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1980 PESTICIDE USE ON FIELD CORN
IN THE CORN BELT

by

Michael Hanthorn, Craig Osteen,
Robert McDowell, and Larry Roberson

January 1982

ERS Staff Report No. AGES820120

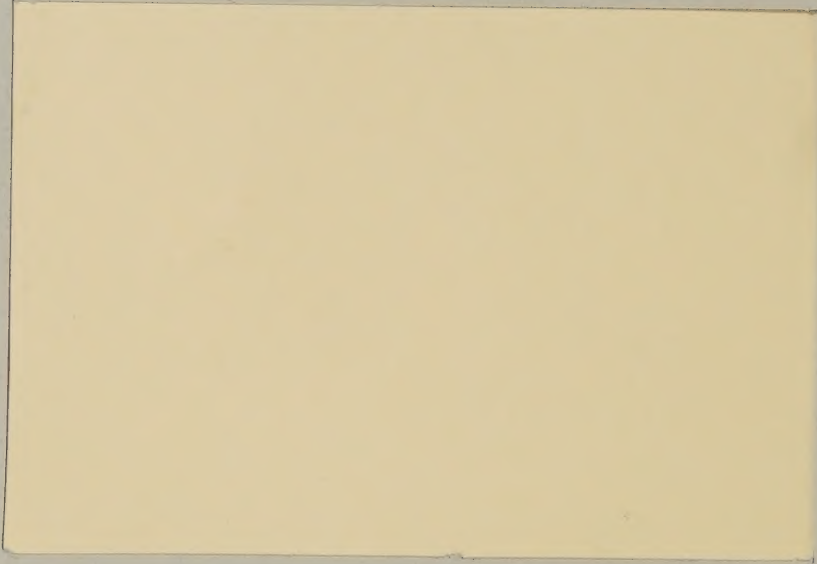
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1980 PESTICIDE USE ON FIELD CORN IN THE CORN BELT. By Michael Hanthorn, Craig Osteen, Robert McDowell, and Larry Roberson; Natural Resource Economics Division, Economic Research Service, U.S. Department of Agriculture, Washington, D.C. 20250; January 1982.

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ABSTRACT

Farmers reported that 144.8 million pounds (a.i.) of pesticides were applied to field corn in the Corn Belt during 1980. This consisted of 127 million pounds (a.i.) of herbicides and 17.8 million pounds (a.i.) of insecticides. Pesticide acre-treatments totaled 75.5 million and consisted of 43.6 million with single material herbicides, 15.7 million with herbicide mixes, and 16.2 million with insecticides. The primary herbicides were alachlor, atrazine, butylate⁺, and 2,4-D. The major insecticides were carbofuran, fonofos, and terbufos. Herbicides were primarily applied to control cocklebur, foxtail, and velvetleaf infestations. Most insecticides were used for corn rootworm larvae control. Coefficients of variation were computed for acres treated with specific pesticides.

Key words: Pesticides, herbicides, insecticides, active ingredient, acres treated, acre-treatments, application rates, primary target pests, field corn, and Corn Belt.

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ACKNOWLEDGMENTS

The 1980 Corn Pesticide Use Survey was conducted by the Statistics Division of the Economics and Statistics Service. Herman W. Delvo provided guidance and made valuable suggestions during this effort. The report was reviewed by Rod Coan, Theodore R. Eichers, Stanford Fertig, Armand Padula, John R. Parks, and Robert F. Torla. A special thanks is extended to Beverly Herath and Andrea Lunsford for typing the preliminary and final manuscript drafts.

AUTHORS

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PREFACE

This report presents data for pesticides applied to field corn in the Corn Belt during 1980. Pesticide use data for the major producing States not included in the Corn Belt and for all major producing regions are available in the following ERS Staff Reports:

- "1980 Pesticide Use on Field Corn in the Northern Plains"
- "1980 Pesticide Use on Field Corn in the Lake States"
- "1980 Pesticide Use on Field Corn in the Major Producing States".

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INTRODUCTION

This report presents pesticide use data for field corn grown in the Corn Belt during 1980. The data include usage patterns and quantities of specific herbicides and insecticides applied to field corn. This information should be useful to policymakers, academic institutions, government agencies, and private and commercial entities in evaluating the impacts of regulatory actions on specific pesticides, conducting economic analyses of pesticide use, developing more effective pest management programs, and conducting pesticide market analyses.

METHODOLOGY AND TERMINOLOGY

The Economics and Statistics Service collected pesticide use data as part of the 1980 Corn Objective Yield Survey. A total of 2,870 farmers were personally interviewed by enumerators in the 16 major field corn producing States, of which 1,210 were located in the Corn Belt. The sample size by State was as follows: Illinois, 260; Indiana, 210; Iowa, 240; Kentucky, 155; Missouri, 150; and Ohio, 195.

Sample fields for each State were randomly selected from farmers who reported through the June Enumerative Survey that they had planted or intended to plant field corn in 1980. Each field corn acre in a State had an equal probability of being selected. Consequently, the probability of a field being chosen was directly correlated to its size.

Several terms pertinent to this report are defined as follows. An "active ingredient" (a.i.) is that portion of a pesticide material that provides the control activity. "Acres treated" are the number of acres receiving one or more applications of a specific pesticide during the growing season. Acres treated with different pesticide materials cannot be summed because more than one material may have been applied on a given acre during the growing season.

Therefore, the addition of these numbers would result in multiple counting. "Acre-treatments" are the number of acres treated with a pesticide material multiplied by the number of applications made during the growing season. Acre-treatments are summed for each product at the State and regional level. "Pesticide mixes" are two or more pesticide materials that are premixed during formulation or tank-mixed at the time of application.

Pesticide application rates vary as a result of weather conditions, soil type, weed spectrum, and insect species. Also, the method of application influences the amount of a material used per acre. Herbicide and foliar insecticide application rates are generally expressed as broadcast rates. The amount of a material applied on an acre in either a band, in-furrow, or spot application is generally one-fourth to one-third the amount applied in a broadcast application. The application rate listed for each material in this report is an aggregation of band, broadcast, in-furrow, and spot applications.

