grown.

The relative importance of resistance, temperature, use of chemicals, rotation and other tillage practices, soil drainage, and soil compaction are not well sorted out at this time but are under study. The relationship of "tolerance" or "field resistance" (as compared to single gene resistance to a single race) and its relationship to commercial production is a matter of serious consideration by many in the public and private sectors.

The fall-spring rainfall situation and the cool planting season in 1983 in Minnesota probably accounts for the unusual severity of Phytophthora root rot in the 1983 season and more "normal" seasons should now prevail and ameliorate the problem compared to this year. It is likely, however, that we will need to put more emphasis on control of this disease in the future than we have in the past. We encourage vigilance; several methods of control are being considered and additional research is needed to identify the best method or methods for the grower.

*Data obtained from National Oceanic and Atmospheric Administration

CORN NEMATODES

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Our last contribution to this series of Special Reports dealt primarily with the corn or lesion nematode, *Pratylenchus hexincisus*, that is the dominant plant parasitic nematode of the silt loam soils of southern and western Minnesota (1). The main ideas developed in that article were: 1) plant parasitic nematodes are not evenly distributed across fields, 2) some fields cannot, for reasons that are still unknown, support damaging or potentially damaging populations of plant parasitic nematodes, and 3) locations where such nematodes are very numerous may be encountered fairly infrequently. Experiments made at the Southern, Southwest and West Central Experiment Stations during the period 1977-1980 have confirmed the fact that moderately large populations of plant parasitic nematodes (more than 500 lesion nematodes/116 cm^3 of soil modified Baermann funnel extraction method) are needed to cause significant losses and that such populations *may* exist even if a corn-soybean rotation is followed. That research has also provided data that suggest that: 1) measurable damage to field corn growing in the heavier soils may not occur if stress is absent and growing conditions are nearly ideal, 2) the average yield reduction attributable to nematodes in such soils is 6%, and 3) future studies will need to determine how much the commonly grown hybrids differ in terms of susceptibility or tolerance.

The effects of various other plant parasitic nematodes including other species of *Pratylenchus* on corn growing in light sandy soils have been studied in Minnesota since in 1977. An experiment was made in 1981 near Big Lake because: 1) the owner of the land was very dissatisfied with his 1980 corn yields from on field in particular, and 2) the end of season plant parasitic nematode populations in that field were quite large (Table 1).

Table 1. Plant parasitic nematode populations present in a corn field located near Big Lake, Minnesota.

Genera	Common Names	Soil Populations/116 cm^3 of Soil		
		Fall 1980	Spring 1981*	May 1981**
Total plant parasitic nematode population		713[a], 385-b 994		
Pratylenchus	lesion		452[a], 143-844[b]	34[a], 0-67[b]
Paratylenchus	pin		12, 0- 44	7, 0-48
Xiphinema	dagger		14, 0- 26	0
Hoplolaimus	lance		6, 0- 14	0

a=mean, b=range, *unplowed field, **planted field

The plant parasitic nematode populations declined only slightly in size over the winter of 1980-1981. A drastic reduction in the size of the nematode populations was associated with land preparation in the spring of 1981. Samples collected at-planting from the untreated control plots contained very few plant parasitic nematodes (Table 1). Tillage operations both dilute and actually reduce nematode populations by exposing them to sunlight, elevated temperatures near the soil surface, and to disiccation. The small at-planting nematode populations and the absence of any readily apparent differences in growth during the 1981 season were almost used to justify not taking yield data from the plots. All of the plots were harvested, however, and the data obtained proved that, as frequently happens with corn grown on heavier soils, there can be significant differences in yield even though there are no observed differences in plant growth. All of the insecticides-nematicides used in these studies were applied in a 7-inch wide band over the row and lightly incorporated Table 2).

Table 2. Effect of application of insecticides-nematicides on yield of field corn at site #1 near Big Lake, Minnesota.

Chemical	Formulation	Application Rate (grams/100' row)	Yield (bu/A)
Furadan	15G	34.70	124.3
Furadan	15C	46.28	122.1
Counter	15G	23.14	117.4
Mocap	15G	23.14	116.5
Mocap	15G	46.28	114.9
Control	---	-----	113.3

The 1981 study was done in a field where the effects of plant parasitic nematodes seemed to be quite general and widespread. In 1983, a similar study was also made near Big Lake in another field where the owner was aware of problem areas or "infection centers" where plant growth in the 1981 and 1982 growing seasons had been weak and abnormal. The study was almost identical to the 1981 experiment: 4-row plots each 86 feet long, 38 inch row spacings. 8 replications per treatment, and 6 treatments including the untreated control. The at-planting nematode populations present in the soil of the check plots were larger and more diverse than the at-planting populations present in the check plots of the 1981 experiment (Table 3). The data (Table 3) further document the fact that plant parasitic nematodes typically are unevenly distributed in even a small, fairly homogeneous area of a level field. In contrast to the 1981 study where differences in plant growth were not apparent, the 1983 plots were characterized by sharp boundaries marking the edges of some of the plots. The corn plants in some of the 600 and 700 series plots were appreciably weaker and less vigorous than plants in some of the other plots. The control plots in those series also had some of the largest at-planting nematode populations (Table 3).

Table 3. At-planting nematode populations present in a corn field-site #2-located near Big Lake, Minnesota.

	Plant Parasitic Nematodes/116 cm^3 of Soil					
Plot #	Helico-tylenchus (spiral)	Hoplo-laimus (lance)	Para-tylenchus (pin)	Praty-lenchus (lesion)	Tylen-chorhynchus (sytlet)	Xiphinema (dagger)
104				273	23	23
201	17			110	17	
305	211		5	75		23
402		43		72		
505				91		21
605				302		26
701		78		269		5
804		6		84		

In 1983, as in other studies done on irrigated sandy soils, Furadan at the "1.5 pound active ingredient rate" was associated with the highest yields per acre (Table 4).

Table 4. Effect of application of insecticides-nematicides on yield of field corn at site #2 near Big Lake, Minnesota.

Chemical	Formulation	Application Rate (grams/100' row)	Yield (bu/A)
Furadan	15G	34.70	137.9
Furadan	15G	46.28	134.7
Counter	15G	23.14	133.6
Temik	15G	23.14	132.4
Mocap	15G	23.14	124.9
Control	---	-----	124.9

In 1981, nearly ideal growing conditions prevailed while 1983 was characterized by excessively warm and dry conditions. In 1981 the plants were exposed to relatively small at-planting nematode populations while the plants in 1983 were exposed to much larger populations of several kinds of highly pathogenic nematodes such as Hoplolaimus and Xiphinema spp. in addition the the "omnipresent" Pratylenchus. Since the young plant is especially vulnerable to the actions of plant parasitic nematodes, it seems reasonable to speculate that the benefits of a nematode control program would have been even larger if a more sensitive-less tolerant hybrid (the 1981 hybrid??) had been tested in 1983.

Hoplolaimus spp. are very pathogenic nematodes that typically are not abundant in Minnesota corn fields (Tables 1 and 3). However, this nematode is presently thought to be the cause of the poor growth of corn plants located in infection centers in sandy loam soil in a field just south of Red Wing in Goodhue County. The infection centers had been recognized as early as 1981 and the largest of them could be recognized on aerial photographs of the area. The nematode, which is commonly known as the "lance nematode" because of its moderately strong stylet or mouth spear, is or can be a migratory endoparasite that lives and reproduces within the cortical tissue of the root. Moderate soil and moderate to very large root populations of the lance nematode were present in samples collected in July from the largest infection center. These populations ranged from 142 to 160 nematodes/116 cm^3 of soil from 473 to 4117 nematodes/gram dry weight of root tissue. The nature and severity of the problem are readily apparent when yield data are considered (Table 5). Five foot long sections of row were harvested and those yields were converted to bushels/acre yield estimates. A distance of ten feet separated adjacent harvest and sampling sites.

Table 5. Estimated yield of corn plants that grew in the center of and at distances of 10 to 150 feet from the center of the "problem area".

101
Extensive corn borer damage
133
117
117
131
87
Extensive corn borer damage
19
31
126, 103, 123, 131, 131, 98, 50, 42, 74, 82, 989, 124, 148, 124
55
86
102
84
122
107
124
118

Although damaging or potentially damaging populations of the lesion nematode, Pratylenchus spp., are commonly found in Minnesota corn fields, this is the first instance of which we have knowledge where another nematode seems to be restricting the growth of corn in Minnesota. Because so little of Minnesota has been surveyed for the presence of plant parasitic nematodes, it seems likely that problem areas like the ones described in this paper may be more common than we presently recognize them to be.

LITERATURE CITED

1. MacDonald, D.H., A.R. Pierce, and P.A. Mansager. 1978. Plant parasitic nematodes in Minnesota corn fields. Special Rept. 12:8184.

MINNESOTA USE OF EMERGENCY EXEMPTIONS (SECTION 18) AND SPECIAL LOCAL NEEDS (SECTION 24 (C)) FOR PESTICIDE REGISTRATION

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At times insects, diseases, or other pests are not adequately controlled by registered pesticides or alternative methods. State and federal laws make allowances for special use registrations to control pests where serious economic losses or threats to public health occur. These registrations are known as Special Local Need, or 24 (C)'s and Emergency Exemptions, Section 18's. The designations refer to two sections of the Federal Insecticide, Fungicide, and Rodenticide Act. The process of special registration is not always understood by user groups and the general public. Questions and concerns have been raised about Special Local Need and Emergency Exemption registrations. It is therefore appropriate to provide some background information, major requirements of the systems, and to comment on them.

State and federal laws require that all pesticides sold or used in Minnesota must be registered with the Minnesota Department of Agriculture and the U.S. Environmental Protection Agency. Products are registered when technical data and other information submitted by the registrant meets certain standards and criteria prescribed by EPA and supported by MDA. The product label specifies registered uses and conditions for use. Presently about 6,800 pesticides are registered in this state and the majority are for agricultural purposes. Since 1977, 104 SLN's have been approved by the MDA and of these 53 are still in effect. During the same period, from two to six Emergency Exemptions have been granted each year, and they have been issued only for one year's duration or less.

SLN's and Emergency Exemptions differ in several ways. The two major points of difference are; first, that an SLN may be approved for a pesticide only when residual tolerances have already been established for food and feed crops involved, while an Emergency Exemption requires setting of a temporary tolerance for residues because none exist at the time of application; and secondly, an SLN is approved by a state agency with EPA having the right to disapprove within a 90 day time period, while an Emergency Exemption is requested of EPA by the state, and the agency has sole authority for granting the request or rejecting it. Other differences are seen in the following sections that include more specific requirements.

SECTION 24 (C) - SPECIAL LOCAL NEED REGISTRATION

Federal Authorization and Conditions

Based on FIFRA which provides registration for additional uses of federally registered pesticides to meet special local needs within a state, the federal law stipulates that:

1. The action must not permit sale or use of a products prohibited by EPA, or previously denied, disapproved, or cancelled by EPA.

2. The action must not impose requirements for labeling or packaging different than those required by FIFRA.

3. The state local need registration is not effective for more than 90 days if disapproved by EPA.

4. The pesticide must have an existing tolerance or exemption under the Federal Food Drug and Cosmetic Act.

5. The state must have capability to assure enforcement of the SLN registration.

Minnesota Requirements

1. A special local need is defined to mean that a pest problem exists or is likely to occur which cannot be effectively controlled because there is no EPA registered pesticide for such use or no registered product under the conditions of use would be as safe and/or efficacious, or a registered product is not available.

2. Suitable alternative control measures are not available.

3. The composition of the product will substantiate the claims made.

4. The product will perform its function without causing unreasonable adverse effects on the environment when used according to widespread and usual control practices.

5. The classification for general or restricted use conforms with FIFRA.

6. The label and other information required for registration complies with the Minnesota Pesticide Law (M. S. 18A.21 - 18A.45) and Rules (3 MCAR 1.0338).

Procedures for Application and Issuance of a Special Local Need Registration

1. Any person may apply in writing. The applicant will be sent instructions and forms and must supply all information specified on a Minnesota Special Pesticide Use Request form including pesticide registration, crop and pest, economic impact and method of application, and related information as requested.

2. An EPA Application for Notification of State Registration of Pesticide to meet a Special Local Need must be completed.

3. The MDA may require formula, ingredients, description of tests and other relevant data. Protection of trade secrets is assured.

4. When all pertinent information is received, MDA must publish a Notice of Intent to issue the Special Local Need Registration in the Environmental Quality Board Monitor and allow 30 days for comment before making the decision to approve or reject the SLN request.

5. The decision to register is based upon study concerning:

   - registration information submitted by the applicant.
   - labels and labeling.
   - research and survey data or recommendations.
   - concurrence of professional staff and other state agencies.
   - agreement from the registrant to support the need.

6. If the decision is made to issue the SLN, notices must be published in the State Register, the EQB monitor, and a news release must be sent to all legal newspapers in the state stating the local need and citizen right to petition for a public hearing.

7. If within 30 days after publication the MDA receives written requests from a federal or state agency, local unit of government, or petition from any person or group containing 500 or more names and addresses of legal voters, and when the MDA decides it to be in the best interest of enviromental health, welfare, or safety, the objections will be considered and the MDA will order a public hearing.

8. If no objections are received, the SLN will be approved for a period of up to five years. The MDA may specify length of time, reporting requirements, and other conditions for use, including the right to revoke, suspend, or amend a SLN if such action is warranted.

Section 18 Emergency Exemptions

FIFRA authorization and Title 40 Code of Federal Regulations, Part 166 provide that the EPA may exempt a federal or state agency from requirements of FIFRA if it is determined that emergency conditions exist which would require such an exemption. An emergency is generally felt to exist when a pest outbreak which can cause significant economic or health problems has occurred, or is about to occur, and no available registered pesticide or alternative method will control the pest. The procedure and detailed requirements for an emergency exemption are summarized for convenience and brevity.

Three basic types of emergency exemptions exist.

1. Specific Exemption - granted for control of a specific pest outbreak only.

2. Quarantine or Public Health Exemption - granted for programs designed to prevent the introduction or spread of a foreign pest.

3. Crisis Exemption - issued when unpredictable pest outbreaks suddenly occur and there is no time to request a specific exemption.

Specific Exemptions are normally used for agricultural pest problems to meet emergency conditions. The state must request the emergency registration of a pesticide in writing to the EPA and send such information as:

1. Nature and scope of the emergency,

2. Estimated time when treatment must begin for effective control,

3. Listing of pesticides proposed for use,

4. Description of the proposed methods for application and related information,

5. Statement concerning possible adverse effects on man and the environment,

6. Statement of economic benefits/losses anticipated with and without the exemption.

7. Statement of monitoring and reporting results of product sales and use for the emergency.

Crisis Exemptions require sending similar support information to EPA except that it need not be provided prior to treatment. If a state elects to use the crisis exemption alternative, EPA must be notified within 36 hours, and detailed information sent within 10 days of the first application.

When EPA receives an emergency exemption request, it is reviewed by several divisions within the agency. The review process is targeted for 58 days during which:

1. A theoretical maximum residue is set on crops, and risks to man and the environment are defined.

2. An economic risk/benefit analysis is conducted.

3. The availability of registered alternatives, the existence of an emergency situation, and the acceptability of risks are determined.

4. The agency sets forth monitoring requirements.

DISCUSSION

There are today a number of critics who advocate changes in state and federal pesticide regulations that would severely restrict the use of SLN's and Emergency Exemptions. Reviews of the 24 (C) and Section 18 parts of FIFRA and the systems used by states and federal agencies to implement them are being studied in detail by the U.S. Congress, EPA, state control officials, the pesticide industry, and many citizen and environmental groups. It is time for agricultural producers, industry, research, extension, and regulatory people to increase their sensitivity for responsibilities and proper role in the SLN and Emergency Exemption systems to ensure that the process for registrations continues to be available and effectively used.

