The Wild Oats Pilot Project

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Wild oats (*Avena fatua* L.) is ranked thirteenth among the world's worst weeds (5) and ranks much higher as a problem in North Dakota agriculture. Nalewaja et al. (6) estimated in 1973 that 90% of the small grain acreage in North Dakota contained wild oats, with 57% of the acreage moderately to heavily infested. A 1979 survey (2) indicated up to 246 wild oats per square yard in North Dakota fields. Annual losses from wild oats in North Dakota have been estimated at $160 to $260 million (6). The cost of wild oats in crop loss and herbicide application has been estimated at over $280 million for Western Canada (1). Although the main losses from wild oats are in small grains, it is also an important weed in sugarbeet, soybean, pea, dry bean, lentil, corn, sunflower and grass seed production. Wild oats infests more than 28 million acres in the United States, causing annual losses of between $300 and $500 million (7).

Losses from wild oats come from decreased crop yields, dockage in harvested grains, increased tillage operations for wild oats control, reduced grain yields from delayed seeding for wild oats control, and the cost for chemical control. Wild oats control practices now available usually do not control all emerged wild oats nor eliminate the wild oats seed reserve in the soil. Complete control of emerged plants in one season will not eliminate a wild oats infestation, because many seeds may remain viable and dormant in the soil.

The Wild Oats Pilot Project was a four-year program conducted under cooperative agreement between the Agricultural Experiment Station of North Dakota State University and the Agricultural Research Service of the United States Department of Agriculture. The goals of the project were to evaluate the cumulative effects of four years of mechanical, cultural, and chemical wild oats control practices on the population of wild oats seed in the soil and develop economical rotation-herbicide systems which would minimize crop losses due to wild oats.

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MATERIALS AND METHODS

Research was conducted on farmers' fields at Fargo, Jamestown, Penn, and Williston, North Dakota. The crop rotation at each site was representative of the farming practices in that region of the state (Table 1). The fields at Fargo and Penn were moderately to heavily infested with wild oats at the beginning of the project. The infestation at Williston was confined to the low-lying field areas, which is typical in that region of North Dakota. The Jamestown location was relocated following the 1976 season, due to an insufficient wild oat population at the original site.

Table 1. Crop rotation at each location of the Wild Oats Pilot Project, 1975-1978.

Location	1975	1976	1977	1978
Williston(1)	Wheat	Fallow	Barley	Fallow
Williston(2)	Fallow	durum	Fallow	Durum
Jamestown	-[1]	-[1]	Durum	Barley
Penn	Barley	Fallow	Durum	Durum
Fargo	Barley	Wheat	Soybeans	Barley

[1]Original Jamestown location was discontinued in fall, 1976, due to insufficient wild oats population.

Fourteen strips were permanently staked in each field prior to planting in the spring of 1975. The fields ranged from 13 to 76 acres and were prepared and planted each year by the cooperating farmers. Seven treatments were replicated twice at each location except Williston, where the replications were fallowed in separate fields in alternate years (Table 2).

Table 2. Wild oats control treatments and stage of application at all sites of the Wild Oats Pilot Project, 1975-1978.

Herbicide[1](Trade Name)	Stage of application
Barban (Carbyne)	1½-2 leaf[2]
Difenzoquat (Avenge)	3-5 leaf[2]
Diclofop (Hoelon)	1-3 leaf[2]
Triallate (Fargo)	PPI or PEI[3]
Delayed seeding	When approximately 80% of small grain in county had been planted
Triallate + barban	
No treatment	

[1]Barban plus 1 gpa aqueous nitrogen was an alternate treatment in certain years.

[2]Leaf stage of majority of wild oats.

[3]Preplant incorporated in the fall, or preemergence incorporated in the spring.

