

TWENTY-SECOND
ILLINOIS
CUSTOM
SPRAY
OPERATORS
TRAINING
SCHOOL

SUMMARIES OF PRESENTATIONS
JANUARY 28 & 29, 1970
URBANA, ILLINOIS



Cooperative Extension Service
University of Illinois at Urbana-Champaign
College of Agriculture
in cooperation with the
Illinois Natural History Survey

This training school is presented specifically for commercial applicators of agricultural chemicals by the University of Illinois at Urbana-Champaign, College of Agriculture, Cooperative Extension Service, and Illinois Natural History Survey, but is open to all persons involved in the handling of agricultural chemicals. The school promotes the proper, timely, and wise use of agricultural chemicals. We gratefully acknowledge the assistance of officers of the Illinois Association of Aerial Applicators and the Agricultural Spraying Association in planning the program. Abstracts in this manual bring to you the latest research information, but do not constitute positive recommendation unless so stated. Statements made herein are the responsibility of either the speaker or the institution he represents. *Reproduction and publication are permitted only with the approval of each author.*

Correct: p. 184, Table 6, right column,
heading change - 1 ppm to 0.1 ppm

FORMAL PROGRAM

Illini Union Building, Illini Room

WEDNESDAY MORNING, JANUARY 28, 1970
VERNON ANDERSON, PRESIDING

8:30 a.m. Color Slides, Movies. Staff
9:55 Welcome Dean O.G. Bentley
Spiders--Their Venom, Habits, and Control D.E. Howell
Weed Control for Soybeans--1970 E.L. Knake
North-Central Weed Control Conference Award L.E. Hannah
Our Illinois Pesticide Accident Report. Roscoe Randell

JOHN ROGERS, PRESIDING

Clinical Symptoms of Carbamate and Phosphate Poisoning

in Florida B.D. Blackbourne
Weed Control for Corn--1970 F.W. Slife
Soybean Seed Treatment Results. D.W. Chamberlain
New Herbicides and New Uses M.D. McGlamery

12:30 p.m. Lunch

MYRLE J. STINNETT, PRESIDING

1:30 Variations in Foxtails in the Midwest M.M. Schreiber
Results of the 1969 Cattle Grub Survey. Steve Moore III, S.M. Sturgeon
Agricultural Chemical Mixtures. J.L. Williams, Jr.
Progress Report on Seed Corn Beetle Control
Soil Treatments. R.E. Sechriest
Seed Treatments. D.E. Kuhlman
Nozzle Types and Uses J.C. Siemens

3:10 Coffee

CHARLES R. HOWELL, PRESIDING

3:30 Controlling Wild Cucumber and Wild Cane J.L. Williams, Jr.
Marihuana: Identification and Control. Juett Hogancamp
Garden Symphylian Research Report. R.E. Sechriest

Controlling Panicum. *J.R. Houghton*

Controlling Climbing Milkweed. *H.D. Coble*

Standardizing Soil-Texture
Terms for Herbicide Use *J.D. Alexander*

5:05 Adjourn

THURSDAY MORNING, JANUARY 29, 1970
DON TEEL, PRESIDING

8:30 Lawn Webworms. *Roscoe Randell*

Insects and Stored Soybeans. *Steve Moore, III*

Growth and Development of Nut Sedge. *Edward Stoller*

Research in Controlling Nut Sedge. *Lloyd Wax*

New Aspects of Alfalfa Weevil Control. *E.J. Armbrust*

New Corn Leaf Blights in Illinois. *A.L. Hooker*

Insect Situation--1970 *Steve Moore, III*
D.E. Kuhlman

10:05 Coffee

Roscoe Randell

RON STICKLER, PRESIDING

10:25 The Changing Role of Honey Bees in Illinois Agriculture:
Grower Needs and Pesticide Usages. *E.R. Jaycox*

Use of Herbicides for Noncrop Areas. *P.R. Craig*
W.R. Donels

Toxicity Ratings for Rootworm Chemicals. *R.E. Sechriest*

Corn-Rootworm Control Demonstration. *H.B. Petty*

1969 Survey of Northern and Western Corn-
Rootworm Adult Populations *D.E. Kuhlman*

Soil Insecticide Recommendation Changes. *H.B. Petty*

Survey of Weeds in Illinois. *M.D. McGlamery*

Weed Control in Alfalfa. *George Kapusta*

Changing Tillage Practices and Implications for
Pest Control *W.R. Oswald*

12:35 Adjourn

ILLINOIS INSECT, WEED, AND PLANT DISEASE SURVEY BULLETIN FOR 1970

Attendance at the Custom Spray Operators Training School does not provide automatic subscription to this weekly Survey Bulletin. Purchase of the Training School Manual does not provide subscription. This has been misunderstood many times in the past and we regret these misunderstandings.

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- Williams, J.L., Jr., Weed Control Specialist, Purdue University, Lafayette, Indiana

*Also members of planning committee.

1970 SMALL-PACKAGE DEALER CLINICS

For the past few years we have scheduled these clinics for the nonagricultural or the small-package dealer. All dealers are welcome to attend. Topics will be discussed by specialists in plant pathology, horticulture, and entomology. Below are the dates, locations, and local person in charge of reservations where necessary.

<i>DATE</i>	<i>TIME</i>	<i>CITY</i>	<i>LOCATION</i>
February 2 and 3	9:30 a.m.	Bartlett (Cook County)	Villa Olivia, Rt. 20
February 6	3:30 p.m.	Springfield	Heritage House, South U.S. 66
February 18	6:00 p.m.	Davenport, Iowa	YW-YMCA, 606 W. 2nd Street, Davenport, Iowa

Advance registration for the Chicago clinic can be made with Stanley Rachesky, Area Adviser, Room 250, 10 North LaSalle Street, Chicago 60602. For the Davenport meeting contact J.E. Kenney, Extension Adviser, 1188 Coaltown Road, East Moline, Illinois.

The program will be similar at each location. It will consist of discussions on dealers' pesticides inventory, safety, and biology of specific pests.

1970 PESTICIDE DEALERS' AND APPLICATORS' CLINICS

As a pesticide dealer or applicator, we invite you to attend one of the area agricultural chemical clinics. The discussions will include the current situation and the why and how of control for weeds, diseases, and insects affecting field crops, as well as the proper use of application equipment. Examination for the Custom Spray Operators' License will be given at the end of the meeting.

We look forward to seeing you at the meeting and discussing problems of mutual interest. The following are the dates and locations for the clinics:

<u>DATE</u>	<u>CITY</u>	<u>LOCATION</u>
February 17....	Jacksonville.....	Black Hawk Restaurant
February 18....	Belleville.....	Augustine's Restaurant (Sun Room)
February 19....	Marion.....	Holiday Inn
February 20....	Effingham.....	Ramada Inn
February 24....	Joliet.....	Rossi Autumn Acres Restaurant
February 25....	Sterling.....	Emerald Hills Country Club (Rt. 2, N. of Sterling)
February 26....	Galesburg.....	Holiday Inn
February 27....	Bloomington.....	Sinorak Restaurant (Jct. 51 & 66, S. edge of city)

A registration of \$3 per person will be charged to cover the cost of the reference packet and other incidental expenses. A copy of the *1970 Custom Spray Operators' Training School Manual* will be included in this packet for the first time.

The program for the clinics is shown on the next page.

9:30 a.m.

Registration and Get Acquainted

9:55 a.m.

PROGRAM

- 9:55-10:00 . . Welcome *Extension adviser*
- 10:00-10:30 . . Armyworms, Fall Armyworms, and Stalk Borer
Problems *Steve Moore*
- 10:30-10:50 . . Field-Crop Disease Situation *Mal Shurtleff*
- 10:50-11:20 . . Corn Seed Insects and Their Control. *Pete Petty*
- 11:20-11:45 . . What's New in Weed Control *Marshal McGlamery*
- 11:45-12:00 . . Calibrating and Adjusting Granular Row
Applicators. *John Siemens*
- 12:00 noon-1:00 p.m. LUNCH
- 1:00-1:10 . . The Illinois Custom Spray Operators' Licensing
Law. *Juett Hogancamp*
- 1:10-1:30 . . Soybean Seed Treatments and New Corn-Leaf
Diseases in Illinois *Mal Shurtleff*
- 1:30-2:00 . . Corn Soil-Insect Control Programs for 1970 *Pete Petty*
- 2:00-2:20 . . Spray Nozzles - Types and Uses *John Siemens*
- 2:20-2:50 . . Controlling Those Problem Weeds. *Marshal McGlamery*
- 2:50-3:00 . . Question Time. *All speakers*
- 3:00-4:00 . . Examination for the Custom Spray Operators' License will be given
by Mr. Juett Hogancamp of the State Department of Agriculture.

Prepared by the Pesticide Dealers' and Applicators' Committee.

THE VENOM, HABITS, AND CONTROL OF SPIDERS

D.E. Howell

I. SPIDERS OF PUBLIC HEALTH IMPORTANCE

- A. Black widow spiders--several species
- B. Brown recluse spiders (Fiddle-back spiders)--several species
- C. Wolf spiders--several species
- D. Miscellaneous--Tarantulas, Chiracanthium

II. IMPORTANCE

A. Bite

- 1. Black widows. Generalized symptoms--neurotoxin, severe muscular pain, muscular contraction, respiratory difficulty and localized action, proteins.
- 2. Brown spiders. Localized action, extensive deep-killing of tissue, may last 6 to 8 weeks, proteins, and peptides.
- 3. Wolf spiders. Rapid reaction, usually surface-involved hemolysis. Severe tissue killing not common.
- 4. Miscellaneous. Tarantula--mechanical wound may release potent, generalized venom. Chiracanthium--painful localized effect.

B. Recognition of bite

- 1. Presence of two small wounds, slightly reddened. For recognition, it is often necessary to use a hand lens.
- 2. Bees, wasps, etc., usually have only 1 small wound.

III. BIOLOGY AND HABITS

- A. Black widows. Live 1 to 2 years. Spin a coarse, irregular web to aid in trapping prey in a sheltered area, such as the corners of a garage or barn, piles of boxes, etc. Web recognized by its strength, irregularity, and location. Most apt to bite when an egg sac is present.
- B. Brown spiders. Live 1 to 2 years. A hunting spider that spins very little, actively catches prey, and is more active at night. Found in dark, sheltered areas such as attics, and in stored goods, caves, barns, under rocks, and in debris.

- C. Wolf spiders. Live 1 to 2 years. A hunting spider, usually found around buildings, but may invade homes. Most commonly found in grass while moving stored materials, invading homes to escape cold, etc. The web is inconspicuous.
- D. Tarantulas. Live up to 23 years. Of minor importance, but much feared. A hunting spider in open areas. Most common in burrows 6 to 24 inches. It leaves the burrows to look for food or during the mating season. Often found by vacationers.

IV. CONTROL

- A. Avoidance. Check clothing, wear gloves, use correct storage.
- B. Biological. Some wasps (mud daubers) very effective.
- C. Chemical. Dieldrin is the best chemical tested. It provided rapid kill for 2 to 6 months when area to be protected was covered with 0.5 percent spray in water. Chlordane at 2 percent is good, also Lindane.
- D. Organic phosphates. Vapona (dichlorvos)--excellent for quick-kill, no residual action. Baytex (tenthion) and Diazinon--good for a short time. Malathion--The insect is able to detect its presence and avoid contact with the poison unless hit by the spray.
- E. Application to specific area where spiders are found is essential.

WEED CONTROL FOR SOYBEANS—1970

E.L. Knake

Although we still do not have perfect answers for all weed problems in soybeans, we have come a long way during the last ten years. There are a number of good herbicides available for the control of annual grasses, our most severe problem. Most soybean herbicides will control pigweed and lambsquarter. Cocklebur control is a little more difficult; but with a well-planned program and some luck, control can be achieved--especially if a concerted effort is made with 2,4-D when fields are planted to corn.

The control of velvetleaf is a little erratic. But we seldom find soybeans with a severe, uncontrolled infestation. Often, a little hand-pulling should not be completely out of the question. Jimsonweed is much more serious in Indiana than in Illinois. We find only an occasional severe infestation of it here. Neither common nor giant ragweed is a widespread problem in Illinois soybean fields. Where these weeds do occur, controls are available.

Some of our major soybean herbicides give little or no control of annual morning-glory. One of the best answers is to place emphasis on 2,4-D when the fields are in corn. Atrazine also provides control in corn.

Smartweed is widespread in Illinois soybean fields. Entire fields may be covered, in contrast with velvetleaf and jimsonweed which are often more scattered. Good controls, however, are available for smartweed in both corn and soybeans.

Panicum has not shown up in soybean fields as much as in corn. This may be partly due to the fact that we have not minimized tillage for soybeans as much as for corn. Also, soybeans may provide greater shading for late-starting panicum.

The control of wild cane and Johnsongrass seedlings is often easier in soybeans than in corn. Wirestem muhly does not seem to be as severe in soybeans as in corn, perhaps partly because of the later, more-intensive tillage used for soybeans.

Good seedbed preparation, early rotary hoeing, and row cultivation to supplement control from herbicides for soybeans are all still quite helpful.

There has been some interest in "solid drilling" with soybeans. Effective control can sometimes be achieved with a carefully planned program, but the majority of our growers prefer not to take some of the risks involved.

Based on research results by some of our staff and on grower experience, we are quite optimistic about double-cropping, with soybeans planted in wheat stubble. Weed control can be achieved by using a carefully planned program and current herbicides and equipment for the no-till planting now available. Double-cropping may not be successful every year, and yields are not always phenomenal. But the batting average and net returns appear to be quite satisfactory.

PREPLANT APPLICATIONS

Treflan continues to be the major herbicide for preplant, incorporated application. Control of annual grass has generally been consistent and good. Pigweed and lambsquarter control can be achieved, but is sometimes disappointing. *Treflan* would be the major consideration for controlling Johnsongrass seedlings and wild cane.

Planavin has found some use in the southern part of the state where promoted. The method of application and spectrum of control are similar to those for *Treflan*. Our research suggests that approximately 1.5 times as much active ingredient of *Planavin* is needed, compared to *Treflan*.

Vernam has been more popular as granules for band application to the surface for control of annual grass weeds. However, one of our major interests in *Vernam* would be as a preplant application to patches of nutsedge or to entire fields with a nutsedge problem. For this use, *Vernam* should be incorporated immediately. The potential for soybean injury from *Vernam* seems to be a little higher than with some other herbicides.

PREEMERGENCE AT PLANTING TIME

Amiben use appears to have tapered off some, but it is still popular and is providing good control of annual grasses and many of the broadleaved weeds. Pigweed and lambsquarter control has been good. That of cocklebur, velvetleaf and jimsonweed is a little erratic. The control of smartweed, though often acceptable, sometimes left a little to be desired in 1969. Other help is needed for controlling annual morningglory.

Ramrod is cleared only for soybeans raised for seed. Since *Lasso* is rather similar to *Ramrod* but has broader clearance, the major interest will be in *Lasso* for soybeans.

Lasso has performed well in controlling annual grasses, pigweed, and lambsquarter. It is approved for surface application at planting time, and may be approved for preplant incorporation in the future. Research results for nutsedge control with *Lasso* have been very encouraging. *Lasso* performs well on soils with over 3-percent organic matter. It has also generally performed well on soils with an organic-matter content of less than 3 percent. Soybean tolerance appears to be above average, although some early leaf deformity may be evident as some leaf crinkle and a shortened midrib of the leaf. For the future, there is interest in a *Lasso-Lorox* combination.

Lorox has gained ground on the silt loam soils containing less than 3-percent organic matter. Although the possibility of soybean injury remains, the potential for injury is reduced by carefully adjusting rates to the organic-matter content of the soil and making accurate, uniform applications. *Lorox* generally gives relatively good control of many of the broadleaved weeds, except for annual morningglory. Its control of velvetleaf is a strong point. Although *Lorox* can control annual grasses, combinations are under consideration to improve grass control still further. *Londax* is a combination of *Lorox* and *Ramrod*. *Londax* is available in granular form as well as a wettable powder. However, *Londax* is cleared only for soybeans raised for seed and not for soybeans to be used for food,

feed, or oil purposes. Londax would have more potential for corn on soils with more than 3-percent organic matter. The Lasso plus Lorox combination does appear to have potential for soybeans on the silt loams with less than 3-percent organic matter. Lorox is a major consideration for double-cropping, to give both postemergence control of existing vegetation and to provide residual preemergence activity.

Chloro IPC does an exceptionally good job of controlling smartweed, even at a reduced rate of 2 to 3 pounds of active ingredient per acre. Chloro IPC is being considered as a treatment to follow Treflan, with the Treflan preplant incorporated and Chloro IPC applied to the surface at planting time. Lasso plus Chloro IPC also looks quite promising. Treflan and Lasso can each sometimes give partial control of smartweed, and the addition of Chloro IPC should strengthen smartweed control considerably.

Alanap Plus is the combination of Alanap plus Chloro IPC. More-recent names have been Whistle and Amoco Soybean Herbicide. In 1970, a little different formulation will be available as Solo, which will be discussed under the section on new herbicides.

The new soybean herbicide Preforan will also be discussed in that section, as will the combination of Dacthal and Lorox.

POSTEMERGENCE SPRAYS FOR SOYBEANS

These have not been very popular in Illinois. Tenoran may be helpful in some situations as a postemergence treatment, mainly for very early control of broad-leaved weeds. The use of 2,4-DB can help control serious infestations of cocklebur, and may also help for giant ragweed and annual morningglory.

Crop tolerance is somewhat limited with each.

OUR ILLINOIS PESTICIDE ACCIDENT SITUATION

Roscoe Randell

PESTICIDE-INGESTION ACCIDENTS

For the past nine years, pesticide ingestion cases involving children 12 years of age and under have been summarized and reported.

Briefly reviewing the procedure for summarizing this information, cases involving children 12 years of age or under who ingest or are contaminated with a hazardous substance are reported to one of the many poison-control centers in Illinois. The case is then reported to the Illinois Department of Public Health. *Dr. Norman Rose, Bureau of Hazardous Substances and Poison Control, Illinois Department of Public Health, Springfield*, provides us with the information on pesticide ingestion cases.

An annual average of 11,567 children eat, or are contaminated with, a hazardous substance (Table 2). Medicines accounted for 6,891 cases, and make up the major portion of this total.

Table 1 shows that the ingestion of pesticides declined from a high in 1960 of 8 percent to 5.2 percent in 1968, averaging 6.5 for the nine-year period. There has been a slight decrease in the annual number of pesticide-ingestion cases since 1960. At the same time, the total number of ingestion cases has increased, along with the population.

Seasonal variations of ingestion cases by pesticide-control agent is shown in Table 3. Ingestions of rodent bait occur most often in November and December. Ant-bait ingestions are most common during the summer months. Those involving roach baits are slightly higher in the early fall. With improper mothball use and with disposal occurring throughout the year, there is no peak period for ingestion cases.

The majority of pesticides ingested by children fall into four groups, in relation to the control being sought--rodents, ants, clothes moths, roaches. These four accounted for 82.1 percent of the cases (Table 4). Of that number, 68.5 percent were obtained as a bait.

Anticoagulant rodenticides made up the largest group of accidental ingestions. The specific pesticides ingested are listed in Table 5. Arsenicals are the next most-important group, followed by naphthalene and PDB.

During 1968, there were 266 ingestion cases in downstate Illinois involving an improper use of baits--73 due to improper use of mothballs, 57 to improper storage, and 12 caused by improper disposal.

ACCIDENTAL DEATHS FROM PESTICIDES

During 1968, the deaths in Illinois resulting from the ingestion of, or contamination by, pesticides included one child who ingested sodium arsenite ant bait and a man who ingested an insecticide used for roach control.

There have now been 24 deaths since 1960 because of accidental ingestion of a pesticide. Fifteen involved insecticides, five rodenticides, and four herbicides. Only 1 of the 24 deaths was an agricultural accident. The remaining ones occurred in or about the home. Baits were responsible for 10 deaths, 9 persons were affected by the pesticide while it was being used, and 9 ingested it as the result of improper storage.

There are indications that the pesticide safety record in Illinois is improving. But as long as there are accidental ingestions and an occasional accidental death, pesticide safety measures need to be followed diligently.

REDUCING THE NUMBER OF PESTICIDE INGESTIONS

The following suggestions are the same as the ones listed in past reports. These points will protect children from poisoning.

1. Use baits properly--out of the reach of children.
2. Store woolens properly--in sealed containers if you use mothballs.
3. Keep all pesticides stored under lock and key.
4. Burn empty pesticide bags, and stay out of the smoke. Burn out or wash out other pesticide containers thoroughly. Then, haul them to the sanitary land fill or bury them--carefully and completely.

Table 1. *Ingestion of Hazardous Materials by Illinois Children Under 12 Years of Age, as Reported to Illinois Poison Control Centers, 1960 Through 1968*

Material	Percent of total									
	1960	1961	1962	1963	1964	1965	1966	1967	1968	Average
Medicine	57.0	56.4	57.2	56.2	59.3	63.4	64.2	64.5	62.9	60.1
Household preparations	15.0	16.4	16.6	16.3	15.0	13.0	12.5	12.2	11.3	14.3
Pesticides	8.0	7.2	7.3	6.9	6.7	6.1	5.7	5.3	5.2	6.5
Paints, etc.	4.8	5.3	4.9	6.3	5.0	4.6	4.6	4.2	3.9	4.8
Cosmetics	2.4	2.7	2.7	3.0	3.0	2.7	2.8	2.3	2.9	2.7
Miscellaneous	12.8	12.0	11.3	11.3	11.0	11.2	10.2	11.5	13.6	11.7

Table 2. *Ingestion of Hazardous Materials by Children Under 12 Years of Age, As Reported to Poison Control Centers, from Average Yearly Cases, 1960 Through 1968*

Material	Bimonthly averages							Total
	Jan.- Feb.	March- April	May- June	July- August	Sept.- Oct.	Nov.- Dec.		
Medicine	1,159	1,204	1,025	927	1,259	1,317	6,891	
Household preparations	215	243	267	280	322	269	1,596	
Pesticides	75	80	140	160	145	119	719	
Paints, etc.	54	69	93	121	122	87	546	
Cosmetics	44	55	56	50	63	56	324	
Miscellaneous	...	...	...	...	...	...	1,491
					GRAND TOTAL		11,567	

Table 3. *Ingestion of Pesticides Intended for Control of Rodents, Ants, Moths, and Roaches by Children Under 12 Years of Age, as Reported to Down-state Illinois Poison Control Centers. Average for 1960 Through 1968*

Pests	Bimonthly total						
	Jan.- Feb.	March- April	May- June	July- August	Sept.- Oct.	Nov.- Dec.	
Rodents	23	20	28	20	26	39	
Ants	5	5	26	37	16	5	
Moths	11	9	17	15	16	15	
Roaches	5	8	8	10	12	9	

Table 4. *Ingestion of Pesticides by Children Under 12 Years of Age, as Reported by Downstate Poison Control Centers. Average for 1960 Through 1968. Based on Pests to Be Controlled and the Source of the Pesticide*

Pests	In use	From			Total	Pct. of total	Pesticide	
		storage	Unknown				obtained as bait	Pct. of total
Rodents	78	18	61	157	33.5	150	95.5	
Ants	50	7	34	91	19.4	84	92.3	
Moths	47	9	28	84	17.9	0	0	
Roaches	27	9	17	53	11.3	31	58.5	
Unspecified	6	10	12	28	6.0	1	3.6	
Flies	4	5	6	15	3.2	4	2.7	
Mosquitoes	1	4	3	8	1.7	0	0	
Flower pests	2	4	3	9	1.9	0	0	
Weeds	4	7	5	16	3.4	0	0	
Others	2	3	3	8	1.7	1	12.5	
TOTAL	221	76	172	469	100	271	...	
PERCENT	47.1	16.2	36.7	...	100	...	57.8	

Table 5 on following page.

Table 6. *Actual and Projected Cases of Pesticide Contamination or Ingestion by Illinois Children Under 12 Years of Age, by Source of or Reason for Exposure, as Reported to Illinois Poison-Control Centers*

Sources	1964			1965			1966		
	Down-state	Chi-cago	Total	Down-state ^{a/}	Chi-cago ^{a/}	Total	Down-state ^{a/}	Chi-cago ^{b/}	Total
Baits	366	194	560	322	202	524	275	186	461
Mothballs	90	48	138	99	60	159	80	33	113
Storage	65	35	100	45	30	75	29	15	44
Disposal	17	9	26	9	7	16	15	6	21
Unknown	16	8	24	61	37	98	96	45	141
TOTAL CASES	554	294	848	536	336	872	495	285	780

Sources	1967			1968			5-year total	Yearly ave.	Pct. total
	Down-state ^{a/}	Chi-cago ^{b/}	Total	Down-state ^{a/}	Chi-cago ^{b/}	Total			
Baits	271	199	470	266	137	403	2,418	484	60.9
Mothballs	85	35	120	73	38	111	641	128	16.1
Storage	63	17	80	57	29	86	385	77	9.7
Disposal	29	7	36	12	6	18	117	23	2.9
Unknown	43	49	92	35	18	53	408	82	10.4
TOTAL CASES	491	307	798	443	228	671	3,969	794	100.0

a/ Downstate cases are actual figures. Complete Chicago totals are not available, but are projected from Chicago pesticide cases and the percentage of downstate cases.

b/ Actual Chicago figures.

Table 5. Cases of Pesticide Ingestion by Children Under 12 Years of Age, as Reported by Downstate Poison Control Centers. 1964 Through 1968, and Total

Pesticide	Number of cases					5-year total
	1964	1965	1966	1967	1968	
Anticoagulant rodenticides	184	169	144	162	164	823
Naphthalene & PDB	90	101	78	85	73	427
Arsenicals	145	117	134	110	108	614
Unspecified	9	38	14	8	41	110
DDT	10	12	9	4	15	50
Chlordane	9	7	9	9	0	34
DDVP	2	1	2	3	11	19
2,4-D	7	3	9	12	10	41
Lindane & BHC	11	13	11	12	8	55
Strychnine	5	5	6	3	4	23
Dieldrin	15	3	15	19	12	64
Sodium fluoride	4	8	3	3	0	18
Thallium sulfate	10	10	13	2	1	36
Phosphorous paste	3	6	4	5	0	18
Pyrethrins	2	16	12	13	5	48
612 and Deet	11	4	6	14	6	41
Boric acid	5	11	7	16	15	54
Diazinon	1	1	4	1	0	7
Ronnel	1	0	0	0	0	1
Rotenone	0	2	1	0	0	3
Malathion	4	3	7	2	3	19
Nicotine	0	2	0	2	1	5
Methoxychlor	2	0	4	1	0	7
Potassium cyanate	1	0	0	1	0	2
Fungicides	0	3	0	2	3	8
Fumigants	0	1	0	1	0	2
Radox	0	0	1	0	0	1
Parathion	1	0	0	1	0	2
Bidrin	0	0	1	0	0	1
Dibrom	0	0	1	0	0	1
Toxaphene	0	0	0	0	1	1
Sevin	0	0	0	0	1	1
TOTAL	532	536	495	491	482	2,536

Table 7. Accidental Deaths, Illinois, 1960, 1961, 1962, 1963, 1964, 1965, 1966, 1967, and 1968

Cause or location	1960	1961	1962	1963	1964	1965	1966	1967	1968	9-year Average	Pct. total
Motor vehicles	1,741	1,843	1,890	2,019	2,205	2,261	2,535	2,490	2,492	2,353	47.27
Home accidents	1,270	1,204	1,286	1,380	1,338	1,260	1,430	1,432	1,400	1,333	26.78
Public accidents	874	923	892	855	892	918	1,084	1,056	1,144	960	19.28
Occupational accidents	318	331	303	312	316	374	346	363	326	331	6.65
TOTAL	4,203	4,301	4,371	4,566	4,751	4,813	5,395	5,341	5,362	4,977	
Fires-explosions	362	338	357	442	379	394	474	408	351	389	7.81
Falls on stairs	136	136	125	106	143	137	121	134	144	131	2.63
Firearms	100	92	117	100	109	105	116	138	135	123	2.47
Drugs, etc.	49	70	81	98	86	101	117	60	74	82	1.65
Barbiturates, etc.	21	29	39	54	39	41	54	62	62	44	0.88
Lead	28	16	26	19	8	18	7	14	12	16	0.32
Aspirin, etc.	12	11	13	11	10	16	11	8	3	11	0.22
Other animals	2	7	6	4	5	3	4	3	3	4.1	0.082
Lightning	4	5	2	4	2	4	2	3	2	3.1	0.062
Petroleum products	0	5	2	3	0	0	1	0	-	1.2	0.024
Insecticides	5	1	0	1	0	3	3	0	2	1.7	0.034
Rodenticides	2	0	1	0	0	1	1	0	0	0.6	0.012
Herbicides	0	1	0	0	1	0	2	0	0	0.4	0.008
Venomous stings, etc.	2	0	0	0	1	3	1	0	3	1.1	.022
Arsenic	1	1	0	0	0	1	4	0	1	0.8	.016

Source: Illinois Department of Public Health, Bureau of Vital Statistics, Springfield, Illinois, from Tables of Accidental Deaths Occurring in Illinois, by Causes of Death and Nature of Injury, as supplied by Clyde Bridger, Chief Statistician.

PESTICIDE POISONING—A MEDICAL EXAMINER'S VIEW

B.D. Blackbourne

THE COMMUNITY STUDIED

The occupational and community hazards of a potentially lethal agent may be evaluated by studying clinical and fatal cases of poisoning in a community that has been at risk for a period of time. In Dade County, Florida (Metropolitan Miami), a high utilization level of pesticides has existed over many years. Since the origin of the Medical Examiner's Office in 1956, a high percentage of all fatal poisonings have been documented.

In a subtropical area involved to this extent in agriculture, pesticides are very necessary; but, at the same time, potentially dangerous. An estimated 250,000 pounds of organophosphate pesticides are used annually in Dade County.

During the past twelve years, over 100 persons in Dade County have died as the result of pesticide poisoning (Table 1). Over half of these have been suicidal ingestions. Forty-one accidental fatal poisonings have occurred from organophosphate and non-organophosphate pesticides (Table 2). The peak incidence of fatal accidental poisoning occurred in 1963. Through an educational campaign directed toward agricultural users and the community, the number of deaths has decreased in subsequent years (Table 3).

FATAL ORGANOPHOSPHATE POISONINGS

In 1959, the first Dade County death from organophosphate pesticides (parathion) was recognized. In the ensuing ten years, 56 deaths have resulted from these agents. Of these, 28 were accidental poisonings, 26 suicides, and 2 murders.

Eighteen children died from organophosphate poisoning. Each death represented a separate poisoning incident. In several cases, more than one child ingested the poison. But in each case, only one died. Thirteen of the 18 children poisoned were 2 years of age or younger; the youngest was 14 months old; 15 were Negro, 3 were white; 14 were boys, 4 were girls.

Eight of these 18 children found a bag or bottle of concentrated parathion and ate it. Nine other children ingested small amounts of parathion spread about the house, and especially the kitchen, for control of roaches or rodents. One child died of Guthion poisoning.

The disposal of empty metal cans and drums containing any potent pesticides is a very serious problem. Hot water or caustic washing is not sufficient to rid the container of the pesticide. Complete burning of the inner liner and all of the pesticide residue is the only way that these containers may be reused. For routine disposal, cans should be crushed or otherwise damaged (so that they will serve no secondary purpose) and then buried in the ground.

Accidental occupational organophosphate poisoning resulted in three deaths during this study. Two had sprayed with parathion the day prior to becoming ill. The third man had dusted collard greens all day using a rag over his mouth instead of a respirator.

Organophosphate poisoning associated with acute alcoholism resulted in the death of five men. In each case, while highly intoxicated with ethyl alcohol (0.15-, 0.23-, 0.27-, and 0.44- percent ethanol), they picked up a bottle and, expecting that it was more alcohol, drank it.

As with any potent drug or chemical when it becomes available in the community and its lethal poison potential becomes known, those people intent on suicide will use it. Forty-five percent of the organophosphate deaths have been suicidal poisonings.

Two persons with mischief on their minds turned to parathion. One woman put one drop in the beer glass of a loan shark who was extracting \$20 a week from her as interest on a \$100 loan. When he rapidly died, she pleaded that she had not intended to kill him--only to make him sick. The other case concerned a man who put parathion in his wife's Kool Aid. Admitted to the hospital in such extreme distress that she could not talk, she wrote "poison" and her common-law husband's name on a pad of paper held by a nurse.

NONFATAL ORGANOPHOSPHATE POISONINGS

An estimated 2,000 nonfatal organophosphate poisonings occur yearly in the United States. This figure may be compared with an estimated 200 fatal poisonings. The majority of both fatal and nonfatal organophosphate poisonings occur in Texas and Florida, where large amounts of these materials are used in agriculture. As in all other forms of poisoning, in order to make a correct diagnosis, someone must suspect a toxic agent as the cause. After reviewing the patient's symptoms, the circumstances of his becoming ill, his age and occupation, and available knowledge about the community, the most-likely responsible agents can be selected and laboratory tests performed. Only through rapid and close communication between those having knowledge of the patient and of the circumstances, the physicians treating the patient, and the chemist performing the tests can the correct poison be identified and therapy initiated.

Briefly, the signs and symptoms of organophosphate poisoning are: increased sweating, increased salivation, muscle jerking, constricted pupils, wheezing, severe abdominal cramps, muscle weakness progressing to paralysis, vomiting and diarrhea, cyanosis and convulsions. Of equal importance in suspecting the diagnosis of organophosphate poisoning is the rapid onset and progression of this unusual symptom complex. If pesticide poisoning is not thought of, the illness may be regarded as a primary lung, brain, or heart disease.

NONFATAL PESTICIDE POISONINGS IN DADE COUNTY, 1964-1968

Ninety-two nonfatal poisonings were documented, 79 of them accidental exposures, 11 attempted suicides, and 2 possible attempted murders. Of the accidental poisonings, 26 resulted from occupational exposure and 41 involved children who had ingested or otherwise had been exposed to the pesticide. Of the 79 accidental poisonings, 40 involved parathion, 12 phosdrin, and 5 diazinon.

FATAL, ACCIDENTAL NONORGANOPHOSPHATE PESTICIDE POISONING

After excluding many suicidal poisonings by nonorganophosphate pesticides, 13 cases of fatal accidental poisoning remain in the Dade County files between 1956 and 1969.

The pesticides involved include: those used in building fumigation (4), arsenic (2), thallium (2), phosphorus (3), and paraquat (1).

The first documented fumigation death occurred in 1957--a 27-year old woman. In January, 1963, a home fumigation using acrylonitrile (34 percent) and carbontetrachloride (66 percent) eventually lead to the death of a 41-year-old woman. In December, 1965, a similar situation resulted in the death of a 22-month-old boy. A fourth death related to tent fumigation. A 57-year-old woman alcoholic recently discharged from jail was advised of the plans to fumigate, and said she would pick up her sweater and leave. When the fumigation was completed the following day and the house inspected, the body of the woman was found in the bathroom. Apparently, she had re-entered the house sometime during the night for the purpose of suicide.

Two accidental arsenic deaths have involved small children. The mother of a two-year-old child mixed up some arsenic and water one evening and absentmindedly left it on the kitchen table. The youngster arose before her mother the next morning and drank the liquid, thinking it was water. She lived 24 hours in the hospital. The other child, 17 months old, apparently found a container of arsenic because white powder was noted on his face when he became dizzy and began to cry. He died 2 hours later.

The two recorded victims of thallium poisoning were 3 and 16 years of age, respectively. Their uncle found a gallon jug of light yellow liquid in a ditch beside the road. Thinking that it was motor oil, he took it home. The father of the two victims tasted it and recognized it as honey. If the container had ever been labelled, the label had come off, for there was no warning on the glass jug of the powerful poison it contained. The 16-year-old died 16 days after ingesting the honey, his 3-year-old sister died 4 weeks after eating the same honey. The other members of the family survived.

The three phosphorus deaths include two children and an intoxicated man, who had all ingested phosphorus. They each died from 3 to 9 hours after ingesting the poison.

The single accidental paraquat poisoning involved an alcoholic woman who, while intoxicated, drank a solution of paraquat thinking it was more liquor. Her husband had brought the paraquat home for use in the yard.

WHAT CAN BE DONE

Action to reduce the fatalities and clinical poisonings from pesticides must involve education of the agricultural handlers of pesticides, and also of the general public.

Safety equipment--including gloves, face masks, and protective clothing--have been prescribed for loaders, sprayers, flagmen, and others. This equipment must, however, be used to be effective.

Pesticide container disposal is a problem. Washing with hot water and soap will not remove all of the pesticide residue; the potential for poisoning remains. Large drums may be commercially reconditioned by burning the inner liner. Smaller containers should be crushed or split with an axe so they will serve no secondary purpose and then buried in the ground.

Pesticides are poisons and must be labelled. If removed from the original labelled container, subsequent containers must indicate by prominent label description the

nature of the contents. All labels must be so affixed to the container that they will not be rubbed off or washed off by rain. Potent and highly toxic agricultural pesticides have no place in the home. Under no circumstances should pesticides be placed in food containers. No bait made by placing a pesticide on food is acceptable for home use.

SUMMARY

During a twelve-year period in Dade County, Florida, 41 deaths occurred from accidental pesticide poisoning. Twenty-five children were poisoned. Seven poisonings occurred during commercial use of pesticide and 7 involved persons who drank the pesticide while acutely intoxicated on ethyl alcohol.

Five principles are suggested to reduce fatal and clinical poisoning:

1. Observe precautions prescribed for the safe handling of pesticides in agriculture.
2. Make sure that pesticide containers are safely disposed of.
3. Do not take agricultural pesticide home for storage, or for use against household pests.
4. Do not place pesticides on food as bait or in food containers for storage or transportation.
5. Always label pesticide containers so that the label cannot be washed off or rubbed off.

Table 1. Pesticide Poisonings, Dade County, Florida, 1956-1968

	Organo-phosphate	Nonorgano-phosphate	Sub total	Total
ACCIDENTAL	28	13	25	41
Children	18	7	7	
Occupational	3	4	7	
Alcohol	5	2	2	
Miscellaneous	2			
SUICIDE	26	46		72
HOMICIDE	2	2		4
TOTAL	56	61		117

Table 2. Pesticides Causing Accidental Death

Pesticide	Number of deaths
Parathion	26
Guthion	1
V.C. 13	1
Methyl bromide	1
Acrylonitrile	3
Arsenic	2
Thallium	2
Phosphorus	3
Paraquat	1
Real Kill	1
TOTAL	41

Table 3. Accidental Pesticide Poisoning, Yearly Incidence, 1957-1968

Year	Fatal	Nonfatal
1957	1	NA
1958	7	NA
1959	5	NA
1960	2	NA
1961	2	NA
1962	1	NA
1963	9	NA
1964	4	22
1965	3	24
1966	2	11
1967	2	11
1968	3	11
TOTAL	41	79

NA--Information not available

Table 4. Nonfatal Pesticide Poisoning, 1964-1968, Dade County, Florida

Accidental poisoning	79
Children	41
Occupational	26
Miscellaneous	12
Attempted suicide	11
Attempted murder	2
TOTAL	92

Table 5. Nonfatal Accidental Pesticide Poisoning, 1964-1968

Year	Poisoning				Pesticide							
	Children	Occupational	Other	Total Accidental Poisonings	Parathion	Phosdrin	Diazinon	Thallium	Phosphorus	Arsenic	Mercury	Other
1964	13	5	4	22	9	1	4	1	2	1		4
1965	10	12	2	24	14	7						3
1966	5	4	2	11	7	3						1
1967	6	4	1	11	5	1			1	2		2
1968	7	1	3	11	5		1			1		4
TOTAL	41	26	12	79	40	12	5	1	2	2	3	14

Table 6. Fatal Accidental Pesticide Poisoning, 1964-1968

Year	Poisoning				Pesticide			
	Children	Occupational	Other	Total Accidental Poisonings	Parathion	Guthion	Acrylonitrile	Paraquat
1964	3		1	4	3	1		
1965	3			3	2		1	
1966	1		1	2	2			
1967			2	2	2			
1968	1		2	3	2			1
TOTAL	8	0	6	14	11	1	1	1

WEED CONTROL IN CORN—1970

F. W. Slife

Chemical weed control in corn has been one of the factors contributing to the very high corn yields obtained in recent years. Chemicals are now available for pre-plant, preemergence, and postemergence--giving the farmer a wide choice of treatments to fit into his management practices.

Although dealers have and will continue to help farmers select chemicals, the major decisions have to be made by the producer. To use chemicals effectively, he must know what weed species he is trying to control, the soil characteristics, and the particular treatment that will best fit into his other practices. With this information the farmer can make the decision, or go to a good dealer for help. In terms of the immediate future, it appears that we will continue to use all three types of treatments, and that there will be no major shift toward any one of the three.

We assume that there will be more and more suggestions about using combinations of weed chemicals. Such combinations offer many advantages, compared with single-chemical treatments. Since combinations must have FDA and USDA approval, it is important to keep abreast of the clearance status of any combination in which you are interested. In addition, many farmers want to know about the compatibility of weed chemicals with other pesticides and fertilizers. More information of this kind is becoming available, but it may be necessary to check compatibility by mixing small batches.

CHANGING PATTERNS

Weed control in corn will be a static matter, but will have to change as new weed problems appear and management practices change.

Examples of change are the increasing amount of panicum and the apparent increase in certain perennials. Panicum seems to have increased because we have planted earlier, achieved excellent weed control in the early part of the season, and have reduced the amount of cultivation after planting. Even though the field has no apparent weeds, a cultivation at lay-by appears to discourage panicum germination after that time.

Logically, some of the perennial weeds that are not affected by treatments for annual weeds will grow better because of the reduced competition. Two good examples are nutgrass and climbing milkweed, which seem to be increasing. But there are a number of other perennials that should be watched. These are common milkweed, ground cherry, bull nettle, trumpet creeper, wild sweet potato, and field bindweed. Besides having fewer annual weeds to compete with, these plants will benefit from reduced corn cultivation. It seems logical that corn cultivation has helped control these species. If and when these kinds of perennials begin to increase, then specific control measures will have to be introduced.

Despite the interest in growing corn with no seedbed preparation and no tillage, such a system can hardly succeed if we cannot achieve weed control. The reduced-tillage systems has so many advantages that every effort possible should be made to put together a weed-control system that will work.

Planting corn in sod does work, and is being used on more acres each year. Planting corn in the previous years' soybean stubble should be acceptable, because there is less surface residue to affect weed chemical application. Planting corn in the previous years' corn stalks without tillage presents more problems than the other two systems. Yet, with the variety of weed chemicals that we have available, we should be able to arrive at some suitable program.

PREPLANT

AAtrex alone, Sutan alone, or Sutan-AAtrex mixtures performed very well in 1969. In most areas, the combination is preferable because of broader spectrum of control. Although the tolerance of corn to Sutan is not as high as with some other compounds, seemingly it will not cause injury if the rates are accurate and suitable incorporation is used. Preplant treatments seem to be more desirable on the medium to heavy soil areas, where some of the preemergence treatments are more variable. On the low-organic-matter soils, preemergence may be preferable because of consistent performance and longer surface residue.

In 1970, both Lasso and Princep will have label approval for incorporation. Although Princep is similar to atrazine, it has performed better on panicum and crabgrass. Corn tolerance is excellent for both Lasso and Princep.

PREEMERGENCE

This type of treatment is being used by more farmers as the basic weed-control practice than any other. The success will tend to improve as new chemicals and combinations become available. AAtrex alone, Ramrod alone, or AAtrex-Ramrod mixtures were all exceptionally good in 1969. These treatments have very high corn selectivity and a good performance record.

Londax also performed quite well in 1969. This combination of Lorox and Ramrod gives wide-spectrum weed control, but rates will have to be adjusted carefully for soil types to avoid corn injury. The results from using Lasso preemergence on corn were exceptionally good in 1969. Although similar to Ramrod in performance and in its spectrum of control on the medium to heavy soils, it continues to perform well on the lighter soil types where Ramrod is variable. Princep will be available for preemergence in corn in 1970. It will be suggested for use particularly on the light soils. It should be better than atrazine for controlling panicum and crabgrass.

The newer compounds, such as Bladex and Rotate, are discussed under new chemicals.

POSTEMERGENCE

The use of 2,4-D continues at a high rate in corn to supplement other weed-control practices. It continues to produce substantial corn injury in isolated fields. Instead of continuing to increase late-season treatments, more attention should be given to precise applications early in the growing season, thus reducing weed competition. Applications should not be made at the time of silking and tassel initiation.

Atrazine plus additives as a postemergence treatment continues to be used by many farmers. Although we believe preplant or preemergence treatments may be more reliable, the atrazine postemergence treatments will work. Where this fits a farmer's program best, it should be continued.

More and more additives are becoming available for atrazine postemergence. At present, there is no information available to indicate that these are superior or inferior to the additives that have been available for several years.

Bladex, although similar to atrazine, is not suggested for postemergence treatments on corn because of the possibility of injury.

Weed control in corn has gradually improved over the past five years, and a wide variety of acceptable chemicals and treatments are now available.

The choice of these treatments should be based on the following:

1. What chemical or chemicals will give the best control.
2. What are chemical or chemicals with the best corn tolerance that will control the weeds on your soil?
3. What chemicals give good weed control, have good corn tolerance, and fit your system of application (preplant, preemergence, postemergence)?
4. What chemicals in formulation best suit your equipment (liquids, granules)?
5. Will a soil-residue problem prevent you from growing crops other than corn the next year?

There are probably other questions that you will want to consider. We would encourage you to try several good treatments on corn and compare the results under your specific conditions.

SEED-TREATMENT TESTS WITH SOYBEANS

D.W. Chamberlain

Soybean seed treatment has been the object of considerable interest for the past quarter century. Tests in the Midwestern and Southern states were run from 1943 through 1946. Since that time, independent tests have been made in the United States, Canada, South America, and other countries. In some instances, attempts were made to control specific diseases; in others, the goal was improved germination.

GENERAL RESULTS

Generally speaking, the most-promising results were obtained with seed of low germination, where increased emergence was necessary to attain the minimum stand for satisfactory yield. Good-quality seed, of good germinability, showed no increase in yield as a result of seed treatment.

Perhaps the most-spectacular instance of success in seed treatment occurred in Canada in 1959-1960. At that time, Canadian seed stocks were generally low in germination; seed treatment increased germination as much as 50 percent in poor-quality seed.

1969 TEST IN ILLINOIS

In 1969, the Extension pathologists in Illinois sponsored another seed-treatment test with soybeans. In cooperation with farm advisers in ten counties, 11 plots, each 10 acres in size, were located. The individual growers furnished their own seed. Captan (Ortho) was applied in the seed box at 4 ounces per bushel.

Stand counts of the emerged seedlings were made on all eleven locations. About 80 percent of the locations showed an increase in emergence for treated seed. Only three of these were statistically significant. Unfortunately, yield data were taken on only five of the eleven plots in the test. Of these, two indicated increased yield from treated seed, two showed no increase, and one showed a reduction in yield from treated seed.

COMMENT

These results on a field scale agree in general with the smaller, experimental-plot tests conducted during previous years. As in the past, recommendations for Illinois suggest chemical treatment for seed that is low in germination. There is still no evidence that increased yields will result from treating good-quality seed of high germinability.

WHAT IS NEW IN WEED CONTROL FOR 1970

M.D. McGlamery

There are few new herbicides for 1970, but several new herbicide combinations are being proposed. Also, there are several herbicide label changes for 1970. Several treatments are being considered for federal approval, but many of these clearances may not be made in time for the 1970 cropping season. You will have to watch labels and clearances as the 1970 planting season approaches.

NEW HERBICIDES

Bladex (SD-15418) is the only new herbicide for 1970. It is chemically related to atrazine (AAtrex), but has a shorter soil life. Blandex should present no problems with residual carryover, but there could be difficulties with late-season weed control. The control spectrum is about the same as for atrazine--possibly less on broadleaved weed control. Rates will vary with soil texture and organic-matter content. If it receives label approval, Blandex will be marketed on a limited scale by Shell as a 80-percent wettable powder for preemergence use on corn.

Maloran (chlorbromuron) had an experimental label for preemergence use on corn in 1969. It may receive a general clearance for corn in 1970. It is a phenylurea herbicide from CIBA, one closely related to Lorox (linuron). The control spectrum should be the same as for linuron, but the specific activity of Maloran is lower and so more will be required for equivalent control. Corn tolerance is marginal. Rates will have to be adjusted for soil texture and organic matter. Pending clearance, it will be marketed as a 50-percent wettable powder.

Preforan (C-6989) has a "seed bean" clearance on soybeans for planting purposes that are not to be sold for food, feed, or oil purposes. Full soybean clearance for 1970 is doubtful.

HERBICIDE COMBINATIONS--GENERAL INFORMATION

Many new herbicide combinations are proposed for 1970. Some of these are to be formulated combinations, while others are proposed as tank-mix or overlay (preplant plus preemergence) treatments. Many of these are combinations of herbicides previously cleared and used to some extent.

The primary purpose of a herbicide combination is to maximize weed control and minimize crop injury (immediate and carryover). Maximization of control may involve a broader control spectrum and a greater adaptation to the soil and climate. Minimization of crop injury usually involves reducing herbicide rates for those with close crop tolerance or long persistence. Problems with herbicide combinations usually involve physical, chemical, or industrial compatibility and differences in optimum placement and timing.

COMBINATIONS FOR SOYBEANS

Solo is a new formulation and proportion of the same active ingredients (naptalam equals Alanap and chloroprotham equals Chloro-IPC) as in Alanap Plus, Whistle, and

Amoco Soybean Weed Killer. The new ratio is 1 to 1, rather than 3 to 2 (naptalam to chloroprotham). This should increase the smartweed control and reduce the likelihood of soybean injury, although control and crop injury will probably be quite variable (as they have been in the past).

Shamrox (Dacthal equals DCPA plus Lorox equals linuron) is a proposed combination from Diamond Shamrock for preemergence use. Rates will need to be adjusted to meet varying soil conditions, since both herbicides are greatly affected by the organic-matter content of the soil. If clearances are received, Shamrox will be marketed in 1970 on a limited scale, both as a wettable powder and a granular formulation.

Noraben (Herban equals norea plus anubeb) is a combination formulated by Hercules. Norea is a phenylurea herbicide that is chemically related to Lorox (linuron). Norea received a soybean clearance in 1969, although it was previously used on sorghum and cotton. The formulation is a water-dispersible liquid (liquid slurry) mixture containing 1.2 pounds per gallon of norea and 1.5 pounds per gallon of amiben. The suggested rate is 2/3 to 1 gallon per acre on a broadcast basis. This herbicide combination is for preemergence control only, and should not be used on sandy soils.

Amiben/linuron is a formulated combination of preemergence herbicides proposed by Amchem Products. The formulation is to be 1-1/2 plus 1/2 pounds per gallon of amiben and linuron (Lorox). The proposed rate is 1 gallon per acre, used as a broadcast preemergence treatment. The rate and ratio will limit this combination to the soils of low organic-matter content.

Amiben/dinitro (DNBP) is another soybean combination proposed by Amchem Products. The formulation is to be 1-1/2 plus 3 pounds per gallon (amiben plus DNBP). The proposed usage is 1 gallon per acre, to be applied from planting to cracking (soybean emergence) stage. Dinitro is a contact herbicide that will control many emerged weed seedlings, thus allowing the cracking-stage treatment to reduce soybean-germination injury. This treatment is similar to the dinitro plus naptalam (Dynap) treatment used on some of the Southern states on soybeans.

Lasso plus Lorox (alachlor plus linuron) is a tank-mix combination proposed by Monsanto for preemergence use on soybeans. The Lorox is to increase the broadleaved weed control, although Lorox is poor on morningglory. Tank mixes allow the user to vary the ratio to meet individual weed and soil conditions. If given federal approval, the suggested rate will be 1-1/2 to 2 quarts of Lasso and 1 to 2 pounds of Lorox per acre.

Chloro-IPC is being proposed by PPG as a tank mix with Lasso, also as a preemergence treatment over preplant-incorporated Treflan. Lasso and Treflan are both variable on smartweed, while Chloro-IPC is very effective for smartweed control.

COMBINATIONS FOR CORN

Lasso plus atrazine (AAtrex) is a tank-mix combination proposed by Monsanto for preemergence and preplant application. Pending clearance, the suggested rates will be 1-1/2 to 2-1/2 quarts of Lasso and 1-1/4 to 2 pounds of AAtrex per acre (broadcast basis). The combination should have good crop tolerance and a good spectrum of control. It will probably be adapted best to the soils of 2 to 5 percent organic matter.

Amiben/atrazine is a formulated combination proposed by Amchem Products for pre-emergence use on corn. The formulation is to be a 25-to-50 percent (amiben to atrazine) wettable powder; proposed rate, 4 pounds per acre of the product (1 pound per acre of amiben and 2 pounds per acre of atrazine). This combination is proposed for the "heavy prairie" soils. The amiben should increase the grass control of atrazine on the high-organic-matter soils, while the reduced rate of amiben should give better crop tolerance than the full rate of amiben (2 pounds per acre) when used alone.

Rowtate (Dacthal plus 2,4-D) is a formulated combination being proposed for pre-emergence use on corn by Diamond Shamrock. If cleared, it will be marketed on a trial basis as a wettable powder, possibly also as a granule. It should not be incorporated, since corn tolerance is only fair with both ingredients in the combination.

Sutan/atrazine will be available (if cleared) on a limited scale as a 36-to-12 percent wettable powder. It will be packaged as a 25-pound unit for use on 3 acres--an effective rate of 3 pounds per acre of butylate (Sutan) and 1 pound per acre of atrazine. New label suggestions will also allow a higher rate of atrazine in the Sutan-atrazine tank mix. This should increase the broadleaved weed control on the soils of higher organic-matter content.

NEW FORMULATIONS

Several new formulations will be available on a trial scale in 1970. Amiben 20 percent granules will be trial marketed as a possible replacement for the 10 percent granule. Londax and AAtrex will be trial marketed as water-dispersible (WDL), liquid-slurry formulations for spray application. WDL formulations eliminate the preslurry mixing required for wettable-powder formulations. Preforan will be available as a 50 percent wettable powder, as well as the 3 pounds-per-gallon EC. Sutan/atrazine will be available on a limited scale as a 36-to-12 percent wettable powder. Some of these formulations may carry only experimental labels. Others may receive full clearance.