RELIABILITY OF ESTIMATES

Estimates based upon sample surveys have varying degrees of statistical reliability. Confidence in data depends upon sample size, sampling methods, and the variability of the responses. To provide the user of the data with some indication of the reliability of the estimates, coefficients of variation (CV's) are presented in Appendix Table 1. The CV is a measure of relative variation (expressed in percentage terms) and can be used to indicate the degree of confidence a user can place in the estimate. The smaller the CV, the more reliable the estimate.

In simplest terms, it can be said there is 95 percent confidence that the sample represents the true population and that the true value for the population lies within an interval defined as the estimated value ± 2 CV's times the

estimated value. For example, with a CV of 10 percent and an estimate of 40, the interval would be 32 to 48. However, there is also a 5 percent chance that the true value does not fall within the interval as defined above because the sample is not representative of the population.

CV's were calculated only for acres treated with specific pesticides. The estimates of acres treated are expected to have greater variation than other data reported. Consequently, for most other information included in this report, the level of reliability should be equal to or greater than reported for acres treated.

CORN BELT

Description

The Corn Belt includes Illinois, Indiana, Iowa, Kentucky, Missouri, and Ohio (Figure 1). This region is the major field corn producing area in the United States. In 1980, 48 percent of the U.S. field corn acreage (40.6 million acres) was planted in the Corn Belt, from which 57 percent of the corn for grain (3.8 billion bushels) and 20 percent of the corn silage (21.8 million tons) were harvested (Table 1). The farm value of corn for grain grown in the Corn Belt during 1980 was \$12.3 billion. Approximately 38 percent of the corn for grain (2.5 billion bushels) was produced on 24.7 million harvested acres in Illinois and Iowa. These two States represented 34 percent of the U.S. total harvested acreage in 1980.

Trends in Pesticide Use

Total acreage planted to field corn and treated with pesticides increased substantially in the Corn Belt between 1972 and 1980. Acres planted increased by 7.6 million, while acres treated with herbicides and insecticides increased 13 and 6.3 million, respectively (Table 2). Virtually all farmers reported

Table 1. Field corn acreage planted and harvested, production, and value in the Corn Belt, 1980

States	Total acres a/			Total production a/		Value of grain b/
	Planted	Harvested	Grain	Silage	Bushels of grain	
	----- Million -----					Million dollars
Illinois	11.7	11.4	0.2	1,066	2.9	3,517
Indiana	6.5	6.3	.1	603	1.9	1,990
Iowa	14.0	13.3	.7	1,463	9.5	4,608
Kentucky	1.6	1.5	.2	103	2.0	383
Missouri	2.6	2.1	.3	110	2.4	379
Ohio	4.2	3.9	.2	441	3.1	1,454
Region	40.6	38.5	1.7	3,786	21.8	12,331
U.S. total	84.1	73.1	9.3	6,648	111.1	21,687
Percent of U.S. total	48	53	18	57	20	57

a/ "Crop Production-1980 Annual Summary", USDA, ESS, Crop Reporting Board, CrPr 2-1(81), January 14, 1981.

b/ "Field Crops-Production, Disposition, Value 1979-80", USDA, ESS, Crop Reporting Board, CrPr 1(81), April 1981.

Table 2. Field corn acreage planted and treated for weed and insect control in the Corn Belt, 1972 and 1980

States	Planted acres		Treated acres				Percent of planted acres treated			
	1972	1980	Herbicides	Insecticides	Herbicides	Insecticides	1972	1980	1972	1980
	----- Million -----						----- Percent -----			
Illinois	9.5	11.7	7.8	11.2	4.4	5.5	82	96	46	47
Indiana	5.1	6.5	4.3	6.4	1.1	2.1	84	98	22	32
Iowa	11.3	14.0	8.7	13.9	3.6	6.1	77	99	32	44
Kentucky	1.1	1.6	.9	1.5	-	.3	78	94	-	19
Missouri	2.7	2.6	2.3	2.4	.5	.7	85	92	19	27
Ohio	3.3	4.2	2.6	4.2	.5	1.7	79	100	15	40
Region	33.0	40.6	26.6	39.6	10.1	16.4	81	98	31	40

- None reported.

a/ "Agricultural Statistics, 1974", U.S. Department of Agriculture.

b/ "Crop Production-1980 Annual Summary", USDA, ESS, Crop Reporting Board, CrPr 2-1(81), January 14, 1981.

c/ Herman W. Delvo, "Herbicide Use on Corn and Soybeans in the North Central Region, 1972", paper presented at the 27th North Central Weed Control Conference, Winnepeg, Manitoba, December 1972.

d/ "1980 Corn Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

e/ Herman W. Delvo, "1972 Corn Objective Yield Survey", USDA, ERS, Farm Production Economics Division, 1972, (unpublished).

using herbicides on field corn acreage in 1980. This represents a 21 percent increase in the percent of planted acres treated with herbicides during this period. The proportion of planted acreage treated with insecticides increased from 31 to 40 percent between 1972 and 1980. The percentage of planted acres treated with herbicides was greater than 92 percent in all of the States during 1980, while the amount of acreage treated with insecticides ranged from 19 percent in Kentucky to 47 percent in Illinois.

Pesticide Use

The major field corn weed and insect pests, as reported by farmers in the Corn Belt, are listed in Tables 3 and 4. Although several pests may have been present at any given time and caused varying degrees of damage, farmers were asked to report what they perceived to be the primary target pest for each material applied to field corn. In 1980, farmers reported that foxtail was the primary target pest for 42 percent of the herbicide acre-treatments, cocklebur for 13 percent, and velvetleaf for 11 percent (Table 3). Corn rootworm larvae were the major target pest for 84 percent of the insecticide acre-treatments and cutworm for 8 percent (Table 4).

Approximately 144.8 million pounds (a.i.) of pesticides were applied to field corn in 1980, consisting of 75.3 million pounds of single material herbicides, 51.7 million pounds of herbicide mixes, and 17.8 million pounds of insecticides (Table 5). Application rates for herbicides, applied alone and in mixes, averaged 1.7 and 3.3 pounds (a.i.) per acre-treatment, respectively. Insecticide application rates averaged 1.1 pounds (a.i.) per acre-treatment.

Farmers made 75.5 million pesticide acre-treatments, comprised of 43.6 million with single material herbicides, 15.7 million with herbicide mixes, and 16.2 million with insecticides.