Herbicides were applied using a tractor-drawn field sprayer with a 30-foot boom. Herbicide treatments were applied in 10 gallons of water per acre (GPA) at 40 pounds per square inch (PSI) except barban alone or in combination with 1 GPA aqueous nitrogen, which was applied in 5 GPA solution at 45 PSI. The aqueous nitrogen was a commercially available formulation 28-0-0 (28% (W/W) nitrogen, ½ from ammonium nitrate and ½ from urea).

Crop spikes (heads) were harvested from within a square yard quadrant placed at 14 locations approximately 200 feet apart in the center of each strip. The number of wild oats panicles within the quadrant was counted and the spikes from within the quadrant were oven-dried to constant weight. The spikes were threshed, cleaned, and weighed to determine crop yields.

The soil at each location was sampled every fall after harvest to determine seasonal effects of the rotation-herbicide systems on the wild oats seed reserves in the soil. Soil samples were taken to a 6-inch depth approximately 200 feet apart in the center of each strip. One soil sample from each strip was dried to constant weight to determine percent soil moisture in the field at sampling. Nylon mesh bags containing the soil samples were placed in a soil washer to remove the soil from the wild oats and other large materials (3). Wild oats seeds were then separated from the residue, counted,and seed reserves expressed as bushels per acre.

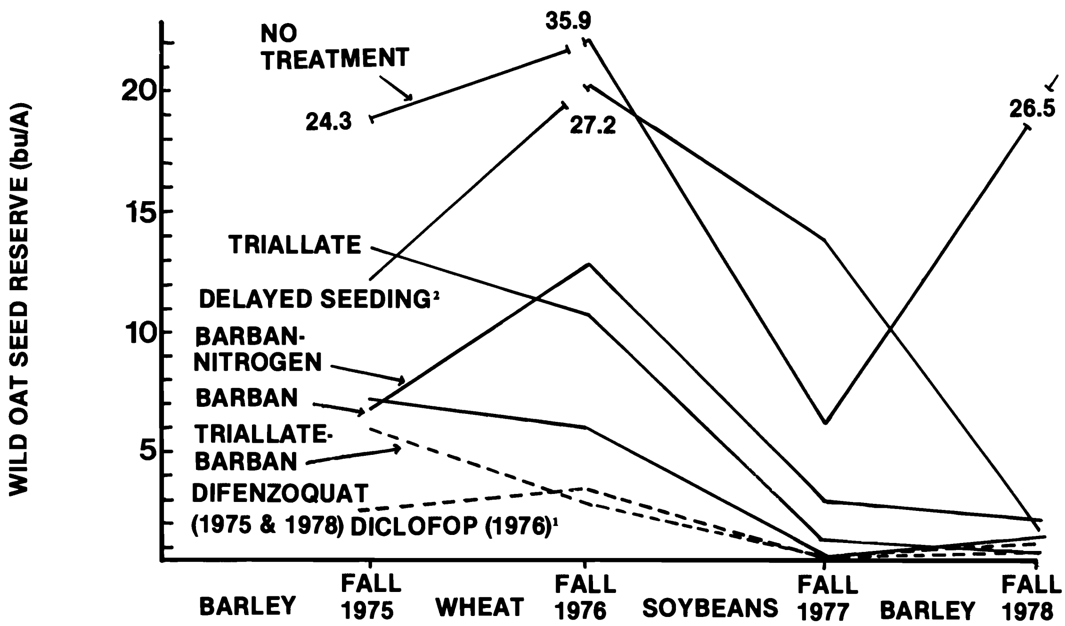
Although wild oats panicle counts, crop yields, and wild oats seed reserves in the soil were determined each year at every location, discussion will relate primarily to seed reserves, which indicate the effects of a treatment on wild oats control as well as on future infestation levels.

Initial seed reserves were determined approximately 14 days after crop seeding in 1975. Wild oats which emerged before soil sampling probably were not counted, so the actual spring reserves in 1975 may have been greater than the data indicate. In addition, certain strips at each location had a higher wild oats infestation than others at the beginning of the experiments. The initial level of wild oats for a given treatment strip was considered when interpreting the results.