NEW LABEL CHANGES

Lasso will carry a label suggestion for preplant-incorporated treatment, as well as preemergence treatment, on corn. Clearance is pending for a higher rate (3 quarts of Lasso per acre) on higher organic-matter soils, especially for preplant incorporation. Yellow nutsedge, fall panicum, witchgrass, and seedling Johnsongrass are being added to the Lasso label.

Princep will carry a label for preplant-incorporated treatment and preemergence treatment on corn. This may be useful in some areas where fall panicum and wild cane are problems.

Treflan incorporation suggestions will include the use of the mulch treader.

Sutan labels will carry the suggestion for a higher rate of atrazine in the Sutan plus atrazine tank mix. Clearance is pending on a higher rate of Sutan (2/3 gallon per acre) in the combination, for use on soils above 5-percent organic matter.

Dowpon label changes include decreasing the rate from 8 to 10 pounds per acre to 5 to 7 for the spring preplant treatment. These changes may make the preplant treatment more appealing for soybeans, but the necessary delay in planting does not

agree with optimum corn planting time. The treatment following small grains is still considered as the best "old-grass" program for the control of Johnsongrass.

Many of the proposed treatments are awaiting federal approval, and several factors can delay these clearances. Dealers, custom applicators, and farmers should be sure that labels are current and that the latest information is available before deciding to use any of these new treatments. Some will have close crop tolerance and limited soil adaptation. It is always wise to try any new treatment on a limited scale, to see if it fits into your crop-weed-soil program before employing it on a full scale.

VARIATIONS IN FOXTAILS IN THE MIDWEST

M.M. Schreiber

Over the past several years, confusion has arisen about the identification of giant foxtail (*Setaria faberii*) in Indiana and adjacent states, where plants similar to giant foxtail in many morphological characteristics have been well distributed. Studies during the last four years clearly indicate that these plants represent new species or varieties of other common species.

MORPHOLOGICAL DIFFERENCES

The one most often confused with giant foxtail is giant green foxtail (*Setaria viridis* var. major), which has reddish-purple awns. However, two additional "species," which we have called "robust foxtail-purple awn" and "robust foxtail-white awn," have also been found. As their names imply, they differ in awn color but also in photoperiodism and floral development.

At several temperatures and photoperiods in growth rooms, giant green foxtail flowered first, followed in order by robust foxtail-white awn, green foxtail (*Setaria viridis*), giant foxtail, and robust foxtail-purple awn. In 1967, 1968, and 1969, under field conditions, the same order was obtained, with the exception that green foxtail was the first to flower.

Seed size, determined on a weight basis, separates one species from another, except for the two robust foxtails. The giant green foxtail, green foxtail, and the two robust foxtails have smaller seeds than giant foxtail. The robusts not only have smaller seeds, but each primary panicle has twice the number of seeds as giant foxtail. Also, our tests have shown that giant green foxtail and the two robust foxtails differ from giant foxtail in that they exhibit no seed dormancy.

RESPONSE TO HERBICIDES

Commercially used herbicides were applied at two rates to each of the five foxtails. Excellent control of all five was obtained with trifluralin, 1 and 2 pounds per acre; benefin, 1 and 2 pounds per acre; amiben, 1.5 and 3 pounds per acre; EPTC, 1.5 and 3 pounds per acre; propachlor, 2 and 4 pounds per acre; and alachlor, at 1 and 2 pounds per acre. The two robust foxtails showed a significant amount of tolerance to 3 pounds per acre of atrazine, while all other species were susceptible. The two robust foxtails were completely tolerant to propazine up to 3 pounds per acre. However, robust foxtail-purple awn had considerable tolerance to butylate at both 2 and 4 pounds per acre. Robust foxtail-white awn was susceptible at both rates, as were the other species.

Linuron at 1 and 2 pounds per acre postemergence provided weak control of both robust foxtails. A similar response was obtained with 2 and 4 pounds per acre of dalapon. This may be due to the more-rapid, earlier growth exhibited by the robust foxtails, compared to the other foxtails.

Herbicide susceptibility can separate some of the foxtails, particularly the robust ones from the others and between the robusts. Also, these data could possibly explain the various reports of *Setaria* species escaping control measures presently used in the Midwest.

RESULTS OF THE 1969 CATTLE GRUB SURVEY

Steve Moore III and S.M. Sturgeon

The purpose of this study was to determine the abundance and distribution of the common cattle grub, *Hypoderma lineatum*, and the northern cattle grub, *Hypoderma bovis*, on native Illinois cattle.

Dairy fieldmen with the Pure Milk Association in the northern section; Prairie Farms, Inc. in the central section; and Mid-America Dairymen, Inc. in the southern section counted the grubs on the dairy cattle. County Extension Advisers in JoDaviess, Henry, Peoria, McDonough, Washington and Pope-Hardin counties and an area livestock adviser in east-central Illinois located the beef herds and helped make grub counts on these cattle. The counts were made in late February and March, midway through the period of grub emergence in Illinois (January to May).

CATTLE CHECKED

Only cattle that had been on pasture the previous spring and summer (1968) and were between 11 months and 2.5 years of age were checked. Cattle in this age group have the highest incidence of grubs.

The grub collections were made each month at the following packing plants:

Northern section: Dubuque Packing Company, Dubuque, Iowa
Swift and Company, Rochelle, Illinois
Central section: Bartlow Brothers Inc., Rushville, Illinois
Calihan Packing Company, Peoria, Illinois
Southern section: Tarpoff Packing Company, Granite City, Illinois
DuQuoin Packing Company, DuQuoin, Illinois

Collections were taken only from native Illinois cattle coming to the packers.

RESULTS

The incidence of cattle-grub infestation appears to be greatest in the southern section and lowest in the central section (Table 1). Beef cattle of similar age to dairy animals have a higher incidence of cattle grubs. The overall state average of 1.9 grubs per animal does not indicate a generally serious problem.

If the threshold for economic infestations is set at 5 or more grubs per animal, then cattle 6 months to 2.5 years old in one out of fifty dairy herds and one out of seven beef herds would justify treatment with a systemic insecticide (Table 2). It is impossible to determine in advance which herd will have an economic grub infestation in any year. However, certain farms have a history of problems with grub, indicating a possible need for treatment.

Two species of cattle grubs, the common cattle grub and the northern cattle grub, are present throughout the state (Table 3). It appears that the common cattle grub is more numerous in the southern section; the northern cattle grub, in the northern section.

Table 1. Cattle Grubs on Native Cattle in Illinois, 1969

	No. of animals checked	No. of grubs found	No. of grubs per animal
<i>NORTHERN SECTION</i>			
Beef Cattle	132	544	4.1
Dairy cattle	201	42	0.2
Total	333	586	1.8
<i>CENTRAL SECTION</i>			
Beef cattle	121	55	0.5
Dairy cattle	128	121	0.9
Total	249	176	0.7
<i>SOUTHERN SECTION</i>			
Beef cattle	130	732	5.6
Dairy cattle	116	43	0.4
Total	246	775	3.2
<i>STATE TOTAL</i>			
Beef cattle	383	1,331	3.5
Dairy cattle	445	206	0.5
Total	828	1,537	1.9

Table 2. Native Cattle Herds with Economic Cattle Grub Infestations in Illinois, 1969

Type of cattle	No. of herds checked	No. of herds with 5 grubs or more per animal	Pct. of herds with 5 grubs or more per animal
Beef	37	5	14
Dairy	43	1	2
Total	80	6	8

Table 3. Species of Cattle Grubs Collected During February, March, and April from Native Cattle at Various Locations in Illinois, 1969

Section	Number of grubs collected					
	February		March		April	
	<i>H. lineatum</i>	<i>H. bovis</i>	<i>H. lineatum</i>	<i>H. bovis</i>	<i>H. lineatum</i>	<i>H. bovis</i>
Northern	1 (25) ^{a/}	3 (75)	5 (18.5)	22 (81.5)	0 (0)	20 (100)
Central	10 (100)	0 (0)	6 (100)	0 (0)	6 (17.1)	29 (82.9)
Southern	105 (100)	0 (0)	21 (100)	9 (0)	0 (0)	16 (100)
Total	116 (97.5)	3 (2.5)	32 (59.3)	22 (40.7)	6 (8.5)	65 (91.5)

^{a/} The figure in parentheses represents percent of total.

AGRICULTURAL CHEMICAL MIXTURES

J.L. Williams, Jr.

Agricultural chemical mixtures, a very inclusive subject, is one of increasing importance to the herbicide industry. By broadest definition, this would include the mixing together of any chemical used in agriculture. Since my area of interest and work involves herbicides, the subject will be restricted to mixtures involving several herbicides or other agricultural chemicals such as insecticides, fertilizers, and the like.

HERBICIDE MIXTURES

First, let us look at mixtures of herbicides only. These offer several advantages over the use of individual materials. A logical and scientific approach to the mixtures shows great promise for:

1. Selectively broadening the weed control spectrum.
2. Increasing crop tolerance.
3. Decreasing soil residue potential.
4. Reducing the influence of the weather.
5. Reducing the influence of the soil.

This really is not a new approach to more-selective weed control. Many combinations have been and are now being used. One could pick many different ones. However, let us look at a few that have been used in corn and soybeans as preemergence treatments for several years--Knoxweed, Roundup, and Alanap Plus. Some of the recently cleared mixtures are Sutan with AAtrex, Primaze, Londax, and Ramrod-atrazine. Others that have shown promise experimentally are Lasso with Lorox and AAtrex with Lasso.

SURFACTANTS

Another area of very great importance that has received considerable attention during the last few years is the use of surfactants with herbicides. Wetting agents and crop oils added to herbicides to increase the foliage penetration are good examples of this. AAtrex with the addition of a non-phytotoxic crop oil and emulsifying agents applied as an early postemergence treatment in corn is an excellent example, and is a subject in itself. Along with increasing herbicidal activity, the selectivity of several herbicides may be altered.

HERBICIDES COMBINED WITH OTHER CHEMICALS

Now, suppose we look at the herbicides combined with other agricultural chemicals, such as fertilizers and insecticides. Generally, this combines operations and means fewer trips over the field, hence lower application costs.

In herbicide combinations with fertilizers, the fertilizers are used mainly as the carrier. The most work has probably been done with AAtrex (atrazine) and liquid nitrogen. If research should show that other chemicals and fertilizer solutions follow the same pattern, there will be few problems with this type of combination. The work with AAtrex and liquid nitrogen indicates no significant change in the weed-control performance of the herbicide.

This has not been entirely the situation when combining herbicides and insecticides. Scattered reports through the literature tell of some of the insecticides changing the activity of the herbicides when applied in combination. Although limited work is going on at the present, there needs to be more research effort in this area.

Several things need to be considered with mixtures, especially those involving herbicides and fertilizers and/or insecticides. The components must be physically compatible in the tank. Sometimes two different formulations can create unusual problems. Check this before you mix. Some companies have specific mixing suggestions.

Generally, in mixing emulsifiable concentrates with wettable powders, the emulsifiable concentrate is mixed with the water first, then the wettable powder is added as a slurry to the tank. Always consult the label before mixing components.

Some companies have procedures for determining the compatibility of herbicides with liquid fertilizers. This test procedure involves the addition of small amounts of the herbicide to equal amounts of water to form a concentrated emulsion. This, in turn, is added to a given volume of fertilizer in a clear glass container. After shaking the container vigorously for a short period of time, the mixture is allowed to stand for 5 to 10 minutes. If the mixture remains uniform and does not separate into an oily film or curdled precipitate, the herbicide is one that will mix satisfactorily with the fertilizer.

If the mixture does separate, several companies suggest the use of compatibility agents. There are several on the market. Test procedures are available from most of the major companies concerning their products in liquid fertilizers. Consult the label for this information.

Another point in question, one that cannot be checked as easily as physical compatibility, is the question of plant tolerance to the mixtures. This also needs much research. Little is being done at the present time.

APPLICATION

Do not overlook the application method. The application and placement must be correct for all components of the mixtures. If you want your fertilizer incorporated, you must determine whether the herbicide will perform as an incorporated application, or whether it must be applied as a surface one. Make sure the application is a uniform one if herbicides are involved in the mixture.

Weeds do not move around like insects.

EQUIPMENT CONTAMINATION

An area of considerable concern and several problems is the contamination of equipment by herbicide mixtures, especially from the standpoint of commercial applications. This has arisen from the use of more than one type of herbicide mixture in the fertilizer applicators. It is very difficult to get either corn or soybeans to

grow in a field that has been treated with Treflan used in a fertilizer mixture that was contaminated with AAtrex.

We know combinations have great possibilities and are here to stay. So, we should strive to use agricultural chemical mixtures to do the job they are supposed to do.

A good weed is a dead weed.

PROGRESS REPORT ON SEED-CORN BEETLE CONTROL

R.E. Seebriest, D.E. Kublman, and H.B. Petty

Considering the number of seed-corn beetles present in Illinois during 1969, we were fortunate that we did not have serious seed-beetle damage to corn. It could happen in 1970. A cheap and simple method of controlling seed corn beetles and maggots is the diazinon planter-box seed treatment. Other soil insects were present in past years, and we looked on seed treatments as a stop-gap, or minimum, control effort, since such treatments interfered with seed drop. Because of the widespread seed-corn beetle damage in 1968 and their apparent resistance to chlorinated hydrocarbons, we recommended the diazinon seed treatment for 1969. Enough diazinon was sold to treat 2 to 4 million acres of corn. This could hardly be considered a small trial run, and some problems were encountered. Circular 899, which is included at the back of this manual, contains a list of precautions to observe when using seed treatments. This includes what we learned to do and not to do.

Table 1. Plant Populations Per Acre Using Various Planter Box Seed Treatments, 1969

Treatment	No. of fields	Plants per acre
None	27	19,769
Heptachlor	20	20,192
Dieldrin	27	20,053
Lindane	27	20,221
Diazinon	27	20,274

Table 1 lists the results from 20 seed-corn fields around the state that received various seed treatments. This was an attempt to find out where the seed-corn beetle problem existed. All four seed treatment chemicals of diazinon, dieldrin, heptachlor and lindane were included. The overall damage was almost nil. In rootworm demonstration fields, we had untreated and diazinon-seed-treatment plots (Table 2). These were scattered from Shawneetown to Quincy to Woodstock. Again, no average field differences are apparent.

In one field (Table 3), there seemed to be some effect from seed treatment. Dieldrin failed to control seed beetles, but diazinon, heptachlor, and lindane appeared to be effective.

The results of laboratory tests are given in Table 4. To determine effectiveness of seed treatments, we confined beetles in containers with treated seed, using silt loam or peat moss. The indications are that peat moss may tie up the chemical and reduce effectiveness. Interestingly enough, this did not happen with diazinon. At any rate, the average control was diazinon, 87 percent; lindane, 55 percent; dieldrin, 30 percent, and heptachlor, 29 percent.

Table 2. Corn Plant Populations From Twelve Rootworm Demonstration Plots

Treatment	Plants per acre
No treatment--rep. 1	23,829
No treatment--rep. 2	23,754
Diazinon seed treatment	23,972

We will continue to recommend the diazinon seed treater when no soil insecticide is used or when chlorinated hydrocarbons or carbamates are used as soil insecticides.

SOIL TREATMENTS

Field results. Stand counts were made on 12 rootworm demonstration fields (Table 5). It is questionable whether there is a difference, but BUX 15 and heptachlor counts may be low and Dasanit high. However, when we examined stands from the Carroll-Ogle County plot (a field of known beetle infestation), we could see a difference (Table 6). Note that the phosphates--Dasanit, Dyfonate, and Phorate--had 3,000 to 4,000 more plants per acre than the check plot, while the carbamates--landrin, carbofuran, and BUX 15--had only 700 to 1,800 more plants per acre than the check. Diazinon seed treatment had 3,400 more and the diazinon soil treatment, at 2 pounds per acre, had 2,453 more plants than the check. Thus, we begin to differentiate between materials.

Table 3. Plant Populations in Carroll County Seed Treatment Plot, 1969

Treatment	Plant pop./A.
None (Av. of 3 plots)	18,547
Diazinon (Av. of 2 plots)	22,000
Lindane	21,280
Heptachlor	21,440
Dieldrin	18,560

Table 4. Seed Treatment and Slender Seed Corn Beetle Control on Peat and Silt Loam Soil in Laboratory Tests

Treatment	Percent of control after 5 to 7 days		
	Silt loam	Peat	Av.
None	...	...	...
Heptachlor	52.5	5.1	29
Dieldrin	60.0	0.7	30
Lindane	97.5	12.7	55
Diazinon	85.0	90.4	87

Laboratory results. We also treated soil in the laboratory at 1 pound per acre, and infested the soil with beetles (Table 7). This was also silt loam and peat moss. Again, notice the drop in control on peat moss. In the peat moss, we also recorded kernel damage, which followed the percent of control.

RECOMMENDATION

Based on the above data, we recommend phosphate soil treatments for seed-corn beetle control. We also recommend the use of the diazinon seed treater with other materials.

Table 5. Plant Populations From Twelve Fields With Soil Insecticide Treatments of 1 Pound Per Acre, 1969

Treatment	Plant pop./A.
None	23,829
Dasanit	24,374
Phorate	23,941
Carbofuran	23,881
Landrin	23,793
Dyfonate	23,716
Heptachlor	23,462
BUX 15 with diazinon seed treatment	23,391
BUX 15 without diazinon seed treatment	23,311
Nothing	23,754
Diazinon seed treatment only	23,972

Table 6. Plant Populations in the Carroll-Ogle County Rootworm Demonstration Plot, 1969

Treatment	Plant pop.	Increased plant pop.
None	18,547	...
Landrin	19,240	693
Dasanit	21,720	3,173
Phorate	22,600	4,053
Dyfonate	21,720	3,173
Heptachlor	20,120	1,573
Carbofuran	19,720	1,173
BUX 15--no seed treatment	20,320	1,773
BUX 15 with diazinon seed treatment	21,880	3,333
Diazinon seed treatment only	22,000	3,453
Diazinon planter (1 lb.)	20,040	1,493
Diazinon planter (2 lb.)	21,000	2,453

Table 7. Various Soil Treatments at One Pound per Acre to Peat and Loam Soils to Control Corn Seed Beetles in Laboratory Tests, 1969

Treatment	Pct. control after 5 to 7 days			Percent damage kernels
	Loam	Peat	Av.	
Nothing	...	..	..	65
Mocap	100	..	..	..
Disulfoton	100	..	..	..
Phorate	98	..	..	..
Diazinon	97	94	96	13
Dasanit	94	..	..	..
Niran	93	..	..	..
Dyfonate	88	80	84	23
BUX 15	88	7	48	58
Landrin	65	4	35	73
Carbofuran	31	..	..	..

TOPICAL TREATMENTS

To further study this seed beetle, we also ran topical application tests by putting small amounts of insecticide on individual beetles. Thus, we found that diazinon was the most toxic to the beetles (Table 8). Diazinon was 1,000 times more toxic than aldrin, and 100 times more toxic than lindane. Generally, the phosphate insecticides are the most promising ones. The carbamates show a little promise. The chlorinated hydrocarbons are not effective now, and will not be practical soon due to resistance.

Table 8. Percent Acetone Concentration to Kill 50 Percent of the Slender Seed Corn Beetles (LC50)

Insecticide	LC50
Diazinon	0.00042
Parathion (Niran)	0.00049
Furadan (Carbofuran)	0.0012
Thimet (Phorate)	0.0015
Dyfonate	0.0018
Dasanit	0.0018
Di-Syston (Disulfoton)	0.0037
Bux	0.0037
Landrin	0.005
Lindane	0.015
Aldrin	0.52

NOZZLE TYPES AND USES

J.C. Siemens

Three types of nozzles are recommended for applying sprays to field crops in Illinois: the hollow-cone, flat-fan, and flooding flat-fan types. For different spraying requirements, a different nozzle type is needed.

HOLLOW-CONE NOZZLES

These are recommended for applying insecticides and fungicides at pressures of 60 p.s.i. and above. The spray pattern is circular, with a very light application in the center. The average droplet is quite small; hence, the use of hollow-cone nozzles where complete foliage coverage is desired and when drift is relatively unimportant.

Slight pressure changes noticeably affect the spray pattern. When a boom is used for broadcast field spraying, the distribution across the swath is not as uniform as that obtained when flat-fan nozzles are used.

The common hollow-cone nozzle tips are the cone and disk types. The whirl-chamber nozzle, which also provides a hollow-cone spray pattern, has been used for the field spraying of pesticides. The whirl-chamber nozzle is normally sold for industrial purposes and not for agricultural field spraying, except for air-craft applications. One advantage of the whirl-chamber nozzle is the large orifice sizes compared with other nozzles having the same capacity. The larger orifice sizes of the whirl-chamber nozzle reduce the problem of clogging, especially for low-volume applications.

The whirl-chamber nozzle has the inherent disadvantage, as with other hollow-cone nozzles, of poor distribution when mounted on a boom for broadcast application. Also, the spray distribution from the whirl-chamber nozzle is not uniform around the hollow-cone pattern. At 30 p.s.i., one of the whirl-chamber nozzles tested delivered 30 percent more material to one part of the pattern.

Among nozzles of the same capacity and operated at the same pressure, the whirl-chamber nozzle produces larger droplets than the cone and disk-type, hollow-cone nozzles, but smaller than the flat-fan nozzle. (See Table 1 for the median-volume, droplet diameter of the various nozzles.)

FLAT-FAN NOZZLES

These are recommended for applying herbicides and some insecticides. When applying herbicides, the pressure should be between 15 and 30 p.s.i., never over 40. The spray pattern is fan-shaped. This nozzle is best suited for spraying herbicides because: (1) when mounted on a boom for broadcast spraying, the spray material is more evenly distributed than it would be with any other type of nozzle; and (2) the flat-pattern nozzle delivers droplets in the small-to-medium size range that are not as susceptible to drift. However, even slight drifting of 2,4-D and other herbicides can cause damage to sensitive crops at fairly great distances. Hence, spraying herbicides under windy conditions should be avoided.

FLOODING FLAT-SPRAY NOZZLES

These are recommended for surface applications of liquid fertilizers. Boom-mounted nozzles on 40-to 144-inch centers provide a wide swath through fewer orifices. Thus, fewer clogging problems occur.

The flooding flat-spray nozzle can also be used for applying herbicides and mixtures of herbicides and fertilizers. The spray is susceptible to wind distortion when used at wide nozzle spacings. However, on the average, drift is probably reduced because of the relatively large particles. Because of the relatively large droplets produced, the flooding flat-spray nozzle is recommended for applying herbicides where drift is hazardous; however, nozzle spacings should be reduced to 40 inches or less and pressures to 20 p.s.i. or less. The fan-like pattern provides enough coarse droplets for weed control

Table 1. Droplet Size Produced by Different Nozzles

Nozzle Type	Spray angle, degrees	Capacity (g.p.m. at 40 p.s.i.)	Median volume droplet diameter (microns) for a pressure of		
			10 p.s.i.	40 p.s.i.	100 p.s.i.
GI solid cone	56	.19	1150	840	480
5002 flat fan	50	.2	580	520	450
6502 flat fan	65	.2	490	450	410
8002 flat fan	80	.2	440	380	360
A1 whirl chamber	70	.2	390	320	220
D3-25 disk type	61	.19	300 (25 p.s.i.)	250 (50 p.s.i.)	230

Data courtesy of the Spraying Systems Company.

(Median volume diameter is the droplet diameter where 50 percent of the total volume sprayed is larger than the median value, and 50 percent smaller.)

Pressure changes affect the width of the spray pattern more than with the flat-fan nozzles, due to the nozzle design and the position in which the nozzles are mounted on the boom.

GENERAL COMMENTS

1. Boomless spray nozzles of different types are available. These nozzles may be satisfactory for applying liquid fertilizers, but should not be used for applying herbicides--except perhaps in pastures, fence rows, and the like. Precision application is only an approximation with boomless nozzles.
2. The pressure listed on nozzle charts is the pressure at the nozzle, not the pressure reading at some other location.
3. Speedometer readings would be fine for adjusting ground speed if wheel slippage did not occur. But all wheels slip, especially drive wheels.
4. When applying fertilizers it is common to change the application rate drastically where the amount being applied is too high or too low. The result is often to apply the correct amount per field but not per acre. This practice cannot be used with pesticide applications or combined fertilizer-pesticide applications.
5. When applying pesticide-fertilizer combinations, narrow the nozzle spacing to 40 inches or less and use as much precision as for a pesticide application alone.

6. Pressure gauges frequently are not very accurate. It would be well to have an extra gauge on hand--one recently checked against a master gauge. The extra gauge can be mounted near a nozzle to determine the exact pressure at the nozzle. By adjusting the pressure-relief valve until the reading on the gauge near the nozzle is the one desired and by comparing this pressure with the pressure reading near the operator, the necessary base for adjusting pressure will be established. The check gauge should then be stored and used only periodically in the same manner.
7. A good rule of thumb is to use the minimum nozzle pressure that provides a normal nozzle-fan angle for herbicides. When spraying insecticides, little is gained by operating above 100 p.s.i., except more drift.
8. For a rough comparison of the durability of different nozzle materials, use the following table. The wear tests were conducted by the Spraying Systems Company, using finely ground quartz suspended in water.

Nozzle material	Life, compared with brass
Plastic-----	1
Aluminum or brass-----	1
Stainless steel-----	3.5
Hardened stainless steel-----	10 to 15
Tungsten carbide-----	180 to 250

CONTROLLING WILD CUCUMBER AND WILD CANE

J.L. Williams, Jr.

Wild cucumber (*Sicyos angulatus*) and wild cane (*Sorghum bicolor*) are serious, individual weeds found primarily in the first river bottoms of southern Illinois and Indiana; also, a serious localized problem in other areas of the two states. Wild cucumber and wild cane can be a composite as well as an individual problem in the river bottoms.

WILD CUCUMBER

Summer applications of 2,4,5-T or mixtures of 2,4,5-T with 2,4-D have given effective control of wild cucumber in corn. On the other hand, applications of our standard 2,4-D treatment in corn have not been effective. The initial work for the 2,4,5-T recommendation was done in Illinois, supported by work in Indiana several years ago.

Two problems exist at present for the use of 2,4,5-T as a control measure for wild cucumber in corn. First, 2,4,5-T is not cleared or labeled for use in corn. Second, cucumber germinates all season long, so a herbicide must persist throughout the season in order to be effective. 2,4,5-T does not give the necessary residual activity. Generally, two or more sprays of 2,4,5-T are required for control throughout the season. These reasons prompted a closer look at wild cucumber control in corn and soybeans.

None of the soil-applied herbicides commonly used in soybeans have given adequate control of wild cucumbers throughout the growing season. Most of these materials lack both the residual activity and the effectiveness against the species for control.

In corn applications of AAtrex (atrazine) or Princep (simazine) or mixtures of the two, herbicides have successfully controlled wild cucumber. Herbicides for effective wild cucumber control must be broadcast applied, because of the cucumber's germination pattern and vining characteristics. Since AAtrex and Princep require above-normal rainfall to move them from the soil surface to the deep germination zone of wild cucumber, preplant soil-incorporated treatments are favored over surface applications. When made, preemergence applications have proven more effective with a shallow cultivation. Broadcast rates of 2 pounds of active ingredient per acre appear adequate for season-long cucumber control on most river bottom soils.

WILD CANE

Since wild cane is an annual, it is controlled more easily than Johnsongrass. However, the herbicides that control Johnsongrass seedlings also control wild cane. The herbicides that have given consistently good control of Johnsongrass seedlings and wild cane for several seasons in our tests are Treflan (trifluralin) and Vernam (vernolate) for soybeans, Sutan (butylate) and Eptam (EPTC) for corn. All four compounds are used as a preplant incorporated treatment.

Injury to the crops has been slightly less with Treflan and Sutan than with the other two materials. Amiben (amiben), Dacthal (DCPA), Planavin (nitralin), and Lasso (alachlor) also have activity on wild cane and Johnsongrass seedlings. Princep has activity for the control of wild cane at the higher approved dosage rate, but is not effective on Johnsongrass seedlings.

MIXTURES

Since both wild cucumber and wild cane occur as a combined problem in river bottom situations, herbicide mixtures become increasingly important in solving the problem. The combination of Sutan and AAtrex has proven very effective, and this mixture also controls several other weed species. Princep could be used alone, since it has proven to be very good for the control of wild cucumber, but it is somewhat less effective for the control of wild cane than Sutan. Since Lasso has wild cane activity, a clearance for an AAtrex-Lasso mixture could provide another effective control.

Although wild cane and wild cucumber are a very severe problem in river bottoms, both can be effectively controlled through chemical treatments.

MARIHUANA: IDENTIFICATION AND CONTROL

Juett Hogancamp

In 1969, the Illinois General Assembly added marihuana to the Illinois Noxious Weed Law, through an amendment. When declared noxious, it joined such serious weeds as Johnsongrass, Canada thistle, and sorghum alnum.

Eleven weeds are listed as noxious under this law. While most of these eleven weeds are difficult to control and compete extensively with cultivated crops, marihuana was added because of its narcotic properties. This plant is commonly found growing on rich soils in all parts of Illinois, but it is most prevalent in the central and northern areas of the state.

IDENTIFICATION

Wild hemp (*Cannabis sativa L.*) is also known as marihuana. Hempweed, reefer, gallowgrass, galloweed, and neckweed are other names for marihuana. Originally, hemp was grown commercially for fiber. During World War II, it was raised in Illinois when overseas sources of rope-making materials were cut off. A planting and processing program was set up in several Midwestern states by the Commodity Credit Corporation and by War Hemp Industries.

In 1943, approximately 44,000 acres were grown in central and northern Illinois. There were eleven processing plants, located at Kirkland and Shabbona in DeKalb County, Earlville in LaSalle County, Galva in Henry County, Galesburg in Knox County, Ladd in Bureau County, Minonk in Woodford County, Lexington in McLean County, Muncie in Vermilion County, Polo in Ogle County, and Wyoming in Stark County.

Marihuana plants often grow on ditch banks; along railroads, roadsides, fence rows, and the edges of fields; in farmyards, gardens, and woodland pastures; and even along streets in towns. The marihuana plant is an annual that grows each year from seed. The plants, male and female, vary in size from 3 to 16 feet at maturity, and have greenish-yellow flowers that appear late in the summer. The male plant produces pollen. After shedding the pollen, the plant may begin to wither. The female plant becomes bushy and heavy with seeds, often remaining green and vigorous until early fall.

The marihuana plant has compound leaves that are palmate in shape, similar to one's hand, with the fingers representing leaflets. Each leaf usually has an odd number of leaflets or lobes, varying from 5 to 11 in number. Seven is the usual number. The stem is rough, ridged, and generally branched. The entire plant may feel sticky to touch. The leaves, stems, and seeds give a distinctive odor when crushed. The root system of the plant consists of a tap root, which may be as much as eight inches in length, from which spring a number of comparatively tiny branches.

CONTROL

Since marihuana is an annual, grows only from seed, and does not reproduce vegetatively from old roots or other plant parts, controls aimed at preventing seed production are essential if marihuana is to be eradicated. Plants appear about the last part of April or early May in Illinois. All the seeds in the soil do not germinate at one time; therefore, some plants may begin growing at various times during the season when soil moisture and temperatures are favorable. Some seeds may even remain viable in the soil for more than a year, so control measures should be repeated until the supply of seed in the soil has been exhausted--either by seeds rotting in the soil or germinating.

The length of time that marihuana seeds may remain viable in the soil is not definitely known, but the period is probably relatively short compared with some other kinds of weed seeds. Preventing seed production for two or three years, so that no new seeds are added to the soil, will help considerably in controlling marihuana. However, there is always the chance of new seed being carried from other locations by birds, flowing water, or on machinery.

Spraying with 2,4-D provides a simple, low-cost, and very effective means of control. For most-effective control, one should spray in late May or June when the plants are relatively small (8 to 15 inches). Approximately 1 pound of 2,4-D in 25 gallons of water for an acre should make an effective spray. Using 2,4-D with 4 pounds of active ingredient per gallon, this would be 1 quart of the 2,4-D formulation in 25 gallons of water, or 1 gallon of 2,4-D in 100 gallons of water. Care should be taken with 2,4-D to avoid damage to nearby, susceptible plants such as soybeans, tomatoes, grapes, and other desirable broadleaved plants.

Tilling the soil with a plow, disk, or other cultivation equipment is desirable for controlling marihuana. Mowing or other means of cutting marihuana can effectively prevent seed production.

Since the Illinois Department of Agriculture is authorized to superintend the enforcement of the Illinois Noxious Weed Law, it urges county boards of supervisors and county boards of commissioners to appoint county weed commissioners to help control this weed. A strong educational program is needed to inform citizens about how to recognize this menace to society and how to combat it. Farmers and others on whose property marihuana is found growing are urged to destroy it as a moral obligation to society.

PROGRESS REPORT ON GARDEN SYMPHYLAN CONTROL

R.E. Sechriest

Experiments were conducted this year to determine which insecticides would best control the garden symphylan and the most-effective method of applying the material. An experiment was conducted in Rock Island County in an 11-acre field on which a 30-percent yield reduction was experienced in 1968, because of garden symphylans.

The results of the experiment are shown in Table 1. One can observe from the data that damage continues throughout the growing season. Many observations were made during the growing season to determine how much the plants were retarded, if not killed outright.

Early in the season, the attacked plants were shorter, wilted, purple, or dead. These differences were not magnified as much as expected as the 1969 season progressed. More than 20 inches of rain fell during the growing season, which allowed the plants with no roots or a poor root system to survive.

In a year of average rainfall or in a dry year, approximately half of the corn plants in the untreated areas would not have survived. Significant differences were still observed in plant height, in spite of high soil moisture.

The untreated plants showed that they were shorter and delayed in tasseling as a result of symphylan root feeding. The harvested corn was higher in moisture content where the symphylans were not treated, and the number of bushels per acre was less than in areas where treatments controlled the symphylans.

The broadcast application generally resulted in better symphylan control than the 7-inch banded application. Bay 37289 and Dyfonate as broadcast treatments provided the best control. Other insecticides giving control nearly as good were VC-13; TZ-67, broadcast or 2 pounds banded; Niran, broadcast; and Furadan, broadcast at 4 pounds per acre.

This work was experimental and many of these compounds and/or uses do not have label approval.

Table 1. Effectiveness of Several Insecticides in Controlling the Garden Symphylan, as Evidenced by Five Evaluation Techniques, 1969.

Insecticide	Formulation	Application	Lb. act./A.	No. of injured plants	Plant height inches	No. of tassels	Percent moisture	Bu./A.
Bay 37289	15G	Broadcast Band	3	10a ^{1/}	94a	126a	23.6a	163a
			1	37	91a	121a	24.5ax	163a
VC-13	20G	Broadcast	9	17a	94a	122a	23.8a	164a
TZ-67 (Thimet + zinophos)	15G	Broadcast	2	18a	92a	132a	23.9a	165a
			4	18a	91a	124a	23.4a	164a
		Band	1	17a	92a	128a	24.1a	167a
			2	24a	91a	125a	23.6a	162a
Mocap	10G	Broadcast Band	2	19a	89	113ax	24.0a	160a
			1	26a	92a	115ax	24.0a	158ax
Niran	10G	Broadcast Band	5	19a	92a	125a	24.1a	163a
			2	24a	90	114ax	24.2ax	163a
Dyfonate	20G	Broadcast Band	2	7a	94a	128a	23.9a	168a
			4	13a	96a	131a	23.8a	163a
			1	27a	94a	116ax	24.3ax	164a
Furadan	10G	Broadcast	2	62 x	83 x	116ax	24.6ax	154ax
			4	10a	95a	133a	23.6a	169a
		Band	1	34	90	122a	24.3ax	157ax
			2	25a	89	115ax	24.0ax	169a
Untreated A	...	...	...	76 x	77 x	94 x	25.6 x	144 x
Untreated B	...	...	...	73 x	72 x	98 x	25.2 x	143 x

^{1/} Figures followed by same letter are not significantly different at the 5-percent level, as determined by Duncan's new multiple-range test.

PANICUM CONTROL

J.M. Houghton

During the past growing season, a number of observations were made on the growth, development, and control of panicum in Illinois. The 1969 weather pattern for Illinois was a normal one--extremely variable, with some areas receiving above-normal rainfall and others receiving a less-than-normal amount. Under these conditions, it was possible to observe the growth and development of panicum under weather extremes.

THE PROBLEM SPECIES

Although there are at least 36 different kinds of panicum in Illinois, we believe that at the present, only 2 are troublesome in cultivated areas. The most-significant one is *Panicum dichotomiflorum*, although *Panicum capillare* is also found here. *Panicum capillare* is easily identified by the hairs on the sheath and leaves. *Panicum dichotomiflorum* lacks hairs. We would prefer to call one of these "Fall Panicum" or "Smooth Panicum" (indicating the lack of hairs) and the other "Witchgrass." Our observations indicate that Witchgrass, although it does occur in cultivated areas, is a very minor problem. The majority of the infestations we have observed have been Fall Panicum.

IDENTIFICATION--PANICUM VERSUS FOXTAIL

Mature panicum plants are easily distinguished from mature foxtail. The seed head is very distinct for each. Panicum plants have an open, diffuse panicle. The foxtail plant has a dense, spike-like inflorescence. Seedling identification, however, is much more difficult, and no one distinguishing characteristic appears to easily separate the panicum and foxtail species.

PARTICULAR RELATIONSHIPS

At present, panicum infestations exhibit a high correlation with atrazine-treated fields, above-normal rainfall patterns, and a reduction in the amount of corn cultivation. An outstanding feature of panicum infestation is its correlation with good weed control. That is, panicum infestations occur first and often become a major problem in fields in which there is excellent control of other broadleaf and grass weeds. It appears, then, that panicum does not compete well with other weed species, becoming a prominent weed only when most other species have been controlled.

In spite of the fact that we consider panicum to be a late germinator, it seems to germinate quite well in the very early spring, along with the other weed species. Many herbicides currently in use will control the initial germination pattern. Yet, because panicum continues to germinate during the season as the herbicide level in the soil begins to go down, the panicum is able to germinate and grow with less and less competition. The possibility exists that panicum does have some resistance to

atrazine, but the more important point is that atrazine normally controls the initial germination.

Panicum is affected by corn stand and density of planting. In 1969, panicum seed was planted in 15-, 20-, 30-, and 40-inch rows of corn. None of the panicum plants survived in the 15- and 20-inch rows, but they were able to exist under relatively dry conditions in the 30- and 40-inch rows. In additional studies, where panicum plants were placed under shade structures, the results indicated that the growth of panicum is affected by any amount of shade, and that panicum plants make their maximum growth in full sunlight. The trend toward 30-inch corn rows obviously will help to control panicum. On the other hand, the trend toward shorter hybrids, which allow more light to reach the ground, will encourage its growth.

UNIVERSITY TESTS AT URBANA AND BROWNSTOWN

In tests initiated specifically for panicum control at Urbana and Brownstown in 1969, Lasso gave outstanding control at the rate of 2 or 3 pounds of active ingredient per acre. Combinations of Lasso-Lorox or Lasso-atrazine were also good, but not as effective as Lasso alone. Where simazine was compared with atrazine, the results favored simazine for panicum control. It will take a period of years to arrive at the best possible treatment for panicum in corn, but the following observations are justified at the present time.

Lasso alone or combined with other chemicals has been superior to Ramrod alone and to Ramrod combinations. Sutan alone or Sutan-atrazine combinations have been very effective, particularly on the medium to heavy soils. On the medium to light soils where atrazine has been used extensively for weed control with high success, some consideration should be given to using atrazine-simazine mixtures, or simazine alone, if and when panicum begins to develop as a problem.

In addition to the preemergence and the preplant treatments, a series of directed sprays applied when the corn was approximately 4 feet tall were evaluated for late-germinating panicum control. The chemicals used were ametryne, prometryne, paraquat, and Lorox. These materials were applied as postemergence sprays with surfactant added. All materials gave excellent control on very small panicum, particularly plants that were up to 3 inches tall. For plants that were 6 to 8 inches tall, the results were not as good. This test indicated, however, that directed sprays are another possibility for panicum control.

In general, atrazine applied postemergence, even with a surfactant, is not considered as effective on panicum as the same treatment on foxtail infestations.

SUMMARY

We have observed that simazine appears to be better than atrazine in controlling panicum infestations, and that waiting to apply postemergence chemicals is less desirable as a means of control than other methods. Directed postemergence sprays may offer a method of controlling late-germinating panicum.

At present, the most-effective preemergence chemicals appear to be Lasso alone, a Lasso-Lorox combination, Sutan or a Sutan-atrazine combination, and simazine alone or a simazine-atrazine combination. It should be pointed out that where cultivation was used when the corn was laid-by, little or no panicum appeared in these plots, compared to the plots where cultivation was not used.

From the standpoint of control, then, picking a good preemergence herbicide and combining it with cultivation appears to be one of the best programs for panicum control.

CONTROLLING CLIMBING MILKWEED

H.D. Coble

In recent years, climbing milkweed has become a problem in many areas of the South and Midwest. The weed is found in the southern two-thirds of Illinois, in almost any crop or noncrop situation. Severe infestations are often found in shrubbery, orchards, fence rows, and recreation areas; also, in corn and soybeans. However, the greatest economic problems have been in corn fields. The infestations there are often serious enough to make mechanical harvest very difficult. The reasons that the most serious infestations are found in corn seem to be:

1. The high fertility levels in corn.
2. The trend to shorter growing corn varieties, which shade the weeds less.
3. Better control of competing weeds, especially of grasses.

GENERAL INFORMATION

Climbing milkweed is a deep-rooted, perennial vine. Therefore, it is absolutely necessary to destroy the root system for good control. In order to get the herbicides that are applied to the foliage into the root system, the application must be made when the plant is actively transporting food substances into the root system for storage. The stage when greatest translocation occurs in most plants is just before bloom. With climbing milkweed, however, this stage occurs after the weed has started climbing on corn, making spray coverage very difficult. Therefore, one objective in our control experiments was to find the growth stage at which adequate translocation could be obtained, and when spray coverage would not be a problem.

STUDIES MADE

Some of our early work indicated that the penetration of herbicides into the leaf was a major problem in controlling climbing milkweed. By using surfactants, we were able to increase penetration about five times. So, the use of surfactants with solutions of herbicides in water might be called the first step in a control program.

Our field work in 1969 dealt with several different herbicides, and with rates applied on three different dates. The most promising and usable treatments are shown on the following page.

On June 27, the corn was about 2 to 3 feet tall. The milkweeds were still mostly on the ground, and were not climbing on the corn very much. On July 18, the corn was just before the tassel stage, and milkweeds were climbing up the corn to 5 or 6 feet, and were beginning to bloom. On August 8, the corn silks were dry, the milkweeds were all the way to the top of the corn, and were beginning to form seed pods.

Herbicide	Rate (lb./A.)	June 27	July 18	August 8
2,4-D	1/2	95	62	10
2,4-D	1	100	100	20
2,4,5-T	1/2	95	95	30
2,4,5-T	1	100	100	80
2,4-D + 2,4,5-T	1/4 + 1/4	98	92	60
2,4-D + 2,4,5-T	1/2 + 1/2	100	90	87
Check	...	0	0	0

Looking at our treatments from the standpoint of economy, ease of treatment, and effectiveness of control, the best overall treatment was 0.5 pound of 2,4-D applied on June 27. Note the decreasing control with a half pound of 2,4-D applied on July 18 and August 8. Thus, the time of application becomes very important in using 2,4-D. If treatments cannot be made at the early date, then higher rates of other herbicides should be used for best control.

SUMMARY

It is obvious from our experiments that climbing milkweed in corn can be controlled. The points to consider in a good control program are:

1. Obtain good control of other weeds with preemergence herbicides and/or cultivation, so that good spray coverage can be achieved.
2. If cultivation is used, wait at least 2 to 3 weeks before spraying for climbing milkweed, so that broken roots will sprout and the herbicide can be translocated into the root system.
3. Treat about the time the milkweeds are spreading on the ground and before any great number of them are climbing on the corn.
4. Always use a surfactant with water solutions of herbicides for best coverage and penetration.
5. Apply herbicides in enough volume and with a nozzle set-up to obtain good coverage of weeds.

STANDARDIZING SOIL-TEXTURE TERMS FOR HERBICIDE LABELS

J.D. Alexander

The nature of the soil is an important factor in the performance of most soil-applied herbicides. Soils high in organic-matter content and clay require higher application rates than those with low amounts of organic matter. The development and use of the soil organic-matter color chart, published a couple of years ago by the Agronomy Department, has helped both farmers and applicators. If the standard soil-texture terms already in circulation for many years were used on herbicide labels and recommendations, this would improve communication between manufacturers and users.

SOIL-TEXTURE TERMS

After looking at a number of herbicide labels, I believe there could be some improvement in the references to the use of soil-texture terms. Many of the current labels refer to "soil type." In soil classification a "soil type" name consists of a "soil type" name consists of a "soil series" name and the textural class of the surface, for example, Flanagan silt loam. A soil type refers to a complete soil profile, normally to a depth of 3 to 5 feet, with all its properties not just to the texture of the surface horizon alone. A more-appropriate term to use on herbicide labels would be "soil texture."

Soil texture, as defined in soil classification, has definite limits of particle size and amount. Essentially, a soil-texture class consists of different percentages of sand, silt, and clay each with definite size limits. For example, sand is 2 to 0.050 millimeters in size; silt, 0.050 to .002 millimeters; clay, less than 0.002 millimeters. Soil texture is based on the material less than 2 millimeters in size. The various percentages of sand, silt, and clay can be noted in the basic soil-texture diagram at the bottom of Figure 1.

I am suggesting a diagram similar to the one shown at the top of Figure 1 for use on herbicide labels, in order to more accurately assess organic matter and texture in relation to the rate of herbicide application. The soil-texture terms in common use in soil classification are grouped into three general classes clayey, loamy, and sandy (shown in Figure 1).

DETERMINING SOIL TEXTURE

Soil texture may be found in several ways. First, if a soil survey report exists, the texture may be noted from the soil type name or soil description. Second, if no soil survey report is available, a general soil map and report for a state, such as in Bulletin 725 *Soils of Illinois*, would be a good guide to textures in your area. Third, soil texture may be determined by rubbing moist soil between the thumb and forefinger. Guides to this procedure are given in Illinois Circular 758, *Understanding Soils*, and in similar publications from other states.

In summary, I am making a suggestion for wider use of standard soil-texture terms in connection with herbicide labels.

ORGANIC MATTER CONTENT ^{1/} (Ave. and Range)	5% (3½-7)			
	3½% (2½-4)			
	2½% (2-3)			
	2% (1½-2½)			
	1½% (1-2)			
		Clayey	Loamy	Sandy
		SOIL TEXTURE ^{2/}		

Rates and recommendations would be inserted in appropriate squares

^{1/} From "Chart for Estimating Organic Matter in Mineral Soils in Illinois," 1968, AG-1941, Univ. of Ill., Coll. of Agr., Coop. Ext. Service.

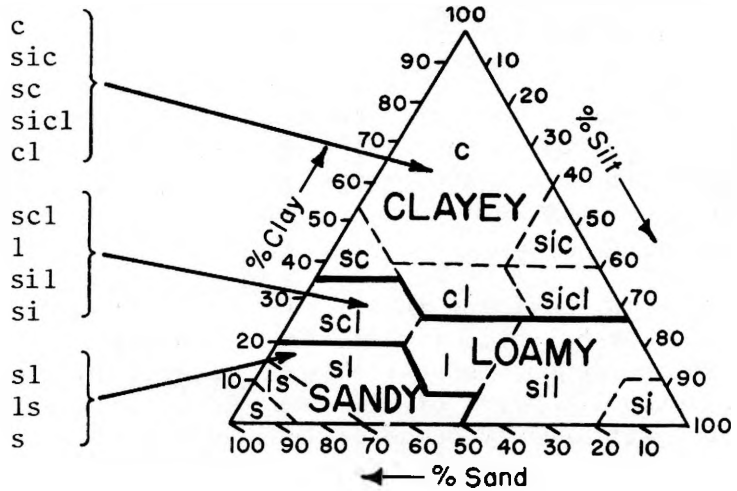
^{2/} Basic soil textural classes associated with the general soil texture groups shown above.

Abbreviations

- Clayey: Clay
- Silty clay
- Sandy clay
- Silty clay loam
- Clay loam

- Loamy: Sandy clay loam
- Loam
- Silt loam
- Silt

- Sandy: Sandy loam
- Loamy sand
- Sand



Basic Soil Texture Diagram

Figure 1.

LAWN WEBWORMS

Roscoe Randell

Lawn webworms rank with white grubs as one of the most serious insects in turf areas, such as parks, golf courses, and home lawns. The degree of damage varies from year to year. There were severe infestations in many areas of Illinois during 1965, 1968, and 1969. Although there are three to five species of webworms that feed on grass, the lawn webworm, *Crambus trisectus* is the most common and probably the most destructive one.

Lawn webworms live near the soil and are leaf feeders, not soil insects, as is sometimes believed. The larvae or worms clip off the grass blades just above the soil line. With moderate to severe infestations especially with drought conditions, brown irregularly shaped patches appear in the sod area. Sometimes the entire sod area is damaged. Well-watered and fertilized lawn areas will support up to six larvae per square foot, while nonirrigated, poorly fertilized lawns will exhibit damage with an average of two larvae per square foot.

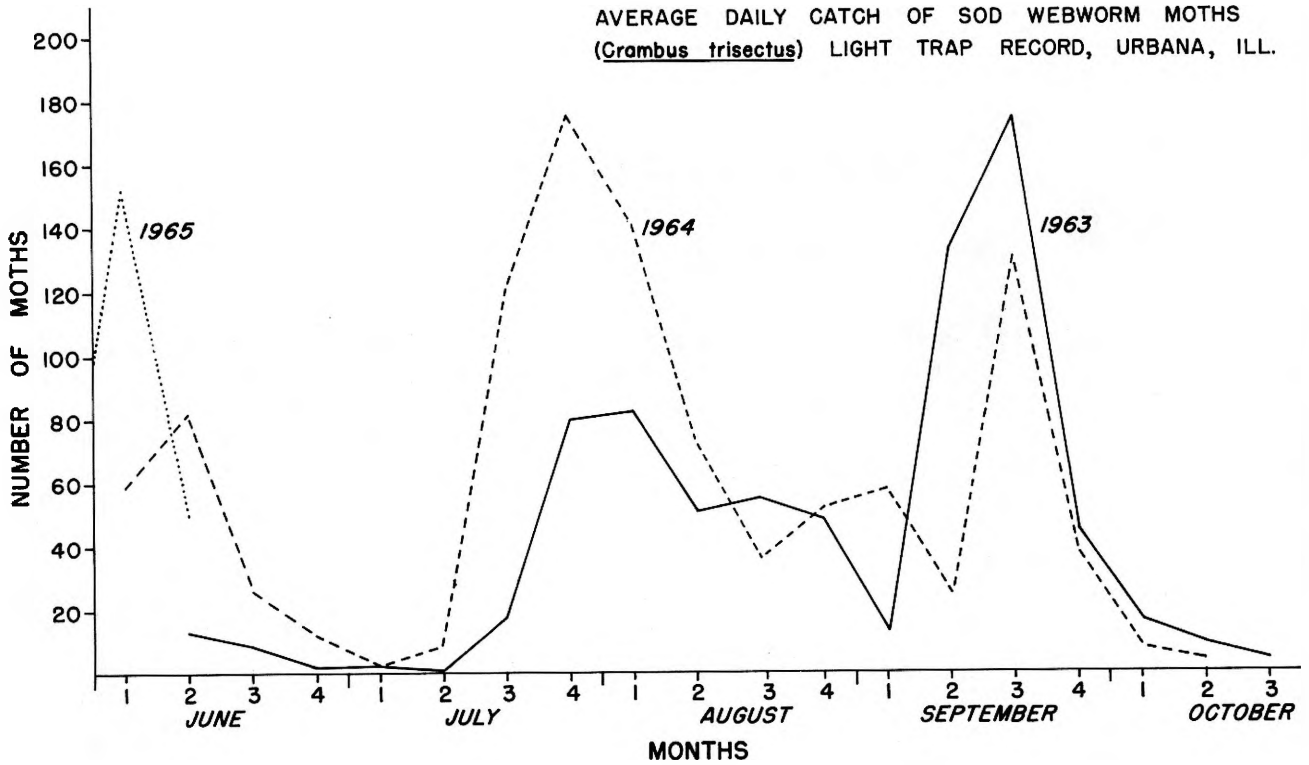
This insect passes the winter as a partly grown larva in a woven silken case on the soil surface of sod areas. Larvae of any size appear to overwinter successfully. The larva resumes feeding in the spring, grows rapidly, and pupates. It emerges as a moth in about 10 days. Peak moth emergence in central Illinois occurs during the first week in June. The female moth is buff-colored and appears almost white while in flight. It lays eggs individually at dusk, dropping them a few inches above the grass area. Egg-laying moths prefer lush-growing, grassy areas to lawns in poorer condition.

In a few days after egg hatch, the tiny worms begin to feed and build a silken case or tunnel. Full-grown larvae are about one inch long. They are grey to dusky-green in color with a dark-brown head and brown spots on the body. Second-generation moths emerge during late July and early August. Often there is a partial third generation (see graph of life cycles for 1963 and 1964).

Heavy moth flights at dusk, flying over the sod area in a zigzag pattern, are a good indication of a webworm infestation. Careful examination of the sod for feeding larvae in their silken tunnels and fresh grass clippings is the only positive means of detection. A good time to make an inspection for the possible presence of the larvae is about 10 days after a heavy moth flight, especially in brown spots in the lawn area.