A substantial increase nationally in the number of 24 (C)'s and Section 18's issued has been a major part of the concern. The number has increased considerably since 1977. By example, in 1976 a total of 380 SLN's and 11 Section 18's were on record for 37 states surveyed. For the period 1978-1982 these same 37 states issued approximately 1,100 total SLN's each year and Section 18's increased from 62 in 1977 to 309 in 1982.

Minnesota's record is included in the above figures, but as mentioned previously, the state has granted about 18 SLN's and about 5 Section 18's each year from 1979 - 1982. Almost an equal number of requests were not accepted for approval. Minnesota is far below the average of most states, largely due to the lack of high value specialty crops grown here as compared to California, Florida, and other states.

Other points of contention voiced by those who oppose special registration systems include the large number of SLN's that are repeated in many neighboring states, and Emergency Exemptions which are identical in many states and repeated year after year. The accusation is that regular and complete product registration through the FIFRA, Section 3 process, is being circumvented.

At the same time some industry and state officials believe that EPA Section 3 registration has not kept pace with registration demand and caused undue hardship for industry and agriculture. Further, many feel that the 24 (C) and Section 18 processes work very well for the intended purposes, and that it has taken a few years to properly establish and use the process.

MDA'S POSITION

The Minnesota Department of Agriculture recognizes pesticides as an important agricutural tool for Minnesota crop and livestock producers. Each registration of an SLN and Emergency Exemption is issued for a specific pesticide for a specific pest in or on a specific site or crop. Special registrations are based on defined systems which allow MDA and EPA to grant pesticide uses for control or eradication of serious pests. MDA attempts to utilize such registration options in an appropriate manner that recognizes problems in agricultural production and assists in methods to help producers prevent economic loss from agricultural pests. The Department also has responsibilities to prevent harm to the environment and to protect public health and the welfare of Minnesotans.

It is in the best interest of agriculture and the chemical industry to operate in a manner that does not abuse the registration systems. Loss of the ability to grant SLN's and Emergency Exemptions most certainly would severely handicap Minnesota's capability to deal effectively with serious economic pest problems when they occur.

In conclusion, the MDA recommends to agricultural users and the pesticide industry that good documentation of needs must be provided for 24 (C) and Section 18 requests. The Department will look very carefully at all data and other information in the light of established standards and criteria for registration. Applicants are encouraged to do their homework thoroughly, furnish solid technical data, and work cooperatively with the Department, the University of Minnesota staff and others who are involved in recommending and approving these requests. No requests will be considered without the required supporting information. Lastly, the applicants should allow sufficient time for review, submission by additional data as needed, and public notice as required.

MDA supports the 24 (C) and Section 18 process and encourages applicants and those involved in using 24 (C) and Section 18 registered pesticides to follow all requirements for registration, abide by the appproved label directions for application, and assist in monitoring and reporting results so that effective pesticides are available to produce the quality of food and fiber associated with today's standard of living and quality of life.

POTENTIAL WEED PROBLEMS ON PIK ACRES

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Many of the acres idled in the 1983 PIK program will require some special weed control considerations in 1984. The two major concerns involve high numbers of weed seeds in the soil and increased vigor of perennial weed stands. On acres where weeds were kept down with combinations of tillage, mowing, herbicides, and cover crops, 1984 will probably be little different from other years, but the following are several reasons why special problems may have developed:

1. Necessary weed control practices may not have been used because the cost seemed too high to justify on set aside acres.

2. Weed control operations may not have been properly timed, allowing many weeds to go to seed before control.

3. Perennial weed stands gained in vigor, even though annual weeds were prevented from going to seed with mowing or burn-down herbicide application.

4. Weeds in a solid seeded cover crop were often not sprayed, and allowed to go to seed.

5. Perennial grass or legume cover crops will need to be controlled in 1984, as well as annual cover crops which were allowed to produce seed.

Allowing a few weeds to go to seed on PIK acres will greatly increase the number of weed seeds in the soil. Annual weeds growing without competition are capable of producing an average of 10,000 seeds per plant in a single growing season. A black nightshade plant can have 1,000 berries, each with 50 seeds, a foxtail head may produce 1,000 seeds and a pigweed plant 100,000 seeds. Fields with poor weed control may contain up to 10,000 seeds per square yard capable of emerging. Next year's herbicide treatment may be overwhelmed by these large populations of weed seed. If next year's herbicide gives 95% control, there may still be 500 weeds per square yard emerging in the field. In these situations an early postemergence and possibly later postemergence herbicide treatment will be essential in addition to preplant or preemergence treatments.

Stands of perennial weeds such as milkweed, nutsedge, Canada thistle, perennial sowthistle, and quackgrass can increase in vigor and spread through lateral roots under reduced tillage. It takes two to three years of tillage and herbicide treatment to bring most healthy stands of perennial weeds under control. If a perennial crop, such as alfalfa, was used as a cover crop in 1983, mold board plowing may be the best way to prepare the land for 1984. Where a no-till crop is planned, herbicides such as

2,4-D, dicamba, paraquat, or glyphosate must be used to control the previous year's perennial crop. If a sorghum-sudan grass cover crop was allowed to produce seed before plowing or mowing, it may be preferable to plant soybeans rather than corn, in 1984, so more herbicide options are available.

Fields which were trashy or weedy in 1983 were attractive egg laying sites for some insect pests. Scouting fields early in the season for pests like cutworm and stalk borers will be particularly important. One unique advantage exists for those who had poor weed control on their PIK acres. Accurate weed maps can be constructed for these fields detailing the weed species and densities present. Weed maps are essential for developing the most effective and economic weed control plans for each individual field. In the past, growers have reported as much as $35/A reduced herbicide costs by knowing the identity, location, and density of their specific weed pests.

CORN WEED CONTROL UPDATE

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A copy of Extension Folder 641-1983 "Weed Control in Corn" is included in this "Proceedings." The 1984 revision of E.F. 641 was not available in time to meet publication deadlines. However, 1984 changes will be minor. Table 1, "Effectiveness of Herbicides on Weeds in Corn," has been expanded to include eastern black nightshade and sandbur. Weed effectiveness ratings for bromoxynil (Buctril, Brominal) were added to Table 1. The expanded rate ranges for cyanazine, cleared recently by EPA, have been included in appropriate tables in E.F. 641-1984.

The EPA clearance status of a new herbicide tridiphane (Tandem) is uncertain at this time. A full clearance is possible for 1984 but, if it is not obtained, limited usage may be possible under an Experimental Use Permit (EUP). Tridiphane is used in combination with atrazine plus oil or cyanazine in postemergence treatments to improve control of small grasses, under 3 inches in height, in corn with no more than 4 leaves.

In continuing studies with EPTC+antidote (Eradicane), weed control was consistently poor at two locations when repeated annual applications had been used for more than three years. However, at one location there was some improvement in weedy grass control in plots where Eradicane use had been discontinued for two years. At two locations two applications of Eradicane Extra in consecutive years resulted in poorer weedy grass control than was obtained from a single application. This suggests similar reductions in effectiveness of Eradicane Extra with repeated annual use as has been observed previously with Eradicane.

Wild proso millet is difficult to control in corn. In research plots the most effective treatments involve sequential herbicide applications. Initial preplant incorporation or preemergence herbicide treatments must be followed by postemergence treatments to prevent regrowth and to control late germinating wild proso millet. Initial treatments with Eradicane, Eradicane Extra, butylate plus antidote (Sutan Plus), and alachlor (Lasso) followed by early postemergence treatments of cyanazine (Bladex) mixtures with metolachlor (Dual), chloramben (Amiben), pendimethalin (Prowl), tri-diphane (Tandem), or Lasso have given satisfactory season-long control of wild proso millet and green foxtail. These treatments are costly and efforts are continuing to develop methods of wild proso millet control in corn that are less costly.

EXTENSION FOLDER 641 – 1983

Weed Control in Corn

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Weed control in corn should be based on an optimum combination of cultural, mechanical, and chemical practices. The ideal combination for each field will depend on several factors including crop being grown, kinds of weeds, severity of the weed infestation, soil characteristics, tillage practices, cropping systems, and availability of time and labor.

Cultural Practices

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

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

Set cultivators for shallow operation to avoid pruning the corn roots and to reduce the number of weed seeds brought to the surface. Throw enough soil into the row to cover small weeds, but avoid excessive ridging that may encourage erosion or interfere with harvesting. Shallow cultivation should be repeated as necessary to control newly germinated weeds.

Herbicides

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

- Label approval for use
- Use of the crop
- Corn tolerance to the herbicide
- Potential for chemical residues that may affect later crops
- Kinds of weeds
- Soil texture
- Soil pH
- Amount of organic matter in the soil
- Climate

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

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

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

—Weather
—Formulation of the chemical
—Application equipment available
—Potential for drift problems

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

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

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

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

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

Preplanting Applications

Some herbicides may be applied to the soil before planting and incorporated 2 to 3 inches into the soil with a disk, field cultivator, or similar implement. The disk or field cultivator should be set to operate twice as deeply as the desired depth of incorporation. Use sweep shovels on the field cultivator to get more uniform mixing of the chemical and soil.

The field should be disked or cultivated twice, crosswise and lengthwise, after applying the chemical. If the soil is not too moist or rough and is in a good tilth condition, adequate incorporation may be achieved with one pass over the field with some combination implements. To avoid excessive loss of volatile chemicals like EPTC or butylate, the first tillage operation should follow immediately behind the sprayer.

Butylate (Sutan+) or EPTC (Eradicane) applied preplanting and incorporated at 3 to 6 pounds per acre has given good control of annual grasses and fair control of a few annual broadleafs, but these chemicals do not control several annual broadleafs or most perennial weeds. Both chemicals are effective against nutsedge. EPTC may be used to control quackgrass, but trial results have been inconsistent. Butylate and EPTC are formulated with an antidote chemical to prevent corn injury. With repeated annual use, the weed control performance of EPTC may decline due to more rapid breakdown of EPTC in the soil. In these fields, use of a new formulation of EPTC that has an added chemical that extends its soil life has improved performance of EPTC.

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

Mixtures of butylate or EPTC (Eradicane) and atrazine or cyanazine (Bladex) applied preplanting and incorporated have controlled both annual grasses and broadleafs. These mixtures improve broadleaf control compared to butylate or EPTC alone. Cyanazine does not carry over to the following year, and the lower rate of atrazine used in the mixtures reduces carryover problems from atrazine compared to those caused by the higher rates used when atrazine is applied alone. Cyanazine with butylate is not recommended for use on coarse- to medium-textured soils with less than 2 percent organic matter because of potential corn injury.

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

Preemergence Applications

Atrazine at 1 to 3 pounds per acre has given good control of annual weeds with no injury to corn. A 3-pound-per-acre rate of atrazine should be used on fine-textured soils or those high in organic matter. One to 2 pounds per acre of atrazine is adequate on sandy soils that are low in organic matter.

Atrazine sometimes affects small grains, flax, sugarbeets, sunflowers, soybeans, other legumes, vegetables, and other sensitive crops planted the following spring. The label recommends that small grains, flax, sugarbeets, vegetables, and small-seeded legumes or grasses not be planted in the year following atrazine application.

Soybeans may be injured the year following atrazine use if the rate of atrazine application was more than 2 pounds per acre of active ingredient in western Minnesota or 3 pounds in eastern Minnesota, or if application was made after June 10. However, in some years, soybean injury has occurred following use within these restrictions, especially on highly alkaline soils of western Minnesota.

Residue can be minimized by using the lowest rate of chemical consistent with good weed control, using band rather than broadcast applications, and plowing or thoroughly tilling the soil before planting soybeans. Atrazine residues are more likely to persist if soil moisture or temperatures are low.

Cyanazine (Bladex), chemically similar to atrazine, has given good control of annual grasses and most broadleafs when applied preemergence. There has been no soil residue the following season except from granules following dry years. Weed control is not as good under dry conditions as under moderate to heavy rainfall. Within the suggested rates of 1.2 to 4 pounds per acre, the higher rates are required on soils higher in organic matter and finer-textured soils. Corn injury may occur on sandy soils. Granular formulations of cyanazine have been less effective than sprays under limited rain conditions.

Propachlor (Ramrod, Bexton) has given good annual grass control when applied preemergence at 4 to 6 pounds per acre. Propachlor does not consistently control most broad-leaved or perennial weeds, but it may be used in mixtures with atrazine or linuron for annual grass and broadleaf control. Corn is very tolerant to propachlor.

Alachlor (Lasso) and metolachlor (Dual) control annual grasses in corn. Both chemicals also have given good control of redroot pigweed, but control of other broadleafs has been erratic. Preemergence applications have controlled nutsedge on coarse soils that are low in organic matter, but on finer-textured, dark soils, preplanting incorporated applications have controlled nutsedge better than preemergence treatments. Corn has good tolerance to alachlor and metolachlor. Suggested rates for alachlor are 2¼ to 4 pounds per acre in the liquid formulation and 2.4 to 3.9 pounds per acre in the granular formulation (Lasso II). Metolachlor is labeled for preemergence application at 1.5 to 3 pounds per acre in the liquid formulation and 1½ to 4 pounds per acre in the granular formulation. Corn, soybeans, sorghum, root crops, potatoes, pod crops, buckwheat, or small grains may be grown the year after using metolachlor; other crops should not be planted for 18 months after application of metolachlor. Any crop may be grown the year following alachlor use.

Pendimethalin (Prowl) may be used alone at ¾ to 2 pounds per acre or in mixtures at ¾ to 1½ pounds per acre for preemergence control of most annual grassy weeds and some broadleafs such as common lambsquarters, pigweed, smartweed, and velvetleaf in corn. In Minnesota trials, preemergence applications of this compound have been somewhat less effective on grasses but more effective on broadleafs than alachlor. Tank mixes with atrazine, cyanazine, or dicamba provide a broader spectrum of weed control.

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

Preemergence Herbicide Mixtures

Mixtures of atrazine with alachlor, linuron, metolachlor, pendimethalin, or propachlor are registered for preemergence application on corn to control annual grasses and broadleafs. Soil residues of atrazine are reduced by using these mixtures since application rates are lower than if atrazine is used alone. These mixtures are less effective than atrazine alone on quackgrass. Do not apply the mixture with linuron after corn is up, or severe corn injury may occur.

A 1:1 ratio of active ingredients of an atrazine-linuron mixture has given weed control comparable to an equivalent rate of atrazine alone on soils low in organic matter. Using linuron in combination with atrazine reduces the likelihood of corn injury and usually improves weed control, compared to using linuron alone. Rates vary from ½ to 1½ pounds per acre of each chemical according to soil type. Corn tolerance to this mixture is not as great as to atrazine alone. Corn injury may occur on coarse-textured soils that have low organic matter content.

The mixtures of atrazine or cyanazine with alachlor, metolachlor, or propachlor control broad-leaved weeds better than alachlor, metolachlor, or propachlor alone and give more consistent control on high organic matter soils or with limited rain than atrazine or cyanazine alone. Corn has good tolerance to these mixtures.

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

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

Early Postemergence Sprays

Postemergence sprays of atrazine effectively control most annual weeds in corn. Broad-leaved weed control is especially good. Grass control is less consistent. It is important to apply early postemergence treatments at the proper time or results may be poor. Apply atrazine while the weeds are less than 1½ inches tall. Application may be made until corn is 30 inches tall. Drop nozzles should be used to keep the spray out of the tops of the corn and to give better spray coverage on the weeds.

Adding 1 gallon per acre of special oils with an emulsifier or ¼ to ½ gallon per acre of special adjuvant-oil emulsions to the spray increases the effectiveness of early postemergence applications of atrazine. Labeled emulsions of either vegetable or petroleum oils are satisfactory.

Various formulations of surfactants and detergents used with atrazine have not improved weed control as much as using oils. Suggested atrazine rates for postemergence application with oil are 1.2 pounds per acre for broadleafs and 2 pounds per acre for annual grasses.

When atrazine is used, early postemergence treatments are preferred to preemergence if the soil is high in clay or organic matter and in western Minnesota, where rainfall is less certain. These are the areas where preemergence applications of atrazine have given less satisfactory weed control.