RESULTS AND DISCUSSION

The wild oats seed reserves in the soil as influenced by the various treatments at Penn and Fargo from 1975-1978 are presented in Figures 1 and 2.

Results of the Wild Oats Pilot Project indicated that wild oats seed reserves in the soil were reduced up to 88% in one year with control measures which prevented wild oats seed production. For example, the wild oats seed reserves, averaged over all treatment strips, decreased 88% during the 1976 fallow season at Penn (Figure 1). The depletion of wild oats seed reserves during the fallow year was partially due to extended germination of wild oats seed during the cool, wet June at Penn in 1976.



¹Diclofop was applied to the strips because difenzoquat was not registered on the wheat variety seeded in 1976.

²The delayed seeding strips were eliminated in 1978, when diclofop was applied to those strips to reduce the severe wild oat infestation which occurred during delayed seeding in 1976.

Figure 2. Effect of 7 treatments on wild oat seed reserves in the soil at Fargo. Herbicides listed were not applied to soybeans in 1977. LSD .05 (Treatment × Year Interaction) = 14.4.

Wild oats seed reserves decreased 79% at Fargo in 1977 (Figure 2). The reduction was attributed to the soybean cropping practices, which included the later seedbed preparation for soybean than small grains, additional tillage during preplant incorporation of trifluralin, and two cultivations after soybeans emergence. Wild oats seed reserves can be reduced greatly in one season with practices that prevent seed production.

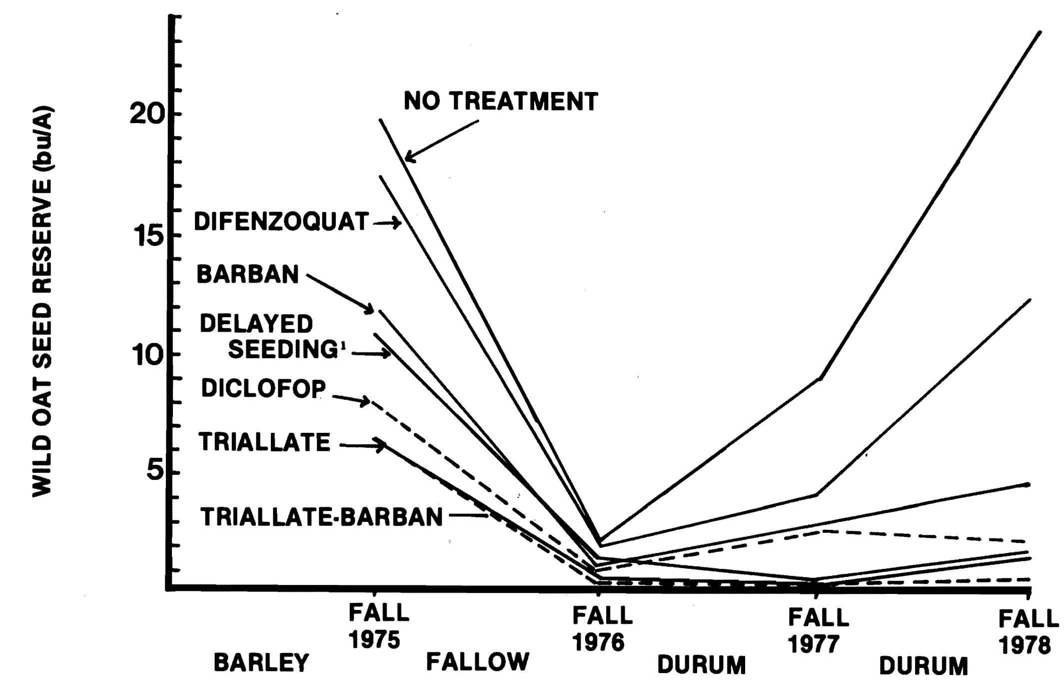
Wild oats seed reserves increased rapidly without the use of control practices. Fallow decreased reserves on the untreated strips to 2.4 bu/A at Penn in 1976, but the reserves increased to 9.1 bu/A in 1977 and 23.1 bu/A in 1978 in the absence of control practices (Figure 1).