Control of lawn webworms can vary throughout the growing season. A well-maintained lawn area will usually support infestations of first-generation webworm during mid-to-late June. Second-generation infestations are usually more severe. Damage from these larvae appear from mid-August until mid-to-late September. Chemical control is usually necessary at this time. The insecticides can be applied either as sprays or granules. If applied as a spray, use 100 to 200 gallons of water per acre, or 25 to 50 gallons for the average home lawn. Most damaged areas soon recover after treatment, especially if irrigated.

AVERAGE DAILY CATCH OF SOD WEBWORM MOTHS
(*Crambus trisectus*) LIGHT TRAP RECORD, URBANA, ILL.



Suggested chemicals for lawn webworm control and their rates are as follows:

Insecticide	Formulation	Rate per 1,000 square feet	Acre
Carbaryl (Sevin)	50% W.P.	1/2 lb.	16 lb.
	5% Granules	4 lb.	160 lb.
Diazinon (Spectracide)	25% E.C.	3/4 cup	4 gal.
	2% Granules	5 lb.	200 lb.
Trichlorfon (Dylox)	50% W.P.	4 oz.	10 lb.
	5% Granules	2-1/2 lb.	100 lb.

INSECTS AND STORED SOYBEANS

Steve Moore III

Infestations of red-horned grain beetles, hairy fungus beetles, black fungus beetles, and more recently a Tineid (relative of the clothes moth) will often develop in stored soybeans having excessive moisture (above 13 to 13.5 percent) and foreign material. These insects are attracted to the mold and decay on the beans and as such, are scavenger insects and not a primary pest of stored grains.

A RECENT CHANGE

Until recent years, there were few reports of insects attacking stored soybeans. However, several bins of properly stored soybeans were found to be infested with Indian meal moth in 1968 and 1969. In the larva or caterpillar stage, this insect moves several feet below the grain surface, feeding mainly on broken grain and foreign material. The mature larva crawls to or above the surface of the grain (on walls and ceiling) and spins a silken web. This webbing may cover the entire surface of the grain.

CONTROL

Control of this insect on stored soybeans must be accomplished by cultural means. There are no insecticides approved by the USDA for use on stored soybeans destined for processing. Therefore, to avoid Indian meal moth infestations, the storage bin should be cleaned inside and out to remove all the old grain and other debris. The walls, ceiling, and floor of the bin should be sprayed with premium-grade malathion, using 3 ounces of the 50- to 57-percent liquid concentrate per gallon of water. In addition, the soybeans should be clean (free of foreign material) and dry (12.5-percent moisture or less) before they are placed in storage.

MALATHION RESISTANCE REPORTED IN IOWA

In several cases reported from Iowa this year, premium-grade malathion treatments failed to control Indian meal moth. No known cases have occurred in Illinois. Stored-grain insects vary in their susceptibility to treatments of premium-grade malathion applied at the suggested rate of 10 p.p.m.

Granary weevils and flour beetles are effectively controlled for a year or more, but not the larvae of black carpet beetles. Indian meal-moth infestations are suppressed for nearly a year, but light infestations will generally appear after that time.

For best protection against the Indian meal moth, premium-grade malathion should be applied uniformly throughout the grain and also to the surface of the grain (capping). The surface treatment should be applied at the beginning of storage and each year thereafter.

Currently, there are no satisfactory substitutes for premium-grade malathion.

THE GROWTH AND DEVELOPMENT OF NUTSEdge

E. W. Stoller

Yellow nutsedge (*Cyperus esculentus* L.) is a weed that infests many crops. It reduces crop yields and increases production costs. Nutsedge infestation seems to be increasing in the Corn Belt.

DESCRIPTION

This plant belongs to the sedge, rather than grass, family. In sedges, the stem is triangular in cross-section. Yellow nutsedge leaves are light green. The seed heads are yellow to yellowish-brown.

Nutsedge reproduces both by seeds and tubers (nutlets). Seeds are very small, about 1 to 2 millimeters long. The tubers vary in shape, size, and color. They are usually spherical, about 1/4 to 1/2 inch in diameter, and are dark brown.

Both seeds and tubers offer a means for the propagation and spread of nutsedge. Although some seeds are viable, seedlings often lack the needed vigor. We believe that the plant propagates mainly by tubers.

GROWTH AND DEVELOPMENT

When a tuber germinates or sprouts, one or more slender rhizomes grow from buds at the apical end. As the rhizome nears the soil surface, it develops into a new plant with a crown, shoot, and roots. The crown is an important zone for the regeneration of new leaf, root, and rhizome growth. The new plant produces rhizomes. These terminate in either additional shoots or tubers. The new shoots also produce additional rhizomes. During long days, most rhizomes produce shoots, but when day-length is shortened, more of the rhizomes produce tubers.

Once established, prolific growth occurs. During one season in Minnesota, a plant from a single tuber produced 1,900 plants plus 6,900 tubers in a patch 6.5 feet in diameter. In Georgia, purple nutsedge (*C. rotundus* L.) produced 12 tons an acre of plant material underground, plus 3.3 tons per acre of foliage in one season.

Under field conditions, most of the tubers are produced in the top 6-inch layer of soil. However, significant numbers of tubers are produced at depths of up to 18 inches. All these tubers are potential sources of the subsequent propagation and spread of the plant. Tubers can produce new shoots when placed in the soil at depths of up to 12 inches. They can sprout and produce new shoots several times.

The growth and development characteristics of nutsedge indicate a potential opportunity for control during the early formation of the crown region of the plant. This region consistently develops at nearly uniform distances below the soil surface, regardless of the depth of the sprouted tubers. Herbicide placement in the zone of crown development could be an effective control practice.

RESEARCH ON NUTSEGE CONTROL

L.M. Wax

The use of herbicides for the control of annual weeds in corn and soybeans has increased markedly in recent years. The available herbicides and herbicide combinations control a broader spectrum of annual weeds than was possible a few years ago. In the absence of competition from annual weeds, certain perennial ones (often not controlled by available herbicides) appear to be increasing in importance in our corn and soybean fields. Yellow nutsedge *Cyperus esculentus* L.) is one such species now on the increase in Illinois. Yellow nutsedge most often infests localized wet areas in fields, but may also spread to surrounding areas. Sometimes it infests entire fields. This weed competes strongly for moisture and nutrients. If not controlled or suppressed, it will often reduce crop yields.

EARLY ACCOMPLISHMENTS

In early research, S-ethyl dipropylthiocarbamate (EPTC) suppressed nutsedge effectively--if incorporated into the soil at rates of 3 to 5 pounds per acre and at rates of 1 to 2 pounds per acre if placed in a thin layer some 1 to 3 inches beneath the surface of the soil. However, such treatments often injured corn, cotton, or soybeans too much if applied before planting or the emergence of the crop.

Later, scientists and engineers in Mississippi developed a technique for injecting the herbicide in subsurface bands or lines on each side of the drill row. This placement resulted in reduced control of nutsedge in the drill row but good control in the bands on each side of the row, greatly reducing injury to cotton.

RECENT STUDIES

Because of the apparent increase in the infestation of nutsedge, we have conducted studies in recent years to evaluate certain treatments for the control of nutsedge in corn and soybeans. Our greenhouse research indicates that incorporated treatments of butylate (S-ethyl diisobutylthiocarbamate), alachlor (2'-chloro-2, 6-diethyl-N-methoxy-methylacetanilide), and propachlor (2-chloro-N-isopropylacetanilide) are promising for the selective control of nutsedge in corn. Atrazine [2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine] was fairly effective, but somewhat less promising than butylate, alachlor, or propachlor. In field studies, these compounds provided some control of nutsedge; however, combination treatments were required to provide satisfactory control.

This is a report on the current status of research involving use of certain chemicals that require registration under the Federal Insecticide, Fungicide, and Rodenticide Act. It does not contain recommendations for the use of such chemicals, nor does it imply that the uses discussed have been registered. All uses of these chemicals must be registered by the appropriate State and Federal agencies before they can be recommended.

The best treatments in these studies were preplanting incorporated applications of either butylate at 4 pounds per acre or alachlor at 2 to 3 pounds per acre, followed by an early postemergence treatment of either atrazine at 2 pounds per acre plus 1 gallon per acre nonphytotoxic oil or 1 pound per acre of linuron plus 0.5 percent of v/v surfactant. Atrazine plus nonphytotoxic oil can be applied safely as an overall spray on young corn. Linuron plus surfactant, however, requires application as a basally directed spray because of its toxicity to corn.

More-recent work in laboratory and field studies indicates that nutsedge is susceptible to early, repeated applications of 2,4-D [(2,4-dichlorophenoxy) acetic acid]. Further work is now in progress to determine the rates of 2,4-D and the conditions for an optimum balance between effectiveness and crop tolerance.

CONTROLLING NUTSEGE IN SOYBEANS

We conducted one field experiment in 1969 to develop methods for controlling nutsedge in soybeans. We evaluated combinations of: (1) intensive tillage before planting to reduce nutsedge vigor; (2) herbicides applied as preplant-incorporated or preemergence treatments; (3) planting a high population of soybeans fairly late in narrow rows; and (4) cultivations after crop emergence. Butylate at 4 and 6 pounds per acre, EPTC at 3 and 5 pounds per acre, and vernolate (S-propyl dipropylthiocarbamate) at 3 and 5 pounds per acre were applied and incorporated one month before planting. Butylate at 4 pounds per acre and EPTC and vernolate at 3 pounds per acre were applied and incorporated just before planting. Alachlor (at 2.5 and 4 pounds per acre) and propachlor (at 5 and 8 pounds per acre) were applied and incorporated just before planting, or they were applied as preemergence treatments to the soil surface just after planting. Wayne soybeans were planted on June 1 in 30-inch rows. All plots were cultivated three times, after crop emergence. Rainfall was limited during the weeks immediately following planting.

The EPTC and butylate preplant-incorporated treatments produced good and fair control of nutsedge, respectively. Both caused severe initial injury to the beans. Vernolate controlled nutsedge almost as well as EPTC, and injured the soybeans less. With good growing conditions later in the season, the soybeans apparently recovered from the early injury caused by all three of these herbicides.

Preplant-incorporated treatments of alachlor and propachlor controlled nutsedge satisfactorily with little injury to soybeans, even at higher-than-normal rates. By contrast, the preemergence applications of these two compounds failed to control nutsedge, probably because of inadequate rainfall.

COMMENTS

We believe this system, which combines intensive preplanting tillage with a herbicide treatment, postplanting cultivation, and the excellent shading ability of soybeans, is one of the most-promising methods for controlling nutsedge in soybeans here in Illinois. We intend to evaluate this system in the future, to obtain data on control and yields covering several different soil types and environmental conditions.

NEW ASPECTS OF ALFALFA WEEVIL CONTROL

E.J. Armbrust

The alfalfa weevil continues to be our most-destructive insect pest on forage crops. This weevil was first discovered in the United States in 1904, near Salt Lake City, Utah, where it was probably introduced from Europe. After a study of the climatic limitations of the weevil in Europe, several workers predicted that the distribution of the weevil would be limited to the Rocky Mountain States and those west of the Rockies. This was the case for nearly fifty years. In 1952, however, an eastern strain of the weevil was discovered in Maryland. It spread rapidly to the north and south. In 1964, it was found for the first time in southern Illinois.

PATTERN OF REPRODUCTION AND GROWTH

During the fall months and on warm days throughout the winter, the females lay clusters of oval-shaped eggs within the alfalfa stem. The eggs darken with age. In warm weather, the eggs hatch in 1 to 2 weeks. In cool weather, egg-hatch is delayed and the eggs accumulate in the fields until temperatures are favorable for hatching. This accumulation of eggs accounts for the sudden increase in the number of larvae and for the almost-complete destruction of first-crop alfalfa in a matter of days. For this reason, growers should make frequent checks in all of their fields.

The newly-hatched larvae are about 1/20 of an inch long and are yellow in color, except for a black head. They begin their feeding in the growing tip of the alfalfa plant. The tip must be peeled apart in order to see the larvae, because the newly-hatched ones are not often picked up with a sweep net.

Larvae feed for 3 to 4 weeks. When fully grown, they are about 3/8 of an inch long, green in color, and have a white stripe down the middle of their backs. Larval feeding results in extremely heavy damage to the first crop. As soon as the larvae have consumed the growing tips, they begin to feed on the lower foliage, skeletonizing the leaves. Damaged leaves dry rapidly, and the field takes on a frosted appearance. In time, there is nothing left but dried stems.

After the larvae finish feeding, they spin delicate net-like cocoons on the plants, within the curl of fallen dead leaves, or in other litter on the ground. The pupal stage lasts for 1 to 2 weeks, after which the new adults emerge--from late May to the middle of June.

The adults are snout beetles about 3/16 of an inch long. They are brown in color and have a broad, dark stripe extending down their backs from the front of their heads over more than half the length of their bodies.

As the adults age, they become almost uniform in color. Most of the adults migrate from the alfalfa soon after emergence and remain in a resting stage during the summer in protected wooded areas, fence rows, and ditch banks surrounding the fields.

They return to the alfalfa during the fall, mate, and begin egg-laying. It is at this time that fall-seeded alfalfa becomes severely infested. The adults are weak fliers. During these migratory periods, they are carried great distances by the wind.

ADULT CONTROL PROGRAMS

Insecticide treatments applied during the fall or early spring for the control of adult alfalfa weevils were effective in reducing this population to the point of eliminating the first larval spray normally applied to first-crop alfalfa. Reinfestation of a field by migrating adults during the spring accounts for additional egg-laying and larval development during that period.

INTEGRATED CONTROL

A large buildup of the alfalfa weevil parasite *Bathyplectes curculionis* (Thomson) occurred in the Lawrenceville, Illinois/Vincennes, Indiana area during 1968 and 1969. The parasite had dispersed into the area with the weevil, since the nearest colonization point for its release was located more than 100 miles from Vincennes. It is significant that this buildup occurred in an area where intensive control programs using two to three treatments of methyl parathion were being applied for alfalfa weevil control. Data on the timing of chemical controls over a wide area (blocks of 200 to 500 acres) show that, properly timed, the use of chemicals appears to be compatible with the insect. It is evident that this parasite will be an important factor to consider in the management of the alfalfa weevil.

It would be premature to predicate the results of this research until data from additional seasons have been accumulated. Nevertheless, certain trends in the data are noteworthy.

Alfalfa weevil populations were significantly depressed by *B. curculionis*. The initial parasites for this control would have had to survive the intensive spraying with methyl parathion in 1967. Weevil populations were so low in 1968 that only one chemical spray was required to protect the alfalfa crop, in contrast with the customary two to three sprays needed in previous seasons.

Our data show that chemical sprays were still necessary for economic control of the weevil, but that the timing of sprays could be very important in their effect on parasite buildup. Properly timed, the use of chemicals appears to be compatible with the parasite. We cannot expect *B. curculionis* to eliminate the alfalfa weevil problem, but it is evident that it will become an important factor to consider in the management of this pest.

YELLOW LEAF BLIGHT AND EYESPOT TWO NEW DISEASES OF CORN IN ILLINOIS

A.L. Hooker

Two new diseases of corn, yellow leaf blight and eyespot, became prevalent over the northern third of Illinois in 1968 and 1969. Yellow leaf blight is the more-widespread one. It has been reported from Iowa to New York. In Illinois, yellow leaf blight has been found in the northern two-thirds of the state, while eyespot has been confined mostly to counties near the Wisconsin border.

CAUSAL AGENTS AND RELATED CONDITIONS

Yellow leaf blight is caused by a pycnidial-producing fungus in the genus *Phyllosticta*. The fungus causes the formation of oval-to-elliptical spots on the leaf. The spots are tan-to-cream colored. On many plants, they are surrounded by yellowish areas. Hence, the common name, yellow leaf blight.

Complete blighting of leaves can occur. The fungus reproduces in leaf spots by producing pycnidia--dark, speck-sized fruiting bodies containing thousands of spores. These spores are released during wet weather and serve to spread the fungus from plant to plant.

Yellow leaf blight can appear on seedling corn planted in fields containing infected corn refuse from the year before. Hot, dry weather in the summer checks the disease. But if conditions are cool and wet in August and September, the fungus spreads to the upper foliage as well as to adjacent fields. Extensive leaf blighting occurs, followed by stalk rot. In some Wisconsin fields, yield losses of 30 to 50 percent have occurred.

Eyespot is caused by the fungus *Kabatiella zaeae*. The infection of this fungus is characterized by many small, 1/8-inch diameter, oval-to-round spots on the leaf. A brown-to-purple border surrounds the tan-to-cream-colored centers. Thus, the common name, eyespot. Eyespot seems to develop best during late August and in September. The fungus produces many spores. These can be spread rapidly and for some distance by the wind. Fields may be killed by this disease within a short time.

CONTROL MEASURES

Both diseases are associated with crop debris. Thus, crop rotation combined with clean plowing are the recommended control measures. Cultural practices that stimulate vigorous growth should help reduce yield losses.

A weekly spray program with Dithane M-45 effectively controlled eyespot in Wisconsin trials. However, the yield advantage achieved was not great. In corn, Dithane M-45 has been cleared for use only on seed fields. Genetic resistance to both diseases is known. The resistance of inbreds and hybrids to yellow leaf blight, however, is lost to a considerable extent when the plants carry Texas male-sterile cytoplasm.

INSECT SITUATION—1970

Steve Moore III, Roscoe Randell, and D.E. Kublman

HIGHLIGHTS

Field-crop insect problems differed in 1969 from those of last year. In 1968, corn leaf aphid, resistant corn rootworms, and alfalfa weevil were the major crop insects--along with green cloverworms on soybeans. There was a decrease in alfalfa weevil activity this past season, fewer corn rootworm larvae, and a very minor corn leaf aphid problem. Both true-armyworm and fall-armyworm populations in corn were well above normal. European corn-borer populations, although not as severe as predicted, were there in moderate numbers.

Insecticide usage on field crops continued to increase. Approximately 7,876,823 acres were treated, with an estimated saving to farmers of \$36,413,387 over and above treatment costs (Table 1). The total acreage of field crops treated increased about 760 acres over the 1968 figure. Those portions treated by commercial air or ground applicators or by individual farm operators are given in Tables 2 and 3.

County Extension advisers in agriculture provided the data for the above figures, and for those in the Tables 1 through 4. Each adviser received an average of 702 inquiries concerning insect pests, of which 492 pertained to agricultural insects and 210 to home and garden insects. The following twenty insects were listed by Extension advisers, in the order of decreasing interest:

- | | |
|------------------------|-----------------------|
| 1. Corn rootworms | 11. Corn leaf aphid |
| 2. European corn borer | 12. Bagworm |
| 3. Armyworm | 13. Sod webworm |
| 4. Grasshoppers | 14. Black cutworm |
| 5. Alfalfa weevil | 15. Garden insects |
| 6. Corn seed beetle | 16. Mosquitoes |
| 7. Fall armyworm | 17. Household insects |
| 8. Flies | 18. Ants |
| 9. Spiders | 19. Flea beetle |
| 10. Termites | 20. Roaches |

CORN INSECTS

Corn soil insects. The major area of insect control continues to be that of corn soil insects. Approximately 66.2 percent of the total corn acreage was treated with an insecticide--saving farmers \$34,772,706 over and above treatment costs. In 1969, chlorinated hydrocarbon insecticides (aldrin and heptachlor) were used on estimated 4,517,931 acres; organic phosphate and carbamates, on 1,990,138 acres (Table 4).

Resistant western and northern corn rootworm. These populations were lower in 1969 than in previous years. The newly hatched worms may have drowned when

Table 1. Acres of Field Crops Treated with Insecticides and Estimated Profit from Treatments, Illinois, 1969

Crop and insect	Acres treated	Estimated profit ^{a/}
<i>CORN</i>		
Armyworms	492,035	\$ 738,053
Corn flea beetle	9,681	48,405
Corn rootworm adults	52,028	208,112
Corn leaf aphid	19,958	99,790
Cutworms	12,927	77,562
European corn borer	195,515	488,788
Grasshoppers	66,386	66,386
Soil insects	6,508,067	32,540,335
Fall armyworms	202,110	505,275
TOTAL	7,558,707	34,772,706
<i>SOYBEANS</i>		
Grasshopper	61,066	183,193
<i>WHEAT</i>		
Armyworms	33,354	133,416
<i>CLOVER AND ALFALFA</i>		
Alfalfa webworm	1,731	10,386
Alfalfa weevil	46,129	184,516
Clover leaf weevil	1,193	1,789
Grasshoppers	71,612	107,418
Meadow spittlebug	1,954	2,931
Pea aphid	3,331	6,662
Potato leafhopper	9,327	18,654
Variegated cutworm	3,541	7,082
TOTAL	138,818	339,438
<i>FENCE ROWS, DITCH BANKS, ROADSIDES, RESERVE ACREAGE, ETC.</i>		
Grasshoppers	65,542	196,626
Armyworms	19,336	58,008
TOTAL	84,878	254,634
1968 total	7,115,207	34,434,233
1969 total	7,876,823	36,413,387

^{a/} Over and above treatment costs.

Table 2. Percent of Total Field Crops Treated by Commercial and Private Applicators in Illinois, 1958 Through 1969

Year	Percent of total acreage treated		
	Airplane application	Ground application	
		Commercial	Individual
1958	3.0	19.5	77.5 ^{a/}
1959	2.6	14.5	82.9
1960	5.6	11.9	82.5
1961	7.4	12.0	80.6
1962	9.9	12.3	77.8
1963	9.2	18.8	72.0
1964	10.1	8.4	81.5
1965	4.9	10.4	84.3
1966	5.8	13.8	80.4
1967	5.5	14.7	79.8
1968	7.1	13.4	79.5
1969	5.3	15.2	79.5

a/ First year in which soil insecticides were included in these calculations.

Table 3. Number of Acres Treated, by Method, for Certain Insects in Illinois, 1969

Insect	Acres treated		
	Airplane application	Ground application	
		Commercial	Individual
Clover & alfalfa treatment	15,110	15,305	33,171
Corn soil treatment	192,534	921,662	5,039,788
European corn borer	122,518	34,385	21,249
Corn leaf aphids	10,684	4,631	4,643
TOTAL	340,846	975,983	5,098,851

Table 4. Number of Corn Acres Treated With Different Types of Soil Insecticides, 1963 Through 1969

Year	Chlorinated hydrocarbons	Organic phosphates and carbamates
1963	...	...
1964	4,009,303	81,822
1965	4,544,432	189,352
1966	5,116,605	326,592
1967	5,601,572	602,721
1968	5,170,726	1,091,143
1969	4,517,931	1,990,138

Table 5. First- and Second-Generation Corn Borer Populations^{a/}

	July 1964	Oct. 1964	July 1965	Oct. 1965	July 1966	Oct. 1966	July 1967	Oct. 1967	July 1968	Oct. 1968	July 1969	Oct. 1969
<i>Northwest</i>												
*Ogle	11	96	0	18	3	58	13	52	0	100	8	85
*Whiteside	6	306	1	69	5	167	22	26	3	177	0	42
Bureau	5	179	3	74	9	129	17	113	1	150	6	198
*Mercer	28	275	9	49	30	109	16	76	3	217	4	331
Average	12	214	3	53	12	116	17	67	2	161	5	164
<i>Northeast</i>												
*Boone	9	34	3	11	6	66	16	12	0	156	24	48
*DeKalb	0	132	0	31	1	21	1	13	1	113	5	73
LaSalle	7	190	0	46	2	88	4	87	5	304	5	97
Average	5	119	1	29	3	58	7	37	2	191	11	73
<i>East</i>												
*Kankakee	4	79	1	28	0	56	1	41	1	94	0	66
*Iroquois	2	191	2	61	0	42	2	21	1	321	1	69
Livingston	10	163	1	32	0	84	13	65	5	540	2	140
*Champaign	1	9	0	10	0	8	0	7	0	80	0	12
Average	4	109	1	33	0	48	4	34	2	259	1	72
<i>Central</i>												
*McLean	3	43	0	45	6	103	4	82	0	267	1	46
Logan	1	17	0	10	3	28	1	30	0	41	0	13
Average	2	30	0	28	5	66	3	56	0	154	1	30
<i>West</i>												
*Knox	8	56	3	45	4	232	14	136	11	158	11	183
*McDonough	4	123	11	98	2	153	9	93	7	191	2	199
Average	6	90	7	72	3	193	12	115	9	246	7	191
<i>West-Southwest</i>												
Christian	1	15	0	23	1	15	2	74	0	158	0	44
Sangamon	2	12	0	8	0	15	0	16	0	84	2	7
Macoupin	1	120	2	73	9	84	2	53	3	177	0	339
Greene	1	78	4	81	11	167	14	147	7	236	2	311
Average	1	57	2	46	5	70	5	73	3	164	1	175
Overall average	5	111	2	43	5	86	8	60	3	195	4	121

a/ Asterisks indicate an 11-county comparison (see Table 6).

water stood in the corn rows for several days during peak egg-hatch in June and early July. Also, insecticides for the control of resistant rootworms were more widely used in 1969 (1,990,138) than in 1968 (1,091,143). They killed about 90 percent of the worms in 1969, compared to 65 percent in 1968,

Since the adult beetles (adult populations about 50 percent lower in 1969) deposit eggs for the following year's crop of rootworm larvae, it is possible that our 1970 rootworm damage will be much less severe than in previous years. However, farmers who have experienced rootworm damage in the past should continue their rootworm insecticide program.

Western corn rootworms. These insects were probably present in the area north of a line from Pittsfield to Champaign in 1969. In 1970, damage is most likely to occur north and west of a line from Carthage to Bloomington to LaSalle to Joliet (Figure 1). In late August and September, western corn-rootworm beetles will seek fields in fresh silk where they feed and lay their eggs. Thus, the fields most likely to be damaged by western corn rootworms in 1970 could be those in which there was a late, 1969 corn crop. Furthermore, damage is more common during the second year corn.

Farmers who have experienced damage from western corn rootworms on their farm should, by all means, treat fields fitting this description.

Northern corn rootworm. These populations are higher in the northern half of Illinois (north of Highway 36 that runs through Pittsfield, Springfield, and Decatur) than in the southern half. However, damage has occurred in the southern half of Illinois in bottom land and other areas where corn is grown for several years continuously.

Third-year or more corn is most likely to be damaged. This rootworm population usually reaches its peak in the sixth or seventh year of continuous corn. Although this rootworm is usually a problem in continuous corn, second-year corn will be damaged occasionally.

Seed-corn beetles. They hollow out the seeds and cut sprouts. Seed-corn maggots just hollow out the seeds. Both are resistant to aldrin, heptachlor, dieldrin, lindane, and probably chlordane. Although seed-corn beetles were extremely abundant in 1969, damage from them was not as great as in 1968. A few fields were severely damaged in 1969 and required replanting, several fields were borderline, the stand in many fields was reduced, but the majority of fields were unaffected.

Seed-corn beetles and seed-corn maggots will still be present in 1970. If germination is rapid, damage will be light. If germination is slow, damage will be greater.

Garden symphylans. These were moderately abundant in most corn fields, at least in the northern half of the state. Timely rains allowed plants to overcome the damage caused by this pest. Fields where there was a problem in 1969 should be treated in 1970 with the insecticide Dyfonate, if corn is to be grown.

Black cutworm. Damage from this pest was light for the third consecutive year. An estimated 25,593 acres of corn were replanted because of cutworm injury. Black cutworms can not be discounted as a potential problem for 1970. The

moths migrate from states to the south of us into Illinois each spring. It is impossible to forecast more than a week or two in advance how severe the problem will be.

A wet, cool spring is most favorable for cutworm development. Some damage occurs somewhere in Illinois each year. Farmers should check young corn in the low, wet spots or poorly drained areas in fields, watching for cut or missing plants as a sign of cutworm damage.

The trend towards early planting may increase the severity of cutworm damage. The more mature the corn (earlier plantings) when cutworms strike, the lower the chance of plant recovery and the more serious the loss in stand.

European corn borer. First-generation populations were damaging in occasional fields of early planted corn, but populations were low in general. However, a few first-generation borers were present in almost every field of early-to-medium planted corn.

Conditions in late July and August were favorable for second-generation moth development, egg-laying, and the survival of second-generation larvae (Tables 5 and 6). As a result, the 1969 overwintering corn-borer population (although somewhat lower than in 1968), still reached a state average of 170 borers per 100 stalks of corn (Table 7).

The incidence of infection by disease organisms among overwintering borers is much higher than last year. If corn borers are subjected to extremes in temperature (heat or cold) most of the diseased borers will die from the added stress. This would reduce problems for 1970. On the other hand, with favorable weather for borer survival, the overwintering populations are high enough in many areas (Figure 2) to still present a potential problem to early planted corn in 1970.

Corn leaf aphid. Populations were low in 1969, and only occasional fields became heavily infected. One notion is that fewer winged adults migrated into the state to start colonies. By the time aphids were starting to increase in number, much of the corn had developed beyond the stage (late-whorl to early tassel) suitable for aphid development and survival. It is impossible to predict problems with corn leaf aphids more than a week or two in advance.

Corn flea beetles. This insect was less damaging in 1969 than in 1968. An estimated 9,681 acres were treated. Corn fields with grassy borders are the ones most likely to be infested, especially in the southern half of the state.

Common stalk borers. These were more numerous in 1969 than in previous years. The young worms start their development in hollow stem weeds and grasses along the edges of fields. Then, they move into larger-stemmed plants--such as corn. Therefore, most infestations are along the border rows in corn fields.

Damage from stalk borers will often occur elsewhere in corn fields if grasses and weeds are left to grow. Minimum-tillage corn fields were often moderately to severely damaged by common stalk borers this year when the grasses or weeds were left between the rows. By the time the damage is noticed, the worms are usually deep in the whorl and it is too late for effective insecticide treatments.

The common stalk borer moths emerge in late August and early September, depositing their eggs on grasses and weeds. The eggs overwinter and hatch-out the following

May. The worms become full-grown in late July and early August. Keeping weeds and grasses cut in August along the edges of the fields will help prevent problems during the following year.

True armyworms. Abundant and damaging, this pest hit grassy corn fields--particularly those in northwestern and western Illinois. 1969 was a record year for this problem in Illinois. Approximately 492,035 acres were treated for control. The wet but relatively cool weather in June and early July provided conditions favorable for moth flights, egg-laying, and worm survival. These were the second-generation armyworms, many of which originated from wheat fields in the south-central and southern sections of the state.

Southwestern corn borers. These were found for the first time in Perry, Franklin, Hamilton, White, Jackson, and Williamson counties. This insect is now present in fifteen counties in the extreme southern section (Figure 3). Damage in late-planted corn was light to severe in the southern two tiers of counties during 1969.

The severity of the problem in 1970 will depend on how well the borers survive the winter. This pest appears to be gradually adapting to Illinois conditions, and we can expect a slow but continual movement northward--with increased problems in future years.

Table 6. Average First- and Second-Generation Corn Borer Populations (11-County Comparison)^{1/}

Year	First generation	Second generation
1959	5	109
1960	9	117
1961	3	82
1962	10	139
1963	14	126
1964	7	122
1965	3	42
1966	5	92
1967	9	51
1968	3	183
1969	5	105

^{1/} Starred counties, Table 5.

SOYBEAN INSECTS

Grasshoppers. They were more abundant in 1969 than in 1968. Damage to marginal rows of soybeans was common in some areas. In occasional fields, grasshoppers are expected to present some problems in 1970 in the western, southwestern, and southern sections where fall adult counts indicated a light to threatening condition (Figure 4). Hot, dry weather during the major period of egg-hatch in June favors the survival of young hoppers.

Table 7. Corn Borer Fall Population Surveys in 36 Counties, 1959 Through 1969
(County Averages Expressed in Borers Per 100 Stalks of Corn)

	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
<i>Northwest</i>											
Jo Daviess	114	68	46	98	70	146	17	69	39	295	112
Winnebago	83	131	51	114	214	93	28	54	34	213	71
Ogle	211	125	49	95	121	96	18	58	52	100	85
Whiteside	184	76	131	29	178	306	69	167	26	177	42
Bureau	208	36	97	135	370	179	74	129	113	150	198
Mercer	100	132	111	428	287	275	49	109	76	217	331
Average	150	95	81	150	207	183	43	98	57	192	139
<i>Northeast</i>											
Boone	64	75	47	70	88	34	11	66	12	156	48
Lake	39	24	12	13	15	59	10	33	11	158	65
DeKalb	200	57	126	81	160	132	31	21	13	113	73
DuPage	59	65	34	53	58	45	11	33	30	70	71
Will	75	92	76	101	119	78	16	38	37	87	99
LaSalle	120	55	127	66	258	163	46	88	87	304	97
Average	93	61	70	64	116	90	21	47	32	148	75
<i>East</i>											
Kankakee	107	59	133	152	52	79	28	56	41	94	66
Iroquois	61	122	109	198	85	191	61	42	21	321	69
Livingston	85	129	59	81	83	163	32	84	65	540	140
Vermilion	11	41	14	42	14	11	17	16	11	195	92
Champaign	3	13	5	10	14	9	10	8	7	80	12
Average	53	73	64	97	50	91	30	41	29	246	76
<i>Central</i>											
Peoria	53	160	121	237	110	106	66	708	191	285	267
Woodford	121	205	122	131	210	154	81	493	125	288	64
McLean	118	247	49	88	65	43	45	103	82	267	46
Logan	12	54	18	23	47	30	10	28	30	41	13
Macon	28	29	12	23	14	17	6	5	23	52	28
Average	66	139	64	100	89	70	42	267	90	187	84
<i>West</i>											
Henderson	87	136	117	174	150	223	106	285	115	287	367
Knox	108	135	53	190	194	56	45	232	136	300	183
Hancock	64	278	35	142	206	102	89	171	109	99	205
McDonough	65	193	48	192	144	123	98	153	93	191	199
Adams	175	207	62	129	118	179	73	502	98	169	269
Brown-Cass	109	91	41	67	88	117	84	148	58	349	184
Average	101	173	59	149	150	133	83	249	102	233	235
<i>West-Southwest</i>											
Sangamon	14	90	13	20	10	12	8	15	16	84	7
Christian	36	114	21	24	15	15	23	15	74	158	44
Madison	33	111	77	150	56	30	126	90	107	425	447
Average	28	105	37	65	27	19	52	40	66	222	166
<i>Southwest</i>											
St. Clair	9	38	13	89	108	46	98	96	110	357	444
Average	9	38	13	89	108	46	98	96	110	357	444
<i>East-Southeast</i>											
Moultrie	9	29	6	30	23	4	13	22	66	172	54
Clark	27	20	12	20	21	16	151	74	8	189	207
Jasper	16	49	53	102	25	24	40	44	59	196	118
Lawrence	29	41	8	44	22	28	62	48	15	199	172
Average	20	35	20	49	23	18	67	47	37	189	138
AVERAGE, ABOVE 36 COUNTIES.	79	98	59	101	106	95	49	120	61	205	139
AVERAGE, ALL COUNTIES SURVEYED.	74	101	56	99	98	100	57	112	57	211	170

Green cloverworms. They were much less numerous in 1969 than in 1968.

Japanese beetle. This is a quarantinable insect, first found in Illinois in 1953 is still present in a number of counties (Figure 5). In some of these counties, eradication programs are being conducted by federal and state agencies. In other counties, only suppression programs or limited controls are being employed.

SMALL GRAIN INSECTS

True armyworm. Populations were generally low in wheat fields. Only occasional fields needed treatment. An estimated 33,354 acres were treated for control in 1969. True armyworms survive best in a wet, cool spring, but it is impossible to predict the severity of the infestation. This armyworm generally does not overwinter successfully in Illinois, but migrates on the prevailing south and southwest winds in the spring.

Cereal leaf beetles. These were found for the first time in Douglas, Clark, Ford, and McLean counties during 1969 (Figure 6). The cereal leaf beetle has now been identified in seventeen counties. Crop damage from this beetle is not expected within Illinois during 1970. Parts or all of the infested counties have been placed under a federal quarantine. Surveys will be conducted by regulatory officials in 1970 to detect the spread of this insect.

Hessian fly. Populations remained low in 1969. The fall survey indicated an average of 2 flaxseeds per 100 tiller, which is about the same as in the fall of 1968 (Table 8). The average number of flaxseeds per 100 tillers is given for the counties surveyed in August in Figure 7.

CLOVER AND ALFALFA INSECTS

Alfalfa weevil. This insect caused light-to-moderate damage to alfalfa in the southern half of the state in 1969. An estimated 46,129 acres of alfalfa were treated. Weevil development was slow, and damaging levels came late (as in 1968). Wasp parasites of the weevil became numerous and helped check weevil populations, requiring less insecticides for control.

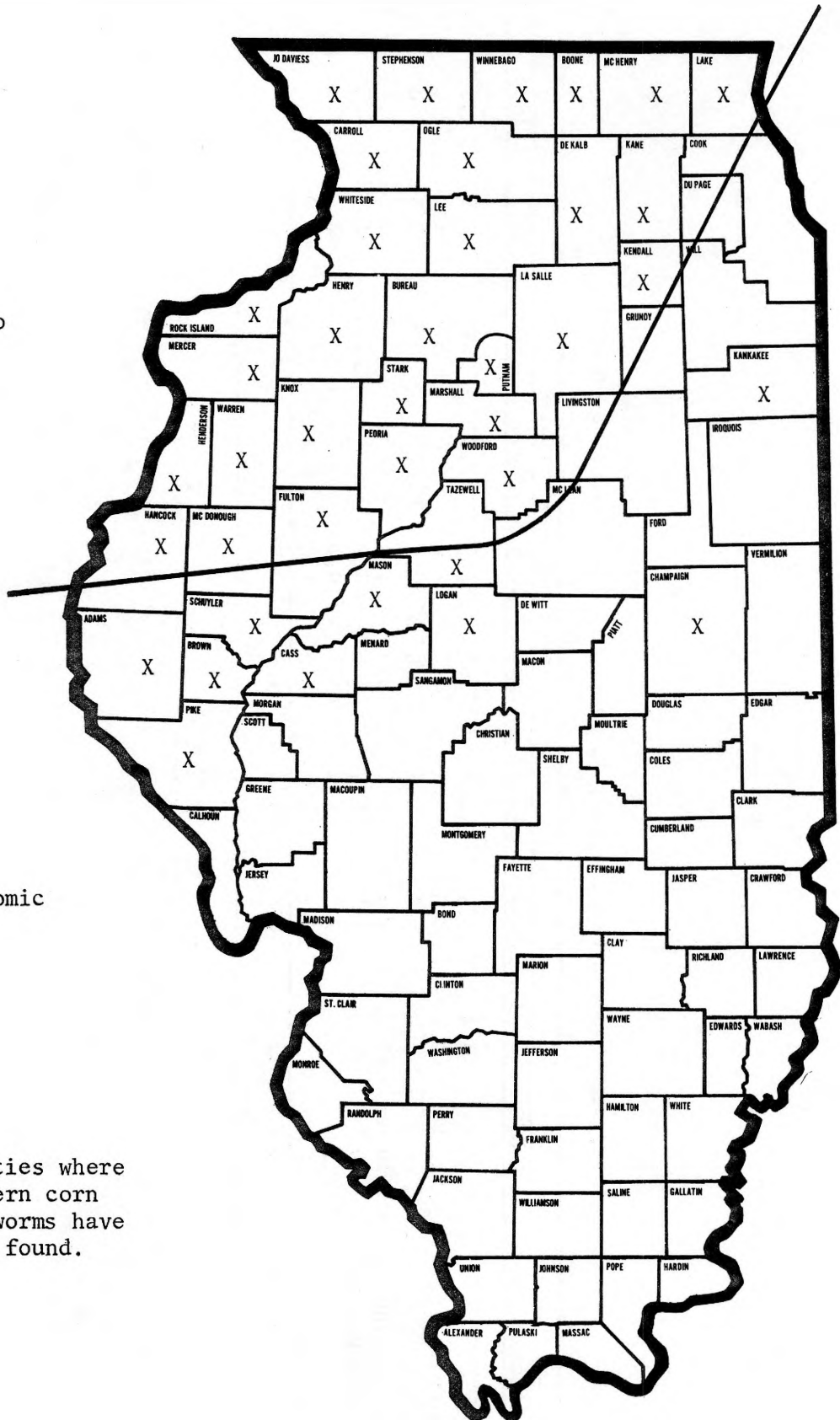
In 1970, we can expect moderate-to-severe damage south of a line from Watseka to Hardin, and light-to-moderate damage in the area south of a line from Aurora to Carthage and north of a line from Watseka to Hardin (Figure 8).

Meadow spittlebugs. Populations were generally low in 1969, and treatments were seldom needed. The results of the adult survey conducted in late August (Figure 9) indicated a low population. Damage in 1970 should be noneconomic.

Table 8. Hessian Fly Populations, by Sections, July 1959 Through 1969

Section	Flaxseeds per 100 tillers										
	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
West	8.0	4.4	1.5	10.8	7.5	2.2	2.0	7.2	2.5	1.0	1.0
Central	20.8	4.7	2.0	3.3	4.0	1.6	0.0	2.1	1.0	0.0	1.0
East	0.8	6.9	1.5	5.2	3.0	0.0	2.0	0.0	0.5	0.0	0.0
West-southwest	16.4	18.0	21.2	24.1	10.5	1.9	1.1	15.9	3.7	0.18	1.0
East-southeast	10.0	10.0	3.8	12.4	2.5	4.2	0.4	25.6	4.2	4.3	3.0
Southwest	5.4	10.7	7.7	11.9	1.2	10.1	3.7	8.8	2.8	4.2	3.0
Southeast	6.2	15.7	33.6	10.9	3.0	1.0	0.8	22.6	13.0	2.0	2.0
State average	9.2	11.4	8.0	11.2	4.8	3.4	1.5	14.4	5.3	1.9	2.0

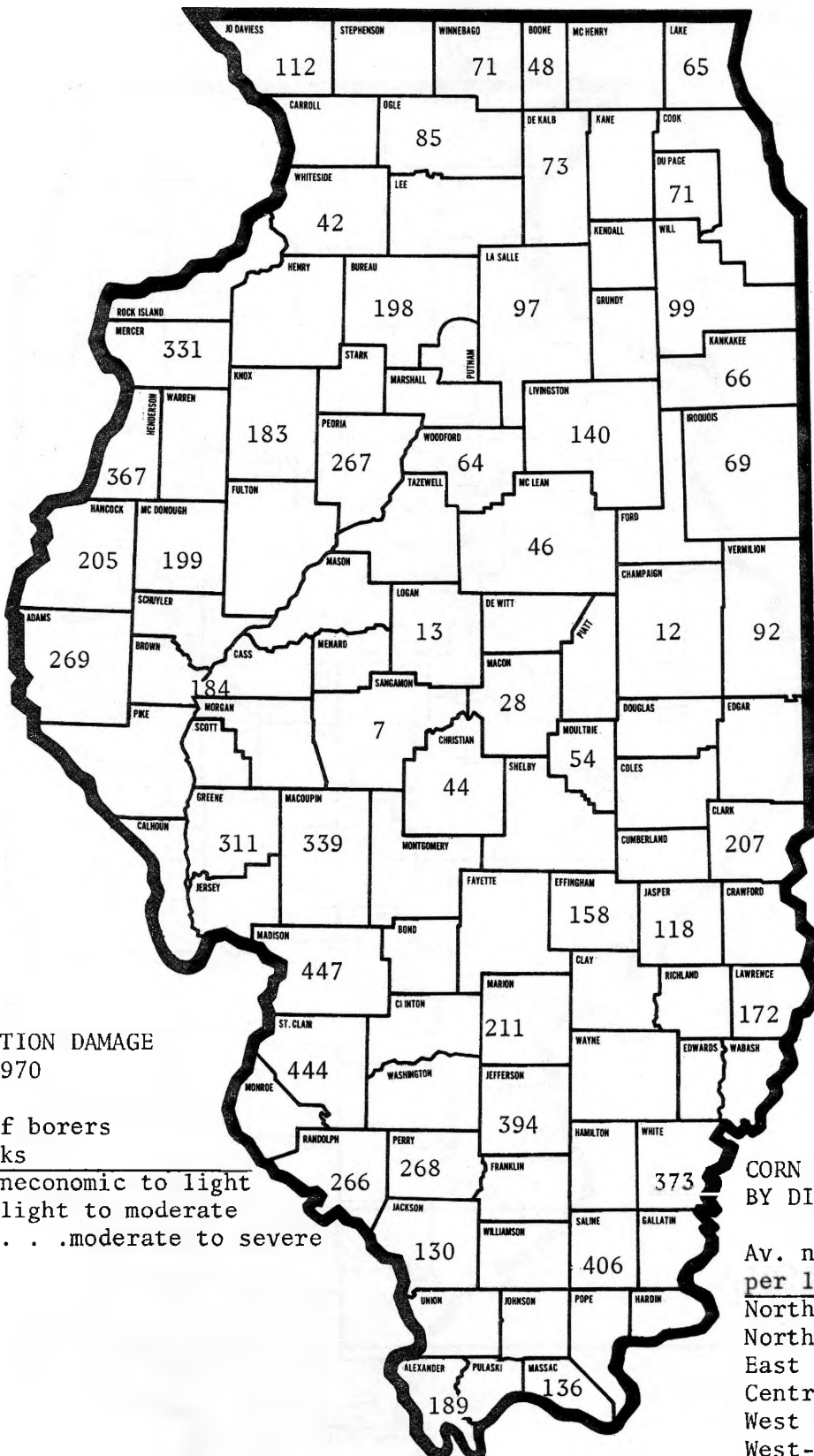
Light to
severe



Noneconomic

X Counties where
western corn
rootworms have
been found.

Figure 1. Western Corn Rootworm Prospects for 1970.



FIRST-GENERATION DAMAGE
POTENTIAL, 1970

Av. number of borers
per 100 stalks
 0-100. . .noneconomic to light
 100-250. . .light to moderate
 250 and over. . .moderate to severe

CORN BORER POPULATIONS,
BY DISTRICT, FALL, 1969

Av. number of borers
per 100 stalks
 Northwest. . . .139
 Northeast. . . . 75
 East 76
 Central. 84
 West 235
 West-southwest .166
 East-southeast .138

AVERAGE NUMBER OF BORERS PER 100 STALKS OF CORN 75

Figure 2. European Corn Borer Prospects, 1970

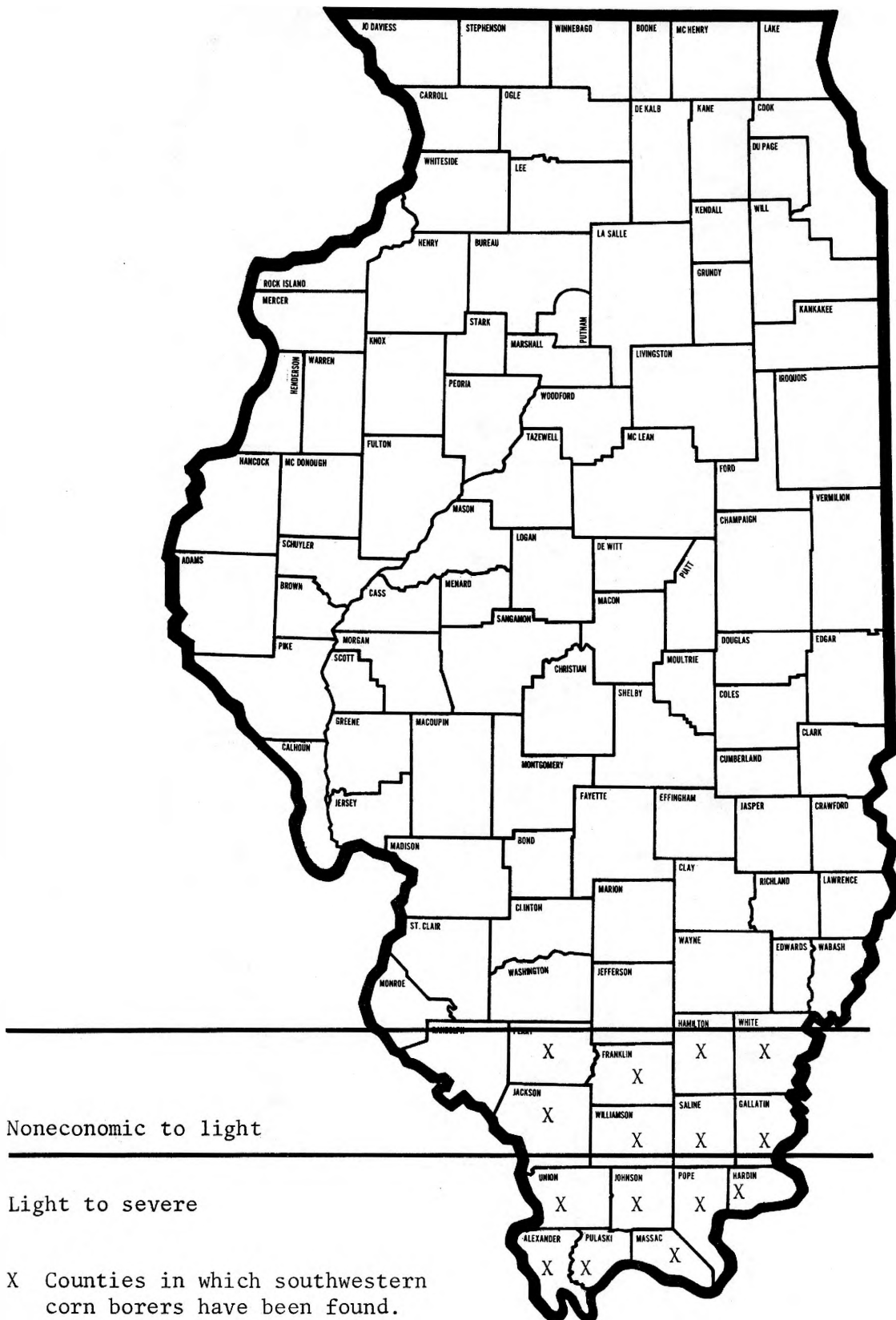
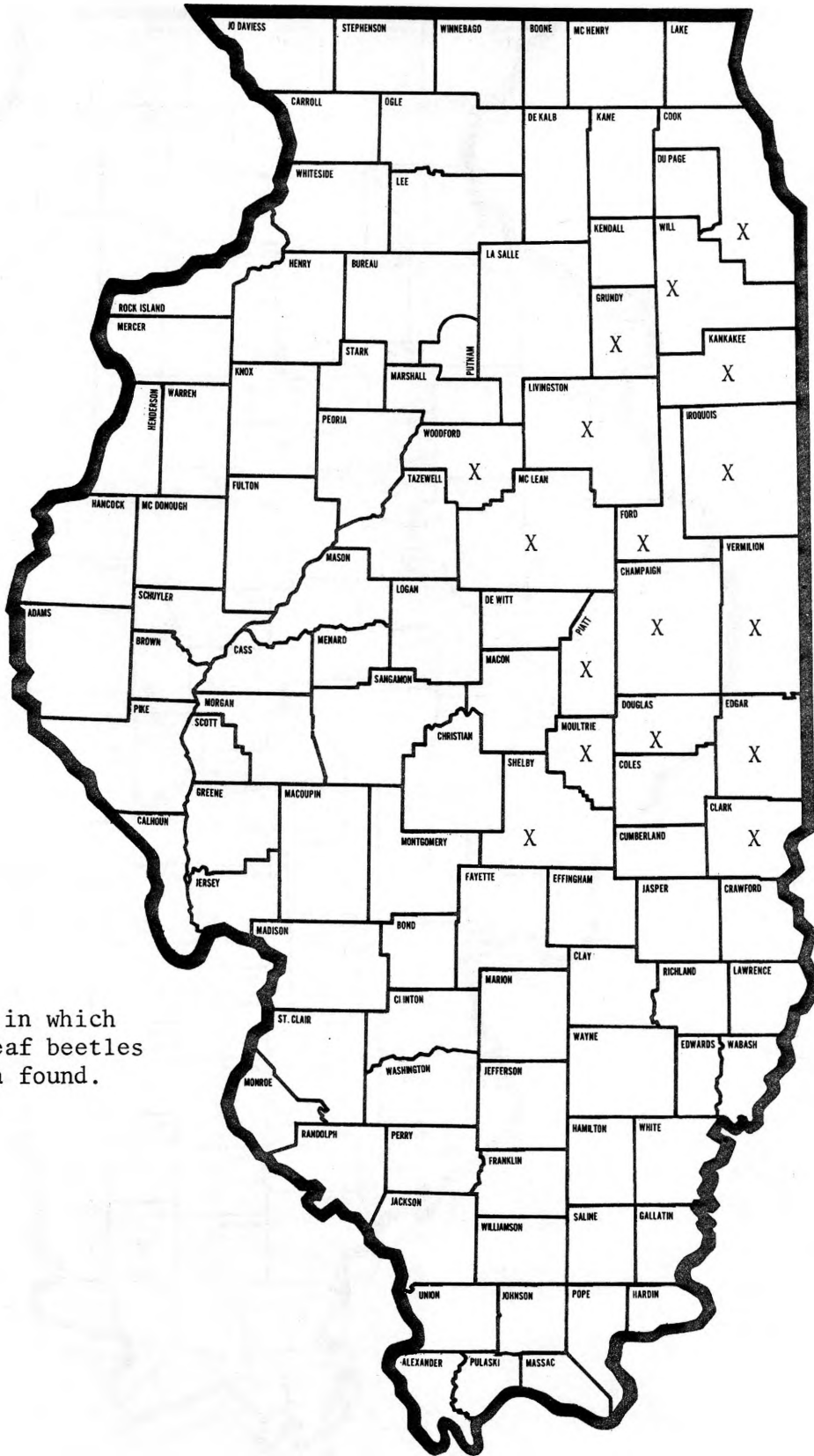


Figure 3. Southwestern Corn-Borer Prospects for 1970



X Counties in which Japanese beetles have been found.

Figure 5. Japanese Beetle Distribution, 1969



X Counties in which
cereal leaf beetles
have been found.