Severe corn injury has resulted from adding 2,4-D to this mixture. Corn injury has occurred also when atrazine and oil were applied to corn growing under cold, wet conditions, or if frost occurred shortly before or after application.

Cyanazine (Bladex 80W) is effective on annual grasses and broadleafs as an early postemergence herbicide. It is cleared for use through the 4-leaf stage of corn and before weeds are more than 1½ inches tall. Pigweed and lambsquarters have shown some tolerance. Oils or surfactants added to the spray increase the potential for corn injury and have resulted in severe corn injury and stand reduction under conditions of heavy rains or dews, cool temperatures, and cloudiness.

Under dry conditions, vegetable oils or certain surfactants may be used to improve weed control. Use only the wettable powder formulation for postemergence application. Do not use on sands with less than 1 percent organic matter.

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

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

Table 3. Herbicide names and formulations

Common name	Trade name	Concentration and commercial formulation[1]
Alachlor	Lasso Lasso II	4 lb/gal L 15% G
Alachlor + atrazine	Lasso/atrazine	9 + 6% G, 2½ + 1½ lb/gal F
Atrazine	AAtrex, others	80% WP, 4 lb/gal F 90% WDG
Atrazine + metolachlor	Bicep	2 + 2½ lb/gal F
Bentazon	Basagran	4 lb/gal L
Bentazon + atrazine	Laddok	1.66 + 1.66 lb/gal F
Bromoxynil	Brominal, Buctril	2 or 4 lb/gal L
Butylate and protectant	Sutan+	6.7 lb/gal L, 10% G
Butylate + atrazine	Sutan + atrazine, Sutazine	18% + 6% G 4.8 + 1.2 lb/gal L
Cyanazine	Bladex	80% WP, 15% G, 4 lb/gal F
Dicamba	Banvel	2 or 4 lb/gal L
EPTC and protectant	Eradicane	6.7 lb/gal L
EPTC + protectant + extender	Eradicane Extra	6 lb/gal L
Linuron	Lorox	50% WP, 4 lb/gal F
Metolachlor	Dual	8 lb/gal L, 25% G
Pendimethalin	Prowl	4 lb/gal L
Propachlor	Bexton, Ramrod	65% WP, 20% G, 4 lb/gal L
Propachlor + atrazine	Ramrod and atrazine	48.1 + 20.9% WP
2,4-D	several	various

[1] G = Granular, L = Liquid, WP = Wettable Powder, WDG = Water Dispersible Granule, F = Flowable.

Pendimethalin (Prowl) in mixtures with atrazine or cyanazine wettable powder may be applied after corn emergence, but not later than when corn is in the two-leaf stage and when weeds are no more than 1 inch tall. These mixtures have been effective against annual grasses and broadleafs. The early postemergence application of pendimethalin and cyanazine used following a preplanting application of EPTC has improved the control of wild proso millet and woolly cupgrass.

Bromoxynil (Brominal, Buctril) applied at ¼ pound per acre as an early postemergence spray controls some annual broad-leaved weeds, including annual smartweeds, wild buckwheat, cocklebur, kochia, common lambsquarters, pigweed, common ragweed, Russian thistle, wild sunflower, and wild mustard. Bromoxynil does not control grasses or perennial weeds. To be most effective, bromoxynil must be applied when weeds have 2 to 4 leaves and corn is less than 6 inches tall. Corn leaf burn may occur, especially under conditions of high temperature or high humidity. Follow specific label information.

Table 2. Suggestions for chemical control of weeds in corn

Method of application Chemical-common name (Trade name[1])	Rate—lb/A of active ingredient or acid equivalent broadcast[2]	EPA registration limitations on crop use	Remarks[3]
PREPLANTING INCORPORATED			
Alachlor (Lasso)	2 to 4	None	Preplanting application of alachlor or metolachlor at the high rates is suggested if nutsedge is a problem, but for annual grasses only, shallow incorporation or preemergence application is preferred. Incorporate butylate or EPTC immediately after application. Do not use butylate or EPTC on corn seed stock.
(Lasso II)	2.4 to 3.9		
Atrazine (AAtrex, others)	2 to 3	Do not graze or feed forage for 21 days after treatment.	
Butylate (Sutan+)	4 to 6	None	
Cyanazine (Bladex)	2 to 4	None	
EPTC (Eradicane or Eradicane Extra)	3 to 6	None	
Metolachlor (Dual)	1½ to 3	None	
(Dual 25G)	1½ to 4		
Atrazine + alachlor	1 to 2 + 1½ to 2½	Do not graze or feed forage for 21 days after treatment.	
Atrazine + butylate (Sutazine or tank mix)	1 to 1½ + 3 to 4	Do not graze or feed forage for 21 days after treatment.	
Atrazine + EPTC	1 to 1½ + 3 to 4	Do not graze or feed forage for 21 days after treatment.	
Atrazine + metolachlor (Bicep or tank mix)	1 to 3 + 1¼ to 3	Do not graze or feed forage for 21 days after treatment.	
Cyanazine + alachlor	1 to 2.2 + 2 to 2½	None	
Cyanazine (Bladex) + butylate	1½ to 2 + 3 to 4	None	
Cyanazine + EPTC	1½ to 2 + 3 to 4	None	
Cyanazine + metolachlor	0.8 to 2½ + 1¼ to 2½	None	
PREEMERGENCE			
Alachlor (Lasso)	2 to 3½	None	Atrazine may carry over and affect crops the next year. Other chemicals do not carry over. Because of potential crop injury, do not use preemergence applications of cyanazine, dicamba, or linuron on sandy soils. Linuron is suggested for use only on soils between 1 and 4 percent in organic matter. Use dicamba only on medium- and fine-textured soils with more than 3% organic matter. Propachlor does not persist long enough in sandy soils to give satisfactory weed control.
(Lasso II)	2.4 to 3.9		
Atrazine (AAtrex, others)	1 to 3	Do not graze or feed forage for 21 days after treatment.	
Cyanazine (Bladex)	2 to 4	None	
Metolachlor (Dual)	1½ to 3	None	
Propachlor (Ramrod, Bexton)	4 to 6	None	
Atrazine + alachlor	1 to 2 + 1½ to 2½	Do not graze or feed forage for 21 days after treatment.	
Atrazine + metolachlor (Bicep or tank mix)	1 to 3 + 1¼ to 3	Do not graze or feed forage for 21 days after treatment.	
Atrazine + propachlor	1 to 1½ + 2 to 3-3/4	Do not graze or feed forage for 21 days after treatment.	
Cyanazine + alachlor	1 to 2.2 + 2 to 2½	None	
Cyanazine + metolachlor	0.8 to 2½ + 1¼ to 2½	None	
Cyanazine + propachlor	1 to 1.8 + 2½ to 6	None	
Dicamba (Banvel) + alachlor	½ + 2 to 2½	Do not graze or feed silage prior to milk stage.	
Dicamba + metolachlor	½ + 2 to 2½	Do not graze or feed silage prior to milk stage.	
Linuron (Lorox) + alachlor	½ to 1½ + 1 to 3	Do not graze or harvest immature corn for feed within 12 weeks after treatment.	
Linuron + propachlor	1 to 1½ + 2 to 3	None	
POSTEMERGENCE			
Atrazine (AAtrex, others) + oil	1.2 to 2	Do not graze or feed for forage for 21 days after treatment.	Apply atrazine when weeds are less than 1½ inches tall.
Bentazon (Basagran)	3/4 to 1	None	Apply bentazon when weeds are 2 to 6 inches. Earlier application is more effective on most weeds.
Bentazon + atrazine (Laddok) + oil concentrate	½ to 3/4 + ½ to 3/4 + 1 qt/A	Do not graze or feed for forage 21 days after application.	Controls only broadleafs. Apply when weeds are less than 2 to 4 inches and corn has 1 to 5 leaves.
Cyanazine (Bladex 80W)	2	None	Apply cyanazine when weeds are less than 1½ inches tall and before corn has more than 4 leaves. Use vegetable oil or surfactant under acid conditions only. See label.
Pendimethalin (Prowl) + atrazine	3/4 to 1½ + 1 to 1½	None	Apply spike to 2-leaf stage of corn and up to 1-inch weeds.
Pendimethalin + cyanazine 80W	3/4 to 1½ + 1 to 2	None	
Dicamba (Banvel)	¼	Do not graze or harvest for feed before milk stage.	Apply dicamba before corn is 2 feet tall and not within 15 days of tasseling. Follow drift control precautions on label.
Dicamba + 2,4-D amine	¼ + ¼	Do not graze or harvest for feed before milk stage.	
2,4-D amine	¼ to ½	Do not forage or feed fodder for 7 days following 2,4-D application.	Apply 2,4-D at these rates when corn is 4 inches to 3 feet tall. Use drop nozzles after corn is 8 inches tall. Earlier applications on small weeds are more effective.
2,4-D ester	1/6 to 1/3	Do not forage or feed fodder for 7 days following 2,4-D application.	
2,4-D amine	½ to 1	Do not forage or feed fodder for 7 days following 2,4-D application.	Apply 2,4-D at these rates only after corn is 3 feet tall. Use drop nozzles so only base of stalk is sprayed. Do not apply between tasseling and dough stage of corn.
2,4-D ester	1/3 to 2/3	Do not forage or feed fodder for 7 days following 2,4-D application.	

[1] See table on herbicide names. Trade names are used to identify the herbicide discussed. 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.

[2] These rates will need to be properly interpreted for the formulation you use and for band width and row width if the chemicals are not applied broadcast. See Agricultural Chemcials Fact Sheet No. 5, *How to Calculate Herbicide Rates and Calibrate Herbicide Applicators.* The proper rate depends on such things as soil characteristics, kinds of weeds, size of weeds and crop, temperature, and moisture conditions.

Postemergence Applications

Annual broad-leaved weeds can be controlled with broadcast postemergence applications of ¼ to ½ pound per acre of 2,4-D amine when the corn is 4 to 8 inches tall. More severe onion leafing may occur from 2,4-D applications made in the 2- to 3-leaf stage of the corn.

The ¼-pound rate has been adequate for susceptible weeds and is less dangerous to corn. The ½-pound rate has been satisfactory for moderately resistant weeds, but corn usually has been injured by this rate. Rainfall within 8 hours after application reduces the effectiveness of 2,4-D amines more than the effectiveness of 2,4-D esters. About 1/3 less acid equivalent of 2,4-D esters is needed than of the 2,4-D amines.

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

To reduce the danger of 2,4-D injury when the corn is more than 8 inches tall, avoid spraying the upper leaves and leaf whorl of corn by using drop nozzles between the rows. However, adequate spray coverage of the tops of the weeds is necessary for maximum weed control. If nozzles are directed toward the row from both sides, the herbicide concentration must be reduced to compensate for the double coverage. Do not use spray additives with 2,4-D as corn injury may be increased.

Some injury may result when corn is sprayed with 2,4-D. Brittleness, followed by bending or breaking of stalks, is the most serious type of injury, and it may result in severe stand losses when applications of 2,4-D are followed by a storm or careless cultivation.

Several factors influence the degree of injury resulting from 2,4-D. Hybrids vary in tolerance to 2,4-D. Corn growing rapidly is more susceptible than corn developing under less favorable growth conditions. When temperatures exceed 85° F. just before or at the time of 2,4-D application, the corn is more likely to be injured.

At the rates of application commonly used, the stage of growth at which treatment is made during the period from emergence to tasseling is less critical than the effects of environmental factors.

If broad-leaved weed control is necessary after the last cultivation, 2,4-D ester at ½ pound per acre or 2,4-D amine at 3/4 to 1 pound per acre may be applied using drop nozzles. Do not apply 2,4-D from tasseling to dough stage, or poor kernel set may occur. 2,4-D can be applied at ½ to 1 pound per acre after the dough stage if necessary, but it is more beneficial to control weeds earlier.

Dicamba (Banvel) as a postemergence spray in corn has given better control of Canada thistle and smartweed than 2,4-D with less effect on the corn. Dicamba also controls other broad-leaved weeds except mustard, but it does not control grasses. But when used, dicamba drift has often affected soybeans in the vicinity of treated cornfields.

Dicamba may be used in corn at ¼ pound per acre, either alone or in mixtures with 2,4-D amine at ¼ to ½ pound per acre. The lower rate of dicamba has given satisfactory weed control with less crop effect than the higher rate. Applications can be made until corn is 2 feet tall or until 15 days before tassel emergence, whichever occurs first. Do not use on corn grown for seed. Later applications, especially when corn is tasseling, may result in poor kernel set. Use drops after corn is 8 inches tall. Do not use additives with dicamba.

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

Caution: Soybeans and other broad-leaved plants are very sensitive to dicamba. In recent years, there were many instances in which dicamba drift affected soybeans. Users of dicamba must take special precautions to avoid spray drift at the time of application or vapor drift for several days after application. Spray drift can be minimized by reducing sprayer pressure, increasing water volumes with larger nozzles, and using drop nozzles to keep the spray release as low as possible and still give weed coverage. Drift potential is greater with windy or high temperature conditions.

Applications are not recommended at temperatures above 85° F. Spray and vapor drift effects on soybeans can be reduced by spraying corn early in the season when temperatures are lower and before soybeans have emerged, or when they are small. Do not graze or harvest for dairy feed prior to the milk stage of the grain if corn is treated with dicamba.

Directed Sprays

These cannot be used on small corn. Therefore, early season weed growth must be controlled by some other means (rotary hoe, harrowing, herbicides, or cultivation) to prevent yield losses from early weed competition. Directed sprays are considered emergency measures to control heavy weed stands within corn rows.

Specially designed equipment has been developed to make directed spray applications in corn. When applying directed sprays, the nozzles should be mounted so that wheels, skids, cultivator shanks, or similar devices control the nozzle height. To minimize spray contact with corn leaves, use attachments to lift the corn leaves and direct the spray to the base of corn plants and onto weeds in the row.

Directed sprays of linuron at 1½ pounds per acre can be applied when the corn is not less than 15 inches tall. Ametryne (Evik) is cleared for use as a directed spray at 1.6 to 2 pounds per acre after corn is 12 inches tall. Do not apply ametryne later than 3 weeks prior to tasseling. Ametryne should not be used on sandy soils. Adding a wetting agent is necessary for effective weed control with linuron or ametryne.

Care must be taken in application to minimize spray on the corn leaves while covering most of the weed foliage with the spray. Either chemical will kill the corn leaf tissue it contacts and, if leaf kill is extensive, corn yields may be reduced.

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SOYBEAN WEED CONTROL UPDATE

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The 1984 revision of Extension Folder 580 is not yet available but a copy of E.F. 580-1983 is included as a reference with this update. Revisions for 1984 are relatively minor. In Table 1, "Effectiveness of Herbicides on Major Weeds in Soybeans," herbicide effectiveness ratings on sandbur have been included. Full EPA clearances for the use of sethoxydim (POAST) and fluazifop (FUSILADE) to control annual and perennial grasses in soybeans were received in 1983. Revisions are being made in E.F. 580-1984 to indicate these registration approvals. Research is under way on six herbicides that have similar selectivity for postemergence control of annual and perennial grasses in soybeans. None of these compounds are expected to receive EPA registration in 1984.

Ethylfluralin (Sonalan), related chemically to trifluralin (Treflan), fluchloralin (Basalin) and pendimethalin (Prowl), has similar herbicidal characteristics to these chemicals and can be used in a similar manner on soybeans. Preplanting soil incorporation is required for maximum herbicidal effectiveness. It is slightly less active than Treflan so higher application rates are necessary to obtain satisfactory weed control. Sonalan gives partial control of eastern black nightshade while Treflan, Basalin and Prowl have little effect on this weed. CAUTION: Sonalan has not yet been registered for use on soybeans but EPA clearance is expected prior to the 1984 growing season. A change in the Treflan label now permits fall applications, if applications are made after October 15. This gives more flexibility in the use of Treflan on soybeans.