Atrazine acre-treatments totaled 13.1 million, or 30 percent of the single

Table 3. Percentage of field corn herbicide acre-treatments by primary weeds controlled as reported by farmers in the Corn Belt, 1980 a/

Pests	Percent						
	Iowa	Mis- souri	Illi- nois	Ken- tucky	Indi- ana	Ohio	Region
<u>Grasses</u>							
Broadleaf signalgrass	1	-	1	3	4	3	2
Crabgrass	-	2	-	15	2	1	1
Foxtail	44	27	47	23	44	32	42
Johnsongrass	-	2	3	13	4	1	2
Panicum	-	1	1	1	1	8	1
Quackgrass	2	-	-	-	1	6	2
Other	1	9 <u>b/</u>	2	12	2	1	3
<u>Broadleaf weeds</u>							
Canada thistle	2	-	-	-	1	6	1
Cocklebur	16	28	13	12	6	6	13
Morningglory	3	5	2	2	5	5	3
Pigweed	5	7	6	5	6	3	5
Ragweed	1	1	2	11	5	15	4
Smartweed	5	3	5	2	4	4	5
Velvetleaf	15	6	13	-	6	4	11
Other	4	8	4	1	8	3	4
Nutsedge	1	1	1	-	1	2	1

- None reported.

a/ "1980 Corn Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

b/ Includes barnyardgrass, 2 percent, and shattercane, 5 percent.

Table 4. Percentage of field corn insecticide acre-treatments by primary insects controlled as reported by farmers in the Corn Belt, 1980 a/

Insects	Percent						
	Iowa	Mis- souri	Illi- nois	Ken- tucky	Indi- ana	Ohio	Region
Corn rootworm larvae	94	27	85	55	77	81	84
Corn rootworm beetle	-	-	1	-	4	2	1
Cutworm	4	61	9	3	11	3	8
European corn borer	2	-	2	32	1	-	2
Wireworm	-	9	-	-	2	13	3
Other	-	3	3	10 <u>b/</u>	5	1	2

- None reported.

a/ "1980 Corn Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

b/ Includes armyworm, 7 percent.

Table 5. Usage patterns and quantities of specific pesticides applied to field corn in the Corn Belt, 1980 a/

Pesticides	: Acres b/	: Acre-	c/	:Pounds of active ingredient
	: treated	: treatments	: Total	: Per treatment
----- Million -----				
HERBICIDES				
<u>Single materials</u>				
Alachlor	7.7	7.7	16.3	2.1
Atrazine	12.9	13.1	20.0	1.5
Butylate ⁺	6.1	6.2	20.4	3.3
Cyanazine	3.7	3.7	6.6	1.8
Dicamba	2.7	2.7	1.0	.4
Metolachlor	2.3	2.3	4.1	1.8
2,4-D	5.8	5.9	2.8	.5
Other	-	2.0	4.1	2.0
Total	-	43.6	75.3	1.7
<u>Tank-mix materials</u>				
Atrazine + alachlor	4.2	4.3	5.6+7.6	1.3+1.8
Atrazine + butylate ⁺	3.1	3.1	3.8+9.3	1.2+3.0
Atrazine + cyanazine	.9	.9	1.0+1.2	1.2+1.4
Atrazine + metolachlor	1.2	1.2	1.8+2.1	1.5+1.7
Atrazine + simazine	.7	.7	.8+ .8	1.1+1.1
Atrazine + other d/	-	1.5	1.8+3.6	1.2+2.4
Cyanazine + alachlor	.5	.6	1.1+1.0	1.9+1.7
Cyanazine + butylate ⁺	1.7	1.7	2.9+5.1	1.7+3.0
Cyanazine + other e/	-	.2	.4+ .4	2.0+2.0
Dicamba + 2,4-D	1.3	1.3	.5+ .5	.4+ .4
Other	-	.2	.4	2.0
Total	-	15.7	51.7	3.3
 Total herbicides	-	59.3	127.0	2.1
INSECTICIDES				
Carbofuran	4.0	4.1	3.9	.9
Chlorpyrifos	1.9	1.9	2.2	1.2
Fonofos	2.8	2.8	3.2	1.2
Phorate	1.7	1.7	1.4	.8
Terbufos	4.8	4.8	5.7	1.2
Other	-	.9	1.4	1.5
Total	-	16.2	17.8	1.1
 TOTAL PESTICIDES	-	75.5	144.8	1.9

a/ "1980 Corn Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

b/ Data in this column for "other" and "total" were not reported because two or more materials may have been used on the same acre resulting in multiple counting.

c/ Most farmers applied herbicides and insecticides one time during the growing season. The average number of applications per season for each material can be determined by dividing acre-treatments (column 2) by acres treated (column 1).

d/ Other includes bentazon, bifenox, dicamba, EPTC⁺, metribuzin, paraquat, penoxalin, propachlor, and 2,4-D.

e/ Other includes EPTC⁺, metolachlor, and 2,4-D.

material herbicide acre-treatments. Alachlor, butylate⁺, and 2,4-D accounted for 19.8 million (45 percent) of these acre-treatments. All of the butylate⁺ included in this report contained an additive to protect the corn seed from possible damage and was sold as Sutan⁺. Atrazine plus alachlor and atrazine plus butylate⁺ accounted for 7.4 million (47 percent) of the herbicide mix acre-treatments, while cyanazine plus butylate⁺ and dicamba plus 2,4-D totaled 3 million acre-treatments (19 percent).

Foxtail was the primary target pest for three-fourths of the alachlor and butylate⁺ acre-treatments (Appendix Table 2). Approximately 41 and 13 percent of the atrazine acre-treatments were made to control foxtail and cocklebur infestations, respectively (Appendix Tables 2 and 3). Over 60 percent of the 2,4-D acre-treatments were made for cocklebur and velvetleaf control.

The two major field corn insecticides, carbofuran and terbufos, constituted 4.1 and 4.8 million (25 and 30 percent) of the insecticide acre-treatments, respectively (Table 5). About 6.4 million (39 percent) of the insecticide acre-treatments were made with chlorpyrifos, fonofos, and phorate. Between 92 and 100 percent of the carbofuran, fonofos, phorate, and terbufos acre-treatments were made for corn rootworm larvae control (Appendix Table 4). Cutworm was the major target pest for 58 percent of the chlorpyrifos and 81 percent of the ethoprop acre-treatments. In addition, 37 percent of the chlorpyrifos acre-treatments were made for corn rootworm larvae control.