Figure 6. Cereal Leaf Beetle Distribution, 1969

Noneconomic to light damage

Light to moderate damage

Moderate to severe damage

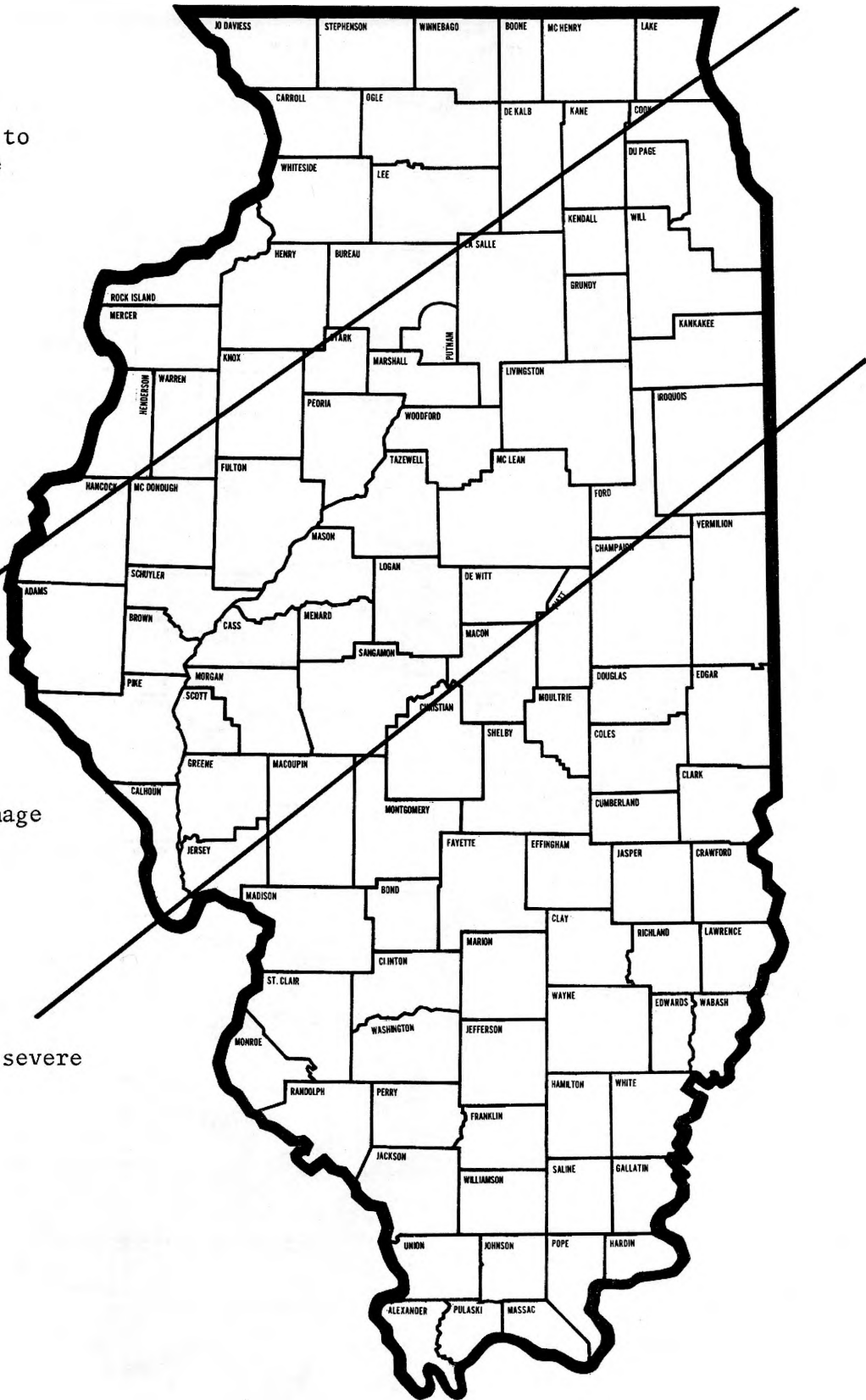


Figure 8. Alfalfa Weevil Prospects, 1970

THE CHANGING ROLE OF HONEY BEES IN ILLINOIS AGRICULTURE: GROWER NEEDS AND PESTICIDE USAGE

E.R. Jaycox

If you think honey bees and pesticides are quite incompatible, you share the opinion of many people--in Illinois and elsewhere. However, the use of insecticides for insect control and that of bees for pollination have identical goals and purposes: the production of quality food crops in such quantity that growers can make a reasonable profit, while providing food at a reasonable price to the consumer.

To meet the need of the grower who must have both bees and pesticides, we *can* use them compatibly through proper selection and timing. Many growers have been forced to reconsider their need for providing crop pollination, and in some cases for modifying their pesticide usage, because of the change in the number of honey bees in Illinois.

THE CHANGE IN NUMBERS

From 1958 to 1968, the estimated number of honey bee colonies, or hives, in Illinois dropped 37 percent--from 140 to 88 thousand. This reduction leaves an average of only 1.6 colonies per square *mile* (640 acres) to do the job of pollinating our fruit, vegetable, and seed crops. In spite of help from solitary bees and other kinds of insects, many crops such as apples, cucumbers, watermelons, pumpkins, and red clover need one strong colony of honey bees per *acre* in order to produce the best yield.

The reduction in the number of colonies has been caused by the continued low income from honey production and the increased difficulty in finding suitable locations for apiaries. Great decreases in pasture and hay acreages have not been offset by any increase in the acreage of other plants that provide nectar and pollen. This downward trend in the number of bees will probably continue until returns from pollination rentals help to provide a better income for beekeepers.

RENTED COLONIES AND SUPPLEMENTAL POLLEN

The use of rented colonies of honey bees for pollination in Illinois is increasing, and will continue to do so even more rapidly as the number of bees declines further and growers see the results that can be achieved. Apple growers are using more honey bees than before, and are also providing additional live pollen to increase fruit set in improperly planted orchards. In some cases, yields have risen three- to five-fold. The success of the system has led some growers to plant new orchards--ones that will always require honey bees and supplemental pollen to produce a commercial crop. More bees will also be used for the production of strawberries and other small fruits.

Cucurbit crops, including melons, squash, cucumber, and pumpkin, require bee visits. Many species produce better-quality fruit if the flowers receive multiple visits by

honey bees. In some areas of Illinois, the early bloom on pumpkin vines does not set fruit as it should because of lack of bees near the fields. This can be demonstrated easily by examining the quantity of the nectar and the pollen left in the flowers when they begin to close in mid-morning. You can actually pour nectar from the unvisited and unpollinated pumpkin flowers. Yields per plant may be greater on the edges of a field than in the center, an indication that the few bees present find plenty of food without moving very far from the edge where they first reach the field.

INTERACTING FACTORS

If growers are to produce optimum yields on insect-pollinated crops, they must obtain and conserve the insects that do the job--primarily honey bees. The pesticide program and planting plan must create the least hazard in order to prevent any reduction in yield from lack of pollination. If possible, growers should plant cucumbers and melons as far away as possible from snap beans and other crops that require the greater quantities of pesticides that could drift onto open flowers visited by bees. Such planning is of little help if a nearby farmer fails to use care in selecting and applying herbicides on his blooming crops that are attractive to bees.

Salesmen and spray operators should consider the overall needs of these growers in making recommendations. Obviously, compromises must be made to control pest insects effectively where pollinators are involved. Where there are no alternatives to the use of highly toxic materials, the bees should be moved out of the area. Illinois Circular 940, *Pesticides and Honey Bees*, presents the problem in greater detail and provides toxicity ratings for commonly used pesticides.

Most beekeepers are not equipped to move their colonies for pollination purposes, and many are not interested in doing so. The result is that growers have serious problems in finding good colonies of bees to rent. If the bees he rents are then damaged by misuse of pesticides, the grower may be unable to obtain any for the next season, or the price may be much higher. If bee losses are evident from year to year in an area (such as one where carbaryl is used extensively on sweet corn), local growers may notice reduced yields on their insect-pollinated crops because beekeepers will be hesitant to bring colonies into the area.

The use of pesticides in one area can also affect the growers of crops in others because of the limited number of bees for rent. Colonies not at full strength (population) when they go into winter may not be available in early spring for apple pollination. This can add to the grower's problem, since the weather can influence the pollination of spring-blooming plants more easily than later ones.

In 1967, lack of pollination because of rain caused a disaster in the California fruit industry. It was called "the year the bees did not fly." Each time Illinois fruit growers have too few bees, or the bees cannot fly, the size of that year's crop is automatically reduced. We often forget this simple fact as we concentrate on other aspects of production.

SUGGESTIONS

Growers with large acreages of insect-pollinated crops should consider improved means of obtaining bees. If it is impossible to find capable beekeepers who are willing to provide good colonies every year, some other source should be considered. Perhaps a beekeeping branch of the business or a cooperative effort among large

growers would provide the answer. Spray operators and other service-oriented agricultural businesses should carefully consider whether they might expand their services to offer insect *management*, in place of only insect control. Both the need and demand are increasing for such a service.

The control of damaging insects and the provision of beneficial insects by the same individual or organization would be a logical combination--placing these functions in the hands of people with the required knowledge and ability. The result could be stated in a simple equation: Pollination plus protection equals production and profit.

Honey bees and pesticides are not such strange bedfellows after all.

USE OF HERBICIDES FOR NONCROP AREAS

P.R. Craig and W.R. Donels

Each year, those of us involved in the management of highway roadsides are feeling more of the pressures placed on turf-management people. While we do not possess any substantial quantity of fine turf, we make amends by struggling with a vast volume of coarse-textured turf, trying to control erosion. The total right-of-way acreage has increased each year, with the construction of new highways and the reconstruction of existing highways on wider right-of-way. Today, our total right-of-way exceeds 135,000 acres.

HISTORICAL COMMENTS

From the time man first became an agriculturist, he has, out of economic necessity, constantly searched for more-efficient tools with which to perform his tasks and realize a better way of life. We, too, have felt the need to search for such tools. Within the last decade, we have intensified our efforts in this direction. It is no longer economically feasible to support the expansion of men and machines that would be required to physically and mechanically control the vegetation on this vast volume of noncrop land. Therefore, through economic necessity, we have turned to chemistry for the solution to many problems, ones solved by physical or mechanical methods in the past.

CONTROLLING VEGETATION

Vegetation control along Illinois highways is extremely broad in scope. Although we do not produce or market a food crop, we are, nevertheless, concerned with the many problems involving tolerance, persistence, pollution, and selectivity. In using chemicals, we are bound by economic, moral, and legal considerations, just the same as the agricultural applicator. We work with practically all types of herbicides. The range of maintenance concepts with which we have experience includes pre- and post-emergence weed control of a selective and nonselective nature, with contact and systemic herbicides in woody ornamentals, grasses, and forbs. In addition, we are also concerned with control through growth regulation and soil sterilization.

The majority of our weed-control programs are directed toward the following categories:

1. Tree and shrub plantings.
2. Turf.
3. Fixed objects such as guard rails, sign posts, and drainage structures.
4. Illegal weeds.

Time and space do not permit dealing with each of these four categories in a comprehensive manner, so we have decided to dwell on two of the more unusual categories. In so doing, we may have another opportunity in the future to come back and share our successes and failures in the other two categories.

TREE AND SHRUB PLANTINGS

We take the greatest delight in reporting these activities. Nowhere else has our success-to-failure ratio been as high. Certainly, no other chemical application has produced the obvious and sometimes dramatic results as the mass-planted beds of woody ornamentals. We now have approximately 1 million square yards of ornamental plantings along the roadsides in Illinois. Without the assistance of herbicides, weeds would certainly ruin many of these attractive plantings.

To better understand the nature of our programs in shrub-bed maintenance, it is necessary that some effort be made to define the problems that frequently exist. Prior to about 1966, weed-control practices in shrub beds were primarily of the hoe and roto-tiller type. We had been steadily losing ground in our fight to keep these plantings clean. Invasions of our fescue turf, and of a wide variety of broadleaf weeds and a few annual grasses, persisted and increased. To be effective, we needed a postemergence grass and broadleaf weed killer, to remove weeds and to provide a safe and effective preemergent material that will prevent regrowth. We had worked with Simazine and similar compounds, but found them too unpredictable for widespread use in our program. The 2,4-D materials had little to offer, nor did the conventional preemergence crabgrass materials.

We found a solution both for the reclamation of weed-choked shrub beds and the prevention of subsequent growth after cleaning. For reclamation, (which involved the extra step of removing unwanted existing growth), the contact herbicides were used. In our operations, we applied Paraquat and cacadoylic acid as directed sprays in the early spring. We were successful in killing most weeds prior to the time most shrubs leafed out, with minimum of injury to the plant materials. Some of the perennial broadleaf weeds and the rhizome-producing grasses, such as quackgrass, survived this treatment, making subsequent treatments necessary for control.

USING AND EVALUATING CASORON

In the late fall of 1966, a field experiment with Casoron granular G4 was started. This material was applied to a shrub bed containing *Euonymus alatus compactus*, at a rate of 150 pounds of G4 per acre. The volume and size of weeds in this bed was such that none of the shrubs, which were 3 to 3.5 feet high, were visible from the highway. Through the winter months this material was successful in killing most of the perennial weeds, including an almost complete kill of tall fescue. During the three seasons since this initial use, we have greatly expanded our use of Casoron. It has been most effective, although it has moved out of the shrub bed where it was used in several instances, causing some damage to adjacent turf.

Since Casoron is relatively insoluble in water and does not readily leach into the soil, it is subject to movement by surface water. The problems we have encountered with this material have been minor, usually associated with a sloped shrub bed, and may be due in part to a rate higher than the one specified. Experience has taught us to use this material on calm days. When knapsack spreaders are used for application, this material can be carried outside the limits of the shrub bed by the wind, causing stunting or death to adjacent turf. This creates an ugly, irregular bed line. Also, many of our workers found this material unpleasant to handle without a paper mask covering their nose and mouth.

During 1970, we plan to do some work with Casoron in the wettable-powder form to determine whether it will reduce the possibility of surface movements. In this form we hope we can include fertilizer materials, thus completing two operations

simultaneously. The application rates have been varied from 150 to 200 pounds of granular material per acre--with the heavier rate applied to heavy soils, to those high in organic matter, and to shrub beds containing several inches of decomposed organic mulch. Wettable powders may lend themselves better than the granules to the higher rates of application.

WORK WITH OTHER MATERIALS

As we evaluate Casoron, we are also working with Treflan, Dymid, Enide, Eptam, and Amiben. Our experience with these materials, although limited in relation to Casoron, has indicated that these materials are effective. Because they do not have the post-emergence grass activity of Casoron, none of these materials were used as extensively.

During 1970, we plan to broaden our usage of the other preemergent materials in our shrub-bed maintenance programs. We know little about the residual effects of these chemicals on the plant materials we use them around. Therefore, we intend to keep searching, testing, and evaluating existing materials and new ones as they appear on the market, to provide a sound basis for selecting alternate materials when necessary.

FIXED OBJECTS--GUARD RAILS, SIGN POSTS, STRUCTURES

In this category we have been working on the control of weeds and high grasses next to the highway structures. The large amount of structure creates a problem of hand-trimming for our mowing operations. We have 1,200 miles of guard rails, 3,200 miles of access-control fence, and 350,000 sign posts. The cost of trimming around all of these fixtures is prohibitive. At present, many are being ignored. The effort by the Division of Highways to control the vegetation by chemical means is becoming more varied as the search continues.

COMMENTS

Undoubtedly, we will not find one answer to our problems with the use of one chemical or one means of application. The use of sterilants as the means of control has presented us with one basic problem. This problem is a way of applying enough material to last long enough to cover the cost of application and have the material remain within the area to which it was applied.

In our Chicago District, a combination of road tars and Urox mixture was used along the fence line and under the median guard rail. This material was applied by using a liquid-asphalt distributor containing a mixture of asphalt emulsion and Urox. The rate used is three gallons per acre. The material was spread in a wide-enough strip along the objects so that the larger mowers could cut the rest. The application procedure varied greatly in speed because of the poor mobility of the equipment on slopes and around plant material.

The results of the chemical function were fair in restricting vegetative growth. At the end of the first session, there was some evidence of regrowth in the strip. Although the asphalt emulsion did hold the Urox in place, it was hard to control the spray when it was being placed. Even with all the flaws worked out of this method, it leaves a lot to be desired in terms of cost and control.

Other districts have tried additional chemicals, without using a carrier or holding material. Chemicals such as Hyvar S, Karmex, Telvar, and Simazine are examples of the wettable-powder forms used. Granular materials used have been Urox 11 and Ureabor in several districts throughout Illinois.

The Effingham District seems to be satisfied with our method of chemical control along the guard rail and around sign posts on Interstate 70. They are using a mixture of 3 pints of Paraquat and 3 pounds of Simazine to 100 gallons of water per acre around these fixtures. They have found it necessary to modify the equipment used. Through the use of the modified equipment, combinations of chemicals, and the trial use of new chemicals, we are confident that solutions to our vegetation control problems will be found.

It is obvious that chemicals are efficient enough to replace the hoe or mower, and economical enough to make this replacement mandatory for large-scale work. However, the use of chemicals requires a higher degree of professionalism. We have found few absolutes in weed control. Nothing can be taken for granted. Nature is never static, always changing. There are always variables in climate, topography, soil type, fertility, and ecology.

We are grateful to the research people who have worked toward the development of those materials that have become so vital to the success of our weed-control programs. We are pleased to be a part of this progress in plant maintenance.

TOXICITY RATINGS FOR ROOTWORM CHEMICALS

R.E. Seebriest

Northern corn rootworms resistant to aldrin and heptachlor were found in Woodford County, Illinois, in 1963. The problem has spread and now includes all of northern and much of central Illinois, and can be expected wherever northern or western corn rootworms are involved.

This year, northern corn rootworm beetles were collected in Champaign County from the University of Illinois Dairy Farm, in order to determine the relative toxicity of many chemicals. A few beetles were also collected from north of Normal, Illinois, in McLean County.

Beetles were treated individually with insecticide to determine the amount necessary to kill 50 percent of them. The relative toxicities of sixteen common or experimental insecticides were determined (Table 1).

The northern corn rootworms on the University Dairy Farm are obviously susceptible to the chlorinate hydrocarbons. The resistance to aldrin did not significantly change when older beetles were used. The rootworms from McLean County were resistant to aldrin. Compared with 1967 data, the resistance is increasing.

The LC₅₀ for furadan was practically the same for beetles from McLean and Champaign counties. In 1969, Champaign County beetles had the same LC₅₀ rating for diazinon as did those of 1967 from McLean County.

Table 1. Concentration of Insecticide (Gamma Per Insect) Necessary to Kill 50 Percent of the Northern Corn Rootworm Beetles from Two Locations

Treatment	U. of I.	Normal Illinois	
	Dairy Farm	1969	1967
Carbofuran (Furadan)	.0034	.0066	...
Dasanit	.013		
TD-8550	.014		
Parathion (Niram)	.015		
Bay-77049	.021		
Bux	.02		
Carbaryl (Sevin)	.025		
Landrin	.03		
Diazinon	.032	...	.032
Heptachlor	.038	7.5	...
Aldrin (8/12)	.058		
(8/22)	.06		
(9/2)	.05	2.5	1.3
(9/11)	.046		
Phorate (Thimet)	.065		
Dyfonate	.068		
Mocap	.16		
Cythion	.3		
Disulfoton (Di-Syston)	.51		

SUMMARY—1969 CORN ROOTWORM DEMONSTRATIONS

H.B. Petty and D.E. Kublman

Nineteen rootworm-control demonstrations were conducted in 15 counties, under the supervision of Extension Advisers Earl Lutz, Paul Wilson, Charles Englehardt, Mike Sager, Ron Dedert, Ray Rendleman, Don Teel, James McCurdy, Ray Mower, Jon Ellis, Stan Eden, Harold Brinkmeier, George Swallow, Robert Lahne, Ken Bolen, Wallace Reynolds, and Louis Englebrecht. Cooperation was received from the following farmers: Joe E. Logsdon III, Gallatin County; John and Jay Barth, Livingston; J.E. Klockenga, Logan; Robert Scherer, Woodford; Lewis Asher, Adams; Floyd Crose, Hancock; Morris DeSutter, Knox; the Twomey Grain Co., Robert Moore, and Gilbert Hennefent, Warren; Cox Brothers, Stark; Richard Anson, Bureau; Hugh Hermus, Ogle; Lawrence Woessner and Raynor Mosher, Carroll; Cecil Creighton, Jo Daviess and Stephenson; John Pigott, DeKalb; James Nelson and James Flanders, Boone; and Robert Hughes, McHenry.

Planting dates varied from May 2 to June 1, 1969. Row widths varied from 20 to 40 inches. Fertilizer programs varied. Hybrids, although the same in each field, varied from one field to another.

Insecticides were all applied at approximately 1 pound per acre, based on 40-inch row spacing. In 1969, BUXten, carbofuran, Dasanit, diazinon, dyfonate, and phorate were recommended for resistant rootworm control and were used in these demonstrations. Since it was a potential chemical for 1970, Landrin was included. Replicates varied in width from 8 to 12 rows. At the cooperators' leisure (from June 3 to July 6), basal applications were applied. Carbaryl, carbofuran, diazinon, disulfoton, parathion, and phorate were used. The seed was treated with diazinon for all basal plots.

Plant-population counts were made in early June, after plant emergence was complete. One two-hundredths of an acre was counted at each of five places in each replicate.

Larval counts were made from July 8 to July 16 by farmers who attended field meetings. Where the corn was hill-dropped, we dug hills of 2 or 3 plants, depending on the field average. If the corn was drilled, we dug single plants. Two to ten plants were examined for larvae for each plot in each field. The same is true for root ratings, which were made in the three fields that had enough larvae to anticipate root damage. Root ratings were made the week of July 22. The standard rating of 1 (clean) to 5 (all rings of roots destroyed) was employed. Results are recorded as larvae or rating per plant, not per hill. In addition, we used a "pull" tripod and recorded the number of pounds of pull resistance needed to pull the corn plants from the ground. Single plants were selected. The plots were mechanically picked. Yields were computed on the basis of Number 2 shelled corn. Entire plots were picker-harvested, and varied in size from 1/4 to 1-1/4 acres.

RESULTS

We have tabulated seven fields in which the rootworm population averaged 5 or more worms per plant in the untreated plots (Table 1). Although we had not planned to apply diazinon at planting, local dealers in some counties specifically asked us to include it. Thus, of the seven fields with 5 or more rootworms per plant, five contained diazinon at planting for comparison (Table 2). Three fields had 10 or more rootworms per plant in the untreated plots. In these fields, we also rated root damage for 20 plants and recorded the pounds-of-pull-resistance average for each plot, also recording the lodging over 60° (Table 3).

Viewing the results obtained in all seven fields, it appears that the carbamates--BUX15, carbofuran, and Landrin--provided slightly better control of the rootworms than the phosphates--Dasanit, dyfonate, and phorate. However, phorate did compare favorably with the carbamates in the percent of control. With heptachlor, control was unsatisfactory in five of the seven fields and barely acceptable in the other two fields--66 and 68 percent control.

Stand counts revealed little unless there is a reason why the BUX15 and heptachlor plots had slightly poorer stands than the untreated plots. Slight variations in stands are probably chance results.

Basal applications did not provide the control expected. Of the insecticides labelled for basal application, only phorate performed satisfactorily. In 1968 we followed control with all chemicals throughout the month of July and found that with the continued hatch of eggs, the percent of control with basal applications increased during July while the percent of control with planting time applications decreased. Time did not permit observations in 1969.

Yields are always difficult to interpret but carbofuran and dyfonate yields may be better than the others. However, the differences are not great enough to warrant additional comments. Based on rootworm populations, the dyfonate yield was higher than expected, and may possibly be explained by garden symphytan control. Yields from two BUX15 plots were both slightly lower than the others. Again, this does not warrant further discussion, since field irregularities in plot layout can cause such differences. There is probably no significant difference in the yield of heptachlor and check. The yields of carbaryl, disulfoton, and parathion as basal applications cannot be credited to rootworm control, unless control occurred after mid-July. There is the possibility of control of other insects which we did not observe.

Two insecticides, diazinon and parathion, were not included at planting in all fields. Diazinon at planting, included in five fields (Table 2), averaged 34 percent control of rootworm larvae; parathion, in only two fields, averaged 31 percent control. The diazinon yield was in the same range as the untreated plot.

Detailed observations in three fields reveal that at least three methods of measuring practical rootworm control can be used: rootworm count, root rating, and pounds of pull resistance. When we view all three methods--for the three carbamates and three phosphates--it becomes difficult to list them any way except alphabetically.

Although yields and stands are included in the three-field comparison (Table 3), yields and stands in the seven-field comparison (Table 1) are much more reliable because of the greater number of comparisons.

Some fields with 0 to 5 rootworms per plant in the untreated plots were harvested (Table 4). It appears that there are no differences in yields between treated and untreated plots in either the planting or the basal treatments.

There seems to be a difference in yield in favor of carbofuran when the results from two years are compared (Table 5). Also, results with diazinon dropped noticeably in 1969. However, on this limited data, we are unable to select any one insecticide as outstandingly better than the others, comparing BUXten, carbofuran, Dasanit, dyfonate, Landrin, and phorate.

These rootworm insecticides have been applied in liquid starter fertilizers following research on this method by J.W. Apple of Wisconsin. We had three demonstrations of this application method this year. Briefly, applicators that place the insecticide on only one side of the planter shoe are ineffective. Disulfoton placed on both sides of the shoe gave only 60-percent control, and we do not recommend it this year. Although results varied, liquid formulations of the other rootworm insecticides were at least as good as, if not more effective than, granular applications (Table 6), when they were applied on both sides of the planter shoe. Whether many of the insecticides will be labelled for such use is unknown. The wide variety of liquid-fertilizer formulas presents great difficulties for insecticide formulators, because the oil phase of the liquid insecticide is difficult to keep mixed in the fertilizers.

CONTROL OF OTHER INSECTS

The effectiveness of these rootworm insecticides for corn seed-beetle and maggot control has been discussed. There were some garden symphylans in all of these plots. Dyfonate controls them to a reasonable extent at 1 pound per acre in the row. Wireworms, white grubs, cutworms, sod webworms, grape colaspis, or corn root aphids were not present in any of these fields.

No corn leaf aphids were present for observations on systemic control. We counted whorl infestations of first-generation European corn borers in two fields, but found no differences between treatments. Unfortunately, time did not permit us to make dissections to determine the number of borers. We dissected stalks in two fields to determine the control of second-generation corn borers. Infestations varied, so sound conclusions could not be drawn. However, it did seem possible that basal applications of carbofuran and perhaps one or two others may have reduced populations slightly. More information is needed.

CONCLUSIONS

The conclusions drawn from these demonstrations are reflected in recommendations given in Circular 899.

Table 1. Results From Seven Corn-Rootworm Demonstration Plots^{a/}

Treatment	Rate ^{b/}	Plant pop. ^{c/}	Rootworms per plant	Pct. control		Yield, bu. of No.2, shelled corn	Yield saved	
				Ave.	range		Bu.	Pct.
PLANTING-TIME TREATMENTS WITH NO SEED TREATMENT								
Untreated	...	22,816	9.9	..	...	112.8	...	...
Carbofuran	1.0	22,699	0.4	96	77-100	122.5	11.1	10.0
Landrin ^{d/}	1.0	22,479	0.4	96	85-100	117.9	6.5	5.8
BUX 15/ ^{e/}	1.1	21,958	1.0	91	63-97	115.5	4.1	3.7
Phorate	1.1	22,756	1.1	89	54-98	119.0	7.6	6.8
BUX 15/ ^{e/}	1.1	22,150	1.2	88	77-98	116.3	4.9	4.4
Dasanit	0.9	23,470	2.5	74	30-86	117.9	6.5	5.8
Dyfonate	1.0	22,650	2.8	71	30-92	121.1	9.7	8.7
Heptachlor	1.1	22,077	4.7	52	0-68	108.0	-3.4	-3.0
Untreated	...	22,933	9.5	..	...	110.0	...	...

BASAL APPLICATIONS IN JUNE, WITH SEED TREATMENT AT PLANTING

Seed treatment only	...	23,197	8.9	..	...	111.9	...	...
Carbofuran ^{d/}	1.5	...	1.1	90	64-100	123.1	10.2	9.0
Phorate	1.0	...	2.4	78	53-100	119.7	6.8	6.0
Diazinon	1.0	...	5.3	52	14-95	114.9	2.0	1.8
Disulfoton	1.0	...	7.3	34	0-91	117.9	5.0	4.4
Parathion	1.0	...	7.3	34	14-85	118.0	5.1	4.5
Carbaryl	2.0	...	8.2	26	0-63	117.5	4.6	4.1
Seed treatment only	...	...	12.1	..	...	113.9	...	...

^{a/} With 5 or more larvae per plant.

^{b/} Based on 40-row equivalent.

^{c/} Anticipated stand-25,231.

^{d/} Use not labelled.

^{e/} W equals with diazinon seed treatment; WO, without.

Table 2. Results From Five Corn Rootworm Demonstration Plots, 1969^{a/}

Treatment	Rate ^{b/}	Plant pop. ^{c/}	Rootworms per plant	Ave. pct. Yield bu. of No. 2		Yield saved	
				control	shelled corn	Bu.	Pct.
PLANTING-TIME TREATMENTS WITH NO SEED TREATMENT							
Untreated	...	22,902	10.3	...	110.7	...	...
Carbofuran	1.0	22,738	.4	96.5	121.0	13.1	12.1
Landrin ^{d/}	1.0	22,534	.6	94.5	116.5	8.6	8
BUX 15/ <u>We/</u>	1.0	22,042	1.2	87.9	113.3	5.4	5
Phorate	1.1	23,082	1.0	89.1	117.9	10.0	9.3
BUX 15/W	1.0	22,266	1.3	87.1	113.6	5.7	5.3
Dasanit	0.9	23,730	2.4	75.9	116.3	8.4	7.8
Dyfonate	1.0	22,742	2.9	71.2	119.1	11.2	10.4
Heptachlor	1.1	22,180	4.8	52	103.8	-4.1	-3.8
Diazinon	1.0	23,158	6.7	33.9	108.4	0.5	0.5
Untreated	...	22,746	9.9	...	105.1	...	...
BASAL APPLICATIONS IN JUNE, WITH SEED TREATMENTS AT PLANTING							
Seed treatment only	...	23,292	9.53	...	106.7	...	...
Carbofuran ^{c/}	1.5	...	1.13	88.3	122.6	14.2	13.1
Phorate	1.0	...	2.43	74.9	118.3	9.9	9.1
Diazinon	1.0	...	4.32	55.3	110.8	2.4	2.2
Disulfoton	1.0	...	7.12	26.4	116.9	8.5	7.8
Parathion	1.0	...	5.1	47.3	116.2	7.8	7.2
Carbaryl	1.0	...	5.07	47.6	115.3	6.9	6.4
Seed treatment only	...	...	9.8	...	110.1	...	...

a/ With 5 or more larvae per plant and 5 field comparisons, so 1 pound of diazinon could be included.

b/ Based on 40" row equivalent.

c/ Anticipated stand 25,430.

d/ Use not labelled.

c/ W equals with diazinon seed treatment; WO, without.

Table 3. Results From Three Corn Rootworm Demonstration Plots, 1969

Treatment	Rate ^{a/}	Plant pop. ^{b/}	Rootworms per plant		Root rating ^{c/}	Lb./pull resistance	Lodging over 60°	Yield, bu. of No. 2 shelled corn	Yield saved	
			No.	Pct. control					Bu.	Pct.
PLANTING-TIME APPLICATIONS, NO DIAZINON SEED TREATMENT USED										
Untreated	...	19,027	12.4	...	3.58	172	17	108.6	..	..
Carbofuran	0.9	19,640	0.4	97	2.01	312	2	119.6	12.3	11.5
Landrin ^{d/}	1.0	19,627	0.8	94	2.37	243	5	115.9	8.6	8.0
Phorate	1.0	20,640	1.2	91	2.68	232	8	116.5	9.2	8.6
BUX 15/ <u>we/</u>	1.2	19,253	1.9	86	2.22	242	9	109.8	2.5	2.3
BUX 15/ <u>woe/</u>	1.2	19,600	1.8	86	2.49	286	6	113.4	6.1	5.7
Dasanit	0.9	20,533	2.8	79	2.55	204	7	113.2	5.9	5.5
Dyfonate	1.0	20,307	3.5	74	2.61	280	3	117.3	10.0	9.3
Heptachlor	1.1	19,320	5.9	55	3.53	189	25	108.4	1.1	1.0
Untreated	...	18,927	14.0	...	3.88	137	27	106.0	...	...
BASAL APPLICATIONS IN JUNE, DIAZINON SEED TREATMENT AT PLANTING										
Seed treatment only	...	20,920	15.2	...	3.67	127	32	105.7	...	...
Carbofuran	1.5	19,147	0.9	94	2.24	223	1	121.5	12.9	11.9
Phorate	1.0	19,227	3.2	79	2.97	260	2	117.1	8.5	7.8
Diazinon	1.0	19,437	8.2	45	3.32	205	21	103.4	5.2	4.7
Disulfoton	1.0	19,920	8.5	43	2.91	213	1	116.8	8.2	7.6
Parathion	1.0	19,787	9.3	38	3.46	164	9	112.7	4.1	3.8
Carbaryl	2.0	20,040	10.1	32	3.55	148	17	114.9	6.3	5.8
Seed treatment only	...	20,160	14.5	...	3.56	156	29	111.5	...	...

a/ Based on 40-inch row equivalent least-significant difference, 5 percent level.

b/ Seeded 23,583 kernels.

c/ 1 equals damage to a trace, and 5 equals severe.

d/ Not labeled.

e/ W equals with seed treatment; WO, without.

Table 4. Yields in Bushels From Four Fields With Minor Rootworm Populations

Planting time treatments ^{a/}		Basal treatments ^{b/}	
Treatment	Yields bu.	Treatment	Yields bu.
Untreated	154.2	Seed treatment only	154.6
Furadan	156.7	Furadan	160.4
Landrin	154.9	Phorate	160.9
Phorate	156.5	Diazinon	159.3
BUX 15	155.1	Disulfoton	158.4
Dasanit	156.1	Parathion	163.2
Dyfonate	156.3	Carbaryl	159.8
Heptachlor	152.0		
Check	154.2	Seed treatment only	160.4

a/ Yields from four fields.

b/ Yields from three fields only. Cannot be compared with planting time treatments.

(Table 5 appears on next page.)

Table 6. Liquid Starter Fertilizer--Insecticide Combinations and Granular Formulation Comparisons

	Percent control of rootworms
Granular formulations	77
Liquid formulations in fertilizer	87
Disulfoton liquid in fertilizer	60
Furadan granules	93

Table 5. Rootworm Demonstration Plots, 1968-1969^{a/}

Treatments ^{a/}	Plant population			Rootworms per plant			Percent control	Yield, No. 2 shelled corn			
	1968	1969	Ave.	1968	1969	Ave.		1968	1969	Ave.	Savings
Untreated	20,651	22,875	21,763	15.2	9.7	12.5		111.4	111.4	111.4	
Dasanit	20,927	23,470	22,199	3.7	2.5	3.1	67	122.9	117.9	120.4	9.0
Phorate	20,732	22,756	21,744	4.7	1.1	2.9	77	120.1	119.0	119.6	8.2
Dyfonate	20,793	22,650	21,722	4.6	2.8	3.7	70	121.8	121.1	121.5	10.1
Furadan	20,876	22,699	21,788	1.2	0.4	.8	94	125.8	122.5	124.2	12.8
BUX	20,518	22,150	21,334	2.8	1.2	2.0	84	120.8	116.3	118.6	7.2
Diaz. basal	20,651	23,583 ^{c/}	22,117	5.2	5.3	5.3	58	119.7	114.9	117.3	5.9
Diaz. planting ^{b/}	21,518	23,158	22,338	6.5	6.7	6.6	48	122.6	108.4	115.5	5.8

a/ Only those insecticides used both years = 15 fields.

b/ Total of 13 fields. Compared with check for 13 fields, not 15.

c/ Diazinon seed treatment used only in 1969.

1969 SURVEY OF NORTHERN AND WESTERN CORN ROOTWORM ADULT POPULATIONS

D.E. Kublman

For the fifth consecutive year, we conducted a random survey of 230 cornfields in twenty-three counties to determine the distribution and abundance of western and northern corn-rootworm adults. The survey was made during the second week of August. Beetle counts were taken in each field on 25 plants, selected at random. The counts included the average number of beetles per ear plus those present on the remainder of the corn plant. For this report, the sum of "beetles per ear" plus "beetles per plant" is reported as the "average number of beetles per plant."

We wish to thank the County Extension Adviser in the counties listed below for their assistance in obtaining the crop and soil-insecticide history of the fields. The following counties were surveyed:

<i>District</i>	<i>County</i>
Northwest.....	Lee, Mercer, Ogle, Stephenson, Whiteside
Northeast.....	Boone, DeKalb, Kane, LaSalle
West.....	Henderson, McDonough, Warren
East-central.....	Champaign, Iroquois, Livingston, McLean
West-southwest.....	Greene, Macoupin, Montgomery
East-southeast.....	Gallatin, Shelby, Wabash, White

CORN ROOTWORM ABUNDANCE AND DISTRIBUTION

Adult western and northern corn-rootworm populations decreased substantially in 1969, compared to 1968 (Table 6). The greatest decline in the number of adult corn-rootworms was in the northern districts. Populations have been high previously. Only 3 percent of the fields in these districts averaged more than 3 beetles per plant. The number of rootworms also decreased in the other districts. In 1969, some 40 percent of the fields in northern Illinois averaged 1 or more rootworm beetles per plant, compared to 59 percent in 1968 (Table 6). Rootworm population trends for 1966 to 1969 are also given in Table 6.

The highest northern corn-rootworm populations were found in Ogle County. Moderate populations were present in Lee, Stephenson, Whiteside, and McLean counties. The highest western corn-rootworm populations were found in Stephenson, Henderson, and Mercer counties (Table 7). Western corn rootworms were present in 55 of the 230 fields surveyed.

Several reasons have been proposed for the decline in the number of corn rootworms in 1969. Heavy rains during May and June could have killed many of the newly hatched larvae, since water stood in some fields for several days. Predaceous insects may also have fed on larvae and eggs. Another mortality factor may be the desiccation of rootworm eggs during the winter months. The hatch of rootworm eggs subjected to drying is reduced substantially.

An estimated 2 million acres of corn ground were treated with organic phosphate and carbamate insecticides in 1969, killing about 90 percent of the worms that contributed to the decline in rootworm populations.

How many beetles should one find to predict problems during the following year? We believe an average of 3 or more per plant could lead to a serious situation. Adult females lay from 200 to 1,000 eggs. If the plant population is 20,000 per acre with an average of 2 females per plant, the potential number of eggs laid per acre could range between 8 and 40 million.

ROOTWORM POPULATIONS IN RELATION TO ROTATION AND INSECTICIDE USE

A summary of the rotation and soil-insecticide history for 166 fields is given in Tables 1 and 2. The highest adult populations were found in untreated fields or fields treated with chlorinated hydrocarbons.

CROP ROTATIONS

Corn rootworms are usually found in abundance where continuous corn is grown. The counties in the northeastern, northwestern, and western districts of Illinois have the highest percentage of continuous corn land (Table 3) and the greatest number of rootworms. An exception was the east-southeast district, where 34 percent of the corn fields were third-year corn or beyond, but the number of rootworms was low. A comparison of crop rotations for 1968 and 1969 indicates that farmers in the rootworm problem areas (northern Illinois) are staying with continuous corn and using organic phosphate and carbamate insecticides for rootworm control. Thirty-seven percent of the fields surveyed in 1968 were in third-year corn or beyond. In 1969, this figure was 30 percent.

INSECTICIDE USE

The farmers surveyed in 1969 reported using a soil insecticide on 69 percent of their corn acreage (Table 5), compared to 63 percent in 1968. There was a slight decline in the use of chlorinated hydrocarbons, and a moderate increase in the use of organic phosphates and carbamates insecticides. A greater percentage of fields in third- and fourth-year corn were treated with soil insecticides than in past years (Table 4).

A summary of insecticide use, by districts, is presented in Table 5. In the primary rootworm areas, between 43 to 58 percent of the fields were treated with organic phosphates or carbamates.

SUMMARY

1. Adult corn rootworm populations declined sharply during 1969 in northern and central Illinois (Table 6). On a state-wide basis, only 3 percent of the fields averaged 3 or more beetles per plant, compared to 9 percent in 1968.
2. The proportion of fields treated with organic phosphate and carbamate insecticides in Illinois increased from 19 percent in 1968 to 27 percent in 1969 (Table 5).
3. Western corn rootworm beetles were found in 55 of 230 fields on the random survey.

Table 1. Adult Corn Rootworm Populations as Related to Crop Rotations and Soil-Insecticide Treatment, by Districts, 1969

Average no. of beetles per plant	Number of fields, according to years in corn and soil treatment ^{a/}							
	1 year		2 years		3 years		4 years	
	Untr.	Tr.	Untr.	Tr.	Untr.	Tr.	Untr.	Tr.
<i>Northeast</i>								
0	2	2	2	...	...	...	...	...
0.1 to 1.0	2	1	1	...	1	5	...	3
1.1 to 3.0	...	2	1	...	...	...	...	2
3.1+	1	...	...	...	...	...	...	...
TOTAL	5	5	4	...	1	5	...	5
<i>Northwest</i>								
0	...	1	...	...	...	...	...	...
0.1 to 1.0	3	10	...	2	...	1	...	5
1.1 to 3.0	...	3	1	4	...	...	1	5
3.1+	...	...	...	...	...	...	...	...
TOTAL	3	14	1	6	...	1	1	10
<i>West</i>								
0	...	...	...	...	...	1	...	1
0.1 to 1.0	1	10	...	4	...	1	...	5
1.1 to 3.0	1	1	...	1	...	1	...	1
3.1+	...	...	...	...	...	...	...	...
TOTAL	2	11	0	5	...	3	...	7
<i>East-central</i>								
0	6	1	...	1	...	...	...	...
0.1 to 1.0	3	3	1	1	...	...	...	1
1.1 to 3.0	1	...	1	...	...	...	...	...
3.1+	...	...	...	...	...	...	...	...
TOTAL	10	4	2	2	...	...	...	1
<i>West-southwest</i>								
0	5	4	2	7	...	3	...	1
0.1 to 1.0	2	...	1	...	...	...	...	2
1.1 to 3.0	...	...	...	...	...	...	...	...
3.1+	1	...	...	...	...	...	...	...
TOTAL	8	4	3	7	...	3	...	3
<i>East-southeast</i>								
0	5	7	1	2	...	4	...	5
0.1 to 1.0	2	1	...	...	...	...	...	...
1.1 to 3.0	...	...	...	1	...	...	...	...
3.1+	...	...	1	...	...	...	...	...
TOTAL	7	8	2	3	...	4	1	5

^{a/} Includes chlorinated hydrocarbons, organic phosphates, and carbamates.

Table 2. Summary of Adult Corn Rootworm Populations in Relation to Crop Rotation and Soil-Insecticide Treatment for 166 Fields, 1969

Average no. of beetles per plant	Number of fields according to years in corn and soil treatment ^{a/}							
	1 year		2 years		3 years		4 years	
	Untr.	Tr.	Untr.	Tr.	Untr.	Tr.	Untr.	Tr.
0	18	15	5	10	0	8	1	7
0.1 to 1.0	13	25	3	7	1	7	0	16
1.1 to 3.0	2	6	3	6	0	1	1	8
3.1+	2	0	1	0	...	...	...	...
TOTAL	35	46	12	23	1	16	2	31

a/ Includes chlorinated hydrocarbons, organic phosphates, and carbamates.

Table 3. Percent of Fields in Continuous Corn, by District, 1969

District	No. of fields	Years in corn			
		One	Two	Three	Four
Northeast	25	40	16	24	20
Northwest	36	47	19	3	31
West	28	46	18	11	25
East-central	19	74	21	0	5
West-southwest	28	43	36	11	10
East-southeast	30	53	13	14	20
AVERAGE	166	49	21	10	20

Table 4. Percent of Fields Treated With a Soil Insecticide in Relation to Years in Continuous Corn, 1969

District	No. of fields	Years in corn			
		One	Two	Three	Four
Northeast	25	50	0	83	100
Northwest	36	82	86	100	91
West	28	85	100	100	100
East-central	19	29	50	...	100
West-southwest	28	33	70	100	100
East-southeast	30	53	60	100	83
AVERAGE	166	53	66	94	94

Table 5. Corn Soil Insecticide Use, by District, 1969

Insecticide	District						Pct. of all fields
	NE	NW	W	E-C	WSW	ESE	
None	40	14	7	63	39	37	31
Aldrin or Heptachlor	16	25	50	37	61	63	42
Organic Phosphate	16	19	14	0	0	0	13
Carbamate	28	39	29	0	0	0	13
Combinations	0	3	0	0	0	0	1

Table 6. Adult Rootworm Population Trends, 1966-1969

Region	Year	No. of fields	Average number of beetles per plant			
			0-1	1-3 (Percent of fields)	3-5	5+
N. Ill.	1966	80	65	15	11	9
	1967	80	60	17	14	9
	1968	90	41	39	12	8
	1969	90	60	37	3	0
Central Ill.	1966	70	79	13	4	4
	1967	80	75	15	5	5
	1968	65	55	40	2	3
	1969	70	81	17	2	0
S. Ill.	1966	70	96	4	0	0
	1967	40	95	5	0	0
	1968	70	96	4	0	0
	1969	70	94	2	4	0
State Average	1966	220	79	11	5	5
	1967	200	73	14	8	5
	1968	225	62	29	5	4
	1969	230	77	20	3	0

Table 7. Adult Western and Northern Corn Rootworm Populations, 23 counties, 1969

District	County	No. fields surveyed	No. fields with WCR's	Av. no. NCR's per plant	Av. no. WCR's per plant	Total Beetles per plant
Northwest. . .	Lee	10	3	0.9	0.1	1.0
	Mercer	10	10	0.1	0.9	1.0
	Ogle	10	9	1.9	0.2	2.1
	Stephenson	10	9	0.8	1.0	1.8
	Whiteside	10	6	0.9	0.2	1.1
	AVERAGE				0.9	0.5	1.4
Northeast. . .	Boone	10	1	0.6	0.02	0.6
	DeKalb	10	0	0.5	0	0.5
	Kane	10	0	0.6	0	0.6
	LaSalle	10	0	0.6	0	0.6
	AVERAGE				0.6	...	0.6
West.	Henderson	10	10	0.1	0.8	0.9
	McDonough	10	1	0.3	0.1	0.4
	Warren	10	6	0.4	0.1	0.5
	AVERAGE				0.3	0.3	0.6
East-central. .	Champaign	10	0	0.3	0	0.3
	Iroquois	10	0	0.3	0	0.3
	Livingston	10	0	0.1	0	0.1
	McLean	10	0	1.2	0	1.2
	AVERAGE				0.5	0	0.5
West-southwest.	Greene	10	0	0.4	0	0.4
	Macoupin	10	0	0.0	0	0
	Montgomery	10	0	0.1	0	0.1
	AVERAGE				0.2	0	0.2
East-southeast.	Gallatin	10	0	0.4	0	0.4
	Shelby	10	0	0.4	0	0.4
	Wabash	10	0	0	0	0
	White	10	0	0	0	0
	AVERAGE				0.2	0	0.2

CHANGES IN SOIL-INSECTICIDE RECOMMENDATIONS

H.B. Petty

ALDRIN AND HEPTACHLOR

Certain factors had to be considered when we made our 1970 soil insecticide recommendations, omitting aldrin and heptachlor:

1. Aldrin and heptachlor can no longer be depended on to control northern, western, and southern corn rootworms. Granted, they will still give control in some fields, but the percentage is too small.
2. Aldrin and heptachlor can no longer be depended on to control corn seed beetles and corn seed maggots. Topical applications, seed-treatment tests, and field experience have confirmed this. As has been pointed out, damage in 1969 was not as great as expected. But potential was there, and the beetles were present in large numbers in aldrin- and heptachlor-treated fields. Control failures in some fields, however, resulted in stand losses of 20 to 40 percent.
3. Aldrin and heptachlor do not control garden symphylans, a new pest that may be on the increase.
4. Our 1953 to 1958 studies by J.H. Bigger showed that aldrin and heptachlor treatments almost always saved 2 to 4 bushels per acre, even when there were no wireworms, cutworms, white grubs, or rootworms. Bigger always assumed that this yield difference resulted from beetle and maggot protection averaging at least 500 and sometimes 2,000 to 3,000 plants more per acre in the treated than untreated areas. In those years, the return for treating all corn with aldrin or heptachlor was:

33 percent of the fields--no return, to money back.

24 percent of the fields--money back, to twice the cost of the investment.

18 percent of the fields--two to three times the cost of the investment.

25 percent of the fields--three or more times the cost of the investment.

5. With the corn seed beetle and maggot resistance, the return will be:

57 percent of the fields--no return, to money back.

18 percent of the fields--one to two times the cost of the investment.

25 percent of the fields--two or more times the cost of the investment.

But rootworms have become resistant. Now the return will be:

75 percent of the fields--no return, to money back.

25 percent of the fields--one or more times the cost of the investment.

6. Aldrin and heptachlor have been used so long that we believe the wireworm population is at an all-time low. We think the low residues now in the soils will

kill new wireworms as they hatch from eggs, reducing the odds to about 10 percent of the fields with a money-back-or-more return.

7. We cannot assess two problems--cutworms and white grubs. One species of white grubs has been troublesome in our corn-corn-soybean-soybean, 4-year rotation--that one is *Phyllophaga rugosa*. There is no common name. It is sporadic, but has a 3-year life cycle, and should not be a problem until 1971, and the spring of 1972.

Cutworms can be partially controlled with basal sprays of carbaryl, diazinon, Dylox, and toxaphene. Endrin is also labelled for this use. Cutworm control by spraying the base of the corn plants is difficult or unsuccessful because farmers often do not find the infestations until the worms are large and difficult to control. Thus, *farmers have to be alert and watch low spots and overflow ground.*

Considering all these factors, we believe that we should no longer *promote* the application of aldrin or heptachlor in Illinois.

DIELDRIN AND HEPTACHLOR

Several years ago, we recommended that dairy farmers not use certain chlorinated hydrocarbons on their farms. In general, the majority of dairymen followed this suggestion, but some did not. Each year a few dairymen are "off the market" for a few weeks to several months because their cows were accidentally fed granules and the insecticide showed up in the milk. In certain cases, no explanation could be found for the appearance of dieldrin or heptachlor epoxide in milk except that those materials had been used in corn fields on the farm.

We have reported soybean residue studies in previous years. An occasional field could be found where the beans had over 0.03 p.p.m. of dieldrin or heptachlor epoxide in them. The state average was less than 0.01 p.p.m., generally considered as a practical zero level. But there are still those few fields.

Occasional animal carcasses can be found with minor amounts of dieldrin or heptachlor epoxide residues in them. Although few in number, we must consider them.

Sludge in streams contains extremely small amounts of dieldrin and heptachlor epoxide. Those doing experimental work with bird populations can also find traces of these two chemicals in various tissues.

When we considered the insect situation, cost and return for treatment, and the so-called "environmental contamination," we felt we could no longer recommend the use of aldrin or heptachlor in Illinois. Therefore, we urge you to use up existing supplies in 1970 on (1) corn after grass sods, (2) where white grubs are a problem, or (3) corn after clovers. However, when using up such supplies, be sure to also use a diazinon seed treatment.

Our recommendations for this year are:

1. If nothing else is done, use a diazinon seed treatment.
2. Or, use 1-1/2 pounds of diazinon, or 1 pound of Dasanit, Dyfonate, or phorate on the surface of the soil ahead of the press wheel. Dyfonate will help control symphylans and may help control wireworms and rootworms.

3. If rootworms are expected, use Dasanit, Dyfonate, or phorate. Or, use a diazinon seed treatment and BUXten, carbofuran, or Landrin. With the latter three, watch for earthworm kill.

For basal applications use the diazinon seed treatment at planting and then make the basal application of BUXten, Dasanit, or phorate in the forepart of June.

4. Plan to have very low or exhausted inventories of all chlorinated hydrocarbons (aldrin, BHC, chlordane, DDT, dieldrin, heptachlor, lindane, toxaphene, etc.) by the fall of 1970.

SURVEY OF WEED PROBLEMS IN ILLINOIS

M.D. McGlamery

In 1969, the Illinois Extension advisers were asked to complete a questionnaire about weed problems in their county. The advisers rated the perennial weeds by severity and the annual weeds by crop (corn or soybeans) where they were a problem. The advisers also noted which areas of weed control they felt needed more emphasis or information.

SURVEY RESULTS

Herbicide weed selectivity was the area designated as needing the most emphasis (Table 1). Herbicide injury was rated next. We updated our herbicide weed selectivity and crop-tolerance charts for the *1970 Weed-Control Guide* (included in the back of this manual).

The economics of herbicides and herbicide residues are rated third and fourth as areas needing more emphasis. The advisers also thought more information was needed on herbicide incorporation.

The most-common perennial weeds in Illinois according to this survey are common milkweed, yellow nutsedge, and field bindweed (Table 2). The perennial weeds rated as severe in over ten counties were yellow nutsedge, quackgrass, Johnsongrass, and Canada thistle.

The most-common annual grass weed was listed as giant foxtail. It was mentioned as a problem in all but three counties (Table 3). Fall panicum and green foxtail were rated second in corn and soybeans, respectively, while barnyardgrass was rated third in both.

The two most-common annual broadleaved weeds were smartweed and pigweed. Many broadleaved weeds are considered more of a problem in soybeans than in corn. Morningglory and common ragweed are about equal as problems in corn and soybeans. Wild cucumber is generally more of a problem in corn.

CROP ROBBERS

Table 4 lists the "Top Ten Crop Robbers" in Illinois, by crop-reporting districts. The county distribution of each weed is shown in the maps at the end of this paper. Quackgrass, wirestem muhly, and Canada thistle are the more-common problems in northern Illinois; trumpet creeper, climbing milkweed, and Johnsongrass, in southern Illinois. Three perennial weeds found throughout the state are field bindweed, common milkweed, and yellow nutsedge.

Among the annual grasses, fall panicum and crabgrass are more-frequent problems in southern Illinois, while yellow foxtail was mentioned as more of a problem in northern Illinois. Pigweed, smartweed, morningglory, and cocklebur are quite common throughout the state. Velvetleaf is more of a problem in northern and

central Illinois, while giant and common ragweed are more prevalent in southern Illinois.