AC-252214 is a promising new herbicide not yet cleared for weed control in soybeans. Evaluation trials at Waseca, Lamberton, Morris, and Rosemount, MN in 1983 demonstrated that this herbicide can provide effective control of both annual broadleaf and grassy weeds at rates of 1/8 to 3/8 pounds per acre. It gave satisfactory weed control in preplanting incorporated, preemergence and postemergence applications. Herbicidal activity was greater on broadleaf weeds than on grasses. Soybean tolerance appeared to be satisfactory.

New postemergence grass herbicides evaluated in 1983 were SC-1084, HOE-33171, haloxyfop and CGA-82725. Soybean tolerance was satisfactory with all of these herbicides. All are very effective in controlling wild proso millet and wolly cupgrass. However, wild proso millet control with these herbicides under low rainfall was poorer than in previous years. Generally, higher rates were required for foxtail control. Quackgrass is still more difficult to control; requiring higher rates and, frequently, a second application.

EXTENSION FOLDER 580—1983

Cultural and Chemical Weed Control in Soybeans

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

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

Cultural Practices

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

Herbicides

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

Herbicide mixtures are used to overcome the limitations of single chemicals. Certain mixtures may (1) control more kinds of weeds, (2) give more consistent performance with different soils and weather conditions, (3) lessen soil residue problems, (4) increase persistence enough to give full season weed control, or (5) reduce crop injury. See table 2 for labeled tank-mixes of herbicides suggested for use in Minnesota. Only those mixtures that have been field tested under local conditions should be used. The use of some mixtures may result in poor weed control or crop injury.

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

Preplant Incorporated Applications

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

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

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

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

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

Preplant Incorporated or Preemergence Applications

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

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

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

	Preplant incorporated								Preemergence							Postemergence								
	Alachlor (Lasso)	Chloramben (Amiben)	Fluchloralin (Basalin)	Metolachlor (Dual)	Metribuzin (Sencor or Lexone)	Pendimethalin (Prowl)	Trifluralin (Treflan)	Vernolate (Vernam)	Alachlor (Lasso)	Chloramben (Amiben)	Chlorpropham (Furloe Chloro IPC)	Naptalam + dinoseb (Dyanap)	Linuron (Lorox)	Metolachlor (Dual)	Metribuzin (Sencor or Lexone)	Acifluorfen (Blazer)	Bentazon (Basagran)	2,4-DB (Butoxone or Butyrac 200)	Diclofop (Hoelon)	Dinoseb (Premerge)	Naptalam (Alanap L)	Naptalam + dinoseb (Dyanap)	Fluazifop (Fusilade)	Sethoxydim (Poast)
Crop tolerance	G	G	F/G	G	F	F/G	F/G	F	G	G	G	P	F	G	F	F	G	P	G	P	G	F	G	G
Grasses																								
Barnyardgrass	G	G	G	G	F	G	G	G	G	F/G	P	P	F	G	F	P	N	N	G	P	P	P	G	G
Woolly cupgrass	G	G	G	G	P	G	G	F/G	G	G	P	P	P	G	P	P	N	N	P	P	P	P	G	G
Giant foxtail	G	G	G	G	F	G	G	G	G	F/G	P	P	F	G	F	P	N	N	G	P	P	P	G	G
Green foxtail	G	G	G	G	F	G	G	G	G	F/G	P	P	F	G	F	P	N	N	G	P	P	P	G	G
Yellow foxtail	G	G	G	G	F	G	G	G	G	F/G	P	P	F	G	F	P	N	N	F	P	P	P	G	G
Wild proso millet	F	F	F	F	P	F	F	F	F	F	P	P	P	F	P	P	N	N	P	P	P	P	G	G
Nutsedge	G	P	N	G	P	N	N	G	F	P	N	P	P	F	P	P	G	N	P	P	P	P	N	N
Quackgrass	N	N	P	N	P	P	P	F	N	N	N	P	P	N	P	N	N	N	N	P	N	P	F	F
Broadleafs																								
Canada thistle	N	N	N	N	P	N	N	N	N	N	N	P	P	N	P	P	G	P	N	P	P	P	N	N
Cocklebur	P	P	N	N	F	N	N	P	N	P	P	F	P	N	F	F	G	F	N	F	P	F	N	N
Kochia	P	G	G	P	G	G	G	—	P	G	P	F	F	P	G	—	—	—	N	—	F	F	N	N
Lambsquarters	F/P	G	G	F/P	G	G	G	G	F/P	G	P	F	G	F/P	G	P	F	P	N	P	—	F	N	N
Venice mallow	P	G	P	P	G	P	P	G	P	G	P	—	G	P	G	—	G	P	N	—	—	—	N	N
Mustard	P	F	P	P	G	N	N	F	P	F	F	G	G	P	G	G	G	P	N	G	—	G	N	N
Eastern black nightshade	F	F	P	F	P	P	P	P	G	G	P	—	P	G	P	G	F	P	N	G	—	—	N	N
Hairy nightshade	F	F	F	F	P	P	P	P	G	G	P	—	—	F	P	F	F	—	N	—	—	—	N	N
Pigweed	G	G	G	G	G	G	G	G	G	G	P	F	G	G	G	G	P	P	N	P	—	F	N	N
Common ragweed	P	G	N	P	G	N	N	P	P	G	P	—	G	P	G	G	G	P	N	F	—	—	N	N
Giant ragweed	P	F	N	P	F	N	N	P	P	F	P	—	F	P	F	G	F	F	N	—	—	—	N	N
Smartweed	P	G	P	P	G	F	P	P	P	G	G	F	F	P	G	G	G	P	N	G	—	F	N	N
Wild sunflower	P	P	N	P	F	N	N	P	P	P	P	—	P	P	F	F/G	G	P	N	F	—	—	N	N
Velvetleaf	P	F	N	P	F	F	N	F	P	F	P	—	F	P	F	P	G	P	N	P	—	—	N	N

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

Table 2. Labeled tank mixes[1] of suggested incorporated and preemergence herbicides for soybeans.

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

[1]See table 1 for effectiveness of herbicides on major weeds and table 3 for additional use information.

L = labeled; — = unlabeled

Table 3. Suggested herbicides for weed control in soybeans.

Chemicals	Formu-lation(s)	Pounds per acre of active ingredient or acid equivalent broadcast	Application time(s)	Remarks	Environmental Protection Agency registration limitations on crop use
Fluchloralin (Basalin)	4 lb/gal L	½ to 1½	Preplant incorp.	Must be incorporated	Do not graze or feed forage
Pendimethalin (Prowl)	4 lb/gal L	½ to 1½	Preplant incorp.	Incorporate to reduce crop injury	None
Trifluralin (Treflan)	4 lb/gal L	½ to 1	Preplant incorp.	Must be incorporated	None
Vernolate (Vernam)	7 lb/gal L	2 to 3	Preplant incorp.	Incorporate immediately	None
Alachlor (Lasso)	4 lb/gal L 15% G	2 to 4	Preplant incorp. or preemergence	Incorporate for nutsedge control	None
Chloramben (Amiben)	1.8 lb/gal L, 75% DS, 10% G	1.8 to 2.7	Preplant incorp. or preemergence		None
Chlorpropham (Furloe Chloro IPC)	4 lb/gal L 10% G	2 to 3	Preplant incorp. or preemergence	For smartweed control	None
Metolachlor (Dual)	8 lb/gal L	1½ to 3	Preplant incorp. or preemergence	Incorporate for nutsedge control	None
Metribuzin (Sencor, Lexone)	4 lb/gal L 50% WP 75% DF	¼ to ¾	Preplant incorp. or preemergence	Increased soybean injury potential at high use rates. Use in combinations at lower rates. See label for soil use restrictions. Soybean injury may occur on akaline soils, sandy soils and where atrazine residues are present.	None
Linuron (Lorox)	50% WP	½ to 2½	Preemergence	Increased soybean injury potential at high use rates. Use in combinations at lower rates. Do not use on soils with organic matter higher than 5 percent or lower than ½ percent	None
Acifluorfen (Blazer)	2 lb/gal L	⅜ to ½	Early postemergence (soybeans in first trifoliolate, weeds less than 2 inches tall and 4 true leaves)	Controls many annual broadleafs, including black nightshade	Do not graze or use soybean hay or forage
Bentazon (Basagran)	4 lb/gal L	¾ to 1½	Early postemergence (see label)	Controls most annual broadleafs, Canada thistle, nutsedge	
2,4-DB amine	2 lb/gal L	⅕	Postemergence directed	For cocklebur control	Do not harvest within 60 days after application
Diclofop (Hoelon)	3 lb/gal L	¾ to 1¼	Early postemergence when soybeans are between the first and sixth trifoliolate leaf stage, before annual grasses exceed 4 leaves, before volunteer corn exceeds 10 inches	Controls many annual grasses and volunteer corn	Do not graze or use soybean hay or forage

[1] *G = granular; L = liquid; WP = wettable powder; DF = dry flowable.*

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

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

Metribuzin has provided good control of several common hard-to-control broadleaf weeds, but it has marginal crop safety. Potential crop injury can be decreased by using reduced rates of metribuzin with another herbicide. See the label for restrictions on various soils and soybean varieties. Soybean injury is more likely on alkaline soils, sandy soils, where atrazine residues are present, or if used with vernolate.

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

Pendimethalin (Prowl) applied preemergence to soybeans has controlled annual grasses and certain broadleaved weeds; however, callusing and brittleness of soybean stems has occurred. Such injury has not occurred when pendimethalin was incorporated.

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

Postemergence

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

Acifluorfen can be applied once (early postemergence) during a season to control broadleaf weeds in soybeans, including pigweed, wild mustard, Pennsylvania smartweed, common ragweed, giant ragweed, black nightshade, and buffalobur. Application must be made before the weed exceeds the maximum labeled leaf stage. Later treatment will result only in temporary control. Weeds treated beyond the labeled leaf stage may regrow from surviving roots and stems.

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

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

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

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

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

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

Fluazifop (Fusilade) and sethoxydim (Poast) are new postemergence chemicals for annual and perennial grass control in soybeans. Soybeans have good tolerance. Neither chemical controls broad-leaved weeds. An oil concentrate is used with the spray to improve performance. Both chemicals are expected to have full clearance for use in 1983.

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REDUCED EFFECTIVENESS WITH REPEATED ANNUAL APPLICATIONS OF ERADICANE AND ERADICANE EXTRA

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Wild proso millet (Panicum miliaceum L.) is a difficult to control annual grassy weed that is on the increase in Minnesota. Germination occurs over an extended period resulting in seedling establishment after herbicides have dissipated. Some herbicides dissipate faster with repeated annual applications and these results can be observed with herbicides used to control wild proso millet. Two studies will be discussed that relate to repeated annual applications of Eradicane ($EPTC^+$) and Eradicane Extra ($EPTC^+$ + Extender).

One study was initiated on the John Dosdall farm near Morris, Minnesota, in 1981 to determine effectiveness of repeated applications of Eradicane and Eradicane Extra for control of wild proso millet in corn in a field that had 4 consecutive years of EPTC or Eradicane history prior to this experiment. During the conduct of this experiment, Eradicane and Eradicane Extra were applied at 6 lb/A during each year of the study.

Evaluation of percent control of wild proso millet in 1983 (Tables 1 and 2) showed that control was reduced as the evaluation date was delayed. This is primarily due to an extended period of germination for wild proso millet. Percent control of wild proso millet is also dependent on which herbicide was applied in 1983 and the history in 1981 and 1982 of that applied herbicide. Percent control of wild proso millet with Eradicane was reduced with increased use in the previous 2 years. Percent control of wild proso millet with Eradicane Extra was also reduced with increased use of Eradicane Extra in the previous 2 years.

Table 1. 1983 percent control wild proso millet with Eradicane and with various years of history of Eradicane use.

		Years of Eradicane History			
			1981		1981
				1982	1982
Herbicide	Evaluated	1983	1983	1983	1983
		- - - - % Control WPM - - - -			
Eradicane	6/26	72	66	50	45
Eradicane	8/15	20	18	0	6

Table 2. 1983 percent control wild proso millet with Eradicane Extra and with various years of history of Eradicane Extra use.

		Years of Eradicane Extra History			
			1981		1981
				1982	1982
Herbicide	Evaluated	1983	1983	1983	1983
		- - - - - % Control WPM - - - - -			
Eradicane Extra	6/26	82	60	65	33
Eradicane Extra	8/15	50	30	37	10

Percent control of wild proso millet in 1982 and 1983 with Eradicane and Eradicane Extra with 1981 histories of Eradicane, Eradicane Extra and a check are given in Table 3. The least effective sequence is an application of Eradicane Extra in 1981 followed by Eradicane in 1982 and 1983.

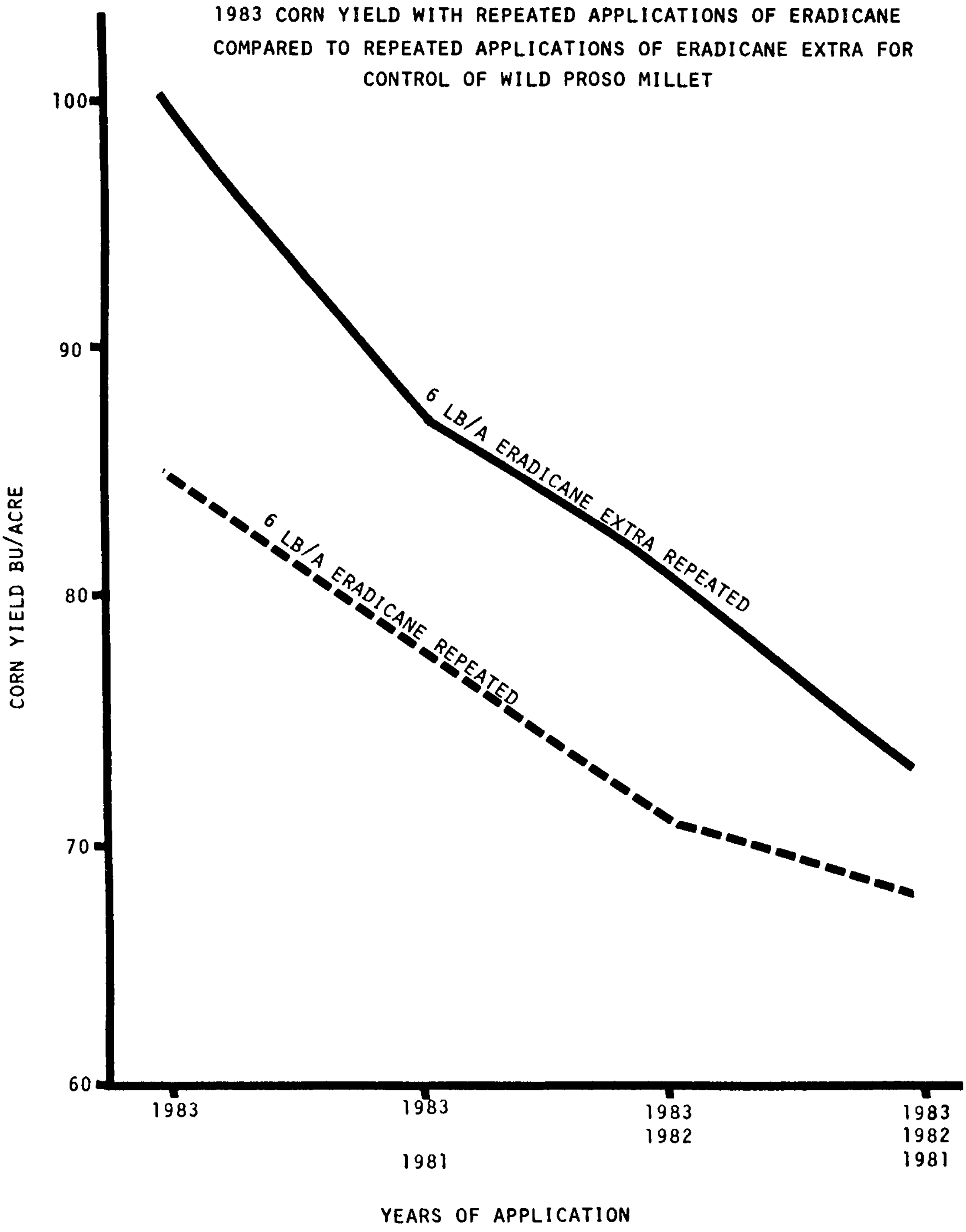
Table 3. Early evaluation of percent control wild proso millet with Eradicane and Eradicane Extra applications in 1982 and 1983 with various histories of herbicide application in 1981.