Soybean cropping practices at Fargo in 1977 reduced wild oats reserves on the untreated strips by 30 bu/A at Fargo in 1977, but the reserves increased by 20 bu/A in 1978 with no control practices (Figure 2).

Wild oats seed reserves in the soil remained below 1 bu/A from fall of 1976 to fall of 1977 at Penn on the areas treated with triallate, triallate plus barban, and delayed-seeded (Figure 1). These strips contained fewer than one wild oats plant per square yard in the wheat crop in 1977. However, the small number of wild oats seed produced in 1977 prevented a reduction in seed reserves below levels which existed in the fall of 1976. Excellent wild oats control with barban plus nitrogen, difenzoquat, and triallate plus barban at Fargo in 1978 did not reduce the low reserves of less than 1 bu/A which were in the soil in the fall of 1977 (Figure 2).

Annual wild oats seed production is a primary deterrent to eradication. One wild oats plant can produce from 10 to more than 500 seeds (4). One wild oats panicle per square yard may produce up to 1.5 bu/A of seed to reinfest a field, indicating that even excellent wild oats control, if less than 100%, will not eradicate wild oats from a field. For example, greater than 95% of the wild oats which emerged in the diclofop-treated strips were controlled, and wheat yield was more than doubled compared to the untreated strips, but 2 bushels/A of wild oats seed were produced at Fargo in 1976 (Figure 2). Further, the field strips treated with triallate had 98% control of wild oats, and durum yield was more than doubled compared to the untreated strips, but 1½ bushels/A of wild oats seed were produced at Penn in 1978 (Figure 1).

Wild oats seed reserve data in the fall of 1978 indicated that wild oats seed reserves were still present in all of the treatment strips (Figures 1 and 2), so wild oats eradication had not been accomplished by any treatment in the four years of the Pilot Project. Seed reserves which were less than 1 bu/A after three years of a treatment generally tended to increase in the fourth season of treatment. These increases were probably caused by the combination of three factors: 1) wild oats control by a cultural or chemical practice was not complete in 1978, 2) seed production by surviving wild oats plants was high, and 3) the prolonged cool weather into June in 1978 favored extended germination of wild oats, and plants which emerged after postemergence treatments were not controlled.



¹The delayed seeding occurred too early (May 19) in 1975 to maximize wild oats control because wild oats germinated after seeding were not controlled. Only 30% of the acreage of the county had been seeded by May 19 in 1975.

Figure 1. Effect of 7 treatments on wild oat seed reserves in the soil at Penn. Herbicides listed were not applied in the fallow year. LSD .05 (Treatment × Year Interaction) = 9.6.

Conclusions from the wild oats seed reserve data at Jamestown (Table 3) or Williston (Tables 4 and 5) are limited. Wild oats seed reserve data from the relocated Jamestown site is based on only two seasons and data from Williston is based on very low initial wild oats seed reserves. However, large reductions in wild oats seed reserve in the untreated strips at Jamestown in 1977 again indicated the importance of yearly seed production in maintaining wild oats seed reserves in the soil. Wild oats seed production at Jamestown in 1977 was limited because of extremely dry conditions early in the season. Further herbicide treatments except barban tended to reduce wild oats seed reserves in the soil compared to the untreated strips both years. Wild oats seed reserves in the untreated strips at Williston were similar at the start and end of the Wilds Oats Pilot Project, indicating that in an alternate crop fallow system wild oats infestations will not increase dramatically because fallow in alternate years is an effective deterrent to seed production. Further, all herbicide treatments tended to decrease wild oats seed reserves in the soil compared to the untreated strips at Williston. The sampling technique used in this research was not accurate enough at the low levels of wild oat seed reserves in the soil to precisely determine differences.