Wild cucumber, wild cane, and wild sweet potato were mentioned most often in counties bordered or intersected by rivers that frequently overflow.

STUDENT RESPONSES

An extramural class and an on-campus class also completed the same survey. The relative results were the same, except that fall panicum and yellow nutsedge were not thought to be as severe by the on-campus class as by the extramural class and Extension advisers. This may be a failure of these students to identify those weeds.

Table 1. Areas of Weed Control Needing Greater Emphasis or Information

Area of Weed Control	Need greater	
	Emphasis	Information
	(No. of Ext. advisers)	
Weed herbicide selectivity	60	42
Herbicide injury	52	56
Economics of herbicides	50	34
Herbicide residue	48	48
Herbicide soil relations	32	37
Herbicide incorporation	30	47
Weed control in pastures	29	35
Weed control in legumes	26	36
Cultural and mechanical control	22	17
Aquatic weed control	21	41
Weed control in small grains	13	29
Sod-planting weed control	12	32
Noncropland weed control	12	27

Table 2. Degree of Severity of Perennial Weeds in Illinois

Perennial Weed	Counties		
	Common	Severe	Total
Milkweed (MW)	80	6	86
Yellow nutsedge (YNS)	54	18	72
Field bindweed (FBW)	66	6	72
Wild sweet potato (WSP)	58	7	65
Canada thistle (CT)	51	12	63
Climbing milkweed (CMW)	43	5	48
Quackgrass (QG)	34	13	47
Hedge bindweed (HBW)	37	2	39
Johnsongrass (JG)	24	13	37
Wirestem muhly (WM)	29	5	34
Trumpet creeper (TCr)	26	6	32

Table 3. Annual Weeds That are Problems in Corn or Soybeans

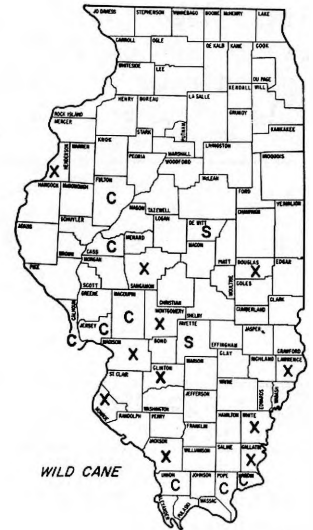
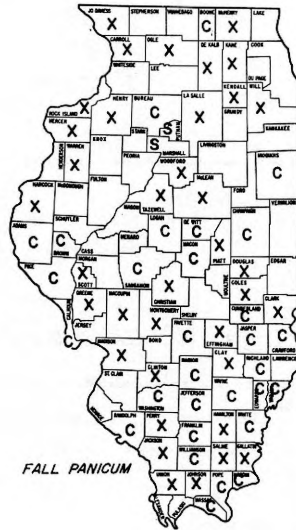
ANNUAL GRASS WEEDS	Counties listing as problem in		
	Corn & soybeans	Corn	Soybeans
Giant foxtail (GFT)	99	...	...
Fall panicum (FP)	37	30	2
Barnyard grass (BYG)	43	13	6
Green foxtail (gFT)	45	...	...
Crabgrass (CG)	32	12	5
Yellow foxtail (YFT)	31	2	2
Wild cane (WCa)	11	8	2
ANNUAL BROADLEAVED WEEDS			
Smartweed (SW)	80	3	9
Pigweed (PW)	77	1	14
Velvetleaf (VL)	52	4	16
Cocklebur (CB)	46	5	21
Morningglory (MG)	45	14	12
Lambsquarter (LQ)	39	4	10
Jimsonweed (JW)	35	6	12
Giant ragweed (GRW)	21	4	9
Common ragweed (CRW)	21	5	5
Wild cucumber (WCc)	2	6	...

Table 4. Weed Ratings, by Crop Reporting District

Crop-reporting district	Top four perennials ^{a/}				Top three annual					
					Grasses ^{a/}			Broadleaves ^{a/}		
Northwest	QG	CT	WM	MW	GFT	BYG	FP	SW	VL	PW
Northeast	QG	CT	FBW	YNS	YFT	GFT	BYG	SW	PW	VL
West	MW	YNS	FBW	WSP	GFT	BYG	CG	SW	PW	CB
Central	MW	CT	FBW	WM	GFT	gFT	FP	SW	PW	VL
East	MW	CT	FBW	YNS	GFT	BYG	FP	PW	VL	SW
West Southwest	MW	WSP	YNS	JG	GFT	FP	BYG	SW	PW	MG
East Southeast	MW	WSP	FBW	JG	GFT	FP	BYG	SW	PW	CB
Southwest	MW	JG	WSP	FBW	GFT	CG	FP	PW	CB	SW
Southeast	JG	CMW	WSP	TCr	GFT	FP	CG	PW	GRW	MG

^{a/} See Tables 2 and 3 for abbreviations.

ANNUAL GRASSES



X Both corn and soybeans

C Corn only

S Soybeans only

ANNUAL BROADLEAVED WEEDS



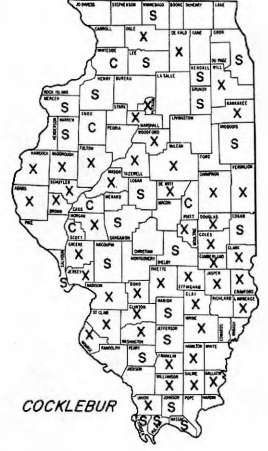
SMARTWEED



PIGWEEED



VELVETLEAF



COCKLEBUR



MORNINGGLORY



LAMBSQUARTERS



JIMSONWEED



COMMON RAGWEED



GIANT RAGWEED



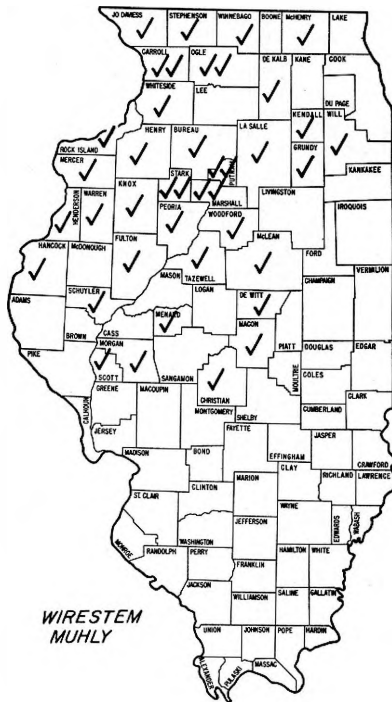
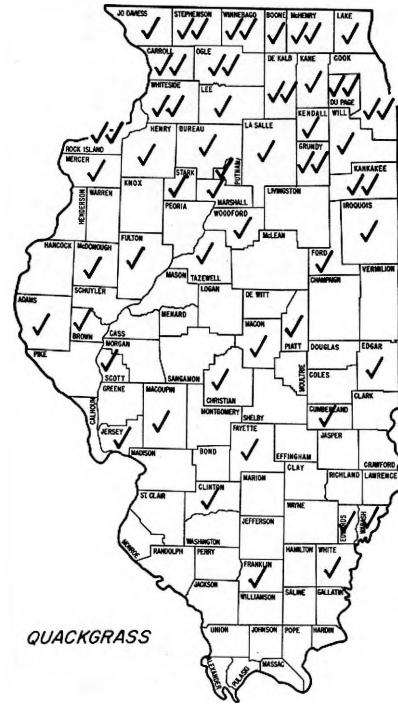
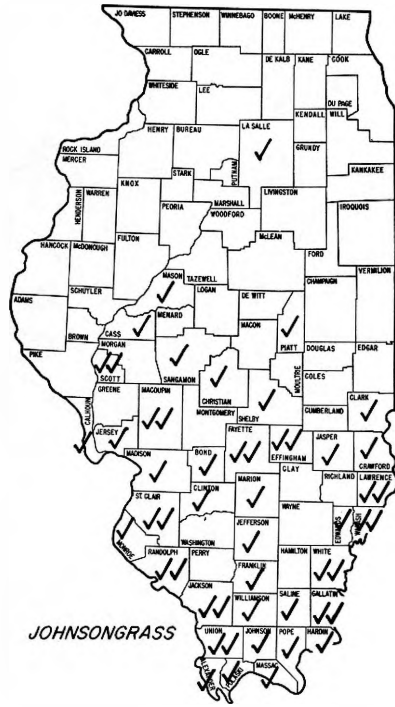
WILD CUCUMBER

X Both corn and soybeans

C Corn only

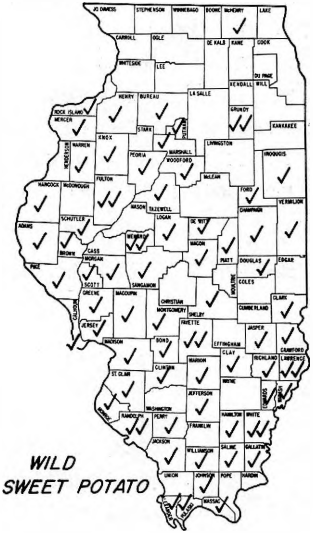
S Soybeans

PERENNIAL GRASSES AND SEDGES (MONOCOTS)



✓ Common
 ✓✓ Severe

PERENNIAL BROADLEAVED WEEDS



✓ Common
 ✓✓ Severe

WEED CONTROL IN ESTABLISHED ALFALFA

George Kapusta

Alfalfa is grown on approximately 750 thousand acres in Illinois, yet little attention has been devoted to weed control for this crop after it is established. Several reasons may be cited: (1) it is somewhat of a regional problem, being more serious in southern Illinois than elsewhere; (2) the gravity of the problem in relation to influencing yield and quality and increasing harvesting problems is relatively unappreciated; and (3) it is somewhat of an invisible problem, since many of the weeds are short and are hidden by the alfalfa canopy.

Most of the weeds that present a problem in established alfalfa fields fall into a group known as "winter annual" weeds. These germinate and become established in October and November, become semidormant through the winter months, then resume growth in early March in advance of alfalfa regrowth. Where winter temperatures are more severe, germination may occur in the early spring rather than late in the fall. These weeds are primarily a problem only in the first cutting, and are more serious in older, thinner stands. Common chickweed, henbit, daisy fleabane, peppergrass, sheperds purse, pennycress, downy brome, cheat, and little barley are among the more-serious species.

RESEARCH INFORMATION

Research to date suggests that these weeds do not consistently reduce alfalfa yields. In fact, harvesting and curing difficulties and lower hay quality probably are the major considerations in deciding on the value of control measures. Several of these species are short and are still very succulent at the time of the first cutting, increasing sickle-bar plugging and substantially lengthening curing time during a high-probability rainfall season. Hay quality may be reduced drastically, since weeds can compose up to 50 percent of total dry weight. The problem is less serious where alfalfa is ensiled, since curing time is of less consequence and quality impairment may be less severe.

CONTROL

The use of herbicides is the only practical method of controlling weeds in alfalfa, once established. To this end, a study was initiated in November, 1968, to evaluate some of the new and older herbicides and to make limited comparisons of fall versus spring applications. The results are presented in Tables 1 and 2.

This data illustrates that a choice of effective, safe herbicides is available for controlling winter annual weeds in established alfalfa. The application of most of these herbicides should be delayed until after the alfalfa becomes dormant in the fall, or prior to regrowth in the spring. Some, however, like Planavin, are more specific and must be applied at a particular time of year. These herbicides should not be used for alfalfa-grass mixtures, since they may injure the grass severely.

Table 1. Selective Control of Winter Annual Weeds in Established Alfalfa, 1969 Weed Control, Alfalfa Injury, and Protein Content^{a/}

Chemical	Lb./A. (a.i.)	Pct. weed control ^{b/}		Alfalfa ^{c/} injury rating	Percent protein, alfalfa
		Broadleaves	Grasses		
Weedy Check		0	0	0	23.3
IPC	2.0	33	43	0	24.0
CIPC	2.0	89	87	0	24.4
Furloe	2.0	88	78	0	21.4
Sinbar	.5	94	92	0	20.8
Sinbar	1.0	97	95	0.5	23.6
Preemerge	2.0	72	77	0	22.1
Enide dinitro	3.5	88	72	0	22.5
Simazine	3.5	97	93	0.5	21.8
GS 14254	0.75	87	85	0	25.2
GS 14254	1.5	98	93	0	22.6
Planavin ^{c/}	0.75	7	7	0	22.3
Planavin	1.0	96	87	0	22.0
Planavin ^{d/}	1.5	13	10	0	22.2
Blade X ^{c/}	2.0	98	94	0	24.2
Blade X ^{c/}	4.0	97	97	2.0	24.1

a/ Conducted in St. Clair Co., near the Southwestern Farms Research Center.

b/ Major weed species: common chickweed, henbit, peppergrass, daisy fleabane, and downy borme.

c/ 0 = no injury; 10 = severe stunting, but not killed.

d/ Spring-applied on March 4, 1969; all other treatments applied November 25, 1968.

Table 2. Selective Control of Winter Annual Weeds in Established Alfalfa, 1969 Alfalfa and Weed Yields^{a/}

Chemical	Lb./A. (a.i.)	1st cutting		2nd cutting	Lb./A. alfalfa @12% 1st + 2nd cutting
		lb./A. Alfalfa	@ 12% Weeds ^{b/}	lb./A..@12% alfalfa	
Weedy Check		2,654	794	6,074	8,728
IPC	2.0	2,753	449	5,742	8,495
CIPC	2.0	2,927	191	6,568	9,495
Furloe	2.0	2,872	311	6,888	9,760
Sinbar	.5	3,100	36	6,604	9,704
Sinbar	1.0	2,912	12	6,831	9,743
Preemerge	2.0	2,939	488	7,268	10,207
Enide dinitro	3.5	2,938	538	6,227	9,165
Simazine	1.5	2,917	6	5,856	8,773
GS 14254	0.75	3,020	238	6,622	9,642
GS 14254	1.5	2,937	53	5,946	8,883
Planavin ^{c/}	0.75	2,225	1,098	6,157	8,382
Planavin	1.0	2,911	198	5,606	8,517
Planavin ^{c/}	1.5	2,991	361	6,353	9,344
Bladex ^{c/}	2.0	2,490	101	6,242	8,732
Bladex ^{c/}	4.0	2,383	5	6,023	8,406

a/ Conducted in St. Clair Co., near the Southwestern Farms Research Center.

b/ Hand-separated values. Major species: common chickweed 80-90%. Balance composed of henbit, peppergrass, daisy fleabane, and downy brome.

c/ Spring-applied on March 4, 1969; all other treatments applied November 25, 1968.

CHANGING TILLAGE PRACTICES AND IMPLICATIONS FOR PEST CONTROL

W.R. Oschwald

The kind and amount of tillage required for efficient crop production have received considerable attention in recent years. This interest has been generated by two particularly important factors.

PRODUCTION COSTS AND ENVIRONMENTAL CONCERN

Spiraling production costs have caused many crop producers to explore the possibilities of reducing these costs by eliminating unnecessary tillage. Also, we are in a period when public concern is widespread about wind and water erosion as agents of environmental pollution. This second factor is only one facet of a general concern about the deterioration of environmental quality.

Tillage practices that leave the soil exposed to the elements for six months or more each year are suspect, as concerned citizens examine the causes of dust in the air, muddy streams, and silt-filled lakes.

CONSERVATION TILLAGE

The concept of conservation tillage has been developed as a positive effort to significantly reduce wind and water erosion in Illinois. Its objective is to permit the production of row crops so that soil losses from wind and water are kept at acceptable levels. Conservation tillage is based on sound principles of erosion control.

The water-erosion-control effect of conservation tillage comes from the following:

1. Dissipation of the impact energy of rain drops.
2. Maintenance of high infiltration rates.
3. Reduction in the velocity of runoff.
4. Management of soils to increase their resistance to erosion.
5. Reduction in tillage so that less energy is available for the detachment of soil particles.

The wind-control aspects of conservation tillage result from the following:

1. Protection of the soil with a vegetative cover.
2. Use of a rough soil surface to reduce wind velocity.
3. Production of stable aggregates large enough to resist movement by wind.
4. Placement of barriers in the path of the wind, to trap drifting soil.

The tillage practices that are used include (a) reduced tillage in moldboard-plow systems, (b) winter cover crops, (c) chisel-plow systems, (d) zero-tillage systems, and (e) strip-tillage systems.

The effectiveness of conservation tillage in reducing erosion can be illustrated with soil-loss estimates, calculated with the Universal Soil-Loss Equation. The estimated soil losses for Tama silt loam--at a 6-percent slope and 300 feet long--with a continuous-corn-cropping sequence are given below.

Conservation practice	Estimated soil loss tons/a./yr.
None ^{a/}	39 ^{b/}
Terraces.....	9 ^{b/}
Chisel plow system ^{2/}	2
Zero tillage system ^{2/}	1

a/ Up-and-down-slope tillage. Contouring will reduce the estimated soil losses by about 50 percent

b/ Exceeds the present soil-loss tolerance of 5 tons per acre per year.

The effect of conservation tillage on soil use involves (a) the reduction of soil losses with a given cropping sequence and (b) the extension of continuous row-crop production to soils where it is not now feasible because of erosion hazard.

The conservation benefits are accompanied by a "cost" in the form of potential and present problems with pest control. Weeds, insects, plant diseases, and rodents and birds are regarded as pests. The problems of pest control in conservation-tillage systems result from changes in the environment that result directly or indirectly from the tillage practices.

WEED CONTROL

The problems associated with inadequate weed control would seem to be the most likely factors limiting the adoption of conservation tillage by farmers. Weed-control difficulties are not unique to conservation tillage systems, but these systems do present some unique problems.

Incorporating herbicides may be difficult in reduced-tillage systems where the interrow area is left rough and porous. However, the loose soil conditions do provide a certain amount of "built-in" weed control. Crop residues on the surface provide direct and indirect interference with effective weed control.

Directly, the residues present a physical block that keeps the herbicide from reaching the soil surface--the site of many weed seeds. Effective mechanical weed control is often difficult to obtain because of the interference of crop residues with the operation of hoes, cultivators, and weederes. Indirectly, the crop residues influence weed problems through their effect on soil-moisture relationships. The mulch reduces evaporation from the soil surface. As a result, soil at the mulch-soil interface is sufficiently moist so that weed seeds can germinate. In clean tillage systems, the surface quarter to half inch of bare soil may dry as a result of evaporation, so that weed-seed germination is hindered. Weed control resulting from soil disturbance is precluded in zero-tillage systems, which by definition rely exclusively on herbicides for vegetation control.

INSECT CONTROL

Insect control problems have been associated with conservation tillage, although such reports have been fewer than those of difficulty with weed control. Incorporation is likely to be more important with insecticides than with herbicides.

The potential problem of reduced insecticide effectiveness with conservation tillage needs to be recognized. Clean tillage has been suggested as a means of corn-borer control for many years. The clean plowing campaigns of the late 1940's and early 1950's are historical examples. Tillage systems that leave residues on the soil surface until they decompose provide a haven for certain insects. This is especially true if the residues are *not* chopped, disked, or shredded.

Grassy weed infestations, although not unique to conservation tillage, may be more severe. Such infestations provide a home for the common stalk borer and other insects. In general, the environmental changes that accompany conservation tillage appear to have the effect of worsening rather than alleviating insect problems.

DISEASE CONTROL

Traditional disease-control practices have included the use of disease-resistant varieties or hybrids, crop rotations, and clean tillage. Making use of resistant varieties or hybrids is still part of the picture, but crop rotations are often regarded as obsolete--except for corn-soybean rotations.

Clean tillage has had the effect of burying the causative organisms along with the crop residues. If left on the soil surface, the disease organisms can be carried to susceptible crop plants by rain-drop splash, wind, or insects. This could be a potential problem with conservation-tillage systems that utilize a mulch of crop residues. The possibilities of severe damage from diseases associated with surface residues are greater with soybeans than with corn. However, the pattern of continuous soybeans or soybeans following soybeans is not as common in most areas as continuous corn or corn after corn.

Tillage-associated disease problems have not been widely reported to date. However, the environmental changes that accompany conservation tillage could increase the seriousness of the problem in the future.

RODENT AND BIRD DAMAGE

Stand reduction caused by mice, ground squirrels, and pheasants has been a problem in the tillage plots on the Agronomy South Farm at Urbana. Pheasant damage is a frequent problem in the plots, and may result in part from the wildlife refuge atmosphere that is maintained on University property. The damage from pheasants does not appear to be closely associated with tillage practices, since it occurs in most plots on the South Farm. Damage from mice and ground squirrels does appear to be associated with tillage treatments. The undisturbed residues provide a haven for mice. The lack of disturbance from tillage equipment leaves the ground squirrel dens undisturbed.

CONSERVATION TILLAGE--PROBLEM OR SOLUTION?

Conservation tillage represents an important technological advance in terms of erosion control. This practice provides effective control at low cost, especially compared to that of installing the new, parallel, tile-outlet terrace systems

(\$50 to \$100 per acre). However, there are particular problems that appear to be associated with tillage treatment. These problems must be solved before conservation tillage will receive general acceptance by farmers.

These problems do not seem to be beyond solution, but they will require recognition of the environmental changes that accompany the conservation-tillage practices. When problems develop, alertness on the part of the crop producer can result in timely, corrective action.

SEED-TREATMENT RECOMMENDATIONS FOR FIELD AND FORAGE CROPS

M.C. Shurtleff and E.E. Burns

RPD No. <u>1/</u>		Fungicide	Remarks
<u>BARLEY</u>			
100	Black (semi-loose) and covered smuts	Ceresan M Ceresan M-DB	Sow <i>only</i> certified, disease-free seed. If possible, apply fungicide 5 days to 3 months before planting. Ceresan M-DB and Panogen PX are drill-box treatments.
103	Seed-borne scab	Ceresan L	
105	Septoria leaf blotch	Chipcote 25	Mercurial fungicides are extremely poisonous. In case of sickness while or after using, call your physician.
106	Bacterial blights	Chipcote 75	Read and follow <i>exactly</i> all directions,, precautions, and dosages given on manufacturer's label. Read <i>Report on Plant Diseases</i> No.1001 (Revised), "Fungicide Seed Treatment for Small Grains."
115	Spot blotch, net blotch, and stripe	Ortho LM Seed Protectant Ortho LM (concentrate)	<i>All treated seed must be prominently colored and labeled, and shall not be mixed with food or feed</i> (FDA Nov. 4, 1964).
116	Scald	Panogen 15	
313	Anthracnose	Panogen 42	
113	Seed rot, root rots, pre-emergence damping-off, seedling blights	Panogen PX	NOTE: True loose smuts of barley, wheat, and rye can only be controlled chemically by treatment with Vitavax-75W (Uniroyal); cleared <i>only</i> for treating foundation and registered seed. Vitavax cannot be used to treat certified seed or seed grown for feed or food purposes. Smut-infected seed may be treated with hot water or by anaerobic storage. (See <i>Report on Plant Diseases</i> No.100 and 112.) Recommended <i>only</i> for those who have the necessary equipment.

1/ Refers to the series *Report on Plant Diseases*. Copies are available from the Department of Plant Pathology, 218 Mumford Hall, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801.

RPD No. <u>1/</u>	Diseases	Fungicide	Remarks
<u>OATS</u>			
103	Seed-borne scab	(Same as for barley.)	If possible, apply a week to 3 months before planting, or use Ceresan M-DB or Panogen PX in the drill box. See section on Barley.
106	Bacterial blights		
111	Septoria leaf blotch		
114	Loose and covered smuts		
313	Anthracnose		
309	Helminthosporium		
113	Seed rot, pre-emer- gence damping-off and seedling blights		

RYE

103	Seed-borne scab	(Same as for barley.)	Apply 24 hours to 3 months before planting, or use Ceresan M-DB or Panogen PX in the drill box. See section on Barley.
106	Bacterial blights		
116	Scald		
309	Helminthosporium		
313	Anthracnose, smuts		
113	Seed rot, pre-emer- gence damping-off and seedling blights		

WHEAT

103	Seed-borne scab	(Same as for barley.)	Apply 24 hours to 3 months before plant- ing, or use Ceresan M-DB or Panogen PX in the drill box. See under Barley (above).
105	Septoria leaf and glume blotch		
106	Bacterial blights		
116	Stinking smut (Bunt)		
313	Anthracnose		
113	Seed rot, root rots, pre-emergence damping- off, seedling blights		

RPD No. <u>1/</u>	Diseases	Fungicide	Remarks
<i>CORN, SORGHUMS, AND BROOM CORN</i>			
	Seed rot, seed-borne root rots, pre-emergence damping-off and seedling blights	Captan <u>2/</u> Thiram <u>3/</u>	Apply any time. Do <i>not</i> use mercury-containing seed disinfectants. All commercially produced field corn is treated by the processor. Most sorghum seed now comes treated. Arasan 42-S is used on sorghums after heading to protect against seed molds.
208	Kernel and head smuts		
202	Helminthosporium leaf blights		
315	Bacterial blights		

FORAGE GRASSES

(Bluegrass, Bromegrass, Millets, Orchardgrass, Redtop, Reed canarygrass, Sudan-grass, Sudangrass-Sorghum hybrids, Tall Fescue, Timothy)

103	Seed-borne scab	Captan	Apply any time. A fungicide containing mercury (see under barley) is needed to eliminate disease-producing fungi and bacteria <i>under</i> the seedcoat. Most forage grass seed, however, cannot be treated with mercury without seriously reducing germination. The recommended fungicides--captan and thiram--are the only protectants against organisms borne externally on the seed and those that attach the germinating seed or young seedling.
105	Septoria leaf blotch	Thiram	
116	Scald		
309	Helminthosporium leaf		
202	Spots and blotches		
311	Selenophoma leaf spot		
313	Anthracnose		
314	Stripe smut and other smuts		
315	Bacterial blights		
113	Seed rot, seed-borne root rots, pre-emergence damping-off, seedling blights, and crown rots		

2/ Captan (with or without dieldrin) is sold as Orthocide 65 and 75 Seed Protectant, Stauffer Captan 75 Seed Protectant, Orthocide Dieldrin 60-15 Seed Protectant, Stauffer 60-15 Seed Protectant and 75-3 Seed Protectant, E-Z-Flo Captan-Dieldrin 60-15 Seed Protectant, Sure Death Caprin Seed Treater, etc.

3/ Thiram (with or without dieldrin) is sold as Arasan 50 and 50-Red Thiram Seed Protectant, Arasan 42-S, Arasan 75, Arasan SF-X, Science Seed Protectant, etc.

RPD No. <u>1/</u>	Diseases	Fungicide	Remarks
<u>LEGUMES</u> (Soybeans, Alfalfa, Clovers, Birdsfoot Trefoil, Lespedeza, and other small-seeded legumes)			
301	Black stem, Cercospora leaf spot, Stemphylium spot, and downy mildew (alfalfa and clovers)	Captan Thiram	Sow <i>only</i> certified, top-quality seed. Seed treatment is <i>not</i> generally recommended for soybeans, clovers, alfalfa, birdsfoot trefoil, and lespedeza. Seed treatment is justified <i>only</i> where the seed is of poor quality or stands consistently fail. Read <i>Report on Plant Diseases</i> No.306 ("Seed Rot. Damping-off, Seedling Blights of Alfalfa and Clovers") and No.506 ("Should Soybean Seed Be Treated?"). Apply fungicide any time. Inoculate <i>after</i> treating seed and <i>within 2 hours</i> of the time of planting.
306	Seed rot, pre-emergence		
504	Damping-off and seedling blights (clovers, alfalfa and soybeans)		
502	Bacterial blights (soybeans)		
503	Brown spot, downy mildew, frog-eye leaf spot, purple seed stain, and anthracnose (soybeans)		
504	Stem canker, pod and stem blight (soybeans)		

FUNGICIDE SEED TREATMENTS FOR FIELD AND FORAGE CROPS, APPROVED BY USDA, JANUARY 1, 1970
 FDA-permitted tolerance (NF or E)

CROP	CAPTAN	CERESAN	ORTHO SEED PROTECTANT	PANOGEN	THIRAM
BARLEY	D	D,E	D,E	D,E	---
CORN	D	---	---	D,E	D
MILLETS	---	D,E	---	---	D
OATS	D	D,E	D,E	D,E	---
RYE	D	D,E	---	D,E	---
SORGHUM	D	D,E	D,E	D,E	D
SOYBEAN	D	---	---	D,E	D
WHEAT	D	D,E,L	D,E	D,E	---

Fungicide Seed Treatments (Con't)

No tolerances have been set for these fungicides on alfalfa, birdsfoot trefoil, bluegrass, bromegrass, broom corn, clovers, lespedeza, orchard grass, redtop, reed canarygrass, sudangrass, tall fescue, or timothy.

Ceresan is sold as Ceresan M (7.7%), Ceresan M-DB (1.93%) and Ceresan L. Ortho Seed Protectant is sold as Ortho LM and Ortho LM Concentrate. Panogen is sold as Panogen 15 (2.2%), Panogen 42 (6.3%) and Panogen PX (0.9%).

The following abbreviations are used:

- D = do not use treated seed for food, feed or oil.
- E = extended tolerance.
- L = single, late fall, low pressure spray - Ceresan L only (use great caution).
- NF = non-food use.

Cooperative Extension Service
University of Illinois College of Agriculture in
Cooperation With the Illinois Natural History Survey
Urbana, Illinois

CHECK LIST OF INSECTICIDES

There are many insecticides listed in Circulars 897 (Commercial Vegetables), 898 (Livestock), 899 (Field Crops), and 900 (Homeowner) containing the current Illinois insecticide recommendations. The following list gives some information about these insecticides; we have also included other insecticides that have label approval but are not in the Illinois recommendations.

The insecticide names are listed at the left in capital letters. Usually these are the common names, but if they are trade names they are marked with an asterisk. Trade names and other identifying names follow the common names. The name of the basic manufacturer is listed after the trade name.

Toxicity ratings for each insecticide are listed below the name. An acute oral toxicity rating for each insecticide is given, also a dermal toxicity rating if known. Acute oral toxicity ratings are usually obtained by feeding white rats, acute dermal ratings by skin absorption tests on rats or rabbits. These figures are expressed as LD50. This means the size of the dose which is lethal to 50 percent of the test animals. LD50 is expressed in terms of milligrams of actual insecticide per kilogram of body weight of the test animal--mg./kg. Chronic oral toxicity (90 days plus) with the no-effect level in the diet is expressed in parts per million. When available, toxicity ratings of insecticides to fish and honeybees are also given. Those for bees can be interpreted readily as follows: (1) High--kills bees on contact and by residues; bees should be removed from area of application. (2) Moderate--kills bees if applied over them; limited damage with correct dosage, timing, and method of application. (3) Low--can be used around bees with few precautions and a minimum of injury.

To express toxicity in practical terms, the factor .003 times the LD50 value will give the ounces of actual insecticide required to be lethal to one of every two 187-pound men or other warm-blooded animals. As an example, the oral LD50 value for malathion is 1,200 mg./kg.; thus, if a group of men each weighing 187 pounds ate 3.6 ounces (1,200 times .003) of actual malathion per man, half of them would succumb. The dermal-toxicity-LD50 value of malathion is approximately 4,000 mg./kg. or for a 187-pound man, 12 ounces. If you check the list of insecticides, you will find some highly toxic chemicals with LD50 values from 1 to 10 mg./kg. For the average man, fatal doses of these would be in the range of .003 to .03 ounce.

By comparison, the oral LD50 value of aspirin is 1,200 mg./kg. or 3.6 ounces per 187-pound man, the equivalent of malathion. The oral LD50 value of ethyl alcohol is 4,500 mg./kg. If a group of 187-pound men each consumed somewhat more than 1 quart of 80 proof whiskey in 45 minutes they would not only be intoxicated, 50 percent of them might die.

It is important to remember that these toxicity ratings of each insecticide listed are approximate and pertain to white rats and sometimes rabbits. Such ratings do serve as a guide to compare the toxicity of insecticides as well as an indication of their comparative acute toxicity to other warm-blooded animals and man. Acute toxicity ratings expressed as LD50 are classified as to their relative danger when being used. An LD50 of 750 mg./kg. or higher is rated as low toxicity, LD50 ratings of 150-750 is moderate, 50-150 is moderately high, and 50 or less is very high.

The chemical group to which the insecticide belongs is given after the toxicity ratings. From this, you can determine which insecticides have similar chemical properties. A brief statement follows the chemical group name, describing in general terms the principal uses for the insecticide.

Remember, this is not a list of recommended insecticides, nor is it to be used in determining what insecticide to use to control a particular insect. This list is a quick insecticide reference to compare common chemical names to trade names, their toxicity ratings and general uses.

ABATE*

American Cyanamid

Acute oral--1,000-3,000
Acute dermal--1,024-1,782
Chronic oral--2

Organic phosphate--Used as a larvicide for mosquito control.

ACARALATE*--see chloropropylate

AKTON*--

SD 9098

Shell

Acute oral--146
Acute dermal--177
Organic phosphate--Insecticide for lawn insects.

ALDRIN

Shell

Acute oral--39-60
Acute dermal--98
Chronic oral--0.5

Fish toxicity--Very high
Bee toxicity--High

Chlorinated hydrocarbon--Used as a soil insecticide for corn soil insects and termites.

* Trade name.

BINAPACRYL	Morocide, Acricid	FMC
Acute oral--161		Bee toxicity--Low
Acute dermal--1,350		
Nitrophenol--A miticide for certain fruit crops.		
BUXTEN*	Ortho 5353	Chevron
Acute oral--87		
Acute dermal--400		
Carbamate--Used for soil insect control in corn.		
BUTOXY POLYPROPYLENE GLYCOL	Crag Fly Repellent	Union Carbide
Acute oral--9,100-11,200		
Chronic oral--640		
Repellent--Used in sprays for cattle against flies.		
CARBARYL	Sevin	Union Carbide
Acute oral--500-850		Fish toxicity--Very low
Acute dermal--4,000+		Bee toxicity--High
Chronic oral--200		
Carbamate--A general insecticide registered for control of many pests of field crops, vegetables, fruit, homeowner, and livestock.		
CARBOFURAN--	NIA 10242, Furadan	Niagara, FMC, Chemagro
Acute oral--5		
Acute dermal--885		
Carbamate--Systemic insecticide for corn soil insects and experimental use on alfalfa weevil.		
CARBON DISULFIDE		Stauffer
Chronic vapor--20 ppm. (40 hr.)		
Acute vapor--200 ppm. (1 hr.)		Allied, Diamond Alkali, Dow, FMC, Frontier, Stauffer
Fumigant--Used on stored products.		
CARBON TETRACHLORIDE		Allied, Diamond Alkali, Dow, FMC, Frontier, Stauffer
Acute oral--5,730-9,770		
Acute dermal--5,070-8,780		
Chronic vapor--10 ppm. (40 hr.)		
Acute vapor--300 ppm. (1 hr.)		
Fumigant--Used as safener in fumigant mixtures for stored grain insects.		
CARBOPHENOTHION	Trithion, Garrathion	Stauffer
Acute oral--10-30		Bee toxicity--Moderate
Acute dermal--27-54		
Chronic oral--5		
Organic phosphate--Insecticide with lasting residue with limited use on some fruits and vegetables. It is used chiefly as a miticide.		

* Trade name.

CHLORBENSIDE	Mitox	Chevron
Acute oral--3,000		Bee toxicity--Low
Chronic oral--20		
Organic sulfide--A miticide used on many fruit crops.		
CHLORDANE	Octachlor, Octa-Klor	Velsicol
Acute oral--335-430		Fish toxicity--Very high
Acute dermal--690-840		Bee toxicity--High
Chronic oral--25+		
Chlorinated hydrocarbon--A residual insecticide for control of ants and roaches and a soil insecticide for termites, lawn, and corn soil insects.		
CHLOROBENZILATE		Geigy
Acute oral--1,040-1,220		Bee toxicity--Moderate
Acute dermal--5,000+		
Chlorinated hydrocarbon--A comparatively safe miticide used in orchards and greenhouses.		
CHLOROPICRIN	Picfume	Dow, Morton
Chronic vapor--0.1 ppm. (40 hr.)		
Acute vapor--20 ppm. (1 hr.)		
Fumigant--Used on stored products in ship holds.		
CHLOROPROPYLATE		Geigy
Acute oral--34,600		Bee toxicity--Low
Acute dermal--10,200		
Chronic oral--40		
Chlorinated hydrocarbon--Miticide for fruit crops.		
CIODRIN*	SD 4294	Shell
Acute oral--125		Bee toxicity--High
Acute dermal--385		
Chronic oral--7		
Organic phosphate--Used to control livestock insects, especially biting flies.		
COMPOUND 4072	SD 7859	Allied, Shell
Acute oral--13		
Acute dermal--30		
Organic phosphate--A residual insecticide for fly control in livestock barns and as a soil insecticide in corn.		

CO-RAL*--see coumaphos

* Trade name.

COUMAPHOS	Co-Ral	Chemagro
Acute oral--15-41		Bee toxicity--Moderate
Acute dermal--860		
Chronic oral--5		
Organic phosphate--A systemic insecticide for beef cattle and poultry to control grubs, lice, and mites.		
CRUFOMATE--see Ruelene		
CYGON*--see dimethoate		
CYTHION*--see malathion		
Acute dermal--3-30		
DASANIT*	Bayer 25141	Chemagro
Acute oral--2-11		
Acute dermal--3-30		
Organic phosphate--Insecticide and nematicide for soil insect control in corn and for onion maggot control.		
DDD*--see TDE		
DDT	Allied, Diamond Alkali, Geigy Lebanon, Montrose, Olin Mathieson, Stauffer	
Acute oral--113-118		Fish toxicity--Very high
Acute dermal--2,510		Bee toxicity--Moderate
Chronic oral--5		
Chlorinated hydrocarbon--Not suggested for use in Illinois.		
DDVP*--see dichlorvos		
DEET	Off, Delphene, diethyltoluamide	Hercules
Acute oral--1,950		
Acute dermal--10,000		
Repellent--Used for control of biting insects and chiggers on man. Applied directly to skin.		
DELNAV*--see dioxathion		
DEMETON	Systox	Chemagro
Acute oral--2-6		Fish toxicity--Moderate
Acute dermal--8-14		Bee toxicity--Low
Chronic oral--1		
Organic phosphate--A systemic miticide and aphicide for use in greenhouses, orchards, and on certain field crops.		

* Trade name.

DESSIN*		Murphy, Union Carbide
Acute oral--100-155		
Acute dermal--1,000		
Carbonate--Miticide for fruit crops.		
DIAZINON	Spectracide	Geigy
Acute oral--76-108		Fish toxicity--High
Acute dermal--455-900		Bee toxicity--High
Chronic oral--1		
Organic phosphate--A general insecticide; can be used as a residual fly spray in barns, also to control insects in soil of cornfields, as well as insect pests of turf, vegetables, fruits, and household.		
DIBROM*--see naled		
DIBUTYL PHTHALATE	DBP	Allied, Monsanto, Commercial Solvent
Acute oral--5,000-15,000		
Repellent--For impregnating clothing to repel chiggers and mites.		
DICHLORVOS	DDVP, Vapona	Shell
Acute oral--56-80		Fish toxicity--Moderate
Acute dermal--75-107		Bee toxicity--High
Organic phosphate--Short-lived residual insecticide for livestock, fly bait, greenhouses, and warehouses. Impregnated in plastic resin strips.		
DICOPOL	Kelthane	Rohm and Haas
Acute oral--1,000-1,100		Fish toxicity--High
Acute dermal--1,000-1,230		Bee toxicity--Low
Chronic oral--20		
Chlorinated hydrocarbon--Miticide used on vegetables, fruit, and ornamentals.		
DIELDRIN	Octalox	Shell
Acute oral--46		Fish toxicity--Very high
Acute dermal--60-90		Bee toxicity--High
Chronic oral--0.5		
Chlorinated hydrocarbon--Used as a seed treatment insecticide and for control of specific fruit insects, lawn soil insects, termites and household insects.		
DIMETHOATE	Cygon, Rogor, Roxion	American Cyanamid
Acute oral--215		Fish toxicity--Very low
Acute dermal--400-610		Bee toxicity--High
Chronic oral--5		
Organic phosphate--A systemic insecticide for use on certain vegetable crops and residual fly spray inside of livestock barns.		

* Trade name.

DIMETHYL PHTHALATE	DMP	Monsanto, Allied
Acute oral--8,200		
Acute demal--4,000+		
Repellent--General purpose mosquito repellent.		
DIMETILAN*	SNIP	Geigy
Acute oral--25-64		
Acute dermal--600+		
Chronic oral--400		
Carbamate--Insecticide impregnated on plastic foam bands for fly control in livestock buildings.		
DINITRO COMPOUNDS	Elgetol 318, DNOC	Dow, FMC, Chem. Ins. Corp.
Acute oral--5-60		
Acute demal--150-600		
Nitrophenol--Used primarily for controlling aphids, mites, and scale insects as dormant fruit spray.		
DINOCAP	Karathane	Rohm and Haas
Acute oral--980-1,190		
Acute dermal--4,700-9,400		
Dinitro--A fungicide used for control of powdery mildew; also acts as a mite suppressant.		
DIOXATHION	Delnav, Navadel	Hercules
Acute oral--23-43		
Acute dermal--63-235		
Chronic oral--4		
Organic phosphate--Miticide and insecticide used as an animal dip and spray.		
DIPTEREX*--see trichlorfon		
DISULFOTON	Di-Syston, dithiodemeton, thiodemeton	Chemagro
Acute oral--2-7		
Acute dermal--6-15		
Chronic oral--2		
Organic phosphate--A systemic insecticide to control aphids, leafhoppers, and flea beetles on certain vegetable crops. Also a soil insecticide for corn.		
DI-SYSTON*--see disulfoton		

* Trade name.

DURSBAN*	Dowco 179	Dow
Acute oral--97-276		
Acute dermal--2,000		
Organic phosphate--Used as a soil insecticide in corn and for mosquito control.		
DYFONATE	N2790	Stauffer
Acute oral--16		
Organic phosphate--Used for soil insect control in corn.		
DYLOX*--see trichlorfon		
ENDOSULFAN	Thiodan, Malix	FMC
Acute oral--18-43		Bee toxicity--Moderate
Acute dermal--74-130		
Chronic oral--30		
Chlorinated hydrocarbon--Used on some vegetable crops to control aphids, cabbage worms, and other caterpillars. Also used for peach borer control.		
ENDRIN		Shell, Velsicol
Acute oral--8-18		Fish toxicity--Very high
Acute dermal--15-18		Bee toxicity--Moderate
Chronic oral--1		
Chlorinated hydrocarbon--Highly toxic residual insecticide used on some field crops and ornamentals.		
ENTEX*--see fenthion		
EPN		DuPont
Acute oral--8-36		Bee toxicity--High
Acute dermal--25-230		
Organic phosphate--Used for insect control on field crops.		
ETHION	Nialate	FMC
Acute oral--27-65		Bee toxicity--Low
Acute dermal--62-245		
Chronic oral--3		
Organic phosphate--Used for onion maggot control, aphids and mite control in orchards.		

* Trade name.

ETHYLENE DIBROMIDE

American Potash, Dow, FMC,
Great Lakes, Michigan Chemical

Acute oral--117-146
Acute dermal--300
Chronic vapor--25 ppm. (40 hr.)
Acute vapor--200 ppm. (1 hr.)
Fumigant--Used on stored products.

ETHYLENE DICHLORIDE

Diamond Alkali, Dow, Olin Mathieson

Acute oral--770
Acute dermal--3,890
Chronic vapor--50 ppm. (40 hr.)
Acute vapor--1,000 ppm. (1 hr.)
Fumigant--Used on stored grains.

EUGENOL

Penick

Acute oral--500-5,000
Attractant--Used for attracting fruit flies.

FAMPHUR

Famphos, Warbex

American Cyanamid

Acute oral--35-62
Acute dermal--1,460-5,093
Chronic oral--1

Organic phosphate--A systemic insecticide used for controlling grubs in cattle.

FENTHION

Baytex, Entex

Chemagro

Acute oral--215-245
Acute dermal--330
Chronic oral--2

Fish toxicity--Low
Bee toxicity--High

Organic phosphate--Residual fly spray for livestock barns. Used in mosquito control and for household insects.

FURADAN*--see carbofuron

NIA 10242, Furadan

Niagara, FMC, Chemagro

GALEGRON

Miticide for fruit crops.

GARDONA*

SD 8447, Rabon

Shell

Acute oral--4,000-5,000
Acute dermal--5,000+

Organic phosphate--Used for earworm control on seed corn, also for control of livestock flies and fruit insects.

GENITE

Acute oral--980
Acute dermal--940

Allied

Sulfonate--Miticide for fruit crops.

GERANIOL

Fritche

Attractant--Used as an attractant in traps for Japanese beetle.

GUTHION*--see azinphosmethyl

*Trade name.

Attractant--Used as an attractant for gypsy moths.

HEMPA

Eastman, Chemical Products

Acute oral LD 100--2,640

Organic phosphate--Used as a chemical sterilizing agent of insects.

HEPTACHLOR

Velsicol

Acute oral--100-162

Fish toxicity--Very high

Acute dermal--195-250

Bee toxicity--High

Chronic oral--0.5-5

Chlorinated hydrocarbon--Used as corn seed treatment, soil insecticide for white grubs, wireworms, and termites.

HYDROCYANIC ACID

HCN

American Cyanamid

Acute oral--4

Chronic vapor--10 ppm. (40 hr.)

Acute vapor--40 ppm. (1 hr.)

Fumigant--Used on stored products, for rodent control and building fumigation.

IMIDAN*

R-1504, Prolate

Stauffer

Acute oral--147-216

Acute dermal--3,160

Organic phosphate--Insecticide for fruit insect control, and against alfalfa insects.

KARATHANE*--see dinocap

KELTHANE*--see dicofol

Chlorinated hydrocarbon--Miticide to be used on vegetables, fruits, and ornamentals.

KEPONE*

Allied

Acute oral--125

Acute dermal--2,000+

Chlorinated hydrocarbon--Used in baits to control ants, roaches, and certain other insects.

KORLAN*--see ronnel

* Trade name.

Acute oral--103-178
Acute dermal--2,500

Carbamate--Experimental insecticide for possible use for soil insect control in corn.

LANNATE*--see methomyl

LEAD ARSENATE

Acute oral--1,050
Acute dermal--2,400+ Bee toxicity--High

Arsenical--Used to control certain chewing insects of fruit and ornamentals.

LETHANE 60*

Rohm and Haas

Acute oral--250-500
Acute dermal--3,000

Thiocyanate--Used in household insecticide sprays.

LETHANE 384*

Acute oral--90
Acute dermal--250-500

Thiocyanate--Used in livestock fly sprays as a quick knockdown agent.

LINDANE

gamma BHC

Hooker

Acute oral--88-91
Acute dermal--900-1,000
Chronic oral--50

Fish toxicity--Very high
Bee toxicity--High

Chlorinated hydrocarbon--Used to control spittlebugs on certain crops and mite and louse control on certain livestock.

MALATHION

Cythion

American Cyanamid

Acute oral--1,000-1,375
Acute dermal--4,444+
Chronic oral--100-1,000

Fish toxicity--High
Bee toxicity--High

Organic phosphate--General use insecticide for homeowner insect control, for certain livestock insects and certain crop insects. Premium grade used for treating grain to be stored.

* Trade name.

MEVINPHOS	Phosdrin	Shell
Acute oral--4-6		Bee toxicity--High
Acute dermal--4-5		
Chronic oral--0.8		
Organic phosphate--A short-lived residual insecticide for control of insects on certain field and vegetable crops.		
MGK-R11*		MGK
Acute oral--2,500		
Acute dermal--2,000+		
Repellent--Used in sprays for cattle against flies.		
MGK-R326*		MGK
Acute oral--5,230-7,230		
Acute dermal--9,400		
Repellent--Used in sprays for cattle against flies.		
MIREX		Allied
Acute oral--600-740		Bee toxicity--Moderate
Acute dermal--2,000+		
Chlorinated hydrocarbon--Used for fire ant control.		
MOBAM*	MCA600	Mobil
Acute oral--234		
Acute dermal--6,230		
Chronic--150		
Carbamate--Experimental insecticide for possible use on soil insects in corn, for insects on ornamentals, and for household insects.		
MOCAP*	VC9104	Mobil
Acute oral--62		
Acute dermal--26		
Phosphate--Experimental residual chemical for possible control of soil insects and nematodes.		

* Trade name.

MORESTAN*		Chemagro
Acute oral--1,100-1,800		Bee toxicity--Low
Acute demal--2,000+		
Chronic oral--50		
Organic carbonate--Miticide to be used on apples prior to bloom.		
MOROCIDE*--see binapacryl		
NALED	Dibrom	Chevron
Acute oral--250		Fish toxicity--High
Acute dermal--800		Bee toxicity--High
Organic phosphate--A short-lived residual insecticide for use in greenhouses and for certain field crops. Also used in fly baits in livestock barns.		
NEGUVON*--see trichlorfon		
NICOTINE	Black Leaf 40, Nicotine Sulfate	Center Chemical, Inc.
Acute oral--83		Bee toxicity--Low
Acute dermal--285		
Heterocyclic botanical compound--Contact insecticide that is used to control aphids.		
OVEX	Ovotran, Chlorofenson, Ovochlor	Dow, Murphy
Acute oral--2,050		Fish toxicity--Low
Chronic oral--25		Bee toxicity--Low
Sulfonate--Used to destroy mite eggs on certain fruit and vegetable crops and ornamentals.		
OXYDEMETONMETHYL	Meta-Systox R	Chemagro
Acute oral--65-75		Bee toxicity--Moderate
Acute dermal--250		
Chronic oral--10		
Organic phosphate--A systemic insecticide for controlling aphids, mites, and other plant-sucking insects.		
PARADICHLOROBENZENE	PDB, Paracide	Dow, Monsanto
Acute oral--1,000+		
Fumigant--Used as fumigant to control fabric pests. Obsolete for peach borer control.		

* Trade name.

PARATHION	Alkron, Niran, Stathion, Thiophos	American Cyanamid, American Potash, Monsanto, Shell, Stauffer, Velsicol
Acute oral--4-13		
Acute demal--7-21		Fish toxicity--High
Chronic oral--1		Bee toxicity--High
Organic phosphate--A highly toxic insecticide to control a wide range of insects and mites on vegetable, fruit, and field crops.		
PENTAC*	HRS-16	Hooker
Acute oral--3,160		Bee toxicity--Low
Acute demal--3,160+		
Chlorinated hydrocarbon--Miticide used on greenhouse floral crops and nursery stock.		
PERITHANE*		Rohm and Haas
Acute oral--4,000+		Fish toxicity--Very high
Chronic oral--500		Bee toxicity--Moderate
Chlorinated hydrocarbon--Used in formulating household insecticides and also used on certain vegetable crops.		
PHORATE	Thimet	American Cyanamid
Acute oral--1-3		Bee toxicity--Moderate
Acute demal--3-6		
Organic phosphate--A systemic insecticide for use on certain vegetable crops, field crops, and as a soil insecticide for corn.		
PHOSDRIN*--see mevinphos		
PHOSPHAMIDON	Dimecron	Chevron
Acute oral--24		Fish toxicity--Very low
Acute dermal--107-143		Bee toxicity--High
Organic phosphate--A systemic insecticide for use on certain fruit and vegetable crops.		
PIPERONYL BUTOXIDE	Butocide	FMC
Acute oral--7,500+		
Acute dermal--1,880		
Chronic oral--1,000		
Synergist--Commonly used with pyrethrum.		

* Trade name.

PYRETHRUM	pyrethrin I and II	FMC, Penick, MGK
Acute oral--820-1,870		Fish toxicity--High
Acute demal--1,880+		Bee toxicity--Low
Chronic oral--1,000		
Botanical--Used as a fly control insecticide in household and livestock sprays.		
RABON--see Gardona		
RAVAP*--mixture of dichlorvos and Gardona.		
RONNEL	Korlan, Trolene, Viozene	Dow
Acute oral--1,250-2,630		
Acute dermal--5,000+		
Chronic oral--10		
Organic phosphate--Used in baits and sprays for fly control in livestock barns.		
ROTENONE	derris, cube	FMC, Penick
Acute oral--50-75		Fish toxicity--Very high
Acute dermal--940+		Bee toxicity--Low
Chronic oral--25		
Botanical--A contact poison used to control certain home garden insects and cattle grubs.		
RUELENE*	Dowco 132	Dow
Acute oral--460-635		
Acute dermal--2,000-4,000		
Chronic oral--10-30		
Organic phosphate--A systemic insecticide for controlling grubs and lice on beef cattle.		
SEVIN*--see carbaryl		
SPECTRACIDE--see diazinon		
STROBANE	3961	Heyden
Acute oral--200		Fish toxicity--Very high
Acute demal--5,000+		Bee toxicity--Low
Chlorinated hydrocarbon--Used for certain cotton insect control and is sometimes used for fly control in livestock barns.		
SULFOXIDE	Sulfox-Cide	Penick
Acute oral--2,000		
Acute demal--9,000+		
Chronic oral--2,000		
Synergist--Commonly used with pyrethrum.		

* Trade name.

THIODAN*--see endosulfan

THURICIDE*--see bacillus thuringiensis

TOXAPHENE chlorinated camphene Hercules
Acute oral--80-90 Fish toxicity--Very high
Acute dermal--780-1,075 Bee toxicity--Low
Chronic oral--10
Chlorinated hydrocarbon--Used to control many insects of grain and forage crops, livestock, vegetable, and fruit crops. Use in backrubbers and as a sheep dip.

TRICHLORFON Dylox, Dipterex, Neguvon Chemagro
Acute oral--560-630 Fish toxicity--Very low
Acute dermal--2,000+ Bee toxicity--Low
Organic phosphate--Dipterex used in fly baits and Dylox as a spray for certain field crops, vegetable and ornamental insects.

TRITHION*--see carbophenothion

VAPATONE*--see TEPP

VAPONA*--see dichlorvos

WARF antiresistant for DDT* Penick
Acute oral--500
Acute dermal--9,400
Sulfonamide--Used with DDT as a residual spray against DDT resistant and nonresistant flies.