	Eradicane		Eradicane Extra	
1981 Treatments	1982	1983	1982	1983
	- - - - - % Control WPM - - - - -			
Check	73	72	77	82
Eradicane	53	66	70	80
Eradicane Extra	7	27	67	60

The following figure presents the corn yield with repeated applications of Eradicane compared with repeated applications of Eradicane Extra for control of wild proso millet. Eradicane Extra used for control of wild proso millet resulted in higher corn yields than Eradicane in all repeated history combinations. Use of both herbicides for control of wild proso millet resulted in reduced corn yields with increased repeated history of use of the herbicides.

Another study was initiated in 1980 at the West Central Experiment Station, Morris, Minnesota, in a field with a 1972-76 prior history of carbamate insecticide use. This study was designed to determine effectiveness of repeated annual applications of herbicide and insecticide combinations for weed control and control of corn rootworm. Eradicane and Eradicane Extra were included as herbicides in this experiment. The same herbicide and insecticide combinations were applied in each year, 1980-1983. In the spring of 1983 before applying 1983 treatments, soil samples from these treatments were sent to Dr. Gordon Harvey, University of Wisconsin, Madison, Wisconsin. In his lab, Dr. Harvey applied 6 ppm of Eradicane and 6 ppm of Eradicane Extra to each soil sample, held at 77°F, and then analyzed after 4 days and 7 days by gas chromatograph for percent of herbicide remaining in the soil sample. Table 4 gives the results of this laboratory determination. Much less herbicide remained after 7 days than after 4 days in this laboratory determination. With Eradicane applied at 6 ppm, both Eradicane and Eradicane Extra history of use decreased the percent Eradicane remaining in the soil sample. With Eradicane Extra applied at 6 ppm, the greatest reduction in percent Eradicane Extra remaining was with an Eradicane Extra history of use. The true check (no history because sampled in an adjoining grove of trees) had the highest percent Eradicane and Eradicane Extra remaining.

After the 1983 treatments were applied soil samples were also taken every 10-14 days this summer from this experiment and sent to Dr. Dave Walgenback, Dr. Duane Matthees, and Dr. Kennedy Gauger, South Dakota State University, Brookings, South Dakota. They analyzed these soil samples for pesticide degradation and for soil bacteria isolates that were capable of degrading certain insecticides. Table 5 shows that all insecticides can be degraded by some of the 257 total bacteria isolates collected from the Morris, Minnesota, and Centerville, South Dakota, soil samples. All the insecticides


1983 CORN YIELD WITH REPEATED APPLICATIONS OF ERADICANE
COMPARED TO REPEATED APPLICATIONS OF ERADICANE EXTRA FOR
CONTROL OF WILD PROSO MILLET
CORN YIELD BU/ACRE
100
90
80
70
60
6 LB/A ERADICANE EXTRA REPEATED
6 LB/A ERADICANE REPEATED
1983
1983
1981
1983
1982
1983
1982
1981
YEARS OF APPLICATION

had some bacteria isolates that did not degrade the specific insecticide. This winter the 257 soil bacteria isolates will be tested with herbicides to determine ability to degrade herbicides.

Table 4. Comparison of Eradicane and Eradicane Extra degradation analyzed from soil samples from an experiment with repeated annual applications of herbicide-insecticide combinations from 1980-1982.[1]

3 years (1980-1982) of consecutive history of		% Eradicane[2] remaining		% Eradicane Extra[2] remaining	
Herbicide	Insecticide	4 days	7 days	4 days	7 days
True check (no history)		88	59	99	80
Eradicane	Check	54	2	78	60
Eradicane	Furadan	59	3	87	73
Eradicane	Amaze	54	2	93	76
Eradicane Extra	Furadan	47	5	84	15
Eradicane Extra	Amaze	73	5	90	16

[1]Field had 5 years (1972-1976) of carbamate insecticide use prior to initiation of this experiment.

[2]Eradicane and Eradicane Extra applied at 6 ppm in lab at University of Wisconsin, Madison (Dr. Gordon Harvey) held at 77°F, then analyzed residues by gas chromatograph.

Table 5. Number of soil bacteria[1] isolates of 257 total observed from WCES, Morris, Minn., and Centerville, So. Dak., capable of degrading certain insecticides.

	Degrading Score 0-5 (0 = none, 5 = most)		
Insecticide	0	4	5
	- - Number of Bacteria Isolates - -		
Amaze	26	5	28
Counter	46	13	13
Dyfonate	23	6	19
Mocap	72	0	3
Thimet	44	6	13
Furadan	44	6	13
Lance	58	6	15

[1]Isolated from soil samples sent to South Dakota State University, Brookings (Dr. Dave Walgenback, Dr. Duane Matthees, Dr. W. Kennedy Gauger) observed which isolates would degrade certain insecticides.

Conclusions:

1) Later dates of evaluation of percent control of wild proso millet resulted in lower percent control ratings for both Eradicane and Eradicane Extra.

2) Percent control of wild proso millet and corn yields were reduced with increased history of both Eradicane and Eradicane Extra.

3) The least effective herbicide sequence was an application of Eradicane Extra in 1981 followed by an application of Eradicane in 1982 or 1983.

4) Under laboratory conditions, a history of Eradicane or Eradicane Extra reduced the percent of herbicide remaining in the soil sample after 4 and 7 days.

5) Some soil bacteria isolates were able to degrade all insecticides tested and some isolates did not degrade certain insecticides.

6) Grateful that pesticides do break down over time in our soils. We do not want to use any very persistent pesticides. The only problem is that some pesticides break down faster in some situations than would be expected.

RESEARCHING TREFLAN CARRYOVER

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OBJECTIVES AND PROCEDURES

Corn growers have reported incidences of Treflan injury on corn following soybeans treated with this herbicide. Injury has been primarily associated with reduced tillage practices. Studies were conducted at Lamberton and Waseca, Minnesota, in 1982 and 1983 to evaluate the effects of tillage practices following soybeans on Treflan injury in corn. The soil type at Lamberton was a Webster silty clay loam with 4 to 5 percent organic matter. At Waseca the soil type was a Webster clay loam with 6 to 7 percent organic matter. Six tillage treatments were evaluated: (1) zero fall and spring tillage, (2) zero fall tillage with one field cultivation just prior to planting, (3) fall ridging to a height of approximately 6 inches using a 'Buffalo Til' cultivator with no secondary tillage before planting with a 'Buffalo Til' planter set to remove most of the ridge in the planting process, (4) fall disking to a depth of approximately 4 inches with a tandem finishing disk with 20-inch diameter blades and field cultivating once just prior to planting, (5) fall chisel plowing to a depth of 7 to 8 inches with a chisel plow equipped with 4-inch twisted shovels and field cultivating once just prior to planting, and (6) fall moldboard plowing to a depth of 8 to 9 inches and field cultivating once just prior to planting.

Two studies were conducted in 1983. The first study, simulated Treflan carryover, was conducted on different sites in 1982 and 1983 at both locations and received 0.75 lb/A of Treflan in late May of 1981 and 1982. This study was initiated after soybean harvest as a randomized complete block (4 to 6 replications) with a split plot arrangement of treatments. Tillage was the main plots and subplots consisted of either no additional fall applied herbicide or 0.75 lb/A Treflan applied in early November of 1981 and 1982. The Treflan was incorporated once with a tandem disk before the fall tillage treatments listed above were installed. The zero fall tillage treatments did not receive the additional fall applied Treflan.

At Waseca a second study, true Treflan carryover, was conducted in 1983. Treflan rates of 0, 0.75, 1.0 and 2.0 lb/A were applied May 25, 1982 and incorporated prior to planting soybeans. The above mentioned tillage practices were superimposed on these Treflan treatments after soybean harvest. No additional Treflan was fall applied in this study. This study was conducted as a randomized complete block with a split plot arrangement of treatments and four replications. Tillage was the main plots and Treflan rates were the subplots.

In all studies two chisel plow treatments were included. One chisel treatment received no compaction other than that done as a result of tillage. Another chisel treatment was compacted with a tractor weighing approximately 15,000 lb and equipped with dual rear wheels. The entire plot area was wheel-tracked twice.

The till-plant treatments were planted with a 'Buffalo Til' planter set to remove most of the ridge in the planting process. All other plots were planted with a John Deere 'Max Emerge' planter equipped with fluted coulters.

All studies were planted to Pioneer Brand '3732' hybrid seed corn. Planting dates were May 4, 1982 and May 10, 1983 for Lamberton, and April 30, 1982 and April 29, 1983 for Waseca. Seeding rates were approximately 24,000 seeds/acre and 26,500 seeds/acre at Lamberton and Waseca, respectively.

Rainfall at both locations was above normal in May of both years. Each year a period of drought followed in mid-summer. Temperature was slightly above normal in May of 1982 at both locations. However, in June of 1982, temperatures were 4 to 5^{o}F below normal. June of 1983 was a very cool month at both locations resulting in slow corn growth. Rainfall for the period April through September was 22.9 and 18.6 inches for 1982 and 1983, respectively, at Lamberton, and 21.4 and 27.8 inches for 1982 and 1983, respectively, at Waseca.

RESULTS AND DISCUSSION

In all studies Treflan resulted in a slight delay (3 days) in corn emergence but did not influence final stands (tables 1-4). The till-plant system resulted in the most rapid emergence. Two reasons are believed responsible for this. First, planting depth was somewhat shallower with the till-plant system than with the other planter and secondly, the elevated ridges warmed up more quickly in the spring. The tillage x Treflan interaction was not significant for final stands. Early plant injury was significantly influenced by tillage in all studies (tables 1 and 2). There were significant tillage x Treflan interactions for early injury that were not consistent among locations and years. Significant early injury in the true Treflan carryover study was observed only for the 2 lb/A rate of Treflan (table 2). Plant height in mid-July was reduced by fall applied Treflan in the simulated study (table 1) and by the 2 lb/A rate of Treflan application in the true carryover study (table 2). Mature plant height was generally not affected by either tillage or Treflan. Tillage affected grain yield in 1982 at both locations and in the true Treflan carryover study in 1983 (tables 3 and 4). The additional fall applied Treflan significantly reduced grain yields at both Waseca and Lamberton. In the true carryover study at Waseca, the 2 lb/A Treflan rate resulted in significantly lower yields (6 bu) than the other Treflan rates which were equal in yield.

Although the moldboard plow tended to reduce Treflan carryover injury, this tillage practice following soybeans is not recommended because it leaves the soil subject to severe erosion potential. More emphasis needs to be placed on selecting the appropriate herbicide rate for the soil type. Frequently, a grower will select the rate based on the finest textured, highest organic matter soil in the field. If the field has coarse textured soils lower in organic matter, these spots are good candidates for carryover where corn follows soybeans treated with Treflan. These lighter colored soils are frequently associated with slopes. As the herbicide is being applied, usually with a tillage tool, reduced ground speed on the hillsides may result in applying more than the target rate on these soils. Since these soils should receive less, not more, herbicide than the fine textured, high organic matter soil in a field, it is not surprising that carryover occurs.

More attention should be given to uniform herbicide application across the sprayer boom. If nozzles are not putting out the proper pattern or if they are overlapping too much or not enough, a non-uniform application results. If there are streaks or "hot spots" in a pattern and the soil is not disturbed much with tillage, these "hot spots" will remain and will likely show up as streaks of corn injury the following year.

Many of the carryover problems could probably be avoided by selecting proper rates, making uniform herbicide application and making sure that the herbicide is incorporated properly. There is some indication that corn hybrid may differ in their degree of tolerance to Treflan. Difference among hybrids is hard to evaluate and data is lacking to provide enough information to allow farmers to select "resistant" hybrids. Growers should still base their hybrid selection on yield performance, maturity, lodging, etc.

The best practice is to avoid potential carryover problems whenever possible. Be sure to calibrate your sprayer properly, checking for uniform output from each nozzle. In many cases it may be possible to get adequate weed control with less herbicide than you have been using. This is particularly true on fields with variable soil types. On these fields it may be necessary to use a spray monitor that allows the rate to be adjusted on the go. This would allow one to reduce rates where appropriate.

Table 1. Influence of SIMULATED Treflan carryover and tillage on corn stand, injury, and plant height at Waseca and Lamberton in 1982 and 1983.

Tillage		% Stand[a]				% Injury				Plant Height (inches)			
		Fall Treflan(lb/A)				Fall Treflan(lb/A)				Fall Treflan(lb/A)			
Fall	Spring	0		0.75		0		0.75		0		0.75	
1982		Wa.	La.	Wa.	La.	Wa.	La.	Wa.	La.	Wa.	La.	Wa.	La.
Zero	Zero	42	69	--	--	6	35	--	--	48	92	--	--
Zero	Field Cult.	42	97	--	--	3	28	--	--	49	95	--	--
Ridge	Till-Plant	74	94	60	94	3	20	18	40	55	94	50	88
Disk	Field Cult.	28	92	18	67	3	30	42	50	47	90	38	72
Chisel	Field Cult.	28	84	12	74	0	30	51	58	49	91	38	71
Chisel	Field Cult.[b]	23	86	7	71	8	30	48	55	45	92	37	72
Moldboard	Field Cult.	29	92	32	84	0	18	14	40	49	95	48	88
LSD(.05) Tillage	Waseca	11.4				8.0				9.1			
	Lamberton	7.4				6.0				4.7			
Significance level for Treflan													
	Waseca	94				99				99			
	Lamberton	99				99				99			
1983													
Zero	Zero	49	106	--	--	8	0	--	--	44	52	--	--
Zero	Field Cult.	44	112	--	--	4	8	--	--	44	46	--	--
Ridge	Till-Plant	115	94	116	94	1	4	27	8	47	51	38	50
Disk	Field Cult.	52	105	31	110	4	9	9	28	42	49	38	34
Chisel	Field Cult.	42	117	40	108	2	15	21	30	43	45	36	35
Chisel	Field Cult.[b]	42	116	24	112	7	10	20	34	43	44	37	38
Moldboard	Field Cult.	50	100	46	103	4	16	10	28	44	39	31	34
LSD(.05) Tillage	Waseca	15				NS				NS			
	Lamberton	6				10				6			
Significance level for Treflan													
	Waseca	98				99				99			
	Lamberton	34				99				99			

[a]% stand on May 13, 1982 at Waseca and May 19, 1982 at Lamberton. % stand May 20, 1983 at Waseca and June 6, 1983 at Lamberton. Data calculated as % of the number of plants at harvest in the moldboard plow treatment with no fall Treflan.

[b]These plots were compacted in the spring before final seedbed preparation with a tractor weighing approximately 15,000 lb and equipped with dual rear wheels. The entire plot was wheel-tracked twice.

Table 2. Influence of four rates of Treflan application in 1982 and tillage on corn stand, injury, and plant height at Waseca in 1983.

Tillage		1982 Treflan(lb/A)				1982 Treflan(lb/A)				1982 Treflan(lb/A)			
		0	0.75	1.0	2.0	0	0.75	1.0	2.0	0	0.75	1.0	2.0
Fall	Spring	% Stand[a]				% Injury				Plant Height (in.)			
Zero	Zero	52	42	42	54	3	4	5	15	35	31	33	31
Zero	Field Cult.	28	27	28	11	3	4	4	20	35	34	33	29
Ridge	Till-Plant	86	81	94	92	4	8	9	34	37	34	33	26
Disk	Field Cult.	29	37	25	10	1	5	7	20	37	35	33	29
Chisel	Field Cult.	38	31	37	20	2	2	8	29	35	34	31	28
Chisel	Field Cult.[b]	30	41	19	18	2	5	6	19	33	35	33	29
Moldboard	Field Cult.	46	32	31	38	1	2	2	11	34	32	33	31
LSD(.05)	Tillage	9				3				NS			
	Treflan rate	7				3				3.5			

[a]% stand on May 18, 1983. Calculated as the % of the final stand in the moldboard plow plots with no Treflan.