IOWA

In 1980, Iowa farmers planted 14 million acres of field corn and treated 13.9 million acres with herbicides and 6.1 million acres with insecticides (Table 2). Approximately 53.6 million pounds (a.i.) of pesticides were applied to field corn, of which 24.5 million pounds were single material herbicides,

22.2 million pounds were herbicide mixes, and 6.9 million pounds were insecticides (Table 6). Application rates for herbicides, applied alone and in mixes, averaged 1.8 and 3.3 pounds (a.i.) per acre-treatment, respectively. Insecticide application rates averaged 1.1 pounds (a.i.) per acre-treatment.

Total pesticide acre-treatments were estimated to be 26.6 million, comprised of 13.6 million with single material herbicides, 6.8 million with herbicide mixes, and 6.2 million with insecticides.

Alachlor, atrazine, butylate⁺, cyanazine, dicamba, and 2,4-D accounted for 12.7 million (93 percent) of the single material herbicide acre-treatments. Butylate⁺ was the primary single material herbicide in Iowa. Atrazine plus alachlor accounted for 1.5 million (22 percent) of the herbicide mix acre-treatments, while atrazine plus butylate⁺ acre-treatments totaled 1.3 million (19 percent). One-sixth (1.2 million) of the herbicide mix acre-treatments were cyanazine plus butylate⁺. As reported by farmers, all of the alachlor and 88 percent of the butylate⁺ acre-treatments were made for foxtail control (Appendix Table 2). About 27 and 20 percent, respectively, of the atrazine acre-treatments were made for foxtail control and cocklebur suppression (Appendix Tables 2 and 3). Of the 2,4-D acre-treatments, 35 percent were made for cocklebur control and 44 percent were made for velvetleaf control.

About 2.3 million (37 percent) of the insecticide acre-treatments were made with terbufos and 3.2 million (52 percent) were either carbofuran, fonofos, or phorate (Table 6). All of the carbofuran, fonofos, phorate, and terbufos was applied for corn rootworm larvae control (Appendix Table 4). Also, corn rootworm larvae control accounted for 60 percent of the chlorpyrifos acre-treatments. Cutworm was the primary target pest for all of the ethoprop and 40 percent of the chlorpyrifos acre-treatments.

Table 6. Usage patterns and quantities of specific pesticides applied to field corn in Iowa, 1980 a/

Pesticides	: Acres <u>b/</u> :		Acre- <u>c/</u> :		Pounds of active ingredient	
	treated	treatments	Total	Per treatment	Total	Per treatment
----- Million -----						
HERBICIDES						
<u>Single materials</u>						
Alachlor	2.0	2.0	4.7	2.3		
Atrazine	1.8	1.9	2.6	1.4		
Butylate ⁺	3.0	3.0	10.4	3.5		
Cyanazine	1.6	1.6	3.1	2.0		
Dicamba	1.4	1.4	.5	.4		
2,4-D	2.8	2.8	1.4	.5		
Other	-	.9	1.8	1.9		
Total	-	13.6	24.5	1.8		
<u>Tank-mix materials</u>						
Atrazine + alachlor	1.5	1.5	1.9+2.7	1.2+1.7		
Atrazine + butylate ⁺	1.3	1.3	1.5+4.3	1.1+3.3		
Atrazine + cyanazine	.5	.5	.5+ .6	1.0+1.2		
Atrazine + other <u>d/</u>	-	.6	.9+1.1	1.5+1.8		
Cyanazine + butylate ⁺	1.2	1.2	2.0+3.8	1.6+3.1		
Cyanazine + other <u>e/</u>	-	.6	1.1+0.7	1.8+1.2		
Dicamba + 2,4-D	1.0	1.0	.4+ .4	.4+ .4		
Other	-	.1	.2	2.7		
Total	-	6.8	22.2	3.3		
Total herbicides	-	20.4	46.7	2.3		
INSECTICIDES						
Carbofuran	.8	.8	.7	.9		
Fonofos	1.1	1.1	1.3	1.2		
Phorate	1.3	1.3	1.0	.8		
Terbufos	2.3	2.3	2.9	1.2		
Other	-	.7	1.0	1.5		
Total	-	6.2	6.9	1.1		
TOTAL PESTICIDES	-	26.6	53.6	2.0		

a/ "1980 Corn Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

b/ Data in this column for "other" and "total" were not reported because two or more materials may have been used on the same acre resulting in multiple counting.

c/ Most farmers applied herbicides and insecticides one time during the growing season. The average number of applications per season for each material can be determined by dividing acre-treatments (column 2) by acres treated (column 1).

d/ Other includes bentazon, bifenox, dicamba, metolachlor, and metribuzin.

e/ Other includes alachlor and metolachlor.

MISSOURI

Acres planted to field corn totaled 2.6 million in Missouri during 1980 (Table 2). Of these, 2.4 million were treated with herbicides and 700,000 were treated with insecticides. A total of 7.3 million pounds (a.i.) of pesticides were applied to field corn, consisting of 2.9 million pounds of single material herbicides, 3.7 million pounds of herbicide mixes, and 582,000 pounds of insecticides (Table 7). Herbicide application rates averaged 1.4 pounds (a.i.) per acre-treatment for single materials and 3.2 pounds (a.i.) per acre-treatment for mixes. The average insecticide application rate was 0.9 pound (a.i.) per acre-treatment.

Pesticide acre-treatments totaled 3.9 million. Of these, herbicide acre-treatments accounted for 3.2 million, consisting of 2 million with single materials and 1.2 million as mixes. Insecticide acre-treatments totaled 643,000.

Atrazine acre-treatments accounted for 701,000 (34 percent) of those made with single material herbicides, while alachlor and 2,4-D acre-treatments totaled 740,000 (36 percent). Atrazine plus alachlor acre-treatments accounted for 486,000 (42 percent) of those made with herbicide mixes and atrazine plus butylate⁺ acre-treatments totaled 164,000 (14 percent).