ZECTRAN* Dowco 139 Dow
Acute oral--25-37 Fish toxicity--Very low
Acute dermal--1,500-2,500 Bee toxicity--High
Carbamate--Used for ornamentals and turf insect control, also for control of slugs.

ZINOPHOS*-- Nemaphos, Nemafos American Cyanamid
Acute oral--9-16
Acute dermal--8-15
Chronic oral--5
Organic phosphate--A soil insecticide for control of garden symphylans and cabbage maggot.

* Trade name.

Prepared by entomologists of the Illinois Agricultural Extension Service and Illinois Natural History Survey. For additional copies, see your county farm adviser.

Urbana, Illinois January, 1970
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POISON CONTROL CENTERS IN ILLINOIS

DOWNSTATE

<u>HOSPITAL AND LOCATION</u>	<u>TELEPHONE</u>	<u>HOSPITAL AND LOCATION</u>	<u>TELEPHONE</u>
<i>Copley Memorial Hospital</i> Lincoln & Weston Ave. Aurora, Ill.	896-4611 Ext. 725	<i>USAF Hospital</i> Chanute Air Force Base, Ill.	893-3111 Ext. 2817 Nt. Ext. 6234 (Limited to treatment of military personnel and families, except for indicated civilian emergencies)
<i>St. Charles Hospital</i> 400 E. New York St. Aurora, Ill.	897-8714 Ext. 50	<i>Memorial Hospital</i> 1900 State St. Chester, Ill.	826-2388 Ext. 44
<i>Memorial Hospital</i> 4501 North Park Dr. Belleville, Ill.	233-7750 Ext. 2501 251	<i>Lake View Memorial Hospital</i> 812 N. Logan Danville, Ill.	443-5221
<i>USAF Medical Center</i> Scott Air Force Base, Ill. Near Belleville, Ill.	256-7595	<i>St. Elizabeth's Hospital</i> 600 Sager St. Danville, Ill.	442-6300
<i>Highland Hospital</i> 1625 South State St. Belvidere, Illinois	547-5441 Ext. 367	<i>Decatur-Macon Co. Hospital</i> 2300 N. Edward St. Decatur, Ill.	877-8121 Ext. 676
<i>MacNeal Memorial Hospital</i> 3249 S. Oak Park Ave. Berwyn, Ill.	474-2211 Ext. 311-312- 314	<i>St. Mary's Hospital</i> 1800 East Lake Shore Dr. Decatur, Ill.	429-2966 Ext. 640
<i>Mennonite Hospital</i> 807 North Main St. Bloomington, Ill.	828-5241 Ext. 311	<i>Holy Family Hospital</i> 100 North River Rd. Des Plaines, Ill.	299-2281 Ext. 856
<i>St. Joseph's Hospital</i> 2200 E Washington St. Bloomington, Ill.	829-9481 Ext. 352-354	<i>Christian Welfare Hospital</i> 1509 Illinois Ave. East St. Louis, Ill.	874-7076 Ext. 232
<i>St. Mary's Hospital</i> 2020 Cedar St. Cairo, Ill.	734-2400 Ext. 4542 Night Ext. 45	<i>St. Mary's Hospital</i> 129 North 8th St. East St. Louis, Ill.	274-1900
<i>Graham Hospital Association</i> 210 W. Walnut St. Canton, Ill.	647-5240 Ext. 48	<i>St. Anthony's Hospital</i> 503 North Maple St. Effingham, Ill.	342-2121 Ext. 67
<i>Doctor's Hospital</i> 404 W. Main St. Carbondale, Ill.	457-4101 Ext. 23	<i>St. Joseph's Hospital</i> 277 Jefferson Ave. Elgin, Ill.	741-5400 Ext. 69, 65
<i>St. Mary's Hospital</i> 400 North Pleasant Ave. Centralia, Ill.	532-6731 Ext. 626	<i>Sherman Hospital</i> 934 Center St. Elgin, Ill.	742-9800 Ext. 682
<i>Burnham City Hospital</i> 311 E. Stoughton St. Champaign, Ill.	336-2533		

<i>HOSPITAL AND LOCATION</i>	<i>TELEPHONE</i>	<i>HOSPITAL AND LOCATION</i>	<i>TELEPHONE</i>
<i>Memorial Hospital of DuPage County</i> 315 Schiller St. Elmhurst, Ill.	833-1400 Ext. 551 & 552	<i>Hoopeston Com. Mem. Hos.</i> 710 E. Orange Hoopeston, Ill.	283-5531
<i>Community Hospital</i> 2040 Brown Ave. Evanston, Ill.	869-5400 Day Ext. 54 Night Ext. 58	<i>Passavent Mem. Area Hos.</i> 1600 West Walnut Jacksonville, Ill.	245-9541 Ext. 222
<i>Evanston Hospital</i> 2650 Ridge Ave. Evanston, Ill.	492-6460	<i>St. Joseph's Hospital</i> 333 N. Madison St. Joliet, Ill.	725-7133 Ext. 793,794
<i>St. Francis Hospital</i> 355 Ridge Ave. Evanston, Ill.	492-2440	<i>Silver Cross Hospital</i> 600 Walnut St. Joliet, Ill.	727-1711 Ext. 731
<i>Little Company of Mary</i> 2800 W. 95th St. Evergreen Park, Ill. (P.O. Chicago.)	422-6200 Ext. 1211	<i>Riverside Hospital</i> 350 N. Wall St. Kankakee, Ill.	933-1671 Ext. 606
<i>Fairbury Hospital</i> 519 S. Fifth St. Fairbury, Ill.	692-2346	<i>St. Mary's Hospital</i> 150 S. Fifth St. Kankakee, Ill.	939-4111 Ext. 735
<i>Freeport Memorial Hospital</i> 420 S. Harlem Ave. Freeport, Ill.	233-4131 Ext. 228	<i>Kewanee Public Hospital</i> 719 Elliott St. Kewanee, Ill.	853-3361 Ext. 219
<i>Northwestern Illinois Community Hospital</i> Summit St. Galena, Ill.	777-1340	<i>Lake Forest Hospital</i> 660 Northwestmoreland Road Lake Forest, Ill.	234-5600 Ext. 608
<i>Galesburg Cottage Hospital</i> 674 N. Seminary St. Galesburg, Ill.	343-4121	<i>St. Mary's Hospital</i> 1015 O'Conor Ave. LaSalle, Ill.	223-0607
<i>St. Mary's Hospital</i> 239 S. Cherry St. Galesburg, Ill.	343-3161 Ext. 210	<i>Condell Memorial Hospital</i> Cleveland & Stewart Ave. Libertyville, Ill.	362-2900 Ext. 325-326
<i>St. Elizabeth's Hospital</i> 2100 Madison Ave. Granite City, Ill.	876-2020 Ext. 224-257	<i>Abraham Lincoln Memorial Hospital</i> 315 Eighth St. Lincoln, Ill.	732-2161 Ext. 346
<i>Ingalls Memorial Hospital</i> 15510 Page Ave. Harvey, Ill.	333-2300 Ext. 787	<i>McHenry Hospital</i> 3516 West Waukegan Road McHenry, Ill.	385-2200 Ext. 614
<i>St. Joseph's Hospital</i> 1515 Main St. Highland, Ill.	654-2171 Ext. 243	<i>McDonough District Hospital</i> 525 E. Grant St. Macomb, Ill.	833-4101
<i>Highland Park Hospital Foundation</i> 718 Glenview Ave. Highland Park, Ill.	432-8000 Ext. 561, 562, 563	<i>Mem. Dist. Hospital of Coles County</i> 2101 Champaign Ave. Mattoon, Ill.	234-8881 Ext. 29 Ext. 43
<i>Hinsdale San. & Hospital</i> 120 N. Oak St. Hinsdale, Ill.	323-2100 Ext. 336	<i>Westlake Hospital</i> 1225 Superior St. Melrose Park, Ill.	681-3000 Ext. 239-226

HOSPITAL AND LOCATION	TELEPHONE	HOSPITAL AND LOCATION	TELEPHONE
<i>Mendota Community Hospital</i> Memorial Drive & Route 51 Mendota, Ill.	7461 Ext. 20	<i>St. Francis Hospital</i> 530 Northeast Glen Oak Ave. Peoria, Ill.	674-2943
<i>Moline Public Hospital</i> 635 10th Ave. Moline, Ill.	762-3651 Ext. 232	<i>Peoples Hospital</i> 925 West St. Peru, Ill.	223-3300 Ext. 55 Night Ext. 40
<i>Community Memorial Hospital</i> W. Harlem Ave. Monmouth, Ill.	734-3141 Ext. 250	<i>Illini Community Hospital</i> 620 W. Washington St. Pittsfield, Ill.	285-2115 Ext. 238 Night Ext. 213
<i>Wabash General Hospital</i> 1418 College Dr. Mount Carmel, Ill.	262-4121 Ext. 231	<i>Blessing Hospital</i> 1005 Broadway Quincy, Ill.	223-5811 Ext. 211 - 212
<i>Good Samaritan Hospital</i> 605 N. Twelfth St. Mount Vernon, Ill.	242-4600 Ext. 303	<i>St. Mary's Hospital</i> 1415 Vermont St. Quincy, Ill.	223-1200 Ext. 275
<i>Edward Hospital</i> South Washington St. Naperville, Ill.	355-0450 Ext. 26	<i>Rockford Memorial Hospital</i> 2400 N. Rockton Ave. Rockford, Ill.	968-6861 Ext. 441
<i>Brokaw Hospital</i> Virginia at Franklin Ave. Normal, Ill.	829-7685 Ext. 274	<i>St. Anthony's Hospital</i> 6666 E. State St. Rockford, Ill.	398-7600 Ext. 228
<i>Christ Community Hospital</i> 4440 W. 95th St. Oak Lawn, Ill.	423-7000 Ext. 659-660	<i>Swedish-American Hospital</i> 1316 Charles St. Rockford, Ill.	968-6898 Ext. 602
<i>West Suburban Hospital</i> 518 N. Austin Boulevard Oak Park, Ill.	383-6200 Ext. 605	<i>St. Anthony's Hospital</i> 767 30th St. Rock Island, Ill.	788-7631 Ext. 771
<i>Richland Memorial Hospital</i> 800 E. Locust St. Olney, Ill.	395-2131	<i>Delnor Hospital</i> 975 N. Fifth Ave. St. Charles, Ill.	584-3300 Ext. 229 Night Ext. 286
<i>Ryburn Memorial Hospital</i> 701 Clinton St. Ottawa, Ill.	433-3100	<i>USAF Medical Center</i> Scott Air Force Base, Ill. Belleville, Ill.	256-7595
<i>Lutheran General Hospital</i> 1775 Dempster St. Park Ridge, Ill.	692-2210	<i>Memorial Hospital</i> First and Miller Sts. Springfield, Ill.	528-2041 Ext. 333
<i>Pekin Memorial Hospital</i> Corner of 14th & Court St. Pekin, Ill.	347-1151 Ext. 241-233	<i>St. John's Hospital</i> 701 East Mason St. Springfield, Ill.	544-6451 Ext. 375
<i>Methodist Hospital</i> 221 Northeast Glen Oak Ave. Peoria, Ill.	685-6511 Ext. 250	<i>St. Mary's Hospital</i> 111 E. Spring Streator, Ill.	672-3189 Ext. 221
<i>Proctor Community Hospital</i> 5409 N. Knoxville Ave. Peoria, Ill.	691-4702 Ext. 791-792	<i>Carle Hospital</i> 611 W. Park St. Urbana, Ill.	337-3313

<i>HOSPITAL AND LOCATION</i>	<i>TELEPHONE</i>	<i>HOSPITAL AND LOCATION</i>	<i>TELEPHONE</i>
<i>Mercy Hospital</i> 1412 West Park Ave. Urbana, Ill.	337-2131	<i>Memorial Hospital for</i> <i>McHenry County</i> 527 W. South St. Woodstock, Ill.	338-2500 Ext. 32
<i>St. Therese Hospital</i> W. Washington St. Waukegan, Ill.	688-6470 688-6471	<i>Zion-Benton</i> <i>Hospital</i> 2500 Emmaus Ave. Zion, Illinois	872-4561 Ext. 240
<i>Victory Memorial Hospital</i> 1324 N. Sheridan Road Waukegan, Ill.	688-4181		

MASTER CHICAGO CENTER
For information, treatment
and reference on poisoning

<i>Presbyterian-St. Luke's Hospital</i> 1753 W. Congress Parkway Chicago, Ill.	SEeley 8-4411 Ext. 2267
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The following Chicago centers
are treatment centers only

<i>Children's Memorial Hospital</i> 2300 Children's Plaza Chicago, Ill.	348-4040 Ext. 338
<i>Cook County Hospital</i> 1825 W. Harrison St. Chicago, Ill.	633-6542
<i>University of Illinois Hospitals</i> 840 S. Wood St. Chicago, Ill.	663-7297
<i>Mercy Hospital</i> 2510 S. Park Way Chicago, Ill.	842-4700
<i>Michael Reese Hospital</i> 29th St. & Ellis Ave. Chicago, Ill.	225-5525 Ext. 761 Night Ext. 767 " " 261
<i>Mt. Sinai Hospital</i> 15th & California Chicago, Ill.	
<i>Municipal Contagious Disease</i> 3026 S. California Ave. Chicago, Ill.	247-5700
<i>Resurrection Hospital</i> 7435 W. Talcott Ave. Chicago, Ill.	774-8000 Ext. 235
<i>Wyler Silvain & Arma Children's</i> <i>Hospital</i> 950 E. 59th St. Chicago, Ill.	684-6100 Ext. 6231 6232, 6032

CHEMICAL CONTROL OF SOME AQUATIC PLANTS FOR 1970

R.C. Hiltibran

Procedures for chemical control of aquatic plants can be divided into three general steps: (1) Identification of the plant that needs to be controlled; (2) selection of an effective herbicide; (3) determination of rate and method of application.

On the following pages is a summary of the rates of herbicide which have been found effective on many aquatic plants common in Illinois. The rates are listed under each aquatic plant and the plants have been divided into six different groups based on the leaf attachment and their distribution in bodies of water. These are: (1) emergent plants with roots in the pond bottom but with foliage extending above the water surface; (2) submersed plants with alternate leaf attachment; (3) submersed plants with either whorled or opposite leaf attachment; (4) floating-leaved plants with roots in pond bottom but with leaves floating on the water surface; (5) free-floating plants, which may have roots but float freely on the water surface; and (6) algae.

Many of the herbicides listed are relatively toxic to fish, but when used according to the recommended rate, these herbicides will not kill the fish. Use only those herbicides listed for each aquatic species. Do not increase the rate to obtain better control. *Read the label carefully.*

Most of the herbicides listed are for postemergent application. Fenac and dichlobenil are for preemergent application. Dichlobenil is effective when applied either to the exposed pond bottom or through the water, but when it is applied through the water, the rate of application must be increased. Fenac must be applied to the exposed pond bottom, as it is not effective as a preemergent herbicide when applied through the water. Applications of preemergent herbicides are recommended in March.

For additional information concerning aquatic plant control, contact the author.

Group and species	Chemical, active ingredient or free acid equivalent	Rate of application	Remarks
<i>EMERGENT PLANTS</i>			
Arrowhead (<i>Sagittaria</i> spp.)	Use one of following:		
	2,4-D ester (20% G)	1 lb./440 sq. ft.	Spread on water
	ester (4 lb./gal.)	1/4 cup/2 gal.	Wet foliage
	amine (4 lb./gal.)	1/4 cup/2 gal.	Wet foliage
	Silvex		
	ester (4 lb./gal.)	1/4 cup/2 gal.	Wet foliage
	potassium salt (6 lb./gal.)	1/4 cup/2 gal.	Wet foliage
	potassium salt (20% G)	1 lb./440 sq. ft.	Spread on water
	Diquat cation	1/4 cup/gal.	Wet foliage
Bulrush (<i>Scirpus acutus</i>)	Use one of following:		
	2,4-D ester (20% G)	1 lb./440 sq. ft.	Wet stems
	ester (4 lb./gal.)	1/2 cup/2 gal.	Wet stems
	Diquat cation	2 T./3 gal. and 1 tsp. non-ionic wetting agent	Wet foliage to the point of runoff
	Dichlobenil (aquatic granules)	100 lb./A.	Apply in March to exposed bottom soil
Cattails (<i>Typha</i> spp.)	Use one of following:		
	Dalapon	4 oz./gal. and 3 caps detergent	Wet foliage
	Amino triazole	2 oz./gal. and 3 caps detergent	Wet foliage
	2,4-D ester (4 lb./gal.)	1/2 cup/gal. and 3 caps detergent	Wet foliage
	Diquat cation	2 T./3 gal. and 1 tsp. non-ionic wetting agent	Wet foliage
Creeping water primrose (<i>Jussiaea repens</i> var. <i>glabrescens</i>)	Use one of following:		
	2,4-D ester (20% G)	1 lb./440 sq. ft.	Spread on water
	ester (4 lb./gal.)	1/4 cup/2 gal.	Wet foliage
	amine (4 lb./gal.)	1/4 cup/2 gal.	Wet foliage
	Silvex		
	ester (4 lb./gal.)	1/4 cup/2 gal.	Wet foliage
	potassium salt (6 lb./gal.)	1/4 cup/2 gal.	Wet foliage
	potassium salt (20% G)	2 lb./440 sq. ft.	Wet foliage
	Diquat cation	1/4 cup/2 gal.	Wet foliage

Group and species	Chemical, active ingredient or free acid equivalent	Rate of application	Remarks
Waterwillow (<i>Justicia americana</i>)	Use one of following: 2,4-D		
	ester (20% G)	1 lb./440 sq. ft.	Spread on water
	ester (4 lb./gal.)	1/4 cup/2 gal.	Wet foliage
	amine (4 lb./gal.)	1/4 cup/2 gal.	Wet foliage
	Silvex		
	ester (4 lb./gal.)	1/4 cup/2 gal.	Wet foliage
	potassium salt (6 lb./gal.)	1/4 cup/2 gal.	Wet foliage
	potassium salt (20% G)	1 lb./440 sq. ft.	Wet foliage

SUBMERSED PLANTS WITH ALTERNATE LEAF ATTACHMENT

Curlyleaf pondweed (<i>Potamogeton crispus</i>)	Use one of following: Endothall (2 lb. sodium salt/gal. or 10% G)	1 p.p.m.	Apply on or below surface
	Diquat cation	0.5 p.p.m. or 1 gal./surface A.	Same as above
	Dichlobenil (aquatic granules)	200 lb./A.	Preemergent application
	Fenac	See manufacturer's directions	Must be applied to exposed pond bottom

Leafy pondweed (<i>P. foliosus</i>)	Same as for curlyleaf pondweed or use one of following: Dichlobenil (aquatic granules)	400 lb./A.	Preemergent application
	Fenac (sodium salt of 2,3,6-trichlorophenyl-acetic acid or 10% G)	See manufacturer's directions	Must be applied to exposed pond bottom

Sago pondweed (<i>P. pectinatus</i>)	Same as for curlyleaf pondweed or use one of following: Dichlobenil (aquatic granules)	100 lb./A.	Preemergent application
	Fenac (10% G)	See manufacturer's directions	Must be applied to exposed pond bottom

Small pondweed
(*P. pusillus*) Same as curlyleaf pondweed

Waterstargrass (<i>Heteranthera dubia</i>)	Diquat cation	1 p.p.m. or 1 gal./surface A.	Apply on or below the water surface
	Potassium endothall	5 p.p.m.	Same as above

Group and species	Chemical, active ingredient or free acid equivalent	Rate of application	Remarks
<i>SUBMERSED PLANTS WITH WHORLED OR OPPOSITE LEAF ATTACHMENT</i>			
Buttercup (<i>Ranunculus</i> spp.)	Diquat cation	0.5 p.p.m.	Apply below water surface
Cabomba (<i>Cabomba caroliniana</i>)	Hydrothol-47 [di(N,N dimethylalkylamine) (salt of endothall); L of G]	2 p.p.m.	Same as above
Coontail (<i>Ceratophyllum</i> spp.)	Use one of following: Endothall (10% G) 2,4-D ester (20% G) Silvex ester (4 lb./gal.) Diquat cation	2 p.p.m. 2 p.p.m. 2 p.p.m. 1 p.p.m. or 2 gal./ surface A.	Spread on water Spread on water Apply below water surface
Slender naiad (<i>Najas flexilis</i>)	Diquat cation Dichlobenil (aquatic granules)	1 p.p.m. or 1.5 gal./surface A. 400 lb./A.	Same as above Preemergent application
Southern naiad (<i>N. guadalupensis</i>)	Diquat cation Dichlobenil (aquatic granules)	1 p.p.m. or 1.5 gal./surface A. 400 lb./A.	Apply below water surface Preemergent application
Watermilfoil (<i>Myriophyllum</i> spp.)	2,4-D ester (20% G) Silvex ester (4 lb./gal.) potassium salt (6 lb./gal) potassium salt (20% G) Endothall sodium salt (2 lb./gal.) potassium salt (10% G) Diquat cation Dichlobenil (4% aquatic granules) Fenac (sodium salt of 2,3,6-trichlorophenyl-acetic acid or 10% G)	2 p.p.m. 2 p.p.m. 2 p.p.m. 2 p.p.m. 3 p.p.m. 3 p.p.m. 1 p.p.m. 240-375 lb./A. or 2.5-3.8 lb./440 sq. ft. See manufacturer's directions	Spread on water Apply below water surface Apply below water surface Spread on water Apply below water surface Spread on water Apply below water surface Must be applied to exposed pond bottom

Group and species	Chemical, active ingredient or free acid equivalent	Rate of application	Remarks
<i>FLOATING LEAVED AQUATIC PLANTS</i>			
American pondweed (<i>Potamogeton nodosus</i>)	Use one of following:		
	Endothall (10% G)	1 p.p.m.	Spread on water
	Endothal (2 lb. sodium salt/gal.)	1/2 cup/gal.	Apply to leaves
	Dichlobenil (aquatic granules)	200 lb./A. or 2 lb./440 sq. ft.	Preemergent application only
<i>FREE-FLOATING AQUATIC PLANTS</i>			
Duckweed (<i>Lemna minor</i>)	Use one of following:		
	Endothall (2 lb. sodium salt/gal.)	1 cup/4 gal.	Apply to leaves
	Diquat cation	1 cup/4 gal.	Apply to leaves
<i>ALGAE THAT RESEMBLE TRUE PLANTS</i>			
Chara (<i>Chara</i> spp.)	Use one of following:		
	Dichlobenil (aquatic granules)	100 lb./A.	Preemergent application only
	Copper sulfate	1 p.p.m.	Postemergent
	Hydrothol-47	0.2 p.p.m.	Postemergent
Filamentous algae	Copper sulfate	1 p.p.m.	Postemergent
	Hydrothol-47	0.2 p.p.m.	Postemergent

PESTICIDES FOR MINIMIZING FISH AND WILDLIFE LOSSES

It is impossible to use strong toxins out-of-doors at any time or place in Illinois without endangering some populations of fish and wildlife. Therefore, the following comments should in no way be construed as acceptance or approval by wildlife conservationists of the widescale use of chemical sprays to control pest populations. From an ecological standpoint there is no "good" time or place to add strong toxins to the environment, especially on a broad scale. The more durable or persistent the chemical, the greater the danger. Consequently when applying pesticides use precautionary measures.

Follow the recommendations given below to help reduce mortality of fish and wildlife when pesticides are used.

1. Restrict the application of agricultural pesticides to agricultural fields where possible.
2. Follow all general and specific safety recommendations of the manufacturer and of state cooperative Extension workers.
3. Treat only when necessary, using the pesticide least toxic to nontarget organisms that will still do the job.
4. Apply the least amount of pesticide(s) that will give effective control.
5. Make every effort to keep toxic materials on the target field and to avoid excessive drift. Do not spray when the wind velocity exceeds 5 to 10 m.p.h.
6. Do not apply pesticides directly to water (ponds, streams, rivers, or lakes) unless the label recommends the material for specific use in controlling a pest species found in water.
7. Avoid spraying the immediate watershed of a lake or pond with chemicals highly toxic to fish. Keep treated animals from going into fish-bearing waters or other water supplies until the spray has dried.
8. Do not treat ditches and channels that drain directly into farm ponds and other waters with chemicals toxic to fish or to warm-blooded animals that may drink the water.
9. Do not store or mix pesticides or liquid fertilizers where accidental spilling or release will drain directly into ditches and streams.
10. Do not use streams, ponds, or water-filled ditches for washing spray equipment or for the disposal of left-over pesticides or liquid fertilizers, particularly anhydrous ammonia.

11. Follow the U.S. Forest Service practice of delineating the infected areas to be treated and then mark off buffer zones bordering lakes, streams, and ponds. There should be a strip of grass at least 50 feet wide around the edge of a farm pond to reduce rapid runoff from the watershed.
12. Do not leave puddles of pesticides on hard surfaces--roads, concrete around buildings, and such. Desirable animals may drink them, or the pesticides may drain into water courses through prepared drainage systems.
13. Do not throw empty pesticide containers into water or leave them where they may be attractive to desirable animal species. Dispose of containers only in an approved manner. Burn paper bags or containers and avoid breathing in the smoke. Bury empty glass or metal containers.
14. Use granules instead of sprays or dusts whenever possible to prevent undesirable drift.
15. Use ground machinery for application near critical wildlife and aquatic areas. This equipment makes it easier to confine the chemicals to specific target areas.
16. Do not spray areas harboring dense populations of wildlife.
17. If at all possible, no direct applications or excessive drift of toxic materials should be permitted in wooded areas, because these areas usually contain the greatest abundance and variety of wildlife.
18. If possible, avoid treating habitats other than row crops or plowed fields between April 1 and June 1, and between September 1 and November 1. If treatment of other habitat is essential, use the chemical least toxic to wildlife.
19. In areas frequented by waterfowl and shorebirds, avoid treatments between October 1 and January 1, between March 1 and April 30, and at any time the area is being frequented by waterfowl. (In several areas in Illinois one or more species of waterfowl or shorebirds will be present from about October 1 through May.)
20. When using treated seed, do not leave spilled seed exposed. See that the seed is all well covered and not readily available to birds and mammals.
21. Disk soil insecticides in immediately upon application, both to avoid wasting insecticide and to prevent wildlife losses.
22. Use methoxychlor instead of DDT spring dormant spray for control of insect vectors or Dutch elm disease. Methoxychlor is much less toxic to vertebrates than DDT.
23. Use the most-selective insecticides at minimum dosage rates and avoid the large-scale use of persistent pesticides (chlorinated hydrocarbons) that are known to concentrate in living organisms.
24. Use the information in the checklist of insecticides or the attached table for the LD50 or LC50 values. Select those insecticides that will do the job but be less toxic to warm-blooded animals, including wildlife.

SOME CHARACTERISTICS OF ANIMAL POPULATIONS IN ILLINOIS, ONES HELPFUL IN UNDERSTANDING THE WILDLIFE-PESTICIDE PROBLEM

First of all, it should be emphasized that we know little about the overall effects of *any* pesticide on *any* population of wild vertebrate animals. Certain general facts have been established, however. A considerable amount of data is available on the acute toxicity of various compounds to a variety of species in captivity. Also, a limited number of studies have been made on the rate of recovery of a population following one or more applications of a pesticide to an area. In populations of wild vertebrates some pesticides may produce great mortality both directly and indirectly through the food chain. It has been shown that persistent chemicals such as the chlorinated hydrocarbons are concentrated from the bottom of the food chain to the top so that animals at the top often accumulate heavy dosages of the toxin. As a result, whole populations may lose their reproductive capacity. Accumulations of pesticides through the food chain may already have reduced the reproductive capacity of the bald eagle, duck hawk, and other raptor populations both in Europe and North America, as well as certain species of fishes and fish-eating birds such as loons and cormorants.

While these discussions refer to all wild vertebrates in general, most of the remarks and examples will refer to birds. Because of their migratory and highly mobile nature, a greater number of birds are susceptible to poisoning from a single application of pesticides than are mammals.

Certain ecological principles should be obvious to everyone. The simpler the habitat, the fewer organisms it supports, both in terms of the numbers of organisms and the variety of organisms. Conversely, the more complex the habitat, the greater the number and variety of organisms. For example, in summer, bare plowed ground usually supports only about 3 to 5 native species of birds with only about 1 bird for every 2 acres. At the other extreme is forest, which supports about 80 to 85 nesting species of birds with about 5 to 8 birds per acre. Of the agricultural habitats in Illinois, corn and soybean fields have the poorest bird populations, essentially the same as plowed bare ground; wheat fields are only slightly better, but oat fields have conspicuously higher bird populations. Grasslands and hayfields are very rich bird habitats with 40 to 70 native species in summer and 3 to 5 birds per acre. The shrub borders and hedges at the edges of cultivated fields have some of the densest populations of birds of any Illinois habitat. Marshlands also have high populations and many species. In Illinois, the prairie-grassland and marsh-dwelling species are the ones in greatest danger of extermination.

Regrettably, the effects of pesticides applied to a wheat field do not stop at the borders of the wheat field because animals, especially birds, from adjacent fields may pass through the poisoned wheat field or even forage at its boundaries. A study made in Illinois in 1964 indicated that in a single breeding season two successive populations of birds were killed in a hayfield from the effects of one application of 1/4 pound of dieldrin on a nearby wheatfield. The hayfield was not sprayed, but the birds there died. A third population of birds that moved into the hayfield within a month of the spray date was unable to produce fertile eggs.

Populations of birds shift greatly from season to season. Between April 15 and June 10, and again between September 1 and November 15, the bird populations in all parts of Illinois reach their greatest heights. Over 200 species are present in the state, and the numbers are many times the normal breeding population. Many of these species are highly insectivorous. After October 1, more and more

waterfowl appear in the wetlands of the state. The songbird populations penetrate every habitat, but are most abundant where there is some woody vegetation. Populations of songbird migrants in open field habitats probably reach their peak in late March to mid-May and in October and early November. Fortunately most of the migrants do not spend time in plowed fields, or corn or bean fields, i.e., bare fields. An exception is the golden plover which passes through the state by the thousands in April and May; these birds regularly feed on bare fields and grasslands and concentrate particularly around rain pools.

In Illinois, bird populations reach their lowest levels in the northern third of the state in the winter (Jan. 1 - March 1), but in the southern third of the state winter populations are even higher than the summer populations in practically all habitats.

SOME USEFUL FACTS ABOUT PESTICIDES AND FISH MORTALITY

There are many causes of fish kills in ponds and streams including insecticides, herbicides, liquid fertilizers, barnyard wash, and numerous other factors which affect the supply of oxygen. Specifically some insecticides are much less toxic to fish than others. Proper selection and use of insecticides will reduce potential danger. We urge extreme care and caution in applying any insecticide near streams and ponds. Remember that even if only a very short section of a stream or dredge ditch becomes toxic, fish and other animals may be killed for many miles as the toxic slug flows downstream. When fish kill occurs, examine all possible causes, including pesticides.

The enclosed table may be of some help to you in answering questions about insecticides and fish kill. We compiled this information from several sources. In using this information, consider the stability of the compound, its tendency to store in fat, method and rate of use, affinity for soil particles, and solubility, as well as exact toxicity.

In the table, LC50 means the amount of pesticide in parts per billion needed to kill 50 percent of the test fish in a 24-hour period in the aquarium. This information applies to kill immediately after exposure and not to continued exposure at lower levels of concentration. Low levels of some pesticides may be stored in fat over a period of weeks. Theoretically this stored material could cause fish mortality if the fat was suddenly used up under stress and the pesticides were thrown all at once into the fish's system.

LD50 is the number of milligrams (0.001 gram) needed per kilogram (1,000 grams) or 2.2 pounds of body weight to kill 50 percent of selected healthy laboratory test animals, usually white rats. Both oral and dermal toxicities are included in the table.

The LC50 and the rate per acre-foot of water is based on laboratory tests on 2-inch bluegills exposed to that concentration for 24 hours at a water temperature of 75° F. When exposed for 96 hours the concentration required to reach the LC50 was much lower. Toxicity varies greatly with fish species, chemical, and formulation of the chemical. The LC50 for naled (Dibrom) to rainbow trout was 70 p.p.b. and for bluegill, 220 p.p.b.; for trichlorfon (Dylox) it was 28,000 p.p.b. for trout and 5,600 p.p.b. for bluegill. Thus this table serves only as a guide. Bluegills, popular Illinois fish species, were used as a guide rather than trout.

Insecticides, Their Common Agricultural Rates, Extent of Use, LD50 to White Rats and Other Animals, 24-Hour LC50 to Bluegills, and the Calculated 24-Hour LC50 in Pounds of Toxicant per Water Acre 3 Feet Deep

Insecticide	Approximate LD50, mg./kg.		Common agr. rate, (lb./A.)	LC50, p.p.b.	Use in Illinois	Lb. toxicant per ft.-acre for blue-gill LC50	Comments apply only to fish kill
	Oral	Dermal					
Toxaphene ^{a/}	85	925	1.5	7 ^{d/}	Moderate	0.02	Extremely toxic to fish. Do not use in the vicinity of streams or ponds.
DDT ^{a/}	115	2,510	...	7 ^{d/}	Light	0.02	
Azinphosmethyl (Guthion) ^{b/}	12	220	0.5	8?	Moderate	0.02+	
Aldrin ^{a/}	49	98	1.0 to 1.5	10	Heavy ^{e/}	0.03	
Dieldrin ^{a/}	46	75	0.015	14	Light ^{f/}	0.04	
Rotenone	75	940+	...	24	None	0.06	
Methoxychlor ^{a/}	5,000	6,000+	1.5	31	Light	0.08	
Heptachlor ^{a/}	131	230	1.0 to 1.5	35	Moderate ^{e/}	0.09	
Diazinon ^{b/}	92	680	1.0	54	Moderate	0.15	Highly toxic to fish. Use great caution if applied in the immediate vicinity of streams and ponds.
Parathion	12	14	0.25 to 0.5	56	Light	0.15	
Lindane ^{a/}	89	950	...	61	None	0.16	
Malathion ^{b/}	1,200	4,000+	1.0	120	Moderate	0.32	Moderately toxic to fish. Use cautiously around streams and ponds. Avoid direct application of agricultural sprays to water insofar as fish are concerned.
Demeton (Systox) ^{b/}	5	11	...	195	None	0.53	
Naled (Dibrom) ^{b/}	250	800	0.75	220	Light	0.59	
Carbaryl (Sevin) ^{c/}	675	4,000+	1.0 to 2.0	3,400	Heavy	9.2	Least toxic to fish. Reasonably safe to use around ponds or streams insofar as fish are concerned.
Trichlorfon (Dylox)	595	2,000+	1.0	5,600	None	15.1	
Methyl parathion ^{b/}	19	67	0.25-0.5	8,500	Light	23.0	
Dimethoate (Cygon) ^{b/}	215	505	0.5	28,000	Light	75.6	

^{a/} Chlorinated hydrocarbons, aldrin (as dieldrin), DDT, dieldrin, and heptachlor (heptachlor epoxide) are stored in fat and persist as residues. Methoxychlor is less readily stored, and its toxicity is lower than many others. Toxaphene does not tend to store and is rapidly excreted.

^{b/} Organic phosphates are usually not readily stored and break down in water. Some are highly toxic to warm-blooded animals.

^{c/} This carbamate is more residual than many phosphates but is relatively non-toxic to fish and wildlife.

^{d/} Lower than some studies show.

^{e/} Used as soil treatments; adheres readily to soil particles.

^{f/} Seed treatment only.

Recently, the news media have carried several stories in which pesticides received adverse publicity. The main object of such news items has been DDT.

The booklet reproduced herein contains a statement prepared by K.R. Fitzsimmons, General Manager of the Agricultural Chemicals Division, Shell Oil Company. It is food for thought.

STATEMENT PRESENTED
TO THE ENVIRONMENTAL
HEALTH SUBCOMMITTEE
OF THE N. Y. STATE
ASSEMBLY HEALTH
COMMITTEE

K. R. FITZSIMMONS
General Manager
Agricultural Chemicals Division
SHELL CHEMICAL COMPANY

at Buffalo, New York
July 9, 1969

Shell believes that whatever the public chooses to have in the way of environmental quality, it will have. When these choices are made, it will then become the responsibility of industry to aid in the development and use of the required environmental quality techniques. As a significant member of the community, however, all of industry, including the chemical industry, has the right and obligation to participate in the formulation of decisions.

We are moving steadily toward improving our capabilities to involve ourselves in such decisions, with the creation of an "Environmental Conservation Department" of the Shell companies, and the addition of a wildlife biologist to the staff of the Shell Chemical Company. These are reflections of Shell's concern about the quality of our environment — a concern that stems not simply from the fact that people have become more demanding and laws more restrictive, but because Shell recognizes that we are approaching a time when the volume of our living space, the availability of our natural resources, the extent of all forms of environmental contamination and the growing world population must inevitably collide. Man's very survival depends upon his ability to govern the forces which promote each of these. Within this context, in utilizing natural resources and in developing products which are to be used to further the production of other resources, especially food and fiber, our concern with

the environment in which that food and fiber is produced is paramount.

Wildlife is primarily a product of agricultural lands. Oft-quoted figures state that from 75 to 90 percent of all wildlife at some point in their life history utilize various types of agricultural lands — for nesting, feeding, loafing, or migrating through. Because we contribute to the productivity of these agricultural lands, we are interested in and concerned with that wildlife which is supported by those areas.

There has been extensive criticism of the chlorinated hydrocarbon insecticides for many years, accelerating during the past year or so, with particular emphasis upon DDT as responsible for reproductive failure in wildlife. The species for which concern has been principally expressed are peregrine falcons, ospreys, brown pelicans, bald eagles and the Bermuda petrel. We do not dispute the fact that during recent years there have been some significant reductions in the populations of these birds, and frankly admit that the scientists of Shell and other chemical companies do not have all the answers to questions raised regarding the possible relationship of the chlorinated hydrocarbon group to these species. However, neither do the critics of this group of compounds have all of the data needed to sustain many of their assertions.

Animal and bird species have waxed and waned throughout history. Some seem now

to be in imminent danger of disappearing. On the other hand, the general trend in bird and mammal populations throughout the North American continent appears to be either stable or increasing at this time. Several years ago, the decline of the endangered whooping crane was attributed to pesticides. In spite of the continuing use of these chemicals, the whooping crane population is increasing — admittedly, substantially under artificial conditions and with tender loving care. The December 1968 revised edition of “Rare and Endangered Fish and Wildlife of the United States”, compiled by the Bureau of Sport Fisheries and Wildlife, U. S. Department of the Interior, lists as reasons for the decline of this species: interference from man, probable illegal shooting of non-breeding birds during the summer and migratory individuals in the fall and occasional shooting on wintering areas. No mention is made of pesticides. In fact, of the 60 species of birds and mammals listed as rare and endangered in the United States, pesticides are mentioned as possible factors in connection with only 3—the Southern bald eagle and the prairie and peregrine falcons.

Unfortunately, there has been a tendency on the part of some to link the decline of a wildlife species with the use of pesticides, particularly the chlorinated hydrocarbons. However, the physical effects that man himself inflicts on wildlife and environment cannot be underestimated. A

recent exhibit in the Smithsonian Institute described 225 species of fish and wildlife that have become extinct in the last 400 years — all before the advent of the chlorinated hydrocarbons. In keeping with this, a look at the past 25 years reveals a growth of all industries in North America unparalleled in any comparable 25-year period, an addition of 60 million new Americans, new highway construction exceeding 40 thousand miles, the utilization of forest products to provide homes for these 60 million new citizens, thousands of miles of high-tension transmission lines, thousands of small aircraft, an enormous expansion of commercial airliner service, additional agricultural productivity to feed not only the 60 million new citizens but an equal or greater number outside the United States, to say nothing of the suburban sprawl created by the need for new homes, the overwhelming problem of sewage disposal, and the surge in outdoor recreation. These are but a few of the factors which have a profound effect not only upon man's immediate world but upon the environment of our wildlife resources.

Within the past 200 years, the continent of North America has lost more bird species than any other land area of comparable size. This appears to be due directly to a relatively sudden onset by a large human population than to any other factor. (Greenway, "Extinct and Vanishing Birds of the World"). Of notable significance is

the fact that not a single bird or mammal has become extinct during the past 25 years from any cause, including the presence of chlorinated hydrocarbon pesticide residues in the environment.

Some ecologists have repeatedly pointed to the food chain build-up of some chlorinated hydrocarbon insecticides in fish and wildlife, and project fatal consequences for birds particularly. This phenomenon can be demonstrated in a few cases, but there is inadequate evidence that under natural conditions it occurs extensively. This is described in a paper published in the July 1968 issue of the *Journal of Wildlife Management* (Volume 32, No. 3, p. 441), which shows a decrease in pesticide levels at each step of the chain involving high residues of dieldrin in soil and the feeding of earthworms from the soil to birds. Similar results were obtained from another study a few years ago in which worms containing DDT were fed to robins (Wisconsin Department of Agriculture, Plant Industry Division, Dutch Elm Disease, 1962 report). After a 30-day diet of DDT-laden night crawlers, the birds were not affected.

Evidence regarding the build-up of pesticide concentrations in organisms has often been misinterpreted, and the significance of this phenomenon exaggerated. Despite their tendency to accumulate in lipids, chlorinated hydrocarbons such as aldrin and dieldrin will reach a finite limit,

and in time may actually decrease. Considerable data on the subacute toxicity of aldrin and dieldrin to birds are available. Work at Stanford Research Institute (Brown *et al.*, 1965) indicated that quail were able to withstand three months' exposure at 10 ppm dieldrin in the diet. Hatchability of eggs at 1 and 10 ppm (47% and 35% respectively) compared favorably with the control (41%).

Last year extensive publicity was given to the failure of Coho salmon to reproduce successfully in Lake Michigan. This was attributed to high DDT residues in Coho eggs. However, the failure of eggs to hatch occurred substantially at only one of the Michigan hatcheries in 1967, and in 1968 that hatchery was not used to produce Coho fry. All other hatcheries reported normal production of viable fry, with egg and fry mortality within acceptable limits for hatchery operations. Certainly the growth and abundance of Coho salmon in Lake Michigan attests to the lack of adverse effects on mature Coho and other lake species from pesticides in this natural habitat. In 1967, the production of all species of fish was greater than ever recorded from the lake, with records going back to 1879. For all of the Great Lakes, fish production in 1967 of 127,365,000 lbs. was exceeded only in the year 1956, and prior to that time this tonnage had not been exceeded since 1918.

The drastic decline of peregrine falcons

in Europe, Great Britain and United States has been attributed to organochlorine residues. Enderson and Berger (1968) attempted to correlate the reduction of the peregrine falcon population with the presence of pesticide residues in Canada and Wisconsin. Peregrine eggs from Canada averaged about twice that found in Great Britain where the peregrine reproduction is declining. At 13 sites in Canada, peregrines averaged 3.0 eggs per pair, which is the normal clutch for peregrines in the Arctic. An average of 2.3 viable eggs or young, or both, were produced by 15 pairs of birds, which suggests that the Canadian peregrines, in spite of higher organochlorine residues, seem to be reproducing and behaving normally, unlike their British counterparts. It is such conflicting data that causes us to believe that this research has not been completed.

Studying the nesting activity of bald eagles in Alaska, Hensel and Troyer (1964) showed that nesting success, based on the number of young leaving nests in relation to number of eggs laid, varied 33 to 77 percent in the summers of 1959, 1961, and 1962. The main cause of nesting failure was abandonment, and the data suggest that there has been no alarming decline in nesting numbers or productivity in the last decade.

Cormorants are migrant fish eaters, spending summers in Maine and the winters in Florida where pesticides (including

DDT and dieldrin) are used to control agricultural pests. A survey of this bird indicated quite substantially that these pesticides have not had any adverse effect on its survival and breeding capabilities. The researcher (C. R. Kury, Department of Conservation, Cornell University—"Pesticide Residues in a Marine Population of Double-Crested Cormorants," *Journal of Wildlife Management*, January 1969) concludes that pesticide residues seem not to have affected the reproductive success of the cormorant, and states further that "the osprey is either unusually sensitive to pesticide residues or some other factor is causing its decline." Similar observations about the osprey and its decline were reported by Frederick C. Schmid, U. S. Fish and Wildlife Service (Chesapeake Science, December 1966) and previously by Ames and Mersereau in 1967 (Some Factors in the Decline of the Osprey in Connecticut, *the Auk*, April 1964). These latter authors comment extensively upon human interference and interference by other wildlife species. They also comment considerably upon DDT and its metabolites and indicate that further study is needed. Until the effects of human interference as related to the metabolic processes of these or any other bird are thoroughly evaluated and understood, conclusions about the metabolic role of DDT, its metabolites and other organochlorine compounds cannot be fully substantiated.

A survey of the numbers of migrating hawks has been carried on continuously since 1934 at Hawk Mountain, Pa., except for the World War II years. The count in 1968 was an all-time high of 29,765, which was 30 percent higher than the previous record year, 1939. The bald eagle count was the same in 1968 as the pre-World War II average.

The residue levels of the chlorinated hydrocarbon pesticide group in the environment is certainly not increasing and may be declining. This is based upon the fact that the use of these products is declining. Further, there is no evidence that this group of compounds is harmful to man or to his environment in general. A report released in June 1969 by the National Academy of Sciences states that present levels of pesticide residues in food and the environment pose no adverse effect on man's health.

During those years when chlorinated hydrocarbon insecticides were applied directly to some closed ecosystems for the control of pest species, salt marshes, swamps, ponds, lakes, etc., for sand flies, mosquitoes, etc., contamination, as we consider it now, and adverse effects upon non-target species, was likely and probable. It *is* a fact that environmental pollution does exist today. It is *not* a fact, however, that the pesticide components of this environmental situation stems from the current agricultural use of those compounds. A striking example of this, and the misin-

formation that reaches the public, was the Mississippi River fish kill stories circulated several years ago in which the kill was attributed to endrin in water run-off from agricultural lands. Subsequently, a team of scientists developed convincing evidence that these fish kills were *not* related to pesticides use on agricultural lands. Unfortunately, this received little attention in the press.

Many uses of the chlorinated hydrocarbon group have been dropped, so that only essential agricultural and non-agricultural uses, including ornamentals and lawns, are now permitted under the law.

The monitoring program of the U. S. Department of Agriculture indicates that even in areas where sizeable quantities of chlorinated hydrocarbon pesticides have been used on large acreage, only traces (less than .05 parts per billion) of these pesticides were found in the run-off water. (Monitoring River Water and Sediments—K. C. Walker). Similar conclusions regarding the loss of organochlorine compounds from agricultural areas in run-off were drawn by Sparr *et al.*, who stated that “in general, it appears that normal sowing of aldrin treated rice seed, spraying of cotton fields with endrin or incorporation of aldrin into the soil of cotton fields do not lead to a high degree of contamination of water courses receiving drainage from the land masses on which these activities take place.”

In view of the negligible contribution by agricultural usage of the chlorinated hydrocarbon pesticides to contamination of rivers and seas, elimination of any such use or similar proposed use as a means of reducing environmental contamination is not warranted. To the contrary, there is ample reason to believe that the current agricultural and non-agricultural uses of these compounds are justified and essential. There is no evidence at the present time that fish and wildlife resources are threatened by any of the uses of this group now registered with the U. S. Department of Agriculture.

SOME RECENT FINDINGS IN PESTICIDE—WILDLIFE RELATIONSHIPS

W.V. Dykstra

Clean water is one of our most valuable natural resources. It is becoming increasingly difficult to find. A 1965 Public Health Report states that measurable amounts of dieldrin and several other pesticides are frequently found in our major rivers. More recently, they have been found at disturbing levels in the Great Lakes and other large bodies of water throughout the world.

Pesticides such as DDT do not stay in the water very long. They are usually absorbed by organic matter in the water such as plankton and algae. They do not stay there very long either. Via the aquatic food chain and absorption, they are transported into the bodies of fish, thence to fish-eating birds and to many other higher forms of life including man.

EARLY RESEARCH BY THE DEPARTMENT OF THE INTERIOR

We in the Department of the Interior have conducted research on hazards of DDT for nearly 25 years, and we have amassed a rather impressive amount of scientific data during that period. We believe that there should be stringent restrictions on its use.

Our first research dealt with toxicity to fish. It was learned very early that applications to water of considerably less than a pound per acre-foot were devastating to fish. This was followed by studies on rates of application. We were concerned then with direct mortality, and we demonstrated that applications in woodlands above two pounds per acre were lethal to many birds, whereas mammals could tolerate as much as five pounds per acre.

Low rates of DDD, a closely related insecticide which is also a metabolite of DDT, applied to a lake for midge control in California, built up in the food chain to a degree that a colony of grebes was virtually eliminated. Because of this, as well as the high fish toxicity, we have consistently recommended that labels for DDT and related compounds carry a warning to avoid contamination of lakes, ponds, and streams.

Research at the Patuxent Wildlife Research Center about 15 years ago demonstrated that DDT in the diets of pheasants and quail at sublethal levels resulted in reduced survival of their offspring. The findings convinced us that DDT might have more serious effects than would be evident from observations of gross mortality of of wildlife.

*This paper was also presented at the 22nd Annual Convention of the Upper Missouri Water Users Association, Huron, South Dakota, December 17, 1969.

Further evidence of bird hazard came from research of other agencies. Heavy losses of robins were caused by Dutch elm disease control. A major factor was shown to be the concentration of DDT in earthworms to such a high level that robins quickly obtained lethal amounts through the food chain. This research was conducted approximately 10 years ago.

Because of the high bird mortality we have recommended against foliar applications of DDT in Dutch elm disease control. Such a provision is necessary, we believe, because of the high rate of application recommended for the control of the elm bark beetle, the primary vector of the disease.

COUNTER CONTENTIONS

Our research was countered by statements from other sources that tended to explain away many of our fears. For example, medical doctors found evidence that DDT in humans tended to build up to a certain level, deemed to be noninjurious, after which it was metabolized about as rapidly as it was ingested. Research on low levels in bird diets seemed to indicate that below five or six parts per million, DDT could be metabolized by some birds indefinitely without causing death or apparent harm. Thus, it was argued that DDT, at levels commonly found in fish and wildlife, posed no threat to them.

RECENT DEVELOPMENTS

Within the past two years, there have been some breakthroughs in DDT research that lead us to believe our earlier fears were justified. Fish in some areas have been found to carry residues of DDT and its metabolites far higher than have been accepted by the Food and Drug Administration in other food products. Our monitoring studies revealed that although the average contamination is low, residues in fish from a few areas significantly exceed the tolerance level permitted in beef fat. This has been especially serious in Lake Michigan where the entire coho salmon resource is threatened by high DDT and dieldrin levels. DDT has been found in coho eggs at rates higher than that which was demonstrated to prevent survival of young in lake trout in New York.

Declines in population of raptorial birds in Great Britain and the United States have been associated with decreases in egg-shell thickness that began in 1947, soon after the widespread use of DDT in the environment. This phenomenon was demonstrated first by Derek Ratcliffe of the Nature Conservancy of Great Britain in a paper published in 1967. It was demonstrated again, this time for the United States, in a paper published in 1968 by J.J. Hickey and D.W. Andersen working under contract with the Bureau of Sport Fisheries and Wildlife and in cooperation with the Bureau's Patuxent Wildlife Research Center at Laurel, Maryland.

The unprecedented thinning of egg shells has been maintained through the years since 1947. At the same time, pharmacological and physiological studies in several laboratories in the United States showed that DDT and many other organochlorine pesticides stimulated activity of enzymes that broke down hormones involved in calcium metabolism as well as reproduction.

These facts furnished the basis for the hypothesis that reproductive failures of certain bird species were caused by DDT and its breakdown products in the environment. The association between thin egg shells and population decline through reproductive failure is clear. However, an experimental demonstration of a cause-and-effect relationship is essential to acceptance of any hypothesis based on correlations alone.

THE PATUXENT FINDINGS

This demonstration came in 1969 from experiments conducted at the Patuxent Wildlife Research Center. The basic findings of experiments conducted with mallard ducks and with sparrow hawks (American Kestrels) are as follows: Mallards that were fed low levels of DDE or DDT in the diet cracked or broke 24 percent of their eggs, whereas birds fed clean food cracked only 4 percent. Good eggs produced by ducks fed DDE had shells significantly thinner than those fed clean food. Good eggs that were incubated and fertile, as shown by the fact that development began, still produced half or less than half as many healthy ducklings as did ducks fed clean food. Thus, important effects on reproduction occurred at several stages. The sparrow hawks were fed diets containing a mixture of DDT and dieldrin, both common environmental contaminants. Egg shells of birds fed these materials were significantly thinner than those of hawks fed untreated food, paralleling results with mallards.

These findings constitute scientific proof that the above-mentioned pesticides have a very significant effect on the survival and reproduction of some species of birds.

INQUIRIES ON THE PACIFIC COAST

Several agencies in California are cooperating in an assessment of the reproductive and population status of brown pelicans on the Pacific coast. On March 19, biologists visited a nesting colony of brown pelicans on Anacapa Island, which is now the only active nesting area off the California coast. The colony was occupied by adult birds and contained 298 nests. However, only 12 nests contained intact eggs; 9 contained a single egg; and 3 had two eggs. Normal clutch size is three eggs. Collapsed, dehydrated eggs were found in or near most of the remaining nests. All eggs had thin shells and most shells were soft, lacking a rigid coating over the shell membranes. The situation represented a complete failure in an attempt at nesting. This colony site was unoccupied when visited again on March 26 and on April 18.

On April 18, a second known colony site on Anacapa was visited. There were about 600 adult birds in the colony and many birds were sitting on nests. Examining the colony, however, biologists found that only 19 of the 339 nests present contained intact eggs. There were fourteen nests with 1 egg, four nests with 2 eggs, and one nest with 3 eggs. Of the 320 nests without entire eggs, one out of three had a collapsed, dehydrated egg in it or nearby. This colony is believed to be a different group of birds than those in the first colony visited. Their reproductive attempt was also a complete failure.