[b]These plots were compacted in the spring before final seedbed preparation with a tractor weighing approximately 15,000 lb and equipped with dual rear wheels. The entire plot was wheel-tracked twice.

Table 3. Influence of four rates of Treflan application in 1982 and tillage on final stands, grain moisture, and grain yield at Waseca in 1983.

Tillage		1982 Treflan(lb/A)				1982 Treflan(lb/A)				1982 Treflan(lb/A)			
		0	0.75	1.0	2.0	0	0.75	1.0	2.0	0	0.75	1.0	2.0
Fall	Spring	% Stand[a]				% Grain H_2O				Yield (bu/A)			
Zero	Zero	93	98	93	93	22.6	23.9	23.6	23.3	124	119	123	119
Zero	Field Cult.	105	101	101	100	24.2	24.2	24.5	24.6	120	130	125	116
Ridge	Till-Plant	90	93	97	93	21.6	21.6	22.0	24.4	113	114	115	112
Disk	Field Cult.	103	101	106	99	22.9	23.5	24.2	24.2	111	112	119	105
Chisel	Field Cult.	104	101	100	93	23.0	23.8	23.8	25.5	125	124	124	116
Chisel	Field Cult.[b]	104	101	100	93	23.7	23.8	24.0	24.8	134	125	126	123
Moldboard	Field Cult.	100	101	101	110	24.5	25.4	25.3	25.2	133	128	133	128
LSD(.05)	Tillage	5				1.1				10.5			
	Treflan rate	NS				0.5				5.1			

[a]% stand final stand. Calculated as the % of the final stand in the moldboard plow plots with no Treflan.

[b]These plots were compacted in the spring before final seedbed preparation with a tractor weighing approximately 15,000 lb and equipped with dual rear wheels. The entire plot was wheel-tracked twice.

Table 4. Influence of SIMULATED Treflan carryover on final stands, grain moisture, and grain yield at Waseca and Lamberton in 1982 and 1983.

Tillage		% Stand[a]				% Grain H_2O				Yield (bu/A)			
		Fall Treflan(lb/A)				Fall Treflan(lb/A)				Fall Treflan(lb/A)			
Fall	Spring	0		0.75		0		0.75		0		0.75	
1982		Wa.	La.	Wa.	La.	Wa.	La.	Wa.	La.	Wa.	La.	Wa.	La.
Zero	Zero	92	86	--	--	26.6	22.0	--	--	170	85	--	--
Zero	Field Cult.	100	100	--	--	26.3	22.9	--	--	162	117	--	--
Ridge	Till-Plant	94	92	90	90	26.4	20.9	27.0	22.4	170	114	165	106
Disk	Field Cult.	100	97	91	92	27.1	24.4	27.5	28.1	166	112	156	76
Chisel	Field Cult.	102	94	94	94	26.5	23.3	28.0	25.5	174	117	155	73
Chisel	Field Cult.[b]	96	98	94	99	27.4	22.6	28.3	26.6	166	118	153	81
Moldboard	Field Cult.	100	100	94	91	26.2	21.8	26.6	22.8	173	114	167	105
LSD(.05) Tillage	Waseca	NS				0.6				7.8			
	Lamberton	NS				1.8				8.4			
Significance level for Treflan													
	Waseca	97				99				99			
	Lamberton	95				99				99			
1983													
Zero	Zero	98	106	--	--	25.1	22.6	--	--	131	92	--	--
Zero	Field Cult	104	112	--	--	25.4	25.3	--	--	141	94	--	--
Ridge	Till-Plant	117	94	120	94	22.7	23.6	24.3	25.7	140	88	127	80
Disk	Field Cult.	106	105	102	110	26.0	27.0	25.0	30.1	139	95	133	85
Chisel	Field Cult.	102	117	105	109	24.4	25.8	25.3	32.6	134	95	124	84
Chisel	Field Cult.[b]	103	116	105	112	25.8	27.2	26.7	32.8	127	91	119	88
Moldboard	Field Cult.	100	100	103	104	24.7	30.4	25.4	31.1	141	83	131	88
LSD(.05) Tillage	Waseca	7				1.2				NS			
	Lamberton	6				3.5				NS			
Significance level for Treflan													
	Waseca	52				98				99			
	Lamberton	34				99				88			

[a]% stand at harvest. Data calculated as % of the number of plants at harvest in the moldboard plow treatment with no fall applied Treflan.

[b]These plots were compacted in the spring before final seedbed preparation with a tractor weighing approximately 15,000 lb and equipped with dual rear wheels. The entire plot was wheel-tracked twice.

CONTROLLED DROPLET APPLICATOR RESULTS

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OBJECTIVES AND PROCEDURES

The objectives of these studies were to compare a Control Droplet Applicator (CDA) with a hydraulic sprayer and to evaluate soybean oil as a herbicide carrier for low volume herbicide application. These studies were conducted on a Webster clay loam soil containing 6 to 7 percent organic matter at Waseca, MN, and on a Doland silt loam containing 4 to 5 percent organic matter at Morris, MN. These studies were conducted as randomized complete block experiments with four replications and a plot size of 15 x 55 feet. Only 10 x 55 feet of each plot was treated with herbicide with an untreated border between plots. Four experiments were conducted with two rates of each of four herbicides: Lasso preemergence (1.5 and 3.0 lb/A), Basagran postemergence (0.38 and 0.75 lb/A), Poast postemergence (0.075 and 0.15 lb/A), and Treflan preplant incorporated (0.38 and 0.75 lb/A). Emulsifiable concentrated formulations of Lasso, Poast and Treflan and a water soluble formulation of Basagran were used.

The Lasso and the Treflan studies were planted on May 26 and the Basagran and Poast studies were planted on May 24 at Waseca. In all studies at Waseca 'Hardin' soybeans were planted in rows 30 inches apart. On May 25 Treflan was applied and incorporated twice with a field cultivator equipped with sweeps and operated 4 inches deep; the preemergence Lasso was applied on May 26. Postemergence Basagran and Poast treatments were applied on June 23 at Waseca when the soybeans were in the first trifoliolate leaf stage. Giant foxtail was approximately 3 inches tall and broadleaf weeds were approximately 2 inches tall.

At Waseca, the Lasso and Treflan studies were also treated on June 23 with Basagran using the same carrier and application system as used for the initial soil applied herbicide. The Poast study also received an application of Blazer (0.25 lb/A) plus Basagran (0.75 lb/A) with 1 qt/A of oil concentrate on July 7, 1983 for broadleaf weed control. An application of 0.2 lb/A of Poast plus 1 qt/A of oil concentrate was applied uniformly on July 7 to the Basagran study for grass control. Escaped broadleaf weeds were removed from the Poast study and escaped grasses were removed from the Basagran study by hand weeding.

At Morris, Treflan was applied and incorporated with a field cultivator on June 1, 1983; Lasso was applied preemergence on June 1. The Basagran and Poast studies were planted June 1; the Lasso and Treflan studies were planted June 2. All studies at Morris were planted to 'Evans' soybeans in rows 30 inches apart. The Basagran and Poast studies were treated on July 5 at Morris when the soybeans were in the third trifoliolate leaf stage; yellow and green foxtail were 4 to 8 inches tall, and redroot pigweed and common lambsquarters were 2 to 8 inches tall. Basagran plus oil concentrate was applied to the Treflan, Lasso, and Poast studies for broadleaf weed control. The Basagran study was treated with Poast and oil concentrate for grass control.

All CDA applications were made with a disc spacing of 40 inches with the disc operated approximately 12 inches above the target area. The discs were positioned to discharge spray particles parallel to the soil surface for preplant and preemergence application. They were tilted at approximately a 15^{o} angle from the parallel position for postemergence applications. The disc speed for the preplant and preemergence studies was 1250 rpm; 2800 rpm was used for the postemergence studies. Hydraulic sprayer treatments were applied with a sprayer equipped with flat fan nozzles spaced 15 inches apart on the boom. All applications with the hydraulic sprayer were made with a total spray volume of 20 gallons per acre (gpa). Water was the carrier for all hydraulic sprayer applications.

All herbicides using the CDA system were made with three herbicide carriers: (1) one gallon per acre of a fully refined soybean oil with no additive, (2) one gallon per acre of a fully refined soybean oil with 15 percent surfactant, hereafter referred to as a soybean oil concentrate, and (3) one quart of soybean oil concentrate with enough water to make a total spray volume of 3 gpa. Carrier volume varied with the herbicide and rate of application for the CDA system. Water with no additive was the herbicide carrier for Lasso and Treflan applied with the hydraulic sprayer. One quart of oil concentrate was added to all Basagran and Poast applications made with the hydraulic sprayer.

RESULTS

All emulsifiable concentrated formulations of herbicides were miscible in either soybean oil or soybean oil concentrate. Basagran was not miscible in either oil and required vigorous agitation for dispersion, and it separated rapidly from the oils when agitation ceased. Use of either soybean oil or soybean oil concentrate as the herbicide carrier did not result in improved weed control with the CDA units, as compared to the CDA applications made with 1 qt/A soybean oil concentrate and water with a spray volume of 3 gpa. The hydraulic sprayer (20 gpa) with water as carrier for Lasso or Treflan gave better control of most weed species than the CDA applicators where either oil was used as the carrier. This was especially true for the lower rate of application. Application of Lasso or Treflan with the CDA system utilizing 1 qt/A of soybean oil concentrate with a total spray volume of 3 gpa gave weed control similar to the hydraulic sprayer applications of these herbicides (tables 1 and 2).

Control of giant foxtail and volunteer corn with Poast were similar for the CDA systems and the hydraulic sprayer (tables 3 and 4). One exception was that use of soybean oil as the carrier for the 0.075 lb/A rate of Poast in the CDA system at Waseca resulted in lower control rating for both giant foxtail and volunteer corn than any of the other systems evaluated. There were no differences among application methods for the 0.15 lb/A rate of Poast.

At Waseca, velvetleaf control was 15 to 20% lower for the CDA system where water and 1 qt/A of soybean oil concentrate were used as the carrier for Basagran as compared to either the hydraulic sprayer with 1 qt/A of soybean oil concentrate with water as the carrier, or the CDA system with either soybean oil or soybean oil concentrate as the carrier (table 3). The higher rate of Basagran (0.75 lb/A) generally provided somewhat better velvetleaf control than the 0.38 lb/A rate. At the higher rate of application the best control of velvetleaf was obtained with the hydraulic sprayer. Best control of common lambsquarters with Basagran was obtained with the hydraulic sprayer. Poor control of redroot pigweed resulted from all Basagran applications regardless of method of application (tables 3 and 4).

An attempt was made at Morris to measure herbicide drift in the Lasso and Poast studies. This was done by measuring the amount of drift from the target area. Drift was accessed by evaluating weed control in the area adjacent to the target area on the leeward side of each plot and the drift away from the target area on the windward side of the plot. Wind speed at the time of herbicide application was 10 to 15 mph at a right angle to the direction of herbicide application. Very little drift occurred with the hydraulic sprayers (tables 2 and 4). All CDA treatments resulted in significantly greater drift than the comparable rate applied with the hydraulic sprayer.

DISCUSSION

The results from this one-year study indicate that herbicide rates cannot be reduced with the CDA system as compared to a hydraulic sprayer. Normal labeled rates should be used for both systems. It further indicates that soybean oil or soybean oil concentrate do not enhance weed control with soil applied herbicides such as Lasso and Treflan. Use of soybean oil concentrate rather than soybean oil as the carrier for Poast resulted in improved control of giant foxtail and volunteer corn at Waseca. However, use of 1 qt/A of soybean oil concentrate in the CDA system with enough water for a total spray volume of 3 gpa, or use of the hydraulic sprayer with 1 qt/A of soybean oil concentrate and enough water for a 20 gpa spray volume, resulted in giant foxtail and volunteer corn control equal to the CDA system with soybean oil concentrate as the carrier for Poast. Neither the soybean oil nor the soybean oil concentrate appeared to be an adequate carrier for Basagran since this herbicide would not mix with either oil.

In a separate study at Waseca soybean oil concentrate was compared to a petroleum oil concentrate (Atplus 411F). Equivalent weed control was obtained with Poast, Basagran, and Blazer with either oil. Therefore, soybean oil concentrate is a good spray additive where needed.

Use of oil as a herbicide carrier is relatively new and will require considerable research to determine its place in herbicide application. Additional safety precautions should be used when applying agricultural chemicals with oil as the carrier. The oil may increase bodily absorption rate of the chemical and the ultra low volume application means the pesticide is applied in a much more concentrated form. Therefore, protective gloves, goggles, aprons and boots should be worn when handling pesticides. One main consideration in deciding what carrier and spray volume to use for a herbicide should be based on the manufacturer's labels. Most pesticides are not labeled at this time for ultra low volume application. Many pesticides specifically state a minimum spray volume of 10 gallons per acre or more.

Table 1. A comparison of a CDA and a hydraulic sprayer for applying Treflan, Lasso, and Basagran at Waseca, MN 1983.

Applicator	Rates	Oil[a]	Water	Total Sol'n	Giant Foxtail 6/23	Giant Foxtail 7/5	Giant Foxtail 9/12	Lambsquarters 6/23	Lambsquarters 7/5	Lambsquarters 9/12	Pigweed 6/23	Pigweed 7/5	Pigweed 9/12	Velvetleaf 7/5	Velvetleaf 9/12	Yield bu/A
	lb/A	qts	Volume qts/A		% Control											
Treflan preplant incorporate + Basagran postemergence 6/24/83																
1. CDA	.38+.38	S.O. (4)	-----	4.38	68	60	53	89	93	94	83	89	94	75	79	27.5
2. CDA	.75+.75	S.O. (4)	-----	4.75	76	70	59	78	91	95	90	96	100	70	78	27.2
3. CDA	.38+.38	S.O.C. (4)	-----	4.38	69	63	61	83	98	98	83	98	91	83	86	29.2
4. CDA	.75+.75	S.O.C. (4)	-----	4.75	83	78	75	98	100	99	97	100	96	85	83	29.5
5. CDA	.38+.38	S.O.C. (1)	10.62	12.0	76	78	60	97	99	100	97	99	100	84	95	29.4
6. CDA	.75+.75	S.O.C. (1)	10.25	12.0	84	78	75	96	100	100	98	100	96	90	98	30.3
7. Hydr.	.38+.38	---	79.62	80.0	79	66	68	98	100	100	96	100	100	94	100	28.1
8. Hydr.	.75+.75	---	79.25	80.0	88	80	79	98	100	100	99	100	100	93	98	33.8
Significance level for herbicide rate					98	95	98	17	26	30	95	79	37	11	17	69
LSD(.05) method of application					NS	NS	13	10	5	5	9	6	NS	11	13	NS
Lasso preemergence + Basagran postemergence 6/24/83																
9. CDA	1.5+.38	S.O. (4)	-----	5.5[b]	21	20	8	45	86	68	46	83	68	84	66	20.1
10. CDA	3.0+.75	S.O. (4)	-----	7.0[b]	68	61	63	83	94	100	94	99	100	63	79	27.5
11. CDA	1.5+.38	S.O.C. (4)	-----	5.5[b]	28	28	13	40	88	75	43	79	66	73	73	19.7
12. CDA	3.0+.75	S.O.C. (4)	-----	7.0[b]	58	53	64	68	84	100	80	91	94	81	88	26.9
13. CDA	1.5+.38	S.O.C. (1)	9.5	12.0	46	40	54	56	91	100	66	86	95	71	94	20.6
14. CDA	3.0+.75	S.O.C. (1)	8.0	12.0	71	65	66	60	100	96	85	94	95	81	90	24.6
15. Hydr.	1.5+.38	---	78.5	80.0	73	56	64	79	100	100	91	98	100	91	100	23.4
16. Hydr.	3.0+.75	---	77.0	80.0	80	66	78	76	99	100	93	99	100	85	99	29.2
17. Weedy Check					0	0	0	0	0	0	0	0	0	0	0	19.1
Significance level for herbicide rate					99	99	99	85	42	85	98	94	89	31	44	98
LSD(.05) method of application					21	14	11	NS	NS	NS	NS	NS	NS	NS	NS	NS

[a]S.O. = fully refined soybean oil with no additive; S.O.C. = fully refined soybean oil with 15% surfactant added.