Farmers reported that a higher proportion of herbicide acre-treatments was made to control cocklebur infestations in Missouri than in the other Corn Belt States (Table 3). Two-thirds of the alachlor acre-treatments were made for foxtail control, while 42 and 22 percent, respectively, of the atrazine acre-treatments were made to control cocklebur and foxtail infestations (Appendix Tables 2 and 3). Butylate⁺ was applied solely for shattercane control and 44 percent of the 2,4-D acre-treatments were made to control cocklebur infestations.

Table 7. Usage patterns and quantities of specific pesticides applied to field corn in Missouri, 1980 a/

Pesticides	: Acres <u>b/</u>	: Acre- <u>c/</u>	:Pounds of active ingredient	
	: treated	: treatments	: Total	: Per treatment
----- <u>Thousand</u> -----				
HERBICIDES				
<u>Single materials</u>				
Alachlor	391	391	731	1.9
Atrazine	701	701	1,056	1.5
Cyanazine	195	195	335	1.7
Dicamba	117	117	53	.5
2,4-D	330	349	250	.7
Other	-	286	509	1.8
Total	-	2,039	2,934	1.4
<u>Tank-mix materials</u>				
Atrazine + alachlor	486	486	669+683	1.4+1.4
Atrazine + butylate ⁺	164	164	200+504	1.2+3.1
Atrazine + metolachlor	98	98	144+154	1.5+1.6
Atrazine + other <u>d/</u>	-	279	296+664	1.1+2.4
Cyanazine + other <u>e/</u>	-	105	168+197	1.6+1.9
Other	-	39	68	1.7
Total	-	1,171	3,747	3.2
Total herbicides	-	3,210	6,681	2.1
INSECTICIDES				
Carbofuran	96	96	89	.9
Chlorpyrifos	313	313	293	.9
Ethoprop	175	175	133	.8
Other	-	59	67	1.1
Total	-	643	582	.9
TOTAL PESTICIDES	-	3,853	7,263	1.9

a/ "1980 Corn Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

b/ Data in this column for "other" and "total" were not reported because two or more materials may have been used on the same acre resulting in multiple counting.

c/ Most farmers applied herbicides and insecticides one time during the growing season. The average number of applications per season for each material can be determined by dividing acre-treatments (column 2) by acres treated (column 1).

d/ Other includes bifenox, cyanazine, dicamba, metribuzin, paraquat, pendimethalin, and 2,4-D.

e/ Other includes alachlor, butylate⁺, metolachlor, and 2,4-D.

Chlorpyrifos and ethoprop comprised 313,000 (49 percent) and 175,000 (27 percent) of the insecticide acre-treatments, respectively (Table 7). Farmers reported that a higher proportion of insecticide acre-treatments was made for cutworm control and a lower proportion was made for corn rootworm larvae control in Missouri than in the other Corn Belt States (Table 4). Corn rootworm larvae control accounted for 80 percent of the carbofuran acre-treatments (Appendix Table 4). The remaining 20 percent were made for wireworm control. About 87 percent of the chlorpyrifos and 78 percent of the ethoprop acre-treatments were made to suppress cutworm infestations. All of the terbufos was used for corn rootworm larvae control.

ILLINOIS

During the 1980 growing season, 11.7 million acres of field corn were planted in Illinois, of which 11.2 million were treated with herbicides and 5.5 million were treated with insecticides (Table 2). A total of 43.1 million pounds (a.i.) of pesticides were applied to field corn, consisting of 24.8 million pounds of single material herbicides, 12.4 million pounds of herbicide mixes, and 5.9 million pounds of insecticides (Table 8). Herbicide applications averaged 1.8 pounds (a.i.) per acre-treatment for single materials and 3.6 pounds (a.i.) per acre-treatment for mixes. Insecticides were applied at an average rate of 1.1 pounds (a.i.) per acre-treatment.

Pesticide acre-treatments totaled 22.8 million and consisted of 14.1 million with single material herbicides, 3.4 million with herbicide mixes, and 5.3 million with insecticides.

Atrazine acre-treatments amounted to 4.4 million (31 percent) of those made with single material herbicides. Acre-treatments of alachlor and butylate⁺ totaled 5 million (35 percent). Atrazine, mixed separately with alachlor and

Table 8. Usage patterns and quantities of specific pesticides applied to field corn in Illinois, 1980 a/

Pesticides	: Acres <u>b/</u> : Acre- <u>c/</u> : Pounds of active ingredient			
	: treated	: treatments	: Total	: Per treatment
----- Million -----				
HERBICIDES				
<u>Single materials</u>				
Alachlor	2.8	2.8	6.0	2.2
Atrazine	4.3	4.4	6.3	1.4
Butylate ⁺	2.2	2.2	7.3	3.2
Cyanazine	1.2	1.2	2.1	1.7
2,4-D	1.7	1.8	.7	.4
Other	-	1.7	2.4	1.4
Total	-	14.1	24.8	1.8
<u>Tank-mix materials</u>				
Atrazine + alachlor	.9	.9	1.2+1.9	1.3+2.1
Atrazine + butylate ⁺	1.0	1.0	1.3+2.9	1.3+2.9
Atrazine + metolachlor	.3	.4	.5+ .6	1.3+1.5
Atrazine + simazine	.3	.3	.3+ .3	1.2+1.1
Atrazine + other <u>d/</u>	-	.4	.5+1.2	1.3+3.0
Other	-	.4	1.7	4.3
Total	-	3.4	12.4	3.6
Total herbicides	-	17.5	37.2	2.1
INSECTICIDES				
Carbofuran	1.1	1.1	1.1	1.0
Chlorpyrifos	.8	.8	1.0	1.2
Fonofos	1.2	1.2	1.4	1.2
Terbufos	1.7	1.7	1.9	1.1
Other	-	.5	.5	1.0
Total	-	5.3	5.9	1.1
TOTAL PESTICIDES	-	22.8	43.1	1.9

a/ "1980 Corn Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

b/ Data in this column for "other" and "total" were not reported because two or more materials may have been used on the same acre resulting in multiple counting.

c/ Most farmers applied herbicides and insecticides one time during the growing season. The average number of applications per season for each material can be determined by dividing acre-treatments (column 2) by acres treated (column 1).

d/ Other includes cyanazine, dicamba, EPTC⁺, and propachlor.

butylate⁺, accounted for 1.9 million (56 percent) of the herbicide mix acre-treatments. Three-fourths of the alachlor and butylate⁺ acre-treatments were made to control foxtail infestations (Appendix Table 2). Likewise, foxtail control accounted for 47 percent of the atrazine acre-treatments. Cocklebur and velvetleaf control constituted 33 and 26 percent of the 2,4-D acre-treatments, respectively (Appendix Table 3).