On April 21, biologists returned from a trip to three colonies off the Pacific coast of Baja, California, where they checked the nesting of brown pelicans. On Los Coronados Island, only 19 intact eggs were found in about three hundred nests. On San Martin Island, there were only seventeen eggs in 100 nests. About 400 miles south of the United States border, on San Benito Island, the biologists found the first evidence of successful nesting. There were 66 intact eggs in thirty-eight nests. But again, 35 nests did not contain viable eggs.

SUMMARY

Information to date shows that serious failure in egg-shell formation has severely reduced productivity over a broad geographical area. Insecticides are the suspected cause of this phenomenon. Residue analyses of eggs have not been completed, but several insecticides have been recovered. DDT and its metabolites ranged from 58 to 1818 p.p.m. in the egg lipids. The thickness of eggshells ranged from 0.38 to 0.58 millimeters.

We at the Interior Department have opposed three major uses of DDT: forest insect control, Dutch elm disease control, and aquatic insect control. In addition, we have severely restricted its use on lands administered by the Department. We are convinced that DDT should not be used extensively wherever there is a safer insecticide that will give relief.

DDT, OTHER PERSISTENT PESTICIDES, AND OUR ENVIRONMENT

H.B. Petty^{1/}

DDT, by prolonging human life through disease vector control and increasing food production, has undoubtedly contributed greatly to overpopulation, especially in some of the underdeveloped countries. "Each successful use of a pesticide in the control of human disease creates an additional demand for the use of pesticides in agriculture and food storage, so that those who do not die of malaria and typhus do not die of starvation or malnutrition" (Barnes, 1966). DDT has been acclaimed for its role in doing this, and the man who discovered its insecticidal properties was awarded the Nobel Prize.

But a good feature of DDT - persistence - which allowed it to perform these wonders, was also responsible for its downfall. This persistence in the environment and the consequent build-up in the food chain of birds, was first extensively studied from 1949-1953 in Urbana, Illinois. Robins died from apparent DDT poisoning (Barker, 1958) after eating earthworms where elms had been sprayed. It had been reported earlier that sprayed spruce budworms and corn borers fed to nestlings gave toxic responses (George and Mitchell, 1947). At the same time it was discovered that small animals were affected when given milk from goats which had been fed large quantities of DDT (Telford, 1945). "Milk and butter from goats orally treated with DDT were significantly toxic to house flies" (Telford, 1945). This led to proof that DDT was excreted in the butterfat of all animals including man, and it stored in fatty tissues of all warmblooded animals in proportion to the rate of intake.

USE OF DDT

In Illinois DDT has been steadily phased out since the late 1940's when its use in dairy barns and on dairy animals was discontinued; its use was discontinued on all forage crops in the 1950's, and by early 1960 it had been largely replaced on vegetable crops. The last noticeable use in agriculture was in 1964 on sweet corn for earworm and corn borer control. Since then, in Illinois, it has been used for Dutch elm disease control (methoxychlor has been recommended for two years), mosquito control (no longer used), and in a few isolated instances, control of the bronze birch borer, other ornamental tree borers, the iris borer, and certain pine moths.

In other states, recent use of DDT has been mainly for cotton, tobacco, and ornamental insect control.

Worldwide, WHO (World Health Organization) has used more than one-half the total world production of DDT in recent years, and this largely to control those insects which transmitted human disease. "In India the annual loss of income because of malaria was estimated, after World War II, to be \$1 billion. Estimates indicate that by 1965, malaria eradication had reduced this figure by 99.9 percent. Additional economic gains resulting from increased production in certain areas have been estimated to be approximately \$140,000,000. The number of malarial deaths has dropped from 750,000 per year to 1,500 per year; the number of cases has dropped from 7,500,000 to 150,000; and nearly 180,000,000 man days have been saved" (Lebrun, 1969).

^{1/} H. B. Petty, Prof. of Agr. Entomology, U. of Ill. Coll. of Agr. at Champaign-Urbana and Ill. Nat. Hist. Survey. Summaries, 22nd Ill. Custom Spray Operators Training School, 1970.

The tremendous number of lives saved by the control of malaria, typhus, dengue, and many others is well documented. Some of these diseases have been almost eradicated in many localities. Two qualities of DDT, low cost and long residual, make it an ideal tool for WHO in their disease control and eradication program. Substitutes which are equally efficient and cheap will be difficult to find.

INSECT RESISTANCE TO INSECTICIDES

Insect strains resistant to chlorinated hydrocarbon insecticides have necessitated the substitution of other insecticides. A few individuals in an insect population can assimilate a chemical and be unaffected by it; they survive and reproduce, and this ability is transmitted to their offspring. In succeeding generations continued exposure to the insecticide "weeds out" the susceptible and leaves the resistant, and this strain will not revert to susceptibility unless susceptible individuals are introduced into the colony. Pure strains of house flies developed in something over 30 generations under constant exposure in the laboratory. During this time other characteristics may be lost or selected out. Certain susceptible strains of house flies required 7 days to complete a generation, compared with 9 days for the resistant strain which developed. Some strains may exhibit different habits, such as an inclination to remain on the floor rather than roost on the ceiling. Other examples can be cited.

Many insect species have developed strains resistant to insecticides - roaches, bedbugs, aphids, human lice, corn rootworms, seed maggots, and many others. But the blatant statement that the use of persistent insecticides serves to develop stronger and bigger insects which require more deadly insecticides in greater quantity to control is absolutely incorrect. The insecticide used to control insects resistant to certain other insecticides may be much less toxic to warm-blooded animals and may even be used in smaller quantities, or it may be more toxic and used in smaller or greater quantities. There is no relationship of one to the other.

This ability of a few to withstand and break down the chemical, followed by the naturally selected resistant strain, is an indication of the ability of the insect to adapt to its environment and survive. This same thing happens when a plant variety or hybrid resistant to an insect suddenly develops susceptibility. The resistant hybrid selected out a resistant strain of the insect species.

THE CHEMICALS AND THEIR METABOLITES

The breakdown products which result when an organic chemical is exposed to the elements are difficult to determine, but many are known. In some instances they may break down into their essential elements; in other cases they may degrade into several chemicals; or they may remain unchanged. As examples, DDT breaks down into DDE, DDD, DDA, and others; a certain amount of aldrin changes to dieldrin; malathion breaks down into phosphoric acid, alcohol, and water; and other phosphates may or may not do the same.

More research has been conducted on DDT and its fate in the environment than on any other pesticide. Dieldrin research reports, although not of the magnitude of the DDT research, are still voluminous. No human can possibly read and retain every word written in all of these research reports. Very few medicines and drugs have been researched as thoroughly as these two.

If this is true, why all the confusion? Unfortunately, the complexity of overall pollution was little known until recently. This confuses the insecticide residue picture of the past 25 years of research. We have now discovered other non-insecticide contaminants which in the past have probably been recorded as DDT and its metabolites. This has been further confused by the fact that two people can look at the same data and arrive at different conclusions. Furthermore, one usually finds only that for which one looks. If we want to find how much DDT there is in soil, birds, fish, etc., we analyze for DDT and its metabolites and perhaps a few other insecticides. In our zeal to find these few chemicals we may completely overlook other insecticides and non-insecticides and thus miss important pollutants. Such past examples as polychlorinated biphenyls (plasticizers), which are present worldwide, complicate tests for the chlorinated hydrocarbons. There may well be other organic chemicals of a similar nature. We also tend to overlook such contaminants as lead, zinc, carbon monoxide and dioxide, sulfur dioxide, chlorinated naphthalenes, etc. as to their effects on the environment.

"We scarcely needed another demonstration of the fact that answers to ecological questions are rarely simple, but one has been provided nonetheless. From the research viewpoint, it reaffirms the necessity of aiming the questions at the problem - the problem of species survival - and not at individual possible causes, one by one. Thus the effects on wild animals of exposure to pollutants of many kinds must receive serious and increased research effort" (Stickel, 1967).

TOXICITY OF INSECTICIDES

Some insecticides are highly toxic to warm-blooded animals when taken internally but relatively safe when applied to the skin; others may be toxic on both exposures. Some may have high vapor toxicity, others not. The emulsifiers, oil carriers, or other diluents may prove, in some cases, to be more harmful than the chemical insecticide itself. No positive rule can be stated that will apply to all insecticides except this: Handle, apply, and store all insecticides with care and respect. They are designed to kill one animal - an insect - and so may be capable of harming another.

Toxicity is expressed as the number of milligrams of the insecticide per kilogram of body weight of the test animal required to kill 50 percent of them; this 50 percent lethal dose is called the LD₅₀ and is often expressed as acute oral, acute dermal, and chronic oral. An LD₅₀ of 1 mg. per kg. equals 0.0016 of an ounce per 100 pounds of a warm-blooded animal. Thus, it would require 0.16 ounce of a chemical with an LD₅₀ of 100 mg. per kg. to be lethal to 50 percent of 100-pound humans fed that amount. The emulsifiable concentrate with two pounds of the insecticide per gallon contains 0.16 ounce of the chemical in two-thirds fluid ounce of the concentrate. (All of the insecticides recommended by the University of Illinois for homeowner use are much less toxic than this.) If this same insecticide were put on sweet corn at the rate of 1.0 pound of the chemical per acre, one person would need to eat all of the plants from 0.01 of the acre (20 x 25 feet) or several hundred pounds of ensilage at one meal on the day it was sprayed in order to consume a dose equivalent to the LD₅₀. Furthermore, crops are not harvested the day they are sprayed. An interval of several days is usually required between application and harvest to allow the residue to dissipate. Therefore, on the day of harvest it might require consumption of the entire acre to obtain a lethal dose.

The LD₅₀ for malathion, 1300 mg./kg., is about the same as it is for aspirin. Similar examples can be cited (Table 1).

The Jensen report (National Research Council, 1969) concluded: "Available evidence does not indicate that present levels of pesticide residues in man's food and environment produce an adverse effect on his health." They recommended: "That studies of the possible long-term effects of low levels of persistent pesticides on man and other mammals be intensified."

Acute toxicity can be viewed from the standpoint of accidental poisoning fatalities. A study made in Illinois in cooperation with the Department of Public Health revealed for the 8-year period, 1960 through 1967, that "...there were 22 deaths due to pesticides, 13 involving insecticides, 5 rodenticides, and 4 due to herbicides. Only one death was the result of an agricultural accident" (Randell, 1969). Of these 22 pesticide deaths, only four were from "modern-day" pesticides: one person died after exposure to parathion under a sprayer on a vegetable farm; two died from accidentally drinking diazinon concentrate; and one died from drinking dieldrin concentrate. To mention a few other causes of accidental deaths during the same period, 16,984 persons were killed in automobile accidents, 880 by accidental discharge of firearms, and 96 from aspirin ingestion. In 1960, 8 percent of the cases of accidental ingestion of all hazardous materials by children under twelve were of pesticides; in 1968 this had been reduced to five percent. Although not perfect by any means, the accident rate for pesticides seems to be low.

OUR FOOD SUPPLY

Many examples can be cited for the increase in quantity and quality of food with the agricultural use of chlorinated hydrocarbons since 1945. This has been pointed out in many instances (Decker, 1964). It is true that many production advances, other than insecticides, have contributed to this yield increase, but insecticides are a definite part (Table 2). Potato yields almost doubled as a result of leaf-hopper control with DDT in 1945-50. Insecticidal control of corn seed beetles and maggots, wireworms, cutworms, and others has permitted earlier planting of corn which in itself increased yields. So, insecticides have played not only an important direct role in food production but also an important auxiliary role in the past quarter century.

The use of the soil insecticides aldrin and heptachlor in Illinois corn fields from 1957-62 saved an average of 8.5 bushels of corn per acre, or a 7.5 percent savings (Bigger, 1963, Table 3). This savings, depending on acres treated, varied from five to 45 million bushels of corn annually from 1957 through 1967. In 6 of the past 20 years, first-generation European corn borers were sufficiently abundant that control with insecticides was warranted in many fields. During these years, 85 fields in which farmers had left untreated strips were sampled for results; an average of 67 percent of the borers were controlled, resulting in savings of 7.2 percent in yield (Luckmann and Petty, 1969). Note the increased efficiency in control, 52 percent to 87 percent, during this period (Table 4).

Quality of food has also increased (Decker, 1964). This is shown by percentage of wormy apples in unsprayed orchards in 1885-1958 (Table 5), which varied little during this period, while percent of wormy apples in sprayed orchards decreased steadily.

Food quality has increased many fold in the past century. Not only will the housewife not accept the appearance of wormy produce, but she dislikes the waste encountered by cutting away insect contamination. Also, grading standards imposed by marketing laws and regulations necessitate discard of insect-contaminated food.

The Jensen report concluded: "Public demand for attractiveness in fruit and vegetables and statutory limits on the presence of insect parts in processed foods, have invited excessive use of pesticides." In my opinion, "demanded" or "required" would have been more apt than "invited."

And here is how it was 102 years ago: "I hope cider drinkers will make note of the fact that maggoty apples can be converted into excellent cider. They would probably not like to eat the maggots; but they smack their lips after drinking the expressed juice of millions of these tender young larvae" (Walsh, 1868).

Today's quality and quantity production has been accomplished without illegal contamination of insecticides on the food. Use of insecticides is governed by the U. S. Department of Agriculture, and tolerances are established by Health, Education, and Welfare, Food and Drug Administration. These tolerances require a 100-fold safety factor and no tolerance is granted if the crop can be produced with no residue (early control, etc.).

It is obviously impossible to use persistent pesticides without leaving a residue of small magnitude. The most notable example of this has been the appearance of these products in minute quantities in milk (Table 6). Residues were found in butterfat studies from 1963-66 when 12,836 samples were taken in a survey and 7,346 (57 percent) were found to have residues, although usually at an amount below actionable levels (Duggan et al. 1967). The amount of chlorinated hydrocarbon insecticide in the milk is dependent upon when and how much was ingested by the animal and the length of time between application of the chemical and feeding (Gannon and Decker, 1960). The longer the feeding period, the longer it takes for the animal to cleanse its system of the persistent insecticide.

When aldrin and heptachlor are used as soil insecticides in corn, some of their metabolites can be found in other crops the following year. One study involved soybeans after corn in Illinois (Petty, 1967). The amount of dieldrin in the aggregate of all soybeans for 1965-67 was less than 0.01 ppm, or negligible (Table 7). In beans from fields where no aldrin had ever been used the amount of dieldrin was 0.005 ppm \pm 0.005. In beans from fields where corn had been treated in previous years the residue was 0.01 to 0.012. Residues in beans in four fields were approaching actionable levels.

The F. D. A. annually checks our food supply through the medium of "market basket" samples. Sampling is done essentially in this manner: A two weeks' supply of food for a 19-year old boy is purchased from the shelves of stores in several major cities, the foods are prepared and subsequently analyzed for residues (Table 8). WHO and FAO (Food and Agriculture Organization) have established acceptable daily intake levels, a level of insecticide intake at which no possible harm could occur. In our intake there is no level close to these levels, which probably have a several hundredfold safety factor. "The dietary intake of the DDT compounds and the aldrin-dieldrin combination has remained relatively constant for the past two years and has not shown significant changes during the four-year period of this investigation" (Duggan and Lipscomb, 1969). So, our food supply appears to be above reproach and the Food and Drug Administration has done and is continuing to do an excellent job of surveillance.

Farmers, to avoid work, controversy, and increased labor costs, would really prefer not to use any of the chemical production tools - fertilizers, pesticides, etc. - if they could get the same income per acre or per tree as they do now. However,

abandoning these tools would reduce yields by 50 to 60 percent, double the cost of food, and greatly reduce the amount available per person. Certainly, much more land would have to be brought under cultivation and we might very likely see hunger riots in the cities.

DDT AND MAN

Several chlorinated hydrocarbon insecticides and their metabolites are stored in the fat of warm-blooded animals, including man. DDT is stored at the rate of 10 to one - if the entire diet contains one part per million of DDT the fat will contain 10 parts per million. Methoxychlor storage rate is one to 100, so, if the entire diet contains 100 ppm of methoxychlor the fat would contain 1 ppm (Metcalf, 1969). These insecticides are not in the fat forever, as some would imply. They are constantly being excreted. When DDT is completely eliminated from the diet it will slowly disappear from the fat of humans.

DDT and its metabolites are constituents of fat in all the peoples of the world (Wasserman et al.). However, it appears that content in the fat of the U. S. A. population has decreased (Table 9) from an average of 15.8 ppm in 1954 to 5.8 ppm in 1968.

"A study was made of 35 men with 11 to 19 years of exposure in a plant that has produced DDT continuously and exclusively since 1947 and now produces 6 million pounds/month. Findings from medical history, physical examination, routine clinical laboratory tests, and chest x-ray film did not reveal any ill effects attributable to exposure to DDT. The overall range of storage of the sum of the isomers and metabolites of DDT in the men's fat was 38 to 647 parts per million as compared to an average of 8 ppm for the general population. Based on their storage of DDT in fat and excretion of DDT in urine it was estimated that the average daily intake of DDT by the 20 men with high occupational exposure was 1.75 to 18 mg. per man per day as compared to an average of 0.04 mg. per man per day for the general population" (Laws et al., 1967).

The teratogenic, tumorigenic, and carcinogenic properties of DDT and other pesticides have been investigated continually for 20 years. Many naturally occurring chemicals in food, when extracted and fed in large doses to test animals, produce such effects. "Tumorigenicity of selected pesticides and industrial compounds was tested by continuous oral administration to both sexes of 2 hybrid strains of mice, started at the age of 7 days. Maximal tolerated doses were given. Administration of 11 of the 120 test compounds induced a significantly elevated evidence of tumors, mostly hepatomas; ...5 were insecticides, 5 were fungicides, and one was a herbicide...It should be stressed that the dose received by the mice was far in excess of that likely to be consumed by humans" (Innes et al., 1969).

"It was concluded that animals on purified diets develop leukemia; addition of DDT to the diet has no bearing on the development of leukemia, and the promoting factor may be a nutritional imbalance. The leukemia was successfully transplanted and its viral origin is presently under investigation...The lifespan was shorter and the mortality rate higher among the animals on purified diets, and the addition of DDT to the diet did not influence these factors" (Kimbrough et al., 1964).

The recent Mraz report to Secretary of Interior Finch recommended modification of the Delaney clause to the Food, Drug, and Cosmetic Act. This clause implies that an absolute zero tolerance be enforced upon any chemical in food that can produce

cancer under any condition. This requirement is excessively conservative for foods containing unavoidable trace amounts of pesticides shown to induce cancer when given in very high doses to experimental animals (Anonymous - Bioscience, 1969).

And in the opposite direction: "...the medical profession is studying its (DDT) uses as a deterrent for cancer. Researchers at Johns Hopkins are studying workers at Montrose Chemical Co. because the incidence of cancer among these men is far below the norm. The men have been exposed to high levels of DDT for over 20 years. According to the American Medical Journal, an isomer of DDT is the only known treatment for adrenal cancer. Doctors are also recommending injection of DDT in peanut oil to counteract overdosages of phenobarbital" (Anonymous - American Fruit Grower).

ENVIRONMENTAL CONTAMINATION FROM SOIL MOVEMENT

Chlorinated hydrocarbons, although almost completely insoluble in water, attach to soil particles like glue, so when the soil is transported the insecticide moves with it. Dust storms illustrate this (Cohen and Pinkerton, 1966). Dust from a mammoth dust storm in the Southern High Plains of Texas was deposited in Cincinnati, Ohio on January 26, 1965. Samples were collected and analyzed for insecticides (Table 10), and the average concentration of DDT was found to be 0.6 parts per million. The insecticides tied on the dust particles may have been carried from Texas to Ohio. Dust fall-out can be up to one cubic inch per 50 square feet, or 15 tons per square mile per month. At the rate of the 0.6 ppm, this amount of dust - 15 tons per square mile - would contain one-fourth ounce of DDT.

Chemists in England studied the rain-out of vaporized insecticides in the atmosphere (Wheatley and Hardman, 1965). This has also been done in the U. S. A. (Cohen and Pinkerton, 1966). These were small amounts (Table 11), and such rain-out may be affected by smoke over cities. "Because DDT in the London atmosphere has been shown to be associated with the particulate content, a reduction of this form of pollution could lead to corresponding reduction in DDT content" (Tarrant and Tanton, 1968).

Studies made elsewhere show somewhat similar results - persistent pesticides in small amounts can be found airborne, which may help explain the wide dispersal of DDT in the environment.

Various studies have been made of stream environments. Only extremely small amounts of the chlorinated hydrocarbon insecticides, DDT, aldrin, dieldrin, and heptachlor, are found in the water (Grzenda and Nicholson, 1965). However, these pesticides do cling to soil and are found in the sediment on the bottom of streams (Table 12). As aquatic organisms filter the water and silt they remove some of the DDT and it is stored in their fat. This is the beginning of the food chain effect or the magnification of residues - as one species of animal eats another the DDT is concentrated at least at the 10 to one ratio; if an animal with one part per trillion comprises the entire diet of another animal, the latter will have 10 parts per trillion, it is eaten, the predator has 100 parts per trillion, the next predator in the chain will have one part per billion, and this can continue so that the final predator on a diet of uncontrolled residues may have many parts per million in its fat. In some cases, the oyster for instance, its filtering mechanism seems to be extremely efficient in removing DDT from water, so that one part per trillion in the water may result in one part per billion, even one part per million in their bodies, a recovery of 1,000 or more times. Other examples of the food chain phenomenon will be cited.

The effect on fish numbers of small amounts of DDT and other persistent pesticides is not too well known. During stress of spawning the fat is used up and the DDT is deposited in the egg and then the embryo and can result in death of the new fry. This disturbance of the reproductive cycle can do harm to useful game species, but rough fish may not be affected. This type of effect can be serious, but accidental fish kill, although spectacular and emotional, is not relatively as important. In 1967, 2.96 percent of the accidental fish kill in the United States was due to pesticides; 329,130 fish were killed by pesticides in the United States, whereas almost 9,000,000 fish were killed by industrial wastes, manure and silage drainage, and mining combined. Counting all sizes of fish, including minnows, it is possible that over 300,000 fish may be found in a few miles of stream. Thus, such a fish loss would be noticed only temporarily and might even prove beneficial in thinning a stunted and starved fish population, as is done deliberately in many lakes and ponds.

It is difficult to assess the impact of pesticides since 1945 on the aquatic environment, as this entire picture was so confused by other pollutants by that time. The Illinois River has been studied extensively. "Starting with the diversion of Lake Michigan waters into the river in 1900, the ecology of this stream has been changed drastically several times. This diversion added to the fish habitat in the lower stretches and removed it completely in the upper river. Drainage enterprises removed half of the floodplain that the river once used and eliminated fish and waterfowl habitat. Navigation dams created new water areas while destroying important waterfowl marshes. Domestic pollution has fluctuated up and down as new sewage treatment plants have been activated and then found to be inadequate as the rising tide of human population in the basin caught up with them. Chemicals have been released into the waters from developing industries on the river's banks and in the watershed.

Although these actions have caused conditions to fluctuate widely, the net result has been an ever-diminishing biological resource as the aquatic habitat and its inhabitants have been degraded by the activities of man" (Mills, Starrett and Bellrose, 1966).

Fish catch figures are confusing. "The total poundage taken from all Great Lakes by commercial fishermen has varied since 1879 from a low of 79 million to a high of 146 million pounds. The 1967 catch was 127 million pounds. In 1967, commercial fishermen took almost 59 million pounds of fish from Lake Michigan - an all-time record since 1879" (Spencer, 1969).

Citing pounds of fish catch without differentiating species may be misleading. Alewives in the commercial fish catch of Lake Michigan up to 1950 were nonexistent and were not a part of the approximately 20 to 40 million pounds of fish taken commercially, but by 1966 they accounted for 29 of the 42 million pounds of the annual catch. Alewives are not used for human food. Lake trout, probably because of the lamprey eel, were almost nonexistent in commercial catches by 1955, but with the control of the lamprey eel they are now beginning to appear again in Lake Michigan. Lake herring showed a drastic decline but their catch was also low in 1940-44. Carp, chubs, and smelt have stayed about the same for the past 30 years, and yellow perch catch is variable. Edible fish catch began to decline noticeably by 1962, while the alewives population began to build up in 1960.^{1/} To repeat, it becomes difficult to interpret the effect or lack of effect of insecticides through the use of gross counts.

^{1/} Smith, Stanford H. 1968. Species succession and fishery exploitation in the Great Lakes. J. Fish., Res. Bd. Can. 25: 667-693.

Sport fishing in Illinois has been at least as good as it was 20 years ago. This may be due to efforts of aquatic biologists and in spite of pesticides. It is also possible that pesticides have had little effect on fishing.

Much has been said about our water supply. The danger comes, not from normal runoff, but from improper disposal of pesticides or from contamination by a manufacturer (Nicholson, 1969). Normal runoff for the chlorinated hydrocarbons has been studied and compared with the permissible levels (Nicholson, 1969). The permissible levels and the levels present in water are quite different (Table 13). In Illinois "Public water supplies were checked from 13 major watersheds and from two cities whose supplies were from deep wells...and in none of these were any detectable residues of pesticides found" (Press, 1967).

Chlorinated hydrocarbons in drinking water do not pose a human health problem, but some aquatic organisms in the water may be endangered, particularly those at the end of a long food chain.

PERSISTENT PESTICIDES IN THE WILDLIFE ENVIRONMENT

A simple food chain effect, the relationship of DDT applications to elms, earthworms eating the leaves, and robins eating the earthworms, was studied from 1949-1953 (Barker, 1958). Similar studies with DDT and other pesticides have been conducted by other workers both in the laboratory and in the field. Earthworms containing three ppm of heptachlor epoxide fed to woodcocks (Stickel et al.) resulted in their death. There was no effect on those birds fed worms containing 0.65 ppm.

The direct effects of insecticide applications under many circumstances have been extensively reported. One such study was conducted in the Sheldon, Illinois area (Scott et al., 1959). In 1954 and 1955 an extra heavy application of dieldrin, three pounds per acre, was applied in granular form, in a few instances as a spray, to a block totalling 4,000 acres. This was a Japanese beetle suppression program and was done with the express knowledge that effects on wildlife were unknown. (Under farm conditions dieldrin was then being used at two to four ounces per acre for grasshopper and armyworm control.) "Severe losses occurred among wildlife populations. Meadow larks, robins, brown thrashers, starlings, common grackles, ring-necked pheasants--ground squirrels, muskrats, and rabbits were eliminated. Horned lark, short-tailed shrews, fox squirrels, woodchucks, and meadow mice appeared to have taken heavy losses. White footed mice, house sparrows, and mourning doves seemed to exhibit a relatively high resistance to dieldrin poisoning. Wildlife populations appeared to have recovered or to have been well on the way towards recovery by the following year" (Scott et al., 1959). Natural restocking occurred - the area was small enough and there was an outside source. Rabbits temporarily returned to population levels higher than untreated surrounding areas and later returned to normal. This "population bloom" can occur for many animals under many conditions after immense population drops.

In addition to direct kill and food chain mortality, the actual mechanics of application may affect wildlife. Aerial application of one-fourth pound of dieldrin to wheat for armyworm control in 1964 affected redwing blackbirds in adjoining margins of a hay field. Nests in progress were abandoned. Whether or not the birds died is unknown. Two new waves of birds nested before successful nesting was accomplished (Graber et al., 1965).

Varying amounts of insecticides can be found worldwide in almost all wildlife. Isolated bird kills have an emotional impact, but as with fish, such losses are not too important. What is important are the long-term effects on reproduction and breeding populations.

In the past it was assumed that moderate amounts of insecticides in any tissue was the cause of the death of a bird. However, death, insecticide content, and application rate were often inconsistent and little correlation, except in massive exposures, could be established. It was shown in 1967 that the pesticide content in the brain was the most consistent criterion. Birds were fed diets containing 2, 10, 50, and 250 ppm of dieldrin. (Two ppm is at least 2,000 times the amount found in the human diet; see Table 6.) When half of the birds in any group died, the survivors were sacrificed for analysis. No deaths occurred in the two and 10 ppm group under normal conditions of daylight. Even at the high dosages some birds survived. Briefly, dieldrin content in the brain of birds that succumbed ranged from 6.2 to 32.9 ppm while residues in those surviving ranged from 0.87 to 4.5 ppm. Brain levels in dead birds were not dependent upon feeding rate. This enables chemists to ascertain if death was caused by pesticides, even though dosage is not known (Dykstra, 1967). Furthermore, in these same experiments the weaker birds succumbed at lower levels of insecticide in the brain. Similar information is available for DDT. One could speculate on survival of the fittest, development of sturdier strains, or selection for resistance or chemical tolerance which has occurred with many species of insects and a few species of fish.

Eagles and the relationship of insecticides to their numbers have been in the news many times over the past years. Several years ago it was supposed that DDT and then dieldrin were killing them. But, "The conclusions to be drawn from field analyses are, first, that exposure of eagles to DDT and dieldrin is nation wide as it is for most other animals, including people; second, that at least an occasional eagle obtains enough dieldrin and possibly enough DDT to place him in hazard; and third, that most eagles that die in the United States today die of causes other than pesticide poisoning. The important question of sublethal effects on behavior, particularly parental behavior, cannot yet be answered" (Stickel et al., 1966).

Another theory was that DDT in small amounts was causing sterility with no symptoms of poisoning. "When bald eagles were fed DDT in the diet at the level of 10 ppm. (dry weight basis) for periods of 60 and 120 days, there was no interference with spermatogenic activity. Degenerative testicular changes were produced only by levels of DDT [160 to 4,000 ppm] that produced abnormal neurological signs and usually resulted in death...Obvious testicular damage occurred only (but not uniformly) at dosage levels that were generally toxic" (Locke et al., 1966).

The most recent research relates to egg shell thickness and egg breakage. Results in Britain were duplicated in the United States. It was shown that the egg shell thickness for eggs of the red-tailed hawk, the golden eagle, and the great horned owl had not changed in 30 years, while the thickness of the shells of eggs of the bald eagle, the osprey, and the peregrine falcon had decreased in the past 30 years. These three showed a decrease of 18 to 26 percent in thickness (Hickey and Anderson, 1968) and this decrease was assumed to be caused by pesticides. In another study Japanese quail were fed 100 ppm of two isomers of DDT in a chick starter diet of low calcium content to provide a calcium stress during egg laying. This DDT content in the diet is known to be much greater than that of wild quail. However, under these conditions egg shells from the quail fed DDT were thinner than shells

from those that did not receive DDT. Such DDT rates would not normally be encountered by quail but might be by raptor birds in the field (Bitman et al., 1969). There was an effect on shell thickness of mallard duck eggs; also, decreased hatchability was observed when the ducks were fed 40 ppm of DDE in their diet (Heath, Spann, and Dreitzer, 1969).

Bird population fluctuations since 1900 are just as difficult to assess as are fish populations since man has interfered so drastically with their environment. Bird census studies prior to 1945 are confusing. Counts are available (Audubon Christmas bird counts) which indicate that some species of birds have increased in number since 1945 but others have decreased. Harvest of mourning doves by hunters has increased greatly since 1945. Pheasant numbers in Illinois have increased. Redwing blackbirds, starlings, and red-headed woodpecker populations have increased.

"It is clear that pesticides should not be blamed as freely as they now are, but it is equally clear that persistent pesticides do kill or handicap birds at many times and places, and that residues are especially high in birds of prey and fish-eating birds" (Moore, 1965).

Many species of wildlife that have declined in numbers since the advent of DDT were also declining prior to that time. In the meantime, highways, airports, golf courses, suburban developments, farming, cars, and exhaust fumes have also been increasing. It is difficult to assess all of these factors, but certainly the wildlife that is surviving is that which has been able to adapt to the conditions presented by man.

A most thorough study of comparative bird populations, 1907-1909 and 1957-1959, was made in Illinois (Graber and Graber, 1963). This showed that although the total population of birds in the two periods was comparable, the number of species has declined (Table 14). The study compared natural habitat and managed habitat. Natural habitat, such as grasslands and forests, presented a greater variety of nesting conditions, with a greater variety of species being present than in a managed habitat, such as house yards and corn fields, which had a limited variety of nesting conditions and fewer species but denser populations. "Cause and effect on the relationship between population density and avifaunal variety are difficult to establish, but ultimately they relate to the variety and number of niches that a habitat offers and to the inter-specific competition for these niches. Characteristically managed habitats offer a large number of niches even though a small number of niche types, and the bird species best adapted to these niches occupy them so completely as to exclude other species of birds" (Graber and Graber, 1963).

It is apparent that while persistent chlorinated hydrocarbon pesticides have had an adverse effect on some species of birds, they have not affected other species. The ones most affected are the raptors at the end of a long food chain. Unfortunately, the encroachment of human civilization, just its mere presence, cannot be separated from other environmental effects.

"Whatever the genetic or ecological characteristics of the species involved, it is abundantly clear that man, among the various forces that shape our future, is the dominant force of change. In his use of the land for food production, commercial enterprises, home building, and other purposes, he selects (albeit unwittingly) for some species of birds and perhaps inevitably against others" (Graber and Graber, 1963).

PESTICIDES AND THE BALANCE OF NATURE

Man must be considered along with all other plants and animals as a part of nature. One of his first steps in "unbalancing" nature took place when he learned to control human disease through sanitation and preventive medicine, prolonging his life unnaturally. Disease epidemics no longer kill half the population of a continent as they did several centuries ago, so every living human over 30 to 35 years of age is an example of an upset in the balance of nature. This overall increase in population necessitated more cultivation of land. Greater food production saved people from starvation, which in turn increased the need for more food. Finally, food losses to insects became intolerable. Cultural control practices were developed to control insects, and although effective at the time, their effectiveness was not sufficient for a competitive agriculture. In the late 1800's chemical control came into being. By the mid-1940's agriculture was in need of additional control of insects and the moderately effective control measures were rapidly replaced by the new, effective, and cheap organic chemicals.

There is no stable balance or constant equilibrium in nature. From our standpoint, constant change or instability is nature's distinguishing feature. Feast or famine may well describe the outlook of all plants and animals in the wild. Similarly, the population of a crop insect pest is never even; it is receding or climbing, but never stable. We use insecticides to avoid the peak populations and prevent crop loss. This peak may or may not be considered "out of balance." If the pest insect is very prolific and the insecticide only moderately effective on the pest and highly lethal to its parasites and predators, the pest population will rebound and be much more severe than before the application. This has occurred on occasion in the past with infestations of two-spotted mites and several species of aphids. Also, DDT used to control codling moth in orchards killed the parasites of red-banded leaf rollers, a previously unheard of pest in orchards, but it had no effect on the leaf rollers and soon they were serious orchard pests. When these things happen adjustments can be made to take care of these isolated instances. More commonly this type of thing is anticipated and is avoided by proper adjustments.

Pesticides have been only one of man's tools to manage nature. As with all other tools, they have been extremely useful but have on occasion caused harm.

OTHER INSECTICIDES AND LITERATURE

DDT, aldrin, dieldrin, heptachlor, and heptachlor epoxide are the chlorinated hydrocarbons undergoing the most criticism for their persistence in the environment and their effect on wildlife. DDT, for all practical purposes, has been legally eliminated from use. The others may soon be banned or their use severely restricted. In this article we have attempted to supply the main known facts about DDT. Many, but not all, of the principles involved with DDT will apply to some extent to these other four insecticides.

Other chlorinated hydrocarbons upon which there is less pressure are chlordane, endosulfan, endrin, lindane, methoxychlor, and toxaphene. Endrin and toxaphene are not stored in fat to any great extent and are excreted quickly by warm-blooded animals. Toxaphene and chlordane are much less toxic than some. Methoxychlor is a fairly safe insecticide with a low propensity to store in fat and does not persist in the environment. However, it is entirely possible that at some time in the future some of these may be severely restricted in their use.

It is also possible that present pesticides may be retained for certain specific uses, if manufacturers can profitably manufacture small amounts. We might cite

chlordane, dieldrin, and heptachlor for termite control or endrin for control of various cutworms in some cultivated crops.

The organophosphates and carbamates have been liberally substituted for the chlorinated hydrocarbons, starting as early as 1950, but they have continued to be used in some cases where there were not satisfactory substitutes. For example, aldrin and heptachlor were applied and worked into the soil of corn fields to control the soil insect complex. "It is unlikely that birdlife is appreciably affected by this method of application" (Hickey, 1961). These two insecticides are no longer recommended in Illinois, primarily because insect resistance to them has so reduced their effectiveness that profitable use is questioned. Certain organophosphates and carbamates have been suggested to replace them. However, this is not true in many states and aldrin and heptachlor are still needed for soil insect control.

The literature cited in this article is a relatively small sample of all that is published. There are actually hundreds of scientific publications on all the phases of pesticides discussed here. This arbitrary selection of citations was an attempt to provide a cross section and give an unbiased account of the facts involved in the present popular pesticide controversy.

SUMMARY: THE FUTURE OF PESTICIDES

Pesticides have prolonged man's life span through disease control and ample food supply; they have increased his enjoyment of this longer life by providing reasonable freedom from nuisance insect pests. All this has not been attained without cost, however; man and his food have been protected, but lives of some species of wildlife, particularly raptorial and fish-eating birds, have been endangered because there are no controls on contamination of their foods.

If we were to increase production per unit, an equivalent amount of land now in cultivation could revert to grassland or wooded area. Numbers and species of wildlife would prosper with the increase in varied nesting cover and general habitat. If food production per unit is decreased, more land will have to be cultivated, thereby destroying already limited wildlife habitat and decreasing numbers and species. In the future we must incorporate all methods of insect control in order to provide sufficient human food, minimize wildlife losses and otherwise reduce contamination of the environment. The future of pesticides is tied in with these goals. It is clear that we must utilize all types of control measures - less persistent pesticides, chemical sterilization of insects, introduction and more careful utilization of natural controls, and many other sophisticated methods. On occasion the housewife may have to accept less attractive fruits and vegetables and federal and state agencies may occasionally have to relax grading standards. However, all authorities on the subject believe that insecticides are a part of our future and that their wiser use can be accomplished. Food production must be maintained in the face of the increasing population; we cannot, as some pure environmentalists advise, allow food production to decrease to the point that starvation will take care of the population problem.

Table 1. Toxicities of a Few Selected Insecticides

Insecticide	LD ₅₀ in mg. per kg.		
	Acute oral	Acute dermal	Chronic oral
Aldrin	50	98	0.5
Azinphosmethyl	12	220	5
BUXten	87	400	-
Carbaryl (Sevin)	675	4000 plus	200
Chlordane	380	750	25 plus
DDT	115	2510	5
Dieldrin	46	75	0.5
Heptachlor	130	225	0.5 - 5.0
Lindane	90	950	50
Malathion	1175	4444 plus	100 - 1000
Methoxychlor	5000	6000 plus	100
Toxaphene	85	925	10

Table 2. Average (U.S.) Per Acre Crop Yields for Five Years before and at Five-year Intervals after DDT Came into Use

Crops with insecticide use rated as:	Percent Deviation from 1941-45 Yields			
	1941-45	1947-51	1952-56	1957-61
Scant	0	-9	-11	1
Light	0	5	10	23
Moderate	0	7	24	48
Heavy	0	28	55	86

Table 3. Effect on Yields of Plant Cover Present When Winter and Spring Treatments were Applied, 1957-1962

		Average yield #2 corn		Increase for treatment	
		Treated areas	Untreated areas	Bushels	Percent
Stubble (corn, soybean, or grain)	(45) ^{1/}	109.8	101.9	7.9	7.7
Sod	(6)	115.8	108.4	7.3	6.8
Plowed ground	(11)	117.6	106.2	11.4	10.7
Average	(62)	111.8	103.3	8.5	7.6

^{1/} Numbers in () indicate number of tests involved.

Table 4. Average Control in Farmers' Fields and Effects on Yields, 1947-1950, 1956, and 1964.

	Number of fields	Number of borers per 100 stalks			Borer control	Corn yields per acre, No. 2 shelled			
		Untreated area	Treated area	Difference		Untreated area	Treated area	Difference	Yield saved
					perct.	bu.	bu.	bu.	perct.
1947...	14	272	132	140	52	81.6	89.8	8.2	9.1
1948...	13	259	89	170	66	104.4	110.7	6.3	5.7
1949...	19	268	92	176	66	83.7	92.0	8.3	9.0
1950...	22	252	72	180	71	83.8	89.3	5.5	6.2
1956...	15	231	44	187	81	104.6	111.4	6.8	6.1
1964...	2	136	18	118	87	93.0	98.8	5.8	5.9
Aver., all fields		254	83	171	67	90.4	97.4	7.0	7.2

Table 5. The Percentage of Apples in Illinois Orchards Damaged by Codling Moth

Year	Unsprayed	Sprayed
1885	68	21.0
1886	40	12.0
1915-18	45	4.4
1956-58	69	2.2

Table 6. Insecticides Most Frequently Found in Milk

Insecticide	% samples with residues	Av. in butterfat ppm.	% of samples with residues greater than 1 ppm.
DDE	40.6	.066	28
Dieldrin	27.9	.042	30
DDT	24.1	.042	20
Hept. Epoxide	23.6	.036	33
TDE	16.9	.026	36
BHC	8.0	.007	18
Lindane	5.6	.004	12
Aldrin	1.4	.001	7
Heptachlor	0.9	.002	16
Methoxychlor	0.7	.001	58
Av. all samples	57.0	-	28

Table 7. Dieldrin Residues in Soybeans, 1965-67

Year	Overall average	Av. for untreated fields	Av. for treated fields
1965	.0087	.0067	.0101
1966	.0078	.0043	.0119
1967	.0080	.0061	.0123

Table 8. Dietary Intake of Pesticide Chemicals

Compound	FAO-WHO Acceptable Daily Intake	1965	Milligrams/Kilograms Body Weight/Day		
			1966	1967	1968
Total aldrin-dieldrin	0.0001	0.00009	0.00013	0.00006	0.00006
Carbaryl	0.02	0.0021	0.0005	0.0001	-
Total DDT, DDE, TDE	0.01	0.0009	0.0010	0.0008	0.0007
Gamma BHC (lindane)	0.0125	0.00007	0.00006	0.00007	0.00004
Total Hept. Hep. E.	0.0005	0.000033	0.00005	0.000021	0.000031
Malathion	0.02	-	0.0002	0.0002	0.00004
Parathion	0.005	-	0.00001	0.00001	0.000001
Diazinon	0.002	-	0.00002	0.000001	0.000001

Table 9. Concentration of DDT and its metabolites in parts per million in people of the world

Nation	Year	Ave.	Range
USA	54-56	15.8	11.7-19.9 ppm
USA	61-62	12.6	
USA	63	9.3	6.7-11.1
USA	64-65	5.8	3.1-8.6
Israel	63-64	19.2	
India	64	23.3	12.8-31.0
Czeck.	63-64	9.2	
England	61-62	2.2	
England	64	4.0	
Canada	59-60	4.9	
Hungary	60	12.4	

Table 10. Pesticide Content of Air-borne Dust, 1965

Insecticide	Concentration ppm.
DDT	0.6 ppm
Chlordane	0.5 "
DDE	0.2 "
Ronnel	0.2 "
Hept. Epox.	0.04 "
2,4,5T	0.04 "
Dieldrin	0.003"

Dust fall = 15 tons/square mile/month in Cincinnati, Ohio

Table 11. Insecticide Content in PPM in Ohio Rainwater

Insecticide	Location in Ohio		
	Ripley	Coshocton	Cincinnati
DDT	0.15	0.07	0.34
DDE	0.03	0.005	0.02
BHC	0.05	0.006	0.02

Table 12. DDT + DDE in a Stream Environment

	Parts per million in essential components	
	edible portions	non-edible portions
33 cotton fields	0.25	
Flint Creek water	0 - less than 0.00001	
" " mud	0.59	
Mollusca	0.275	
Crustacea	0.080	
Insecta - Diptera (mosquitoes, etc.)	0.150	
Coleoptera (beetles)	0.555	
Mixture	0.450	
Green sunfish	0.18 - 0.93	1.58 - 1.70
Largemouth bass	0.05 - 1.50	0.23 - 8.76
Warmouth bass	0.16	0.32

Table 13. Pesticides in Nineteen Selected Western Streams, 1966-68 ^{1/}

Pesticide	No. positive samples	Range in pp billion	^{2/}	
			Permissible in ppb	Desirable by some
DDT	82	.01-0.12)	42	0
DDE	49	.01-.06)		
2,4-D	41	.01-.35C	100	0
TDE	35	.01-.04		
2,4,5-T	28	.01-.07C		
Hept.	27	.01-.04	18	0
Diel.	24	.01-.07	17	0
Silvex	14	.01-.21		
Lindane	13	.01-.02	56	0
Aldrin	11	.01-.04	17	0
Endrin	4	.01-.07	1	0
Hept. epoxide	2	.02-.04	18	0

^{1/} 333 samples from 20 stations.

^{2/} Water criteria developed by a National Technical Advisory Committee to the Secretary of Interior.

Table 14. Estimates of breeding populations of common species of birds in Illinois, 1909 and 1957. The estimates are for all acres of the habitats accounted for in this study.

Species	Year	
	1909	1957
Housesparrow	5,300,000	6,100,000
Redwing blackbird	5,100,000	8,400,000
Common grackle	4,100,000	3,600,000
Meadowlark (spp)	4,000,000	3,800,000
Morning dove	2,500,000	2,000,000
Horned lark	840,000	5,600,000
Dick cissel	1,700,000	3,400,000
Starling	-	3,100,000
Bobelink	1,200,000	1,900,000
10 others	<u>16,490,000</u>	<u>1,900,000</u>
Total Number	40,230,000	37,900,000

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A REPORT FROM HORTICULTURE

VEGETABLE GROWING NO. 4
(REVISED, 1970)

WEED CONTROL IN THE VEGETABLE GARDEN

by H.J. Hopen^{1/}

Three general methods of weed control that can be used in the home garden are:

1. Cultivation and mechanical removal

THIS METHOD IS THE ONE MOST USED, AND IS THE SAFEST ONE IN THE HOME GARDEN. Mechanical removal must be repeated several times throughout the growing season of a crop. Vacations or absence from the garden area is a negative factor for this method. Depending on the size of the garden, weeds can be controlled by power equipment or by wheel and hand hoes.

2. Mulching or smothering of weeds (see Circular 1009, "Mulching Vegetables: Practices and Commercial Applications")

Basically, this is a method of preventing light from reaching the weed seedling. Any number of opaque materials can be used for mulching, such as: Kraft papers, black polyethylene, ground corn cobs, weed-seed-free straw, other fresh vegetation, and composted vegetation.

Additional factors in favor of mulching are: moisture conservation, stabilized soil temperatures, and keeping above-ground, edible plant portions clean.

3. Use of herbicides

This method of control is not practical in small vegetable gardens containing several crop species because different vegetables and weeds vary in their tolerance to herbicides. Ideally, to control weeds in a garden containing several species, several herbicides should be used. Several desirable herbicides for specific species remain in the soil longer than one growing season, and may kill or injure specific species the following year.

Application methods must be carefully controlled when a herbicide is used on small areas. The tendency is to apply additional amounts if the quantity measured out "looks" as though it is not enough.

THE IDEAL METHOD WHEN USING A HERBICIDE TO CONTROL WEEDS IN VEGETABLE CROPS OR STRAWBERRIES IS WITH A HERBICIDE FOR EACH VEGETABLE SPECIES, AS OUTLINED IN CIRCULAR 907, "HERBICIDE GUIDE FOR COMMERCIAL VEGETABLE GROWERS," OR "HERBICIDES FOR COMMERCIAL FRUIT CROPS," H-659.

Many people using chemical weed control in their vegetable garden do not have a sufficient area to treat to make buying several herbicides worthwhile.

1/ Vegetable Crops Specialist, University of Illinois, Urbana-Champaign.

If a gardener is unwilling to remove weeds by hand, and it is convenient to use a herbicide in the home or commercial garden, Dacthal, Amiben, or Treflan can be used on the indicated species. Remember that Dacthal, Amiben, or Treflan possibly is not the most desirable herbicide for a large planting of the individual species. The most desirable herbicides for individual species are listed in Circular 907.

DACTHAL--must be applied to weed-free soil/because it is a weed-seed germination inhibitor. Most effective herbicide action is obtained if rainfall or irrigation is applied 2 to 3 days after application.

Crop	Total pounds* of 2 1/2% granular Dacthal per 1,000 sq. ft.		When to use
	Total pounds* of 5% granular Dacthal per 1,000 sq. ft.		
Snap or garden beans (<u>not</u> lima)	8-9	4-4.5	Immediately after seeding
Broccoli	8-9	4-4.5	Immediately after seeding or transplanting
Brussels sprouts	8-9	4-4.5	Immediately after seeding or transplanting
Cabbage	8-9	4-4.5	Immediately after seeding or transplanting
Cantaloupe	8-9	4-4.5	To the soil, 4-6 weeks after seeding**
Cauliflower	8-9	4-4.5	Immediately after seeding or transplanting
Collards	8-9	4-4.5	Immediately after seeding
Cucumbers	8-9	4-4.5	To the soil, 4-5 weeks after seeding**
Eggplant	8-9	4-4.5	Immediately after transplanting, or up to 6 weeks after transplanting**
Lettuce (leaf and head)	8-9	4-4.5	To the soil, 1-3 weeks after emergence**
Mustard greens	8-9	4-4.5	Immediately after seeding
Onions	8-9	4-4.5	Immediately after seeding
Peppers	8-9	4-4.5	To the soil, after transplanting**
Potatoes	8-9	4-4.5	Immediately after planting
Squash	8-9	4-4.5	To the soil, 4-6 weeks after seeding**
Strawberries	8	4	At time of transplanting or to established beds in fall and early spring (Do not apply after first bloom)
Sweet potatoes	8-9	4-4.5	Immediately after planting
Tomatoes	8-9	4-4.5	To the soil, 4-6 weeks after transplanting**
Turnips	8-9	4-4.5	Immediately after seeding
Watermelons	8-9	4-4.5	To the soil, 4-6 weeks after transplanting**

*Seventy-five percent wettable powder Dacthal can also be used at the total rate of 14 pounds per acre for all except strawberries, on which a total rate of 12 pounds per acre must be used. Five percent and 2 1/2 granular Dacthal is available in 50-pound bags.

**Must be applied to weed-free soil.

AMIBEN (also sold as VEGIBEN)--is a herbicide which is available to many farmers because it is used in soybean culture. It can be used on the following vegetable species:

Crop	Lb. of active ingredient per acre	When to use
Beans, dry	3	Preemergence application
Beans, lima	3	Preemergence application
Peppers	3-4	As soon after transplanting as possible; use GRANULAR form only and apply to dry foliage
Pumpkins and squash	3-4	Preemergence application; use on "heavy" soil, but use Dacthal on "light" soil
Sweetpotatoes	3-4	Apply after transplanting before weeds emerge
Tomatoes	3-4	As soon after transplanting as possible; use on heavy soil only; use GRANULAR form only and apply to dry foliage

TREFLAN--is also used in soybean culture. It can also be used on the vegetable species listed below. Treflan must be incorporated into the soil before transplanting or seeding. To insure uniform incorporation, use a rototiller or double-disk into the soil at right angles.

Crop	Lb. of active ingredient per acre	When to use
Snap and lima beans	0.75	Preplant soil incorporation
Dry beans	1.0	Preplant soil incorporation
Broccoli	1.0	Pretransplant soil incorporation
Brussel sprouts	1.0	Pretransplant soil incorporation
Cabbage	1.0	Pretransplant soil incorporation
Cauliflower	1.0	Pretransplant soil incorporation
Carrots	1.0	Preplant soil incorporation
Kale	0.75	Preplant soil incorporation
Mustard greens	0.75	Preplant soil incorporation
Okra	1.0	Preplant soil incorporation
Peas	0.75	Preplant soil incorporation
Peppers	1.0	Pretransplant soil incorporation
Tomatoes	1.0	Pretransplant soil incorporation
Turnip greens	0.75	Preplant soil incorporation

*1970 Suggested
Insecticide
Guide*

Insect Control for COMMERCIAL VEGETABLE CROPS and GREENHOUSE VEGETABLES

Commercial vegetable gardeners find it impossible to produce vegetables profitably unless they control insects at maximum efficiency and minimum cost. The housewife of today will not accept unsightly wormy vegetables; not only are wormy fruits and vegetables unappetizing but the waste from trimming increases food costs. Thus the commercial vegetable gardener must produce a quality product that is acceptable and safe to the consumer. Careful and correct use of the right insecticides will enable him to do this.

This suggested insecticide guide has been prepared for use by Illinois commercial vegetable farmers; it is not for home gardeners, who should use only those insecticides that are extremely safe to handle, apply, and store. Furthermore, the commercial vegetable gardener must use a wider variety of insecticides than the home gardener in order to obtain maximum insect control at the least cost.

In using insecticides, read the label and carefully follow the instructions. Do not exceed maximum rates suggested; observe carefully the interval between application and harvest, and apply only to crops for which use has been approved. Make a record of the product used, the trade name, the percentage content of the insecticide, the dilution, the rate of application per acre, and the date or dates of application.

Some of the insecticides suggested here can be poisonous to the applicator. In using them, the commercial gardener is expected to use precautions to protect himself, his workers, and his family from undue or needless exposure.

In using this guide, always refer to the table on the next page, which lists the limitations and restrictions on use. These limitations apply to the vegetables as human food. If you use any portion of a vegetable for

livestock food (tops, stalks, etc.) refer to the label for instructions as to the interval required between application and feeding.

The chemical names used in these tables may be unfamiliar to you. These names are the common coined chemical names and as such are not capitalized. Trade names are capitalized. In the table of limitations the common names are listed first. If the trade name is more commonly used, it is listed in parentheses following the common name. Throughout the tables of suggestions, however, the common name is used if there is one. In case of question, refer to the table of limitations.

These suggestions are revised annually. Suggestions sometimes change during the growing season, thus they are subject to change without notification.

These suggestions were prepared by entomologists of the University of Illinois College of Agriculture and the Illinois Natural History Survey.

Leaflets describing the life history, biology, and habits of some of the insects mentioned can be obtained from the offices of county extension advisers or by writing to Office of Agricultural Publications, University of Illinois, Urbana, Illinois 61801. These are indicated by an NHE number in the tables.