OTHER OBSERVATIONS

Panicle count data indicated the quantity of seed produced by wild oat plants in a given season. Triallate, triallate plus barban, and delay-seeded strips contained less than 1 wild oats panicle per square yard, compared to 65 panicles per square yard present on the untreated strips at Penn in 1977. Although panicles per square yard increased to 4.5, 1 and 7, respectively, on the triallate, triallate plus barban, and delay-seeded strips in 1978, these increases were small compared to the 198 panicles per square yard on the untreated strips in 1978.

Table 3. Bushels per acre of wild oats seed reserves in the soil as affected by various control measures at Jamestown, ND, 1976-1978[1].

Treatment	Fall 1976	Fall 1977	Fall 1978
	(bu/A)		
Triallate	14.9	3.9	1.6
Triallate + barban	21.7	4.2	0.3
Barban	30.7	13.9	5.0
Diclofop	16.4	3.2	1.8
Difenzoquat	17.4	6.6	3.5
Delayed seeding	22.1	10.2[2]	0 (1 replication[3])
No treatment	25.8	11.8[4]	5.6
LSD 0.5 Trt. × Yr. Interaction = 12.6			

[1]The original Jamestown location was discontinued in the fall of 1976 due to an insufficient wild oats population. No treatments were used on the new site in 1976. The fall, 1976 reserve data indicate the initial reserves in the soil.

[2] Large wild oats seed reserves on the delayed seeding strips in the fall of 1977 were partially due to the narrowness of one of the strips, which interfered with tillage to control wild oats during seedbed preparation.

[3]The narrow delayed seeding strip was deleted from the experiment in 1978 because it was too narrow to till properly.

[4]The large reduction in wild oat seed reserves in 1977 on the untreated strips was possibly due to poor seed production caused by the very dry spring.

Triallate and triallate plus barban-treated strips contained less than one wild oats panicle per square yard, while the untreated strips contained 491 panicles per square yard prior to harvest at Fargo in 1978. Control methods are needed to prevent both wild oats competition and reinfestation.

Table 4. Bushels per acre of wild oats seed reserves in the soil as affected by various control measures at Williston, field 1, 1975-1978[1].

Treatment	Wheat Fall 1975	Fallow Fall 1976	Barley Fall 1977	Fallow Fall 1978
	(bu/A)			
Triallate	1.5	0.2	0.1	0.03
Triallate + barban	0.7	0.4	0.0	0.07
Barban	0.3	0.1	0.1	0.57
Difenzoquat (1977)	2.1	0.1	0.1	0.22
Barban-nitrogen (1975) Diclofop (1977)	0.8	0.4	0.2	0.95
Delayed seeding	0.9	2.4	0.1	0.45
No treatment	0.8	4.9	2.6	0.95
MEAN	1.0	1.2	0.5	0.5

[1]The Williston locations, typical of the drier regions of North Dakota, often contained wild oats in only one or two samples of each strip.

Table 5. Bushels per acre of wild oats seed reserves in the soil as affected by various control measures at Williston, field 2, 1975-1978[1].

Treatment	Fallow Fall 1975	Durum Fall 1976	Fallow Fall 1977	Durum Fall 1978
	(bu/A)			
Triallate	5.1	0.4	5.9	5.70
Triallate + barban	6.2	0.5	5.2	0
Barban	3.3	0.7	0.1	0.58
Difenzoquat	1.6	0.1	2.0	0.18
Diclofop	3.3	0.7	0.1	0.37
Delayed seeding	9.0	1.1	0.8	0.70
No treatment	7.5	0.7	0.7	7.58
MEAN	5.1	0.6	2.1	2.2

[1]The Williston locations, typical of the drier regions of North Dakota, often contain wild oats in only one or two samples of each strip.

Table 6. Wild oats panicles produced in 1978 after 4 seasons of treatment with triallate alone or plus barban.

Location	Triallate + barban	Triallate alone
	WIOA panicles/Sq. yard)	
Penn	1.0	4.4
Jamestown[1]	0	0.6
Fargo	0.5	0.6
Williston	0.1	8.9

[1]Two year system.