About 4.8 million (91 percent) of the insecticide acre-treatments were made with either carbofuran, chlorpyrifos, fonofos, or terbufos (Table 8). All of the fonofos, phorate, and terbufos acre-treatments, 91 percent of the carbofuran treatments, and 38 percent of the chlorpyrifos acre-treatments were made for corn rootworm larvae control (Appendix Table 4). Cutworm was the primary target pest for 56 percent of the chlorpyrifos acre-treatments.

KENTUCKY

Farmers planted 1.6 million acres of field corn in Kentucky during the 1980 growing season, and treated 1.5 million acres with herbicides and 300,000 acres with insecticides (Table 2). The major corn producing area is located in the western half of Kentucky. Approximately 4.8 million pounds (a.i.) of pesticides were applied to field corn, of which 3.5 million pounds were single material herbicides, 839,000 pounds were herbicide mixes, and 496,000 pounds were insecticides (Table 9). Herbicide application rates averaged 1.8 and 2.8 pounds (a.i.) per acre-treatment, respectively, for single materials and mixes. Insecticide applications averaged 1.3 pounds (a.i.) per acre-treatment.

Pesticide acre-treatments totaled 2.6 million and consisted of 2 million with single material herbicides, 296,000 with herbicide mixes, and 373,000 with insecticides.

About 1.1 million (57 percent) of the single material herbicide acre-

Table 9. Usage patterns and quantities of specific pesticides applied to field corn in Kentucky, 1980 a/

Pesticides	: Acres <u>b/</u> :		Acre- <u>c/</u> :Pounds of active ingredient	
	: treated	: treatments	: Total	: Per treatment
----- <u>Thousand</u> -----				
HERBICIDES				
<u>Single materials</u>				
Alachlor	228	228	502	2.2
Atrazine	1,109	1,121	1,696	1.5
Paraquat	168	168	103	.6
Other	-	455	1,208	2.7
Total	-	1,972	3,509	1.8
<u>Tank-mix materials</u>				
Atrazine + alachlor	52	52	93+115	1.8+2.2
Atrazine + butylate ⁺	26	26	36+ 65	1.4+2.5
Atrazine + simazine	166	166	206+189	1.2+1.1
Atrazine + other <u>d/</u>	-	52	65+ 70	1.3+1.3
Total	-	296	839	2.8
Total herbicides	-	2,268	4,348	1.9
INSECTICIDES				
Carbofuran	322	322	335	1.0
Other	-	51	161	3.1
Total	-	373	496	1.3
TOTAL PESTICIDES	-	2,641	4,844	1.8

a/ "1980 Corn Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

b/ Data in this column for "other" and "total" were not reported because two or more materials may have been used on the same acre resulting in multiple counting.

c/ Most farmers applied herbicides and insecticides one time during the growing season. The average number of applications per season for each material can be determined by dividing acre-treatments (column 2) by acres treated (column 1).

d/ Other includes EPTC⁺, metolachlor, and paraquat.

treatments were atrazine. Also, 166,000 (56 percent) of the herbicide mix acre-treatments were atrazine plus simazine. Crabgrass and Johnsongrass were the primary target pests for 15 and 13 percent of the herbicide acre-treatments, respectively (Table 3). Also, ragweed control accounted for a higher proportion of the herbicide acre-treatments in Kentucky than in most of the other Corn Belt States. Crabgrass and foxtail control accounted for 34 and 38 percent of the alachlor acre-treatments, respectively (Appendix Table 2). Atrazine acre-treatments for foxtail control totaled 22 percent. Cocklebur, crabgrass, Johnsongrass, pigweed, and ragweed control each accounted for 9 to 15 percent of the atrazine acre-treatments (Appendix Tables 2 and 3). Butylate⁺ acre-treatments for crabgrass control totaled 46 percent, while barnyardgrass and Johnsongrass control each accounted for 18 percent. Pigweed was the primary target pest for all of the 2,4-D acre-treatments.

Carbofuran constituted 322,000 (86 percent) of the insecticide acre-treatments (Table 9). Corn rootworm larvae control required a smaller proportion of insecticide acre-treatments in Kentucky than in most of the other Corn Belt States, while European corn borer was the primary target pest for one-third of the insecticide acre-treatments (Table 4). Corn rootworm larvae and European corn borer control accounted for 64 and 32 percent, respectively, of the carbofuran acre-treatments (Appendix Table 4). All of the chlorpyrifos was used to control cutworm infestations.

INDIANA

Approximately 6.5 million acres of field corn were planted in Indiana during 1980 (Table 2). Acres treated for weed and insect control totaled 6.4 and 2.1 million, respectively. Of the 20.8 million pounds (a.i.) of pesticides applied to field corn, 11.1 million were single material herbicides, 7.5 million were

herbicide mixes, and 2.1 million were insecticides (Table 10). The average herbicide application rate was 1.6 pounds (a.i.) per acre-treatment for single materials and 3.2 pounds (a.i.) per acre-treatment for mixes. Insecticide application rates averaged 1 pound (a.i.) per acre-treatment.

A total of 11.3 million pesticide acre-treatments were made on field corn, consisting of 6.8 million single material herbicide acre-treatments, 2.4 million herbicide mix acre-treatments, and 2.1 million insecticide acre-treatments.

Atrazine acre-treatments totaled 3.1 million (46 percent) of those made with single material herbicides and alachlor acre-treatments totaled 1.1 million (16 percent). Atrazine plus alachlor comprised 973,000 (41 percent) of the herbicide mix acre-treatments, while atrazine plus butylate⁺ acre-treatments totaled 527,000 (22 percent). About one-half of the alachlor, atrazine, and butylate⁺ acre-treatments were made to control foxtail infestations (Appendix Table 2). Three-tenths of the butylate⁺ acre-treatments were made for Johnsongrass and quackgrass control. Approximately 25 percent of the 2,4-D acre-treatments were made for morningglory control and 14 percent were made to control cocklebur infestations (Appendix Table 3).