[b]Spray volume for Lasso only - spray volume for Basagran was 4.38, 4.75, 4.38 and 4.75 qt/A for treatments 9-12, respectively.

Table 2. A comparison of a CDA and hydraulic sprayer for applying Treflan and Lasso at Morris, MN 1983.

Applicator	Rate	Oil[a]	Water	Total Sol'n	Foxtail[b]	Pigweed	Lambsquarters	Drift[c]	Yield
	lb/A	(qts)	Volume	qts/A	- - - - - -	% Control	- - - - - -	inches	bu/A
Treflan preplant + Basagran postemergence 7/5/83									
1. CDA	.38	S.O. (4)	-----	4.38	35	48	49	-----	37
2. CDA	.75	S.O. (4)	-----	4.75	58	66	65	-----	40
3. CDA	.38	S.O.C. (4)	-----	4.38	42	49	46	-----	37
4. CDA	.75	S.O.C. (4)	-----	4.75	70	66	69	-----	37
5. CDA	.38	S.O.C. (1)	10.62	12.00	70	55	51	-----	40
6. CDA	.75	S.O.C. (1)	10.25	12.00	82	68	79	-----	40
7. Hydr.	.38	---	79.62	80.00	55	53	55	-----	41
8. Hydr.	.75	---	79.25	80.00	80	74	84	-----	45
9. Weedy Check		---	-----	-----	0	0	0	-----	30
LSD(.05)									7
Lasso preemergence + Basagran postemergence 7/5/83									
1. CDA	1.5	S.O. (4)	-----	5.5	60	--	--	55	44
2. CDA	3.0	S.O. (4)	-----	7.0	76	--	--	45	48
3. CDA	1.5	S.O.C. (4)	-----	5.5	50	--	--	41	50
4. CDA	3.0	S.O.C. (4)	-----	7.0	76	--	--	41	52
5. CDA	1.5	S.O.C. (1)	9.5	12.0	48	--	--	55	43
6. CDA	3.0	S.O.C. (1)	8.0	12.0	79	--	--	53	49
7. Hydr.	1.5	---	78.5	80.0	68	--	--	10	43
8. Hydr.	3.0	---	77.0	80.0	88	--	--	2	46
9. Weedy Check		---	-----	----	0	--	--	--	36
LSD(.05)									7

[a] S.O. = fully refined soybean oil with no additive; S.O.C. = fully refined soybean oil with 15% surfactant added.

[b] Mixed population of green and yellow foxtail.

[c] Drift taken only on the Lasso study. Data are inches of herbicide drift from target area as accessed by weed control on the leeward side of the plot outside of the target area and lack of weed control on the windward side of the target.

Table 3. A comparison of a CDA and hydraulic sprayer for postemergence application of Poast and Basagran at Waseca, MN 1983.

Applicator	Rate	Oil[a]	Water	Total Volume	Volunteer Corn 7/5	Giant Foxtail 7/5	Giant Foxtail 9/12	Yield
	lb/A	(qts)	Volume qt/A		- - - - - % Control	- - - - - -		
Poast applied 6/23/83 (Basagran + Blazer applied 7/9/83)								
1. CDA	.075	S.O. (4)	-----	4.20	53	80	80	30.7
2. CDA	.15	S.O. (4)	-----	4.39	83	93	97	32.0
3. CDA	.075	S.O.C. (4)	-----	4.20	80	88	92	31.7
4. CDA	.15	S.O.C. (4)	-----	4.39	76	92	94	31.1
5. CDA	.075	S.O.C. (1)	10.80	12.00	66	91	94	31.9
6. CDA	.15	S.O.C. (1)	10.61	12.00	85	92	96	32.6
7. Hydr.	.075	S.O.C. (1)	78.80	80.00	76	89	98	32.6
8. Hydr.	.15	S.O.C. (1)	78.61	80.00	84	92	98	33.3
9. Weedy Check					0	0	0	21.6
Significance level for herbicide rate					99	99	99	33
LSD(.05) method of application					NS	NS	4	NS

Applicator	Rate	Oil[a]	Water	Total Volume	Pigweed 7/5	Pigweed 9/12	Lambsqtrs. 7/5	Lambsqtrs. 9/12	Velvetleaf 7/5	Velvetleaf 9/12	Yield
Basagran applied 6/23/83 (Poast applied 7/9/83)											
1. CDA	.47[b]	S.O. (4.9)	-----	5.37	60	48	73	66	86	88	31.8
2. CDA	1.2[b]	S.O. (6.6)	-----	7.80	65	58	80	85	91	86	32.5
3. CDA	.38	S.O.C. (4)	-----	4.38	50	18	68	73	82	78	29.2
4. CDA	.75	S.O.C. (4)	-----	4.75	58	23	83	76	86	85	29.4
5. CDA	.38	S.O.C. (1)	10.62	12.00	54	49	73	68	69	61	32.2
6. CDA	.75	S.O.C. (1)	10.25	12.00	55	54	66	76	74	61	33.5
7. Hydr.	.38	S.O.C. (1)	78.62	80.00	63	51	84	90	86	90	32.5
8. Hydr.	.75	S.O.C. (1)	78.25	80.00	68	59	94	97	96	97	33.7
9. Weedy Check					0	0	0	0	0	0	21.2
Significance level for herbicide rate					75	50	89	97	84	48	54
LSD(.05) method of application					NS	16	12	13	12	15	3.4

[a] S.O. = fully refined soybean oil with no additives; S.O.C. = fully refined soybean oil with 15% surfactant. The numbers in ( ) indicate oil volume in quarts/A

[b] These rates were supposed to be .38 and .75 lb/A. However, the wrong orifice was used when these treatments were applied and the listed rates resulted.

Table 4. A comparison of a CDA and hydraulic sprayer for postemergence application of Poast and Basagran at Morris, MN 1983.

Applicator	Rate	Oil[a]	Water	Total Sol'n	Foxtail[b]	Pigweed	Lambsquarters	Drift[c]	Yield[e]
	lb/A	(qts)	Volume	qts/A	- - - - - - -	% Control	- - - - - - -	inches	bu/A
Poast applied 7/5/83 - Basagran for broadleaf weed control									
1. CDA	.075	S.O. (4)	-----	4.20	81	--	--	20	39
2. CDA	.15	S.O. (4)	-----	4.39	89	--	--	21	45
3. CDA	.075	S.O.C. (4)	-----	4.20	55	--	--	14	49
4. CDA	.15	S.O.C. (4)	-----	4.39	75	--	--	34	41
5. CDA	.45[d]	S.O.C. (1)	9.64	12.00	93[d]	--	--	12	45
6. CDA	.90[d]	S.O.C. (1)	7.26	12.00	96[d]	--	--	18	48
7. Hydr.	.075	S.O.C. (1)	78.80	80.00	82	--	--	1	44
8. Hydr.	.15	S.O.C. (1)	78.61	80.00	90	--	--	1	45
9. Weedy Check		---	-----	-----	0	--	--	0	34
LSD(.05)									12
Basagran applied 7/5/83 - Poast applied for grass weed control									
1. CDA	.38	S.O. (4)	-----	4.38	--	8	15	--	50
2. CDA	.75	S.O. (4)	-----	4.75	--	20	65	--	46
3. CDA	.38	S.O.C. (4)	-----	4.38	--	5	50	--	46
4. CDA	.75	S.O.C. (4)	-----	4.75	--	10	35	--	46
5. CDA	.38	S.O.C. (1)	10.62	12.00	--	8	10	--	39
6. CDA	.75	S.O.C. (1)	10.25	12.00	--	20	50	--	50
7. Hydr.	.38	S.O.C. (1)	78.62	80.00	--	20	50	--	53
8. Hydr.	.75	S.O.C. (1)	78.25	80.00	--	42	70	--	49
9. Weedy Check		---	-----	-----	--	0	0	--	34
LSD(.05)									9

[a] S.O. = fully refined soybean oil with no additive; S.O.C. = fully refined soybean oil with 15% surfactant added.

[b] Mixed population of green and yellow foxtail.

[c] Drift taken only in the Poast study. Data are inches of herbicide drift from target area as accessed by weed control on the leeward side of the plot outside the target area and lack of weed control on the windward side of the target area.

[d] These rates were mistaken applied; rates should have been .075 and .15 lb/A

[e] Only two replications were harvested for yield in the Basagran study.

CROP COMPETITION WITH WILD PROSO MILLET IN MINNESOTA

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The rapid spread of wild proso millet throughout Minnesota and the North Central region makes it one of the most difficult grass weeds to control. The introduction of new postemergence herbicides for use in soybeans has improved the situation considerably. Effective control in corn has been inconsistent and can be quite costly. Our research has been directed toward a better understanding of the biological development of wild proso millet and its responses to competition from various crops. Research conducted in the Department of Horticulture indicates that wild proso millet seed germinates most readily in warm soil and peak emergence appears to be during the later part of May and early June. Wild proso millet develops more slowly when the temperature is less than 80°F. It has been observed in Minnesota and Ontario that wild proso millet will germinate and produce seed throughout the growing season. These are some factors which lead us to investigate different systems of producing corn, soybeans and wheat to create an environment detrimental to wild proso millet growth and development.

We have an incomplete picture of the effects of different densities of wild proso millet and the length of time competition from wild proso millet can be tolerated in crops. However, in an experiment at Rosemount, Minnesota in 1982, it was observed that densities of 70, 39, and 745 plants/m^2 of cultivated proso millet competing with corn for the entire season reduced corn yield by 13, 52 and 64%, respectively (Table 1). During 1980 to 1982 wild proso millet reduced soybean yields by 48% and corn yields by 27% in Wisconsin. Evaluation of several herbicide combinations indicates that 90% control can be attained in both crops resulting in 10% yield reduction in heavily infested fields (Table 2).

From evaluations throughout Minnesota it appears that wild proso millet densities of 500-800 plants/m^2 are quite common in heavily infested fields. A two year study conducted at Morris, Minnesota demonstrated that from 2-10% of the wild proso millet population emerged in the first two weeks of May, with peak emergence occurring by the 2nd or 3rd weed of June (Table 3). In 1983 at Morris, Minnesota plots were sprayed with glyphosate at two week intervals from May 4 to July 13 to determine the density of wild proso millet populations became established during this period. There was no difference in population densities for emergence between May 7 and June 6 with the final population reaching approximately 600 plants/m^2. After June 15, 87% fewer plants were established, with final populations ranging from 28-100 plants/m^2 (Table 4). A study at Waseca, Minnesota in 1983 in which wild proso millet was planted at 14 day intervals from May 11 to September 11, indicated that flowering began 55 days after emergence during the period from mid-May to mid-June. Plants emerging on August 8th or 23rd required only 21 days and 16 days to reach the reproductive stage of development. Plants emerging on September 6 were killed by frost on September 23rd prior to flowering. The time to flowering in cultivated proso millet also declines with daylength.

Several studies were initiated in 1983 at the Southern Experiment Station in Waseca, Minnesota to determine responses of wild proso millet to artificial and crop shading. Corn and soybeans were planted early or late in one of three different row spacings to determine the amount of light intercepted by the various crop canopies during the season and the effect the resultant shading had on wild proso millet emerging throughout the season. Figures 1 and 2 depict the reduction in sunlight at the ground level at the mid-point between the crop row. Soybeans planted May 11 in 10-inch rows intercepted greater than 80% of the available light 56 days after planting to maturity. Twin-row and 30-inch row soybeans required 79 days to intercept the same level of light. Soybeans planted in 10-inch rows on May 26 required 54 days to reach an equivalent level of shading as soybeans in 10-inch rows planted on May 11. Corn in 30-inch or twin-row spacing required 79 or 64 days from planting on May 11 or 26, respectively, to reach the 80% level of light interception. The drought conditions during July and August adversely affected corn growth more than soybean growth and probably masked the effect of increasing corn population in the twin-row treatments. Readings taken in the corn or soybean rows indicated that greater than 85% of the incoming sunlight was intercepted by the crop canopies 56 days after the May 11 planting date or 41 days after the May 26 planting date. In contrast to corn and soybeans, wheat grown at Morris, Minnesota required only 35 days to intercept 90% of the light. Therefore by the first week in June when most of the wild proso millet is emerging wheat reduces incoming light by 90% while corn and soybeans intercept less that 10%.

Wild proso millet was planted on May 11, June 2, June 16, July 7, and July 14 in the study in which the light measurements were taken. In both corn and soybeans the July 7 and 14 wild proso millet plantings were lost due to drought conditions. Planting corn and soybeans early in May reduced the dry weight and number of panicles produced by wild proso millet more than did planting late in May. Wild proso millet emerging with the crop or within the first three weeks after planting was least affected by crop shading. Soybeans planted in 10-inch rows were more competitive with early emerging wild proso millet than were soybeans in 30-inch or twinrows. Wild proso millet emerging after June 16th in either corn or soybeans experienced greater than 95% reduction in dry weight and number of panicles produced compared to wild proso millet grown without crop competition. Figure 3 shows panicle production for wild proso millet planted at eight times during the season and harvested in September. Maximum panicle production occurred for plants emerging during June. Plants harvested on August 9th at Morris, corresponding to the harvest of wheat, produced significantly fewer panicles. Wheat is an effective competitor with wild proso millet. In 1982 and 1983 no tillers were produced and dry weight was reduced by 93% and 99% for plants emerging with wheat compared to wild proso millet grown without wheat competition. Wild proso millet emerging 2 weeks or more after wheat did not survive in 1983. Planting wheat the second week in May at Morris in 1982 resulted in 54% reduction in wild proso millet dry matter production.

A second study at Waseca evaluated the effects of five levels of artificial shading on the growth and development of wild proso millet. Three densities of wild proso millet were included to represent no interplant competition and two densities of wild proso millet encompassing the range of wild proso millet population found in farmer's fields. Tillering was reduced by increasing levels of shading, population density or both as shown in Table 5. Shading did not affect seedling emergence indicating that wild proso millet plants will emerge in reduced light if temperature and moisture conditions are favorable. Mature seed collected from main stem panicles in each shading treatment differed in germination percentage (Table 6). In a related study, the germination of matured seed increased as plants flowered later in the season (Table 7). The results suggest shading and photoperiod influence wild proso seed dormancy but further investigation is required to permit a definite statement.

In summary, it appears that there are ways to adjust cropping systems to increase the competitive effects of crops on wild proso millet. Crops that develop a canopy rapidly during May and June before a majority of wild proso millet seed emerges reduce the amount of light available to wild proso millet which limits growth and seed production. Corn and soybeans planted in 30-inch or twin-rows required at least 80 days to develop a canopy that will interfere significantly with wild proso millet development. Soybeans planted in early May in 10-inch rows required 56 days to reduce light penetration to the ground to less than 10%. Wheat required only 35 days from planting to intercept 90% of the incoming light.

Shading reduced tillering, panicle production and dry weight of wild proso millet, and may alter the dormancy of wild proso millet.

Table 1. Effect of 3 cultivated proso millet densities on corn yield at Rosemount, MN, 1982.

Plants/m^2	% Yield reduction
70	13
391	52
745	64

Table 2. Wild proso millet control and yield reduction in corn and soybeans, Rio WI, 1980-82.

	% Control*	% Yield reduction
Soybeans		
Treflan, ppi	34	41
Lasso, pre	64	37
Treflan + Poast + oil conc, ppi + pst	91	10
no herbicide	0	52
Corn		
Eradicane, ppi	56	51
Eradicane Extra, ppi	75	24
Eradicane + Prowl/Bladex, ppi + pst	88	11
no herbicide	0	73

*Evaluation taken 3rd week of June.