Barley (Table 7) and wheat (Table 8) yields were averaged over years and locations and analyzed statistically, excluding the data from the Williston location. Barley and wheat yields on all treated strips were significantly greater than on the untreated strips. Wheat yields were less on delay-seeded strips than on strips treated with diclofop or triallate plus barban. Wheat and barley yields on strips treated with triallate or barban tended to be less than yields on strips treated with both triallate and barban.

Table 7. Bushels per acre of barley averaged over comparative sites and years of the Wild Oats Pilot Project.

Treatment[1]	Barley yield P75,F78,J78[2]	P75,F78[3]	P75,J78[4]	F78,J78[5]
	(bu/A)			
Triallate + barban	42.0	39.6	40.4	45.8
Barban + N	---	35.0	---	---
Difenzoquat	---	---	37.6	---
Diclofop	---	---	---	44.6
Triallate	37.3	34.5	36.0	41.5
Barban	35.6	32.8	34.9	39.1
No treatment	23.3	16.4	31.0	22.4
LSD .05	9.6	13.2	4.2	11.8
Two replications per site	6	4	4	4

[1]All treatments may be compared only within columns. No delayed seeding comparisons are included because some severely infested strips were treated with herbicides in 1978 due to farmer request.

[2]Penn, 1975; Fargo, 1978; Jamestown, 1978.

[3]Penn, 1975; Fargo, 1978.

[4]Penn, 1975; Jamestown, 1978.

[5]Fargo, 1978; Jamestown, 1978.

Table 8. Bushels per acre of wheat averaged over comparative sites and years of the Wild Oats Pilot Project.

Treatment[1]	Wheat yield P77,P78,F76,J77[2]	P77,P78,F76,J77[2]	P77,P78,J77[3]	F76[4]
	(bu/A)			
Diclofop	29.6	29.1	27.7	35.5
Triallate + barban	28.6	28.1	27.2	32.7
Difenzoquat	---	---	24.0	---
Barban + N	---	---	---	30.4
Barban	24.4	23.0	22.6	29.7
Triallate	24.3	25.0	23.9	25.2
Delayed seeding	---	22.4	---	---
No treatment	16.3	16.8	16.7	15.0
LSD .05	4.9	5.8	5.0	14.4
Two replications per site	8	7[5]	6	2

[1]All treatments may be compared only within columns.

[2]Penn, 1977 and 1978; Fargo 1976; Jamestown, 1977.

[3]Penn, 1977 and 1978; Jamestown, 1977.

[4]Fargo, 1976.

[5]One replication of the delayed seeding was eliminated at Jamestown in 1977.

An analysis of the cost of the treatments versus the yield increases in the Wild Oats Pilot Project indicated that herbicides or delayed seeding increased the profit margin compared to no treatment (Tables 9 and 10). Treatment with triallate plus barban, although more expensive to apply than either herbicide alone, produced a greater net return because of the increased yields compared to triallate or barban alone. Herbicide treatments produced greater net returns than delayed seeding. All of the treatments, locations, and years could not be included in the analysis because some of the treatments were not used throughout the experiment.

HERBICIDE EFFECTIVENESS

Preplant incorporated triallate was the most consistent of the herbicides used for wild oats control in small grains averaged over the four years and four locations of the Pilot Project (Table 6). The greatest decrease in wild oats seed reserves by a treatment at Penn in 1975 occurred on the triallate-treated strips, which had contained the highest wild oats seed reserves at initiation of the Pilot Project in the spring of 1975. Reserves on the triallate-treated strips decreased from 22.3 to 6.5 bu/A at Penn in 1975, while seed reserves on the untreated strips increased from 8.1 to 19.7 bu/A. Triallate applied in the spring followed by postemergence barban reduced wild oat seed reserves from 13.4 to 6.5 bu/A at Penn in 1975 (Figure 1). However, other research results have indicated that adequate soil moisture is necessary at the time of wild oats emergence for effective control with triallate. Triallate is a preemergence herbicide, which makes it difficult to determine the potential wild oats population and benefits from treatments before herbicide application.