Carbofuran was the primary insecticide, accounting for 965,000 (45 percent) of the insecticide acre-treatments (Table 10). Chlorpyrifos, fonofos, and terbufos acre-treatments constituted 1.1 million, or 49 percent of the insecticide acre-treatments. Corn rootworm larvae were the major target pest for 96 percent of the carbofuran, 88 percent of the fonofos, 100 percent of the phorate, and 78 percent of the terbufos acre-treatments (Appendix Table 4). Corn rootworm larvae and cutworm control comprised 36 and 55 percent of the chlorpyrifos acre-treatments, respectively.

Table 10. Usage patterns and quantities of specific pesticides applied to field corn in Indiana, 1980 a/

Pesticides	: Acres <u>b/</u>	: Acre-	<u>c/</u>	:Pounds of active ingredient	
	: treated	: treatments	: Total	: Per treatment	
----- <u>Thousand</u> -----					
HERBICIDES					
<u>Single materials</u>					
Alachlor	1,125	1,125	2,177	1.9	
Atrazine	3,142	3,142	5,060	1.6	
Butylate ⁺	488	488	1,382	2.8	
Metolachlor	861	861	1,499	1.7	
2,4-D	567	604	255	.4	
Other	-	600	768	1.3	
Total	-	6,820	11,141	1.6	
<u>Tank-mix materials</u>					
Atrazine + alachlor	973	973	1,167+1,603	1.2+1.6	
Atrazine + butylate ⁺	527	527	646+1,191	1.2+2.3	
Atrazine + metolachlor	338	338	475+557	1.4+1.7	
Atrazine + other <u>d/</u>	-	413	527+831	1.3+2.0	
Other	-	113	473	4.2	
Total	-	2,364	7,470	3.2	
Total herbicides	-	9,184	18,611	2.0	
INSECTICIDES					
Carbofuran	815	965	784	.8	
Chlorpyrifos	413	413	534	1.3	
Fonofos	300	300	251	.8	
Terbufos	338	338	422	1.3	
Other	-	113	150	1.3	
Total	-	2,129	2,141	1.0	
TOTAL PESTICIDES	-	11,313	20,752	1.8	

a/ "1980 Corn Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

b/ Data in this column for "other" and "total" were not reported because two or more materials may have been used on the same acre resulting in multiple counting.

c/ Most farmers applied herbicides and insecticides one time during the growing season. The average number of applications per season for each material can be determined by dividing acre-treatments (column 2) by acres treated (column 1).

d/ Other includes cyanazine, EPTC⁺, paraquat, simazine, and 2,4-D.

OHIO

Farmers in Ohio planted 4.2 million acres of field corn in 1980, and reported that all of the acreage was treated with herbicides and 1.7 million acres were treated with insecticides (Table 2). The total volume of pesticides applied to field corn was 15.2 million pounds (a.i.), composed of 8.4 million pounds of single material herbicides, 5 million pounds of herbicide mixes, and 1.7 million pounds of insecticides (Table 11). Single and combined material herbicides were applied at an average rate of 1.7 and 3.1 pounds (a.i.) per acre-treatment, respectively. Insecticide application rates averaged 1.1 pounds (a.i.) per acre-treatment.

Approximately 8.2 million pesticide acre-treatments were made in 1980. This total included 5 million single material herbicide acre-treatments, 1.6 million herbicide mix acre-treatments, and 1.6 million insecticide acre-treatments.

Atrazine and alachlor acre-treatments totaled 1.8 and 1.1 million (37 and 22 percent) of those made with single material herbicides. Of the total herbicide mix acre-treatments, 334,000 (20 percent) were made with atrazine plus alachlor and 319,000 (19 percent) were made with atrazine plus metolachlor.

Herbicide use patterns in Ohio were similar to those in Illinois and Indiana, although some minor variations were reported. One-fourth of the herbicide acre-treatments were made to control Canada thistle, morningglory, panicum, and quackgrass, while 15 percent of the herbicide acre-treatments were made for ragweed control (Table 3). Foxtail control accounted for 47 percent of the alachlor, 39 percent of the atrazine, and 50 percent of the butylate⁺ acre-treatments (Appendix Table 2). About 38 percent of the 2,4-D acre-treatments were made to control morningglory infestations, 27 percent were made for cocklebur control, and 13 percent were made for Canada thistle

Table 11. Usage patterns and quantities of specific pesticides applied to field corn in Ohio, 1980 a/

Pesticides	: Acres <u>b/</u>	: Acre-	: Pounds of active ingredient	
	: treated	: treatments	: Total	: Per treatment
	----- <u>Thousand</u> -----			
HERBICIDES				
<u>Single materials</u>				
Alachlor	1,093	1,093	2,132	2.0
Atrazine	1,839	1,840	3,322	1.8
Cyanazine	508	508	888	1.7
Dicamba	428	428	121	.3
Metolachlor	406	406	828	2.0
Other	-	749	1,141	1.5
Total	-	5,024	8,432	1.7
<u>Tank-mix materials</u>				
Atrazine + alachlor	334	334	608+673	1.8+2.0
Atrazine + metolachlor	319	319	442+511	1.4+1.6
Atrazine + other <u>d/</u>	-	551	775+1,030	1.4+1.9
Cyanazine + other <u>e/</u>	-	174	298+431	1.7+2.5
Dicamba + 2,4-D	203	203	57+70	.3+ .3
Other	-	58	131	2.3
Total	-	1,639	5,026	3.1
Total herbicides	-	6,663	13,458	2.0
INSECTICIDES				
Carbofuran	827	842	842	1.0
Fonofos	218	218	250	1.1
Terbufos	377	377	436	1.2
Other	-	116	200	1.7
Total	-	1,553	1,728	1.1
TOTAL PESTICIDES	-	8,216	15,186	1.8

a/ "1980 Corn Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

b/ Data in this column for "other" and "total" were not reported because two or more materials may have been used on the same acre resulting in multiple counting.

c/ Most farmers applied herbicides and insecticides one time during the growing season. The average number of applications per season for each material can be determined by dividing acre-treatments (column 2) by acres treated (column 1).

d/ Other includes butylate⁺, cyanazine, dicamba, EPTC⁺, paraquat, simazine, and 2,4-D.

e/ Other includes alachlor and butylate⁺.

control (Appendix Table 3).