Table 3. Seasonal emergence of wild proso millet at Morris, MN.

Evaluation date		% Emerged	
1982	1983	1982	1983
5-12	5-13	2	10
5-28	5-27	62	65
6-12	6-17	100	92
6-24	--	121	--
8-11	7-21	100	100

Table 4. Wild proso millet population establishment at Morris, MN, 1983.

Spray date[1]		Plants/m^2	Plants/A	DW kg/ha
5-4		632	2,558,543	3374
5-17		576	2,331,648	3833
6-1		496	2,007,808	3502
6-15		92	372,416	1970
6-29		100	404,800	1113
7-13		28	113,344	513
	LSD .05	46	--	1127

[1] Glyphosate applied at .5 lb/A

Table 5. Seedling emergence and tillering of wild proso millet as influenced by artificial shading.

Shade level	Wipm density			
	-------------plts/m²------------			
-----%-----	11	440	880	% Emergence
0	69[1/]	5	2	82
30	14	3	1	86
47	16	0	0	82
63	9	1	0	85
92	0	0	0	79

[1/] Values are tillers per plant for a 20 plant sample harvested when mainstem panicle in no shade treatment was mature.

Table 6. Germination of wild proso millet.

Shade level		Germination
-----%-----		-----%-----
0		15
30		10
47		39
63		49
92		no seed
	LSD .05	17

Table 7. Germination of wild proso millet planted at Waseca, MN, 1983.

Planting date		Germination
		-----%-----
May-26		35
June-2		25
June-16		39
July-7		87
July-14		75
	LSD .05	33

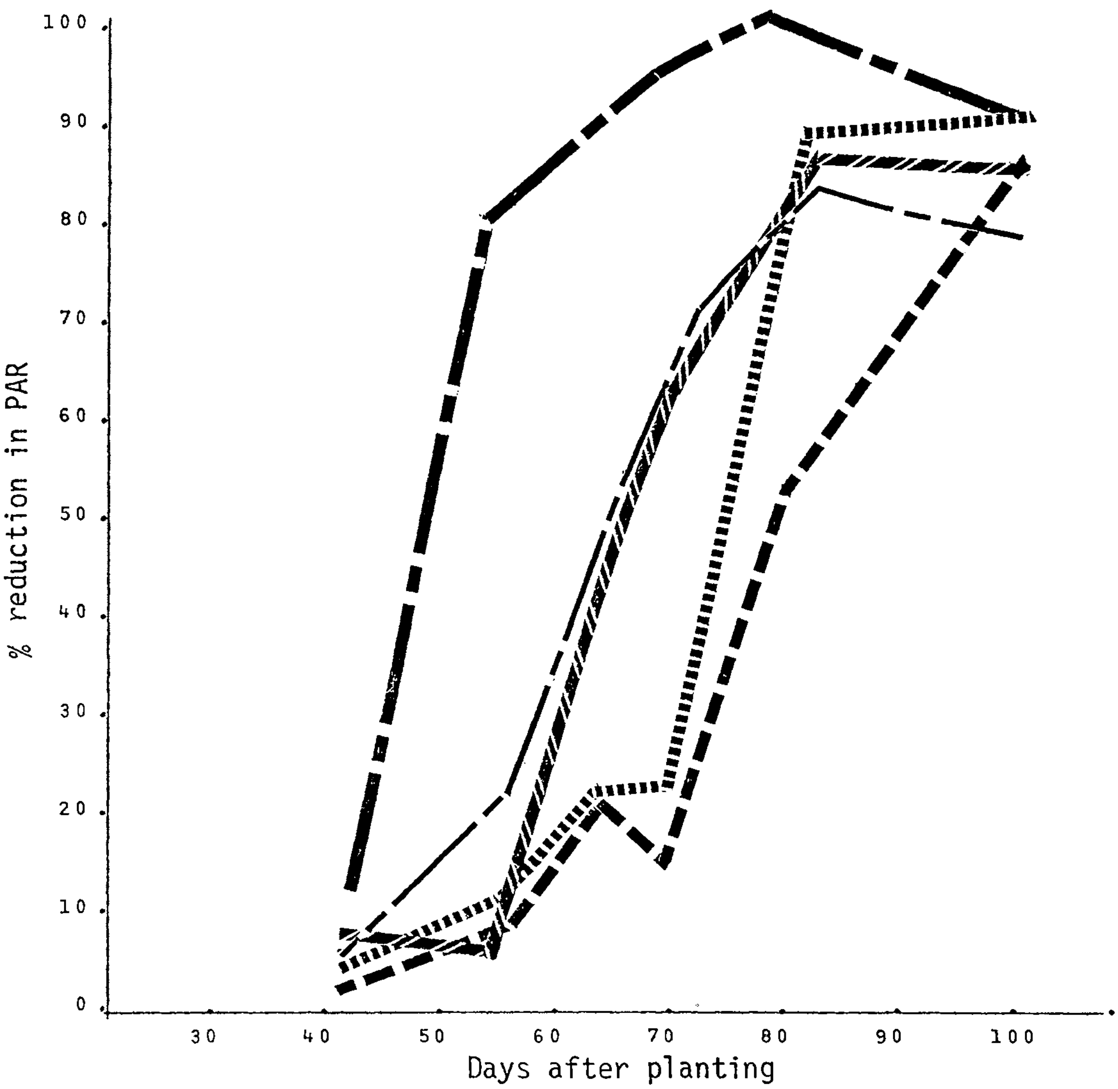
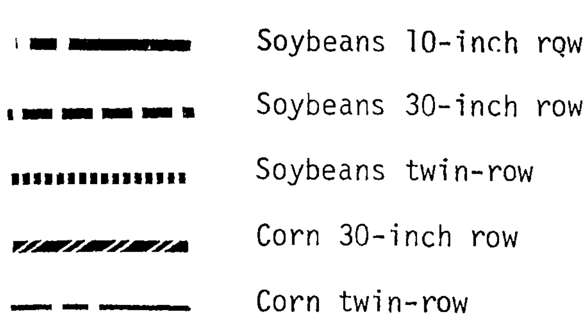


Figure 1. Reduction of PAR in corn and soybeans planted 5-11-83.



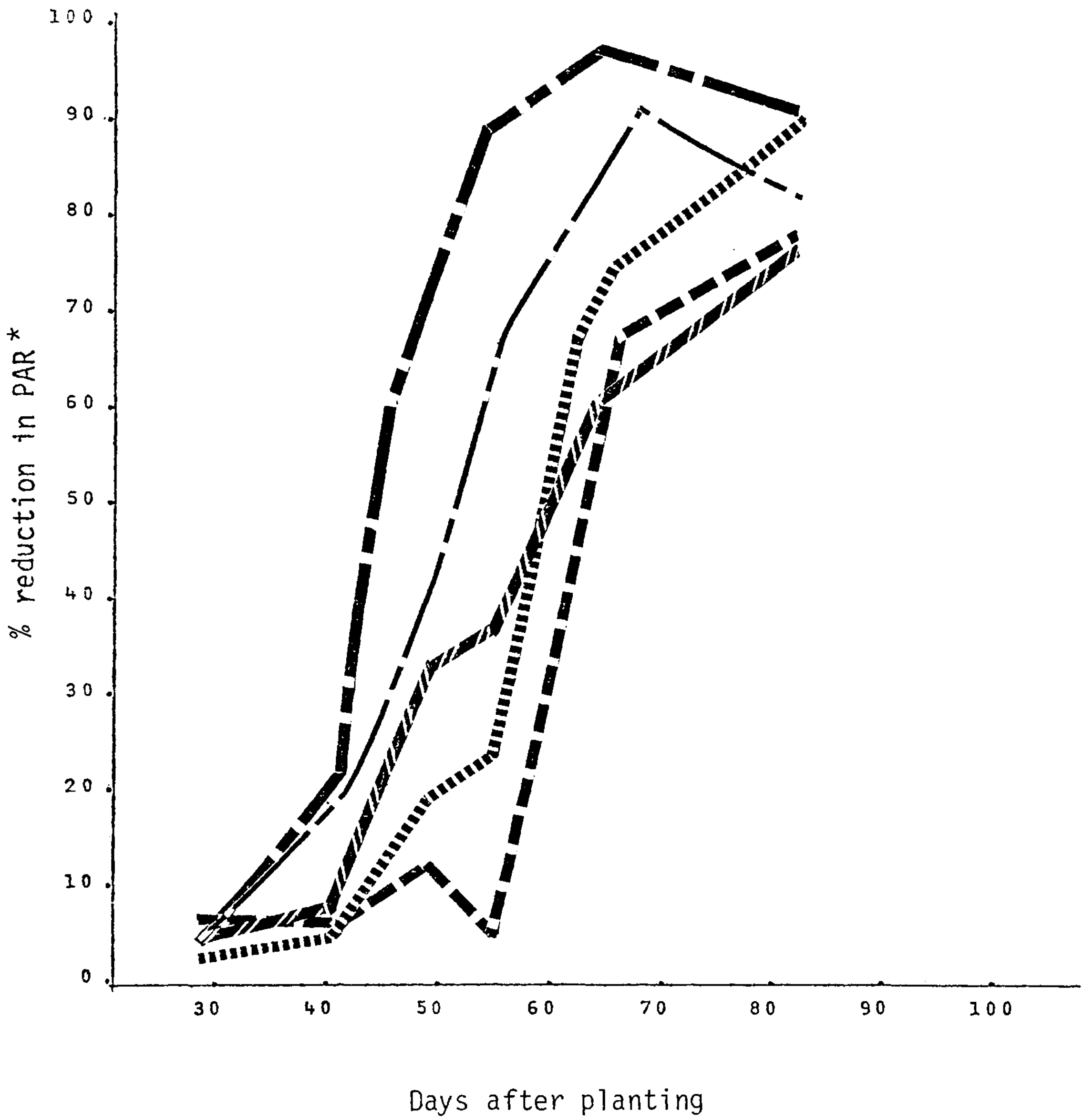


Figure 2. Reduction of PAR in corn and soybeans planted 5-26-83.

Soybeans 10-inch row

Soybeans 30-inch row

Soybean twin-row

Corn 30-inch

Corn twin-row

* PAR = Photosynthetically active radiation

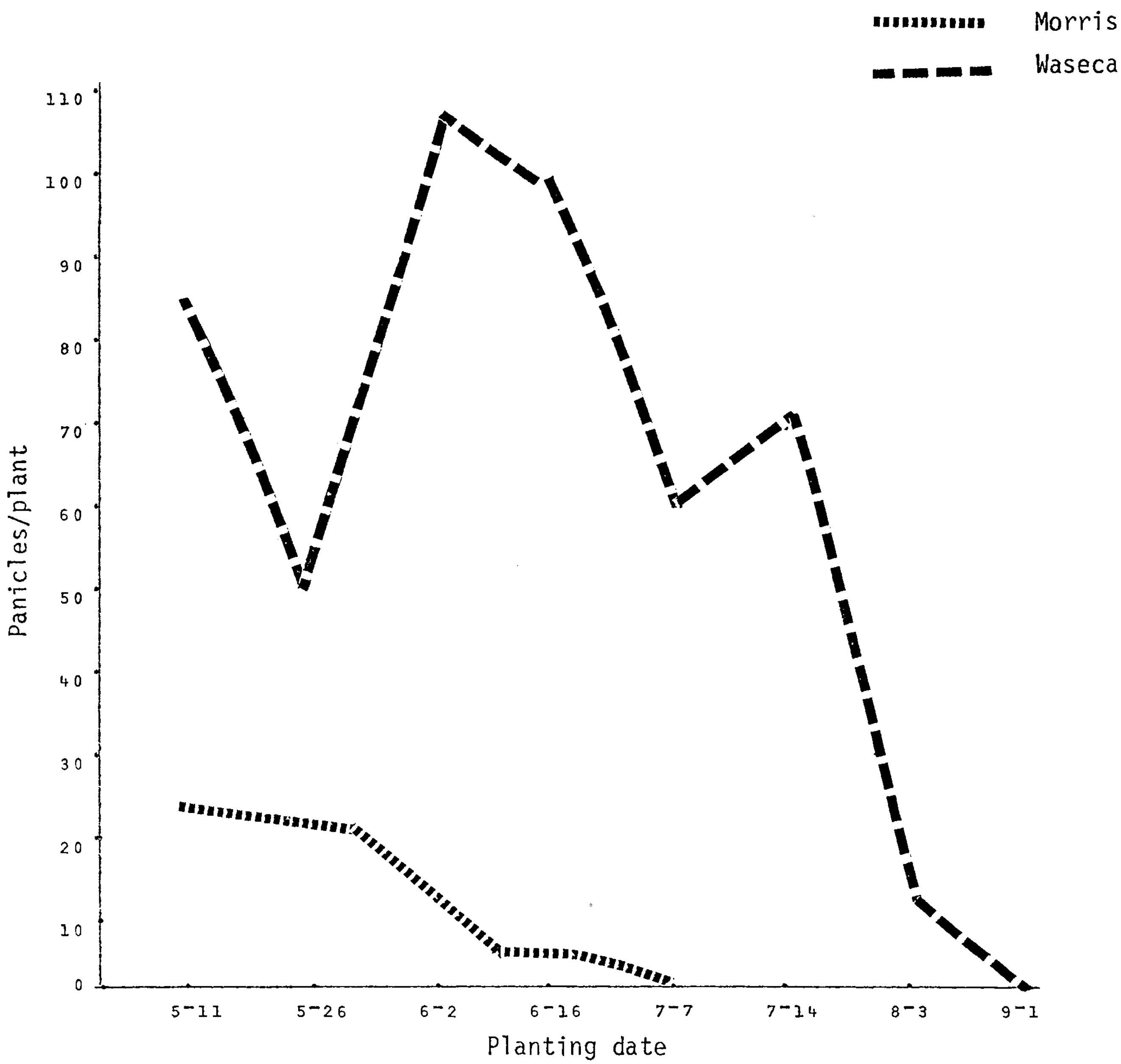


Figure 3. Panicle production of wild proso millet planted at eight dates at Waseca and Morris

SUNFLOWER BEETLE

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

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

Table 1. Sunflower Beetle Larval Control 1983

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

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

Approximately 20 gallons total material per acre
40 PSI
Plots 2 rows x 25' x 4 replicates
Counts taken 72 hours post treatment

Table 2. Sunflower Beetle Larval Control 1983

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

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

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

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

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

Of the compounds presently labeled Lorsban at ¼ lb per acre provided good control of sunflower beetle larvae and will probably be recommended at that rate for 1984.

Products which should be labeled shortly and which performed equal to Lorsban are Pydrin and Furadan. Pydrin at 1/100 pound per acre and Furadan at 1/10 lb per acre provided control equal to or better than Lorsban at ¼ pound per acre in both 1982 and 1983.

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

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

BANDED SUNFLOWER MOTH CONTROL

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

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

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

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

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

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

SUNFLOWER SEED WEEVIL AND BANDED SUNFLOWER MOTH CONTROL

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

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

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

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

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

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

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

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

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Year	Treatment	Yield in pounds of seed/acre	Average oil in percent	Price per pound seed with discounts[1] and bonus	Gross return per acre	Increased return in dollars/acre	
						Due to higher yield and bonus or discount payment	Due to higher oil content alone
1979[2]	bagged	1587	38.3	.090	142.83	190.40	39.20
	open	3267	43.4	.102	333.23		
1980[3]	bagged	1783	46.6	.121	215.74	41.55	10.21
	open	2042	48.7	.126	257.29		
1981[4]	bagged	1899	39.0	.108	205.09	147.75	32.61
	open	2965	44.0	.119	352.84		

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

2) 9 hybrids; 1 open pollinated

3) 19 hybrids; 1 open pollinated

4) 20 hybrids

SEED INSECT CONTROL IN A SEED PRODUCTION FIELD

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

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

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

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

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

ARMYWORM CONTROL

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

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

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

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

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