Table 9. Net returns of treatments used on wheat in the Pilot Project.

Treatment	Wheat Yield[1]	Yield Increase	Total gain at $4.77/bu[2]	Herbicide cost/A[3]	Net gain/A
	(bu/A)		($)	($)	($)
Diclofop	29.1	12.3	58.67	13.93	44.74
Tri + barban	28.1	11.3	53.90	18.48	35.42
Barban	23	6.2	29.57	6.53	23.04
Triallate	25	8.2	39.11	11.95	27.16
Delayed seeding	22.4	5.6	26.71	0	26.71
No treatment	16.8	0	0	0	0

[1]Average of Penn, 1977 and 1978; Fargo, 1976; Jamestown, 1977.

[2]Based on average closing cash Minneapolis prices, 6/10/81, of No. 1 DNS Wheat (14% protein) and No. 1 Hard Amber Durum.

[3]N.D. Crop and Livestock Reporting Service, USDA Bull., 1980; costs include application and incorporation costs, if necessary.

Table 10. Net return of trreatments used on barley in the Pilot Project.

Treatment	Barley yield[1]	Yield increase	Total gain at $3.22/bu[2]	Herbicide cost/A[3]	Net gain/A
	(bu/A)		($)	($)	($)
Tri + barban	42.0	18.7	60.21	18.48	41.73
Triallate	37.3	14.0	45.08	11.95	33.13
Barban	35.6	12.3	39.61	6.53	33.08
No treatment	23.3	0	0	0	0

[1]Average of Penn, 1975; Fargo, 1978; Jamestown, 1978.

[2]Based on closing cash Minneapolis price, 6/10/81, of No. 1 Six-rowed Malting Barley (average of 50-60% Plump range).

[3]N.D. Crop and Livestock Reporting Service, USDA Bull., 1980; costs include application and incorporation costs, if necessary.

CONCLUSIONS

Wild oats control systems should be determined by the level of an infestation. Potential wild oats infestation can be assessed by soil sampling as in the research reported here or by considering past infestation levels and control practices.

Fields densely infested with wild oats will require high levels of control inputs initially; combining competitive crops, tillage and herbicides to reduce seed reserves in the soil to levels where intensive control measures are not needed to maximize crop yields. Intensive systems which effectively control high wild oats infestation are summer fallow, warm season row crops such as soybean or sunflower treated with various herbicides, delay-seeded small grains treated with postemergence herbicides as needed, and normal seeding of small grains with preemergence and postemergence herbicides for wild oats control. Winter wheat and winter rye, although not included in the Pilot Project, would also be intensive control systems because of their vigorous competition with spring germinating wild oats.

Intensive control practices for two years generally reduce wild oats infestation to levels where less intensive systems will give adequate control in subsequent years. Low wild oats infestations can be effectively controlled with only postemergence herbicides in various crops. Wild oats seedling density and stage of development are important considerations when determining the specific herbicide and rate for a given field situation. Further, wild oats infestations often vary within fields and treatments may only be needed in parts of the field.

The economic advantage of elminating control measures when the wild oats plant population is very low must be weighed against the disadvantage of having to control a larger population of wild oats plants the following year. A wild oats plant population as low as three wild oats per square yard, which may not affect yield, can produce up to 4½ bu/A of seed to severely reinfest a field.

Severe wild oats infestations in the Wild Oat Pilot Project were reduced in as little as two years to levels which did not require intensive control measures such as the triallate plus barban treatment. However, eradication was not accomplished in four years, and low wild oats seed reserves increased rapidly when control measures were discontinued.

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CORRECTION

The following "Literature Cited" was inadvertently omitted from the article "The Microbial Environment of the Calf with Diarrhea" which appeared in the November-December 1981 issue of North Dakota Farm Research.

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