Carbofuran was the primary insecticide, constituting 842,000 (54 percent) of the insecticide acre-treatments (Table 11). Fonofos and terbufos acre-treatments totaled 218,000 (14 percent) and 377,000 (24 percent), respectively. A larger proportion of insecticide acre-treatments was made to control wireworm infestations in Ohio than in the other Corn Belt States (Table 4). About 93 percent of the carbofuran, fonofos, and terbufos acre-treatments and all of the ethoprop acre-treatments were made for corn rootworm larvae control (Appendix Table 4).

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5. USDA, ESS, Crop Reporting Board, "Field Crops-Production, Disposition, Value 1979-80", CrPr 1(81), April 1981.

Appendix Table 1. Coefficients of variation for acres of field corn treated with specific pesticides in the Corn Belt, 1980 a/ b/

Pesticides	:	:	Mis-	:	Illi-	:	Ken-	:	Indi-	:	:	:
			Iowa		souri		nois		tucky		ana	Ohio
			----- Percent -----									
HERBICIDES												
<u>Single materials</u>												
Alachlor	18	21	12	22	17	14	7					
Atrazine	18	14	8	6	8	9	5					
Butylate ⁺	14	57	13	29	27	34	9					
Cyanazine	20	30	19	-	44	22	11					
Dicamba	22	40	27	-	44	24	14					
Metolachlor	44	57	29	34	19	25	13					
2,4-D	15	23	15	<u>c/</u>	24	30	9					
<u>Tank-mix materials</u>												
Atrazine + alachlor	21	18	23	49	18	28	10					
Atrazine + butylate ⁺	22	33	21	70	26	57	13					
Atrazine + cyanazine	37	49	57	-	<u>c/</u>	57	26					
Atrazine + metolachlor	85	44	37	<u>c/</u>	<u>33</u>	29	18					
Atrazine + simazine	-	-	40	<u>26</u>	50	70	23					
Cyanazine + alachlor	50	77	<u>c/</u>	-	<u>c/</u>	49	32					
Cyanazine + butylate ⁺	23	70	<u>40</u>	-	<u>71</u>	70	19					
Dicamba + 2,4-D	25	<u>c/</u>	<u>c/</u>	-	-	37	21					
INSECTICIDES												
Carbofuran	29	44	20	18	20	16	10					
Chlorpyrifos	44	23	24	68	29	-	15					
Fonofos	25	-	19	-	35	35	14					
Phorate	22	-	37	-	<u>c/</u>	-	19					
Terbufos	16	70	16	-	<u>33</u>	27	10					

- None reported.

a/ "1980 Corn Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

b/ A coefficient of variation is the standard error of the estimate divided by acres treated times 100. A coefficient of variation describes the relative variation or precision of the estimate. The lower the value of the coefficient, the more precise the estimate.

c/ Use of this material at the State level was not significant and was reported in the "other" category.

Appendix Table 2. Percentage of field corn herbicide acre-treatments by primary grasses controlled as reported by farmers in the Corn Belt, 1980 a/

Herbicides, grasses	Percent						
	Iowa	Mis- souri	Illi- nois	Ken- tucky	Indi- ana	Ohio	Region
<u>Alachlor</u>							
Barnyardgrass	-	10	-	6	-	-	1
Broadleaf signalgrass	-	-	-	-	10	-	1
Crabgrass	-	5	-	34	-	-	1
Foxtail	100	65	77	38	53	47	74
Johnsongrass	-	5	2	6	3	3	2
Panicum	-	-	-	-	-	16	2
Other	-	10	7	-	-	3	4
<u>Atrazine</u>							
Broadleaf signalgrass	-	-	2	5	5	6	3
Crabgrass	-	3	-	11	4	1	2
Foxtail	27	22	47	22	52	39	41
Johnsongrass	-	3	-	13	-	-	1
Panicum	-	3	1	1	-	3	1
Quackgrass	13	-	-	-	1	11	4
Other	-	4	3	5	4	3	3
<u>Butylate⁺</u>							
Barnyardgrass	-	-	-	18	-	-	1
Broadleaf signalgrass	2	-	-	-	-	-	1
Crabgrass	-	-	-	46	-	-	1
Foxtail	88	-	74	9	46	50	75
Johnsongrass	-	-	9	18	15	-	5
Panicum	-	-	2	-	-	13	1
Quackgrass	-	-	-	-	15	-	1
Shattercane	-	100	-	9	-	-	1
Other	2	-	-	-	-	12	2

- None reported.

a/ "1980 Corn Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

Appendix Table 4. Percentage of field corn insecticide acre-treatments by primary insects controlled as reported by farmers in the Corn Belt, 1980 a/

Insecticides, insects	Percent						
	Iowa	Mis- souri	Illi- nois	Ken- tucky	Indiana	Ohio	Region
<u>Carbofuran</u>							
Corn rootworm larvae	100	80	91	64	96	93	92
European corn borer	-	-	9	32	4	-	6
Wireworm	-	20	-	-	-	7	2
Other	-	-	-	4	-	-	-
<u>Chlorpyrifos</u>							
Corn rootworm larvae	60	13	38	-	36	-	37
Cutworm	40	87	56	100	55	-	58
Other	-	-	6	-	9	-	5
<u>Ethoprop</u>							
Corn rootworm larvae	-	11	-	-	-	100	14
Cutworm	100	78	-	-	-	-	81
Wireworm	-	11	-	-	-	-	5
<u>Fonofos</u>							
Corn rootworm larvae	100	-	100	-	88	93	98
Wireworm	-	-	-	-	12	7	2
<u>Phorate</u>							
Corn rootworm larvae	100	-	100	-	100	-	100
<u>Terbufos</u>							
Corn rootworm larvae	100	100	100	-	78	92	98
Wireworm	-	-	-	-	-	8	1
Other	-	-	-	-	22	-	1

- None reported.

a/ "1980 Corn Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.



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