Other circulars on insect control are:

Circular 898 — Insect Control for Livestock and Livestock Barns;

Circular 899 — Insect Control for Field Crops;

Circular 900 — Insect Control by the Homeowner;

Circular 1004 — Pest Control in Commercial Fruit Plantings

These can be obtained from the above offices or from the College of Agriculture, Urbana.

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN COLLEGE OF AGRICULTURE COOPERATIVE EXTENSION SERVICE
In cooperation with ILLINOIS NATURAL HISTORY SURVEY CIRCULAR 897 Urbana, Illinois, December, 1969

Issued in furtherance of Cooperative Extension Work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture.
JOHN B. CLAAR, Director, Cooperative Extension Service, University of Illinois at Urbana-Champaign.

LIMITATIONS FOR FIELD VEGETABLES IN DAYS BETWEEN APPLICATION AND HARVEST AND OTHER RESTRICTIONS ON USE OF INSECTICIDES IN ILLINOIS

(Blank spaces indicate the material is not suggested for the specific use in Illinois)

Insecticide	Beans	Brussels Broccoli sprouts	Cab- bage	Cauli- flower	Horse- radish ¹	Radish ¹	Turnip ¹	Onions	Egg- plant	Peppers	Toma- toes
	azinphosmethyl (Guthion) ²	15	7	21	15
carbaryl (Sevin).....	0	3	3	3	3	3	3,14G	...	0	0	0
Dasanit.....	...	...	...	...	...	...	...	I, J	...	...	...
diazinon.....	...	5	...	7	5	...	10	10	10	...	1
dimethoate (Cygon) ..	0C	7	...	3	7	...	...	14	...	0	7
endosulfan (Thiodan)	CH	7	...	7	B	...	...	...	1	1	1
ethion.....	...	...	...	...	...	...	...	I	...	...	...
dicofol (Kelthane) ...	7C	...	...	...	...	...	...	...	2	2	2
malathion.....	1	3	7	7	7	7	3	3	3	3	1
methomyl (Lannate) ..	...	7	...	7	7	...	...	...	...	...	...
mevinphos (Phosdrin) ².....	...	1	3	1	3	...	3	...	...	...	...
naled (Dibrom).....	...	1	1	1	1	...	4	...	...	...	...
parathion ².....	...	7	7	10	7	...	15	10	15	15	10
phorate (Thimet) ²	I	...	...	...	...	...	...	...	...	...	...
rotenone.....	...	...	...	...	...	...	...	...	1	1	1
toxaphene.....	...	...	B	7D	B	C	C	C	5	5	3
trichlorfon (Dylox)...	...	...	21	21	21	...	...	28C	...	21	21

Insecticide	Pota- toes ¹	Col- lards	Kale	Lettuce	Spinach	Swiss chard	Sweet corn	Cucum- bers ²	Melons ³	Pump- kins ³	Squash ³	
											Winter	Summer
carbaryl (Sevin).....	0	14	14	14	14	14	0	0	0	0	0	0
diazinon.....	...	10	10	10	10	12	I	7	3	...	3	7
dicofol (Kelthane)....	...	...	...	...	...	...	...	2	2	2	2	2
dimethoate (Cygon) ..	0	14	14	14	14	14	...	...	3	...	...	...
dyfonate.....	...	...	...	...	...	...	I	...	...	...	...	...
endosulfan (Thiodan)	0	...	...	14A	...	...	...	...	...	...	...	...
malathion.....	0	7	7	14	7	7	5	1	1	3	1	1
mevinphos (Phosdrin) ²	...	3	3	2	4	...	...	...	...	...	...	...
naled (Dibrom).....	...	4	4	1	1	1	...	...	...	...	...	...
parathion ²	5	10	10	21	14	21	12	15	7	10	15	15
Perthane.....	...	...	...	4	7	...	...	...	...	...	...	...
phorate (Thimet) ²	I	...	...	...	...	...	I	...	...	...	...	...
rotenone.....	...	1	1	1	1	1	...	...	...	...	...	...
toxaphene.....	0	B	28	E	21F	E	B	B	B	B	B	B
trichlorfon (Dylox)...	...	28B	21	28B	...	...	...	...	...	14F	...	...

¹ Root crops such as radishes, turnips, carrots, horseradish, potatoes, and sugar beets should not be grown in soil where aldrin, dieldrin, or heptachlor was applied as a soil insecticide the preceding year.

² To be used only by professional applicators or commercial gardeners.

³ Only apply insecticide late in the day after blossoms have closed to reduce bee kill.

- A. Not more than twice per season.
- B. Not after edible portions or heads begin to form.
- C. Do not use tops for feed or food.
- D. If outer leaves are stripped; otherwise, B.
- E. Do not apply after seedling stage.
- F. Not more than once per season.
- G. If tops are to be used as feed.
- H. Not more than three times per season.
- I. Soil applications at planting time only.
- J. Do not use on green onion crop.

LIMITATIONS FOR GREENHOUSE VEGETABLES

Insecticide	Tomatoes	Lettuce
endosulfan (Thiodan).....	15 hours	...
malathion.....	15 hours	10 days
metaldehyde.....	As bait only applied to soil	
naled (Dibrom).....	1 day	...
parathion ¹	10 days	21 days
tepp ¹.....	...	3 days

¹ Do not use aerosols that contain parathion, tepp, or the propellant methyl chloride in greenhouses connected to living quarters. Should be applied only by a trained operator.

CABBAGE AND RELATED COLE CROPS¹

Insect	Time of attack	Insecticide	Lb. of active ingredient per acre	Placement	Timing of application
Cabbage maggot ² (NHE-44)	All season	diazinon	3	Broadcast	Disk in just before planting. Use only for cabbage, cauliflower, and broccoli.
		diazinon granules	1	Furrow	At time of planting; on turnips a drenching spray of 1 lb. diazinon should be applied 30 days following treatment.
		azinphosmethyl	3 oz. W.P. or 2 oz. E.C. per 50 gal. transplant water		6 fluid oz. transplant water per plant.
		diazinon	4 oz. per 50 gal. transplant water		
Aphid (NHE-47)	All season	azinphosmethyl dimethoate malathion mevinphos parathion	$\frac{3}{4}$ 0.3 1 $\frac{1}{4}$ 0.4	Foliage	When aphids appear, but before leaves begin to curl.
Diamond-back moth larva; imported cabbage worm; cabbage looper (NHE-45)	All season	azinphosmethyl	$\frac{3}{4}$	Foliage	When small worms first appear, and about every 5 to 7 days thereafter. Thorough spray coverage of foliage is important.
		endosulfan	1		
		methomyl	$\frac{1}{2}$		
		mevinphos	$\frac{1}{2}$		
		naled	1		
		parathion with toxaphene ³	$\frac{1}{2}$ 2		
		Parathion with endosulfan ³	$\frac{1}{2}$ 1		
Cutworm	At planting	trichlorfon toxaphene	1 1½-2	Soil	At planting, at base of plant or as needed when damage first occurs.
Flea beetle and leafhopper	All season	carbaryl	1½	Foliage	As needed.

¹ Root crops such as radishes, turnips, carrots, potatoes, and sugar beets should not be grown in soil where aldrin, dieldrin, or heptachlor was applied as a soil insecticide the preceding year.

² Maggots are resistant to aldrin, dieldrin, and diazinon in some areas of Illinois.

³ When using mixtures that have different "days between application and harvest" restrictions, choose the larger restriction.

Note: E.C. = emulsion concentrate; W.P. = wettable powder.

COLLARDS, KALE, LETTUCE, SPINACH, SWISS CHARD

Insect	Time of attack	Insecticide	Lb. of active ingredient per acre	Placement	Timing of application				
Aphid (NHE-47)	All season	diazinon	$\frac{1}{2}$	Foliage	As needed.				
		dimethoate	0.3						
		mevinphos	$\frac{1}{4}$						
		naled	1						
		parathion	0.4						
Cutworm	On seedling plants	toxaphene	1½	Base of plant and soil	When first damage appears.				
		trichlorfon	1						
Leafhopper	All season	carbaryl	1½	Foliage	When first leafhoppers appear and as needed.				
		dimethoate	0.3						
		malathion	1						
Caterpillar (NHE-45)	All season	mevinphos	$\frac{1}{2}$	Foliage	When small worms first appear and every 5 to 7 days thereafter.				
		naled	1						
		Perthane with diazinon or malathion ¹	1 1						
		parathion with endosulfan ¹	$\frac{1}{2}$ 1						
		Leaf miner	All season			diazinon parathion	$\frac{1}{2}$ 0.4	Foliage	When first miners are observed.
		Flea beetle	All season			carbaryl rotenone	1 $\frac{1}{4}$	Foliage	As needed.

¹ When using mixtures that have different "days between application and harvest" restrictions, choose the larger restriction.

BEANS

Insect	Time of attack	Insecticide	Lb. of active ingredient per acre	Placement	Timing of application
Seed maggot (NHE-27)	All season	dieldrin ¹	Manufacturer's directions	Seed	At seeding.
		diazinon 50% W.P. ¹	3/5 oz./bu.	Seed	Treat seed no longer than 3 months before planting.
		phorate granules	1½	Soilband	Place on either or both sides of row at planting but not in contact with seed.
Bean leaf beetle (NHE-67)	Early and late season	carbaryl malathion	1 1	Foliage	When feeding first appears and weekly for 2 or 3 applications as needed.
Leafhopper (NHE-22) and plant bug (NHE-68)	All season	carbaryl	1	Foliage	Before plants become yellow and stunted. Repeat applications at weekly intervals as necessary.
		dimethoate	0.3		
		malathion	1		
		phorate granules	1½	Soilband	As for seed maggot.
Mexican bean beetle	Midseason and late season	carbaryl	½	Foliage	When occasional leaves show lacework feeding.
		malathion	1		
		phorate granules	1½	Soilband	As for seed maggot.
Aphid (NHE-47)	All season	dimethoate	0.3	Foliage	Usually applied when a few aphids can be found on each plant, but before leaves begin to curl and deform.
		endosulfan	½		
		malathion	1		
		phorate granules	1½	Soilband	As for seed maggot.
Blister beetle (NHE-72)	Midseason and late season	carbaryl	1½	Foliage	As needed.
Corn earworm (NHE-33)	Late season	carbaryl	1½	Foliage	As needed, but usually after September 1. Worms may be present before bloom.
Mites	Midseason and late season	dicofol	0.4	Foliage	As needed, but especially during drouthy periods particularly if carbaryl has been used on crops.
		dimethoate	0.3		
		malathion	1		
		phorate granules	1½	Soilband	As for seed maggot.

¹ No restrictions when used as recommended.

CUCUMBERS AND OTHER VINE CROPS¹

Insect	Time of attack	Insecticide ²	Lb. of active ingredient per acre	Placement	Timing of application ²
Striped and spotted cucumber beetles (NHE-46)	Seedling to mature plants	carbaryl parathion	1 ½	Foliage	When beetles first appear; as often as necessary thereafter.
Aphid (NHE-47)	All season	diazinon	½	Foliage	When aphids become noticeable.
		dimethoate	0.3		
		malathion	1		
		parathion	½		
Squash bug (NHE-51)	All season	parathion trichlorfon ³	½ 1	Foliage	Do not apply until first eggs are found hatching (about June 15 to July 15).
Leafhopper	July-August	malathion dimethoate	1 0.3	Foliage	As needed.
Squash vine borer	June-September	carbaryl	1	Base of stem for 3 ft.	Weekly applications when vines begin to run—usually 5 applications.
Pickle worm	August-September	carbaryl	1	Foliage	Weekly applications, beginning in late August.
Mites	July-September	dicofol	½	Foliage	As needed.
		malathion	1		
		parathion	½		
Cutworm (NHE-77)	April-June	carbaryl toxaphene	2 1½-2	Base of plants	As needed.

¹ Pumpkins should not be grown on soil that has been treated with aldrin, dieldrin, or heptachlor the preceding year.

² Spray vine crops with insecticide only late in the day after blossoms have closed to reduce bee kill.

³ Pumpkin is the only vine crop for which trichlorfon should be used for squash bug control. Apply only once per season.

TOMATOES, PEPPERS, EGGPLANT

Insect	Time of attack	Insecticide	Lb. of active ingredient per acre	Placement	Timing of application
Cutworm (NHE-77)	Early and midseason	carbaryl	2	Base of plants or foliage	As needed.
		toxaphene	3		
		trichlorfon	1		
Flea beetle	May-June	carbaryl rotenone	2 0.2-0.4	Foliage	Apply every week as long as needed.
Aphid (NHE-47)	May-July	diazinon	$\frac{1}{4}$	Foliage	As needed, but before leaves curl.
		dimethoate	0.3		
		endosulfan	$\frac{1}{2}$		
		malathion	1		
		parathion	0.4		
Corn earworm	July-September; occasionally in June	carbaryl	2	Foliage	Add to weekly applications of fungicide sprays beginning at first fruit set. If spraying is infrequent, use 6 lb. of toxaphene.
		toxaphene	2		
Hornworm	July-September	carbaryl	2	Foliage	When first small worms appear.
		trichlorfon	1		
Mites	July-September	carbophenothion	1	Foliage	As needed.
		dicofol	$\frac{1}{2}$		
		malathion	1		
		parathion	0.4		
Russet mite	July-September	parathion	0.4	Foliage	As needed.
		sulfur dust ¹	10		
		sulfur spray ¹	10		
Blister beetle (NHE-72)	June-September	carbaryl	$1\frac{1}{2}$	Foliage	As needed.
		parathion	$\frac{1}{4}$		
		toxaphene	2		
Fruit fly and picnic beetle	August-October	diazinon spray	$\frac{1}{2}$	Foliage	When flies or beetles first appear.
		diazinon granules	1		
		pyrethrin dust ¹	1			Foliage	Apply to hamper immediately after it is filled.

¹ No limitations on use.

ASPARAGUS

Insect	Time of attack	Insecticide	Lb. of active ingredient per acre	Placement	Timing of application
Asparagus beetle (NHE-49)	Early and mid-season on spears and ferns	carbaryl ¹	$1\frac{1}{2}$	Spears and ferns	As needed, not oftener than every 3 days.
		rotenone ¹	0.2-0.4	Spears	As needed.

¹ One-day restriction between last application and harvest.

SWEET CORN

Insect	Time of attack	Insecticide	Lb. of active ingredient per acre	Placement	Timing of application
Soil insects (NHE-26, 27, 43)	April-August	diazinon dyfonate phorate	1 1 1	Row	Apply on soil surface behind planter shoe and ahead of press wheel.
Cutworm (NHE-38)	April-June	carbaryl ¹ toxaphene	2-3 3	Base of plants	When first damage appears. Use large quantities of water per acre.
Flea beetle (NHE-36)	April-July	carbaryl ¹	1½	Foliage	As necessary.
Japanese beetle (NHE-32)	July-September	carbaryl ¹	1	Ear zone	As necessary.
Corn borer	June-September	carbaryl spray, dust, ¹ or granules diazinon granules	2 1½	Foliage	Make first application when tassel ratio is 30 to 40. Repeat every 4 to 5 days as long as field has 20 or more unhatched egg masses per 100 plants.
Corn earworm ¹ (NHE-33)	June-September	carbaryl ¹	2	Ear zone	Market corn: At first silk and every 2 to 3 days for 5 to 8 applications. On very early or late planted corn, treatment may be necessary before silking when eggs are being laid on stalks and flag leaves. Canning corn: At 30 to 50% silk and every 3 days thereafter until corn is within 1 week of harvest.
Sap beetle (NHE-10)	July-September	carbaryl ¹ diazinon malathion parathion	2 1 1 ½	Foliage	When adults first appear in field; usually between pollen-shedding and silk-drying.
Corn leaf aphid (NHE-29)	July-September	malathion	1	Foliage	As needed to produce attractive ears for fresh market.

¹ During pollen shed, apply carbaryl as late in the day as possible (preferably after 4 p.m.) to reduce bee kill.

ONIONS

Insect	Time of attack	Insecticide	Lb. of active ingredient per acre	Placement	Timing of application
Onion maggot (NHE-50)	All season	diazinon W.P.	½-1 for 40-50 lb. of seed	Seed	Seed treatment for set onions only. Use lighter dosage of diazinon on sandy, highly mineral soils.
		ethion W.P.	1 for 40-50 lb. of seed		
		Dasanit granules	1	Furrow	Use 1 lb. active ingredient per acre for rows 12" apart; ¾ lb. for rows 18" apart; ½ lb. for rows 24" apart. Up to twice these amounts are needed for ethion on muck soils. Do not use Dasanit on green onions.
		diazinon granules	½-1		
		ethion granules	½-2		
		diazinon	2	Broadcast	Preplanting; disk into upper 1 to 2 inches of soil. Supplement with foliage spray below.
		diazinon malathion	⅓ 1	Foliage	Supplemental to soil treatment. Make first application when first adult flies are seen; make another 1 week later. From then on only as necessary.
Thrips (NHE-48)	Midseason and late season	diazinon parathion	½ ½	Foliage	When injury first appears and every 10 days as necessary.

POTATOES¹

Insect	Time of attack	Insecticide	Lb. of active ingredient per acre	Placement	Timing of application
Flea beetle	May-July	carbaryl endosulfan spray endosulfan dust	1 $\frac{1}{2}$ 1	Foliage	When first damage appears on leaves, and repeat as needed.
Colorado potato beetle	May-July	carbaryl endosulfan spray endosulfan dust	1 $\frac{1}{2}$ 1	Foliage	As needed.
Potato leafhopper (NHE-22)	May-July	carbaryl dimethoate endosulfan spray endosulfan dust	1 0.3 $\frac{1}{2}$ 1	Foliage	Weekly applications when leafhoppers first appear
		phorate granules	2 to 3	Soilband	Place on either or both sides of row at planting but not in contact with seed. Use lower rate on sandy soils and heavier rate on heavy soils. Do not use on muck soils.
Aphid (NHE-47)	All season	dimethoate endosulfan spray endosulfan dust malathion parathion	0.3 $\frac{1}{2}$ 1 1 $\frac{1}{4}$	Foliage	As needed.
		phorate granules	2 to 3	Soilband	As for leafhoppers.
Blister beetle (NHE-72)	All season	carbaryl toxaphene	$1\frac{1}{2}$ 2	Foliage	As needed.
Wireworm (NHE-43)	All season	phorate granules	2 to 3	Soil	Preplanting, disk in; or use as soilband at planting.
White grub (NHE-23)	All season	phorate granules	3	Soil	Preplanting, disk in; or use as soilband at planting.
Grasshopper (NHE-74)	July-September	carbaryl toxaphene	$\frac{3}{4}$ $1\frac{1}{2}$	Foliage	As needed, control in fence rows, roadsides, ditch banks, etc., before migration.

¹ Potatoes should not be grown in soil where aldrin, dieldrin, or heptachlor was applied as a soil insecticide the preceding year.

GREENHOUSE LETTUCE

Insect	Insecticide ¹	Dosage and formulation	Application
Aphid	malathion aerosol	1 lb. 10% aerosol per 50,000 cu. ft.	In a closed greenhouse above plants.
Garden flea hopper	parathion aerosol	1 lb. 10% aerosol per 50,000 cu. ft.	In a closed greenhouse above plants.
Mealybug Spider mite Whitefly	tepp aerosol	1 lb. 5% aerosol per 50,000 cu. ft.	In a closed greenhouse above plants.
Armyworm	malathion aerosol	1 lb. 10% aerosol per 50,000 cu. ft.	In a closed greenhouse above plants.
Cabbage looper Cutworm Sowbug	parathion aerosol	1 lb. 10% aerosol per 50,000 cu. ft.	In a closed greenhouse above plants.
Slug	metaldehyde	Commercially prepared bait or spray	To mulch on soil surface. Do not contaminate edible parts.

¹ See page 2 for limitations between application and harvest.

GREENHOUSE TOMATOES

Insect	Insecticide ¹	Dosage and formulation	Application
Aphid	endosulfan aerosol	1 lb. 10% aerosol per 50,000 cu. ft.	In a closed greenhouse above plants.
Whitefly	malathion aerosol	1 lb. 10% aerosol per 50,000 cu. ft.	In a closed greenhouse above plants.
	naled vapor	5 oz. of 4% E.C. per 50,000 cu. ft.	Apply on steampipes.
	parathion aerosol	1 lb. 10% aerosol per 50,000 cu. ft.	In a closed greenhouse above plants.
Mealybug Spider mite Russet mite Thrip		Use malathion or parathion aerosol as suggested for aphid and whitefly.	
Armyworm	malathion aerosol	1 lb. 10% aerosol per 50,000 cu. ft.	In a closed greenhouse above plants.
Cabbage looper Cutworm Tomato fruitworm	parathion aerosol	1 lb. 10% aerosol per 50,000 cu. ft.	In a closed greenhouse above plants.
Slug	metaldehyde	Commercially prepared bait or spray	To mulch on soil surface. Do not contaminate edible parts.

¹ See page 2 for limitations between application and harvest.

FOR YOUR PROTECTION

Always handle insecticides with respect. The persons most likely to suffer ill effects from insecticides are the applicator and his family. Accidents and careless, needless overexposure can be avoided. Here are a few easy rules that if followed will prevent most insecticide accidents:

1. Wear rubber gloves when handling insecticide concentrates.
2. Do not smoke while handling or using insecticides.
3. Keep your face turned to one side when opening insecticide containers.
4. Leave unused insecticides in their original containers with the labels on them.
5. Store insecticides out of reach of children, irresponsible persons, or animals; store preferably in a locked cabinet.
6. Wash out and then bury, burn, or haul to refuse dump all empty insecticide containers.
7. Do not put the water-supply hose directly into the spray tank.

8. Do not blow out clogged nozzles or spray lines with your mouth.

9. Wash with soap and water exposed parts of body and clothes contaminated with insecticide.

10. Do not leave puddles of spray on impervious surfaces.

11. Do not apply to fish-bearing or other water supplies.

12. Do not apply insecticides, except in an emergency, to areas with abundant wildlife or to blossoming crops visited by bees. Avoid drift onto blossoming crops or onto bee hives.

13. Do not apply insecticides near dug wells or cisterns.

14. Do not spray when weather conditions favor drift.

15. Observe all precautions listed on the label.

16. To avoid bee kill, apply insecticides after bee activity has been completed for the day; use the least toxic materials. *Warn beekeepers that you are applying insecticides.*

*1970 Suggested
Insecticide
Guide*

Insect Control for LIVESTOCK AND LIVESTOCK BARNs

Livestock producers must follow a sound program of pest control if they are to attain maximum income for their farming investment. Flies, lice, mites, ticks, and grubs irritate animals and some of them suck their blood. This reduces meat, milk, and egg production. On occasion, individual animals actually have been killed by attacks of large numbers of pests like horse flies, lice, and mites. Several of these pests can transmit diseases such as anaplasmosis and pink-eye from animal to animal. Thus losses from these pests each year cost Illinois farmers millions of dollars. A livestock producer does not need to share his profits with these insects. They can be readily controlled and in many cases eradicated.

In the following charts only the safest, most effective insecticides are suggested for each specific insect on each type of livestock. Other insecticides that may have label approval for use on livestock are not included because they are less effective or more toxic or present potential residue problems. Blank spaces in the table of limitations (back cover) mean that we do not suggest the insecticide for that specific purpose in Illinois.

In using insecticides read the label carefully and follow all instructions. Do not exceed the rates suggested; observe the interval between application and slaughter and apply only to those animals for which use has been approved. Keep a record of the insecticide used, the trade name, the percentage of active ingredients, the dilution, rate of application, and dates of application. If you are ever questioned, you have the records.

Most of the insecticides are suggested for use as emulsion concentrates since these are the easiest formulations to handle. However, wettable powders can

be substituted for emulsion concentrates providing the finished spray is agitated.

The chemical names used in these tables may be unfamiliar to you. These names are the common coined chemical names and as such are not capitalized. Trade names are capitalized. In the table of limitations (back cover) the common names are listed first. Should the trade name be more commonly used, it is listed in parentheses with the common name. Throughout the tables of suggested insecticides on pages 2 and 3, however, only the common name is used where there is one. In case of question, refer to the table of limitations.

These suggestions are printed annually. Be sure you have the current year's issue. Suggestions sometimes change during the growing season, and so are subject to change without notification.

These suggestions were prepared by entomologists of the University of Illinois College of Agriculture and the Illinois Natural History Survey.

Fact sheets and Circular 925, Insect Pests of Cattle, describing the life history, biology, and habits of most of the insects mentioned, can be obtained from the offices of county extension advisers or by writing to Office of Publications, College of Agriculture, University of Illinois, Urbana, Illinois 61801. These fact sheets are indicated by an NHE number in the tables.

Other circulars on insect control are:

- Circular 897 — Insect Control for Commercial Vegetable Crops and Greenhouse Vegetables;
- Circular 899 — Insect Control for Field Crops;
- Circular 900 — Insect Control by the Homeowner;
- Circular 936 — Pest Control in Commercial Fruit Plantings.

These can be obtained from the same offices.

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN COLLEGE OF AGRICULTURE COOPERATIVE EXTENSION SERVICE
In cooperation with ILLINOIS NATURAL HISTORY SURVEY CIRCULAR 898 Urbana, Illinois, December, 1969

Issued in furtherance of Cooperative Extension Work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture.
JOHN B. CLAAR, Director, Cooperative Extension Service, University of Illinois at Urbana-Champaign.

DAIRY CATTLE, BEEF CATTLE, SWINE, AND SHEEP

(Refer to table of limitations on back page before using insecticides)

	Insect	Insecticide	Amount per 100 gal. water or as directed	How to apply		
Dairy Cattle	Lice and mange (NHE-18)	Ciodrin E.C., 1.1 lb. per gal.	6 pt.	1-2 gal. per animal. Spray entire animal to saturation. Make 2 treatments 14 days apart.		
	<i>Pastured cattle only</i>	Face flies (NHE-106)	Ciodrin 2.0% O. ¹		1-2 oz. per animal; 2-6 times per week. ²	
		Horn flies (NHE-59)	Ciodrin E.C., 1.1 lb. per gal.	8 gal.	1-2 pt. per adult animal per week. ²	
		Stable flies (NHE-61)				
		Horn flies	dichlorvos 1.0% O. ¹		1-2 oz. per animal daily. ²	
		Stable flies	pyrethrin 0.1% + synergist O. ¹			
		Horse flies (NHE-60)	pyrethrin 0.5% + synergist O. ¹		1-2 oz. per animal daily. ²	
			pyrethrin 1% + synergist E.C.	10 gal.	1-2 qt. per animal every 3 days. ²	
Grubs		rotenone 5% W.P.	7½ lb. ³	2 gal. per animal monthly December through April.		
		rotenone 1½% dust		3 oz. per animal monthly December through April. Rub vigorously over affected areas.		
Beef Cattle	Lice and mange (NHE-18)	lindane 20% E.C. lindane 12.4% E.C. malathion 50-57% E.C.	1½ pt. 1 qt. 3 qt.	1-2 gal. per animal. Spray entire animal to saturation. Make 2 applications 14 days apart.		
	<i>Pastured cattle only</i>	Horn flies (NHE-59)	Ciodrin 2.0% O.		1-2 oz. per animal; 2-6 times per week from automatic sprayer. ²	
		Stable flies (NHE-61)	toxaphene 60% E.C.	5 pt.	1-2 qt. per animal every 3 weeks. Only partially controls stable flies. ²	
		Horse flies (NHE-60)	Use as directed for dairy cattle above.			
		Face flies (NHE-106)	Ciodrin 2.0% O.		As for stable flies.	
			Ciodrin E.C., 1.1 lb. per gal.	8 gal.	1-2 pt. per adult animal per week. ²	
			toxaphene 5% O.		Saturate cloth, canvas, or burlap head or back oiler at least weekly. Also controls horn flies and helps prevent buildup of lice in winter.	
		Grubs		rotenone 5% W.P.	As for dairy cattle	
				rotenone 1½% dust		
		The following systemic insecticides, coumaphos, crufomate, and trichlorfon, as sprays provide excellent control of grubs and good control of lice. Use only on <i>native beef cattle</i> ; apply during August or September in the southern half of the state and in September or October in the northern half of the state.				
Swine	Mange and lice	lindane 20% E.C.	1 qt. ³	1-2 qt. per animal. Spray entire animal to saturation. Make 2 applications 14 days apart.		
		lindane 12.4% E.C.	3 pt.			
		malathion 50-57% E.C.	3 qt.			
Sheep	Ticks, lice, and scab (NHE-53)	lindane 20% E.C.	1 qt. ³	Spray entire animal to saturation. Use ½ strength in dipping vat for scab.		
		lindane 12.4% E.C.	3 pt.			
		toxaphene 60% E.C.	3 qt.			
	Nose bot	crufomate 21% E.C.		Administer 2 cc. per 10 lb. of body weight as a drench.		

Note: E.C. = emulsion concentrate, O. = oil solution, W.P. = wettable powder.

¹ The same dosage of a water-base spray may be used, but control is generally less effective.

² Spray head, back, sides, belly, and legs carefully. Start treatments in June.

³ Add 2 pounds of detergent per 100 gallons of spray for better wetting effects.

CHICKENS, LIVESTOCK BARNs, AND SHEDS

(Refer to table of limitations on back page before using insecticides)

Insect	Insecticide	Amount per 100 gal. water or as directed	How to apply	
Chickens	Common red mites, bed-bugs, and lice (NHE-54)	carbaryl 80% W.P. (not for lice)	4 oz. per 5 gal. water	Spray roosts, back walls, side walls, and around nests.
		coumaphos 25% W.P.	6 oz. per 5 gal. water	Spray roosts, back walls, side walls, and nests.
		malathion 50-57% E.C.	10 oz. per 5 gal. water	
	Northern fowl mites and lice (NHE-54)	carbaryl 5% dust		Apply to litter, 1 lb. per 40 sq. ft., and 1 lb. per 100 male birds. ¹
		coumaphos 0.5% dust		Apply to litter and nests, 1 lb. per 20 sq. ft.; 1 lb. per 100 male birds. ¹
		malathion 4% dust		Apply to litter and nests, 1 lb. per 50 sq. ft.; 1 lb. per 100 male birds. ¹
	Northern fowl mites, common red mites, bed-bugs, and lice (NHE-54)	carbaryl 80% W.P.	4 oz. per 5 gal. water	Spray birds and roosting areas (1 gal. per 100 birds). Use in caged laying operations or when litter is sparse or wet.
		coumaphos 25% W.P.	3 oz. per 5 gal. water	Spray birds, nests and roosting areas (1 gal. per 100 birds). Use in caged laying operations or when litter is sparse or wet.
		malathion 50-57% E.C.	5 oz. per 5 gal. water	
Residual Sprays for Livestock Barns and Sheds	House flies (NHE-16, 88) Stable flies (NHE-61)	fenthion 45% E.C. (beef barns only)	3 gal.	Start treatments in June and maintain good sanitation. Apply 2 gal. per 1000 sq. ft. or to runoff to ceilings, walls, and support posts, and outside around doors and windows. Every 4-6 weeks during fly season. ²
		diazinon 50% W.P.	16 lb.	Treat every 2-4 weeks during fly season. ² Otherwise apply as for fenthion.
		dimethoate 25% E.C.	4 gal.	Treat every 4-6 weeks during fly season. ² Otherwise apply as for fenthion.
		Ravap {Rabon 21% E.C. dichlorvos 6% E.C.	4 gal.	
		ronnel 24% E.C.	4 gal.	Treat every 1-3 weeks during fly season. ² Otherwise apply as for fenthion.
		ronnel 25% W.P.	32 lb.	
Space Sprays for Feed Lots and Sheds	House flies (NHE-16, 88) Stable flies (NHE 61) Other flies Mosquitoes and gnats	dichlorvos 22% E.C.	2 gal.	Apply at 5 gal. per acre with mist blower over the top of animals and pens every 4 to 7 days.
		naled 37% E.C. ³	1 gal.	Apply as for dichlorvos.
Baits as Supplements for Livestock Barn and Shed Sprays	House flies (NHE-16, 88)	dichlorvos 22% E.C.	4 oz. per 1 gal. corn sirup and ½ gal. warm water	Apply to favorite fly-roosting areas from tank sprayer as needed to supplement residual spray treatment.
		naled 37% E.C.	2 oz. per 1 gal. corn sirup and ½ gal. warm water	Apply as for dichlorvos.

Note: E.C. = emulsion concentrate, O. = oil solution, W.P. = wettable powder.

¹ The male birds will not require dusting for the control of lice.

² Lasting effects are shortened during periods of hot, dry weather.

³ Temporary stinging of eyes may occur from mist but this is not hazardous.

LIMITATIONS FOR SUGGESTED INSECTICIDES APPLIED TO LIVESTOCK OR IN LIVESTOCK BARN

(Blank spaces in the table denote that the material is not suggested for that specific use in Illinois)

	Dairy		Beef		Swine		Sheep		Chickens	
	Animals	Barns	Animals	Barns	Animals	Barns	Animals	Barns	Birds	Barns
carbaryl (Sevin).....	...	...	...	...	...	...	...	...	E, I	E, I
Ciodrin.....	B	...	B	...	...	...	...	...	...	...
coumaphos (Coral).....	...	...	B, D	...	...	...	...	...	I, J	I, J
crufomate (Ruelene).....	...	...	B, A	...	...	...	B, L, N	...	...	...
diazinon.....	...	H	...	H	...	H, C	...	H	...	H
dichlorvos (DDVP) (Vapona)...	B	C	...	C	...	C	...	C	...	C, O
dimethoate (Cygon).....	...	H	...	H	...	H	...	H	...	H
fenthion (Baytex).....	...	...	...	H	...	...	...	...	...	...
lindane.....	...	...	B, G, K	...	B, G, K	...	B, G	...	...	...
malathion.....	...	...	B	...	B	...	...	...	I	I
naled (Dibrom).....	...	C	...	C	...	C	...	C	...	C, O
pyrethrin.....	B	...	B	...	...	...	...	...	...	...
Ravap.....	...	H	...	H	...	H	...	H	...	...
rotenone.....	B	...	B	...	...	...	...	...	...	...
ronnel (Korlan).....	...	H	...	H	...	H	...	H	...	I
toxaphene.....	...	...	B, F, K	...	...	...	B, F	...	...	...
trichlorfon (Neguvon).....	...	...	B, D, L	...	...	...	...	...	...	...

- A. Do not apply within 28 days of slaughter. Do not apply repeat applications within 28 days. Do not treat after November 1. Do not treat sick animals. Give animals free access to water and feed before and after treatment.
- B. Do not contaminate feed, water, milk, or milking utensils.
- C. As a bait. Do not apply within reach of animals or in milkrooms. Do not contaminate feed, water, milk, or milking utensils.
- D. Do not treat animals less than 4 months old, sick or convalescent animals, or stressed animals. Do not treat for 10 days before or after shipping. Do not apply in conjunction with internal medications or with pyrethrins, allethrin or their synergist, or with organic phosphates. Do not apply in poorly ventilated areas.
- E. Do not apply within 7 days of slaughter and do not treat nesting material. Do not repeat within 4 weeks.
- F. Do not apply within 28 days of slaughter.
- G. Do not spray within 30 days of slaughter. Do not dip within 60 days of slaughter.
- H. When used as a spray, remove animals before treating barn and cover feed and watering troughs. Do not use in milkrooms. Do not apply to animals.
- I. Gather eggs before treatment and do not contaminate feed and water.
- J. Do not apply within 10 days of vaccination or other stress influences. Do not apply more often than once a week.
- K. Do not treat cattle less than 4 months old or pigs before weaning.
- L. Do not apply within 14 days of slaughter.
- M. Do not apply above feed, water, or milking utensils.
- N. Do not drench sick, weak, or overheated animals; lambs under 30 pounds; animals being fed in confinement; or pregnant animals within one month of lambing.
- O. As a space spray do not apply in poultry houses while birds are present.

FOR YOUR PROTECTION

Here are a few easy rules that if followed will prevent most insecticide accidents:

1. Wear rubber gloves when handling insecticide concentrates.
2. Do not smoke while handling or using insecticides.
3. Keep your face turned to one side when opening insecticide containers.
4. Leave unused insecticides in their original containers with the labels on them.
5. Store insecticides out of reach of children, irresponsible persons, or animals; store preferably in a locked cabinet or room.
6. Wash out and bury or burn empty insecticide containers.
7. Do not put the water-supply hose directly into the spray tank.

8. Do not blow out clogged nozzles or spray lines with your mouth.

9. Wash with soap and water exposed parts of body and clothes contaminated with insecticide.

10. Do not leave puddles of spray on impervious surfaces.

11. Do not apply to fish-bearing or other water supplies. Do not allow treated animals in fish-bearing waters or other water supplies until the spray has dried.

12. Do not apply insecticides, except in an emergency, to areas with abundant wildlife or to blossoming crops visited by bees. Avoid drift onto blossoming crops and onto beehives.

13. Do not apply insecticides near dug wells or cisterns.

14. Do not spray when weather conditions favor drift.

15. Observe all precautions listed on the label.

1970 Suggested Insecticide Guides

Insect Control for FIELD CROPS

Insects and related pests play a major role in field crop production in Illinois. Although agronomic practices developed during the past century have reduced the importance of many insect pests, a large number of others, including several new invaders, have continued to threaten grain and forage production. Agronomic practices such as certain tillage operations, destruction of crop residues, selection of resistant hybrids, adjustment of planting dates, rotation of crops, etc., if used properly, still serve to suppress insect populations. Where possible, these practices continue to be used to provide more balanced insect control.

Practical applications of many insect-control techniques continue to be thoroughly investigated. Such control methods as insect sterilization, release of insect parasites, attractants for insect baits and traps, propagation and dissemination of insect disease organisms, as well as the use of insecticides, are being vigorously pursued. Despite the most optimistic reports, however, it is readily apparent that insecticides will be an important part of pest management for many years to come.

Certain precautionary steps should be taken when handling insecticides. Some of the insecticides suggested in the publication can be poisonous to the applicator. The farmer is expected to protect himself, his workers, and his family from undue or needless exposure.

When using insecticides, apply all the scientific knowledge available to insure that there will be no illegal residue on the marketed crop. Such knowledge is condensed on the label. Read it carefully and follow the instructions. But the label should be recent and not from a container several years old. Do not exceed maximum rates suggested; observe carefully the interval between application and harvest; and apply only

to crops for which use has been approved. Make a record of the product used, the trade name, the percentage content of the insecticide, dilution, rate of application per acre, and the date or dates of application.

The chemical names used in these tables may be unfamiliar to you. These names are the common coined chemical names and as such are not capitalized. Trade names are capitalized. In the table of limitations the common names are listed first. Should the trade name be more commonly used, it is in parentheses following the common name. Throughout the tables of suggestions, however, the common name is used if there is one. In case of question, refer to the table of limitations.

This circular lists only suggested uses of insecticides for the control of many Illinois field crop pests, and is not designed to discuss other methods of control. Fact sheets discussing non-chemical control methods, descriptions of specific insects, and their life history and biology are designated as NHE numbers in this circular. This additional information can be obtained from the county extension adviser or by writing to the Office of Agricultural Publications, University of Illinois, Urbana, Illinois 61801.

Other Suggested Insecticide Guides are:

Circular 897 — Insect Control for Commercial Vegetable Crops and Greenhouse Vegetables;

Circular 898 — Insect Control for Livestock and Livestock Barns;

Circular 900 — Insect Control by the Homeowner;

Circular 1004 — Pest Control in Commercial Fruit Plantings.

These suggestions are revised annually by entomologists of the College of Agriculture and the Illinois Natural History Survey.

SPECIAL SUGGESTIONS AND MAJOR CHANGES FOR 1970

Changes in Suggestions During 1970

Certain *major changes* are included in our suggestions for rootworm control this year. We do not recommend carbaryl (Sevin), diazinon, disulfoton (Di-Syston), and parathion as *basal* application insecticides for rootworm control. We have added BUX ten and Dasanit for this purpose, while retaining phorate (Thimet). For *planting-time* application for rootworm control, we retained BUX ten, carbofuran (Furadan), Dasanit, Dyfonate, and phorate (Thimet), and will add Landrin when labeled.

Another major change is to omit recommendations for aldrin and heptachlor as soil insecticides after 17 years of service. Aldrin and heptachlor no longer control two seed and seedling pests—seed-corn beetles and seed-corn maggots. In the past, control of these two insects alone usually paid for control costs. The northern, western, and southern corn rootworms are also resistant to aldrin and heptachlor. Populations of garden symphylans in cornfields have continued to increase, and cannot be controlled with aldrin and heptachlor. Some of the organo-phosphate and carbamate insecticides now available do control these pests.

This change in recommendations does not involve an emergency or legal situation, since aldrin and heptachlor have federal approval. Supplies of these two insecticides already on farms or in stock can be used in 1970. Providing the diazinon seed treatment is also used, the greatest return for such use will come when applied to first-year corn following grass sods or when white grubs pose an obvious threat to corn production. The second most likely place to use existing supplies will be on corn after clovers.

Other insecticides may have to be used for emergency control of *black cutworms*, and will require farmers to check their fields continually to detect early infestations of this pest. Probably as a result of the continued use of aldrin and heptachlor, *wireworm* populations have been very low for the past two years. We expect these populations to remain below economic levels for several years.

Because of decreased control of certain corn pests and low populations of others, the use of aldrin and heptachlor can no longer be justified economically. We will continue to emphasize use of appropriate insecticides only when and where needed. To minimize undue contamination of the environment, we will recommend biodegradable and less persistent insecticides as acceptable ones become available, just as we have been doing for the past decade.

Use of insecticides on Illinois farms has been of great benefit to production, but along with this use has gone the added responsibility of producing food without illegal residues, avoiding unnecessary contamination of the environment and injury to fish and wildlife. The record of the Illinois farmer has been good, but to maintain this record, he must keep abreast of the latest information.

Tolerances for old products may be changed, or new insecticides may receive federal label approval. Consult your University of Illinois county extension adviser for changes made during the year.

Illinois entomologists review all data available and limit the list of insecticides to those that best fit farms in Illinois. Thus, there are other materials labeled for use, but not listed in this circular.

Dairy Farms

As in the past, dairy farmers are cautioned against the use of the chlorinated hydrocarbon insecticides, aldrin, chlor-

dane, dieldrin, DDT, endrin, heptachlor, or lindane on their farms to avoid the possibilities of illegal residues in milk. Dairymen can use the insecticides recommended in the tables.

Soybean Farms

1. *Do not use* the soil insecticides aldrin, chlordane, dieldrin, endrin, heptachlor, or lindane as a soil or foliar treatment for soybeans.
2. If either aldrin or heptachlor has been applied annually in a field for five or more years, allow two years to elapse from the date of the last application before planting soybeans. If aldrin or heptachlor was applied to a field from 1965 to 1969, do not grow soybeans in this field until 1971. If corn is grown in 1970, use one of the suggestions listed on page 3.

Corn Soil Insect Situation

Rootworm populations were lower in 1969 than in previous years. One hypothesis is that the newly hatched tiny worms drowned when water stood in the rows for several days during peak egg hatch in June and early July. In addition, rootworm insecticides were more widely used for control in 1969 than in 1968, and they killed about 90 percent of the worms in 1969, as compared to 65 percent in 1968.

Regardless of the reason, rootworm beetles were much less abundant in Illinois cornfields in 1969 than in 1968. Since the beetles deposit eggs for the following year's crop of rootworm larvae, it is possible that our 1970 rootworm damage will be much less severe than in previous years. However, farmers who have experienced rootworm damage in the past should not be too optimistic, but should continue their rootworm insecticide program or rotate crops.

Although *western corn rootworms* could be found in the area north of a line from Pittsfield to Champaign in 1969, damage in 1970 is most likely to occur north and west of a line from Carthage to Bloomington to La Salle to Joliet.

In late August and September, western corn rootworm beetles may seek fields in fresh silk where they feed and lay their eggs. Thus fields most likely to be damaged by western corn rootworm in 1970 may be those where the 1969 corn was late. Furthermore, damage is more common in second-year corn. If you have had damage from western corn rootworms on your farm, treat fields that fit this description.

Northern corn rootworm populations are higher in the northern half of Illinois (north of Highway 36 running through Pittsfield, Springfield, and Decatur) than in the southern half. However, damage has occurred in the southern half of Illinois in bottomland and other areas where corn is grown for several years continuously.

Third-year or more corn is most likely to be damaged, and the rootworm population usually reaches its peak in the sixth or seventh year of continuous corn. Although this rootworm is usually a problem in continuous corn, second-year corn will occasionally be damaged.

Seed-corn beetles hollow out the seeds and cut the sprouts, while seed-corn maggots just hollow the seeds. Both are resistant to aldrin, heptachlor, dieldrin, lindane, and probably chlordane. Seed-corn beetles were extremely abundant in 1969, but damage from them was not as great as in 1968. A few fields were severely damaged in 1969 and required replanting, several fields were borderline, and the stand in many fields was reduced. Most fields, however, were unaffected.

Seed-corn beetles and seed-corn maggots will still be present in 1970. If germination is rapid, damage will be light. If germination is retarded, damage will be more common.

Garden symphylans were moderately abundant in most cornfields, at least in the northern half of the state. Timely rains allowed plants to overcome the damage caused by this pest. If you had this problem in 1969, we suggest a broadcast application of 2 pounds of Dyfonate per acre disked into the soil before planting. This should control seed beetles, maggots, and rootworms as well as the symphylans. A row treatment of 1 pound per acre of Dyfonate may control symphylans and help reduce other soil pests.

Control of Resistant Seed-Corn Beetles, Seed-Corn Maggots, and Rootworms

A crop rotation may be the easiest method for control of *resistant corn rootworms*. To hold populations of northern corn rootworms at low levels, do not grow corn for more than two years successively in any rotation. In western corn rootworm areas, rotations involving only one year of corn may be required.

In addition to crop rotation, early planting may help to minimize root damage by corn rootworm larvae and pollination damage by the adults, but may increase corn borer problems. Good fertility also helps the plants recover from insect damage.

Although several insecticides are labeled for corn rootworm control, entomologists of the University of Illinois Cooperative Extension Service and the Illinois Natural History Survey suggest the following materials for most effective rootworm control in Illinois. These rates are based on 40-inch row width, and may be adjusted for narrower rows.

For planting application

BUX ten	1 pound per acre
Carbofuran (Furadan)	1 pound per acre
Dasanit	1 pound per acre
Dyfonate.....	1 pound per acre
Landrin (if labeled).....	1 pound per acre
Phorate (Thimet).....	1 pound per acre

These materials were used in Illinois in 1968 and 1969 at the rates listed. To reduce costs, lower rates of application have been suggested. With the reduced rootworm threat, these lower rates may give practical control for 1970. Lower rates generally reduce effectiveness, however, and will not give satisfactory control with heavy infestations.

For basal application in June

BUX ten	1 pound per acre
Dasanit	1 pound per acre
Phorate (Thimet).....	1 pound per acre

Applications of insecticides approved for use during *cultivation* in late May to mid-June are effective. The insecticide is directed at the base of the plant, and for best results should be covered with some soil. These basal applications can be made when it is convenient, but to avoid bad weather, do not wait until the last minute.

Extreme drought conditions may decrease effectiveness of the insecticides. This could be particularly important with basal applications. For this reason, late May to mid-June applications are encouraged to take advantage of normal rainfall patterns.

For liquid applications: Some farmers apply liquid fertilizer with the planter. If this liquid is placed on both sides of the planter shoe, liquid insecticides, if label approved,

can be applied at the same time. Use the same rate of application per acre as you would with granules. Be sure that the applicator is off to one side and not too close to the seed, since either insecticide or fertilizer may interfere with germination.

It may be necessary to add an extra emulsifier such as Compex, since some insecticide solutions may float to the top. This tendency varies with different fertilizers.

Wear rubber or plastic gloves and use extreme care in handling liquid insecticide concentrates. In case of spillage on the skin, wash with soap and water *immediately*.

Resistant seed-corn beetles and maggots can be controlled at planting by planter applications of Dasanit, diazinon, Dyfonate, and phorate (Thimet). They are not controlled by planting applications of aldrin, BUX ten, heptachlor or landrin. Until we have further data, we will not list carbofuran (Furadan) as effective for the control of these beetles.

Planter Box Seed Treatments: *Seed beetles and seed maggots* are resistant to aldrin, heptachlor, dieldrin, and lindane, all commonly used seed treatments in the past. Because of this resistance, diazinon was used as a seed treatment for the first time in 1969. About 10 percent of the farmers using seed treatments had difficulty with seed drop, particularly on days of high humidity. However, some farmers complained that their seeding rate was actually increased and they had thicker stands than desirable.

Our conclusions from this year's work are as follows:

1. Use diazinon seed treater when you are using no soil insecticide, or when you are using aldrin, BUX ten, carbofuran (Furadan), heptachlor, or landrin.
2. You will not need seed treatment when you are using Dasanit, diazinon, Dyfonate, or phorate (Thimet).
3. Whenever you add any powder to the seed, you *may affect the seeding rate*.
4. Treat seed in a separate container so that excess dust will not be in the planter box.
5. Empty planter boxes frequently to prevent powder from accumulating in the bottom. Clean out the trap on plateless planters. Clean up plastic plates at the end of the day.
6. Do not overdose.
7. Check frequently for planter plate wear or chemical caking, particularly on plastic plates. Some plastic plates also become "gummy" from chemical reaction. Most companies this year are making diazinon seed treater from a specially formulated diazinon. The fact that no wetting agent is present should reduce the problems on days of high humidity.

Condensed Soil Insecticide Suggestions

Suggestions for maximum soil insect control in Illinois cornfields in 1970 must be based on individual situations. We have attempted to list these situations below.

1. *Where corn rootworms are not a problem:* Apply 1½ pounds of diazinon, or 1 pound of Dasanit, Dyfonate, or phorate (Thimet) at planting time in a 7-inch band to the surface of the soil ahead of the press wheel. If you do not do this, at least, as a minimum, use a diazinon seed treatment. If you suspect that garden symphylans are present, use Dyfonate at planting time.
2. *Fields where corn rootworm problems are anticipated:* Apply Dasanit, Dyfonate, or phorate (Thimet) as a 7-inch band on the surface of the soil ahead of the press wheel. Or treat the seed with diazinon and apply BUX ten, carbofuran, or landrin as a 7-inch band ahead of the press wheel. Or treat the seed with diazinon and make basal applications in June.

Potential Weaknesses of New Soil Insecticides

A variety of insect pests feed on corn roots, but all are not present in the same year or in the same field. Since it is not known how many of these pests will be controlled by the newer insecticides, you may experience poor control of certain pests. It is doubtful if any of the newer insecticides will control the *black cutworms* at the rates suggested; emergency sprays will be required to control this pest. Make repeated observations of corn in low spots in fields or in overflow land. Cutworms prefer these areas.

BUX ten, carbofuran (Furadan), and landrin apparently are more toxic to earthworms than Dasanit, diazinon, Dyfonate, and phorate (Thimet). The importance of this localized worm-kill to the overall worm population is not known.

Many of these newer insecticides can affect germination. A heavy rain right after planting, particularly shallow planting, may carry the insecticide to the seed and affect germination to a degree. Do not put these insecticides in the furrow with the seed. They must be placed on the soil surface just ahead of the press wheel.

These materials are more water soluble than aldrin and heptachlor, and under certain conditions, they could leach into farm ponds and affect the fish or animals using the water. However, this situation is not likely to occur. These insecticides are toxic to all warmblooded animals, including man. Livestock have been killed by eating the granules. *Therefore, store, handle, and apply these insecticides so that small children and livestock cannot get them.*

LIMITATIONS IN DAYS BETWEEN APPLICATION OF THE INSECTICIDE AND HARVEST OF THE CROP AND OTHER RESTRICTIONS ON THE USE OF INSECTICIDES FOR FIELD CROP INSECT CONTROL

(Blanks in the table denote that the material is not suggested for that specific use in Illinois)

	Field corn				Forage crops			
	Seed and soil	Grain	Ensilage	Stover	Alfalfa	Clover	Pasture	Seed
aziphosmethyl (Guthion) ¹	...	...	...	...	16,E	16,E	...	16,E
BUX ten (0-5353) ¹	A	A	A	A	...	...	...	...
carbaryl (Sevin)	...	0	0	0	0	0	0	...
carbofuran (Furadan) ¹	A	...	...	...	...	...	...	...
Dasanit	A	A	A	A	...	...	...	...
demeton (Systox) ¹	...	...	...	...	21,E	21,E	21,E	21,E
diazinon	A	7	10	10	7	7	K,L	7
Dyfonate ¹	A	A	A	A	...	...	...	...
Gardona	...	A	...	...	...	...	...	...
Imidan	...	...	...	...	7,E	...	...	...
malathion	...	5	5	5	0	0	0	0
methoxychlor	...	...	...	...	7	7	7	7
naled (Dibrom)	...	...	...	...	4	4	4	4
methyl-parathion ¹	...	12	12	12	15	15	15	15
parathion ¹	...	12	12	12	...	...	...	...
phorate (Thimet) ¹	A	B	B	B	...	...	...	...
toxaphene	...	A	C	C	...	...	...	D
trichlorfon (Dylox)	...	40,M	40,M	40,M	...	...	...	...

	Barley		Oats		Rye		Wheat		Soybeans	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Forage
aziphosmethyl (Guthion) ¹	...	...	...	...	...	...	...	...	21	D
carbaryl (Sevin)	F	F	F	F	F	F	F	F	0	0
carbophenothion (Trithion) ¹	...	...	...	...	...	...	...	...	7	D
demeton (Systox) ¹	45,G	21,G	45,G	21,G	...	...	45,G	21,G	...	...
disulfoton (Di-Syston) ¹	...	...	...	...	...	...	...	H	...	...
malathion	...	...	...	...	...	...	...	...	3	1
parathion ¹	15	15	15	15	...	...	15	15	...	...
phorate (Thimet) ¹	...	...	...	...	...	...	...	H	...	...
toxaphene	A	D	A	D	A	D	A	D	21	D
trichlorfon (Dylox)	21	D	21	D	...	...	21	D	...	...

1. Sprays to be applied only by experienced operators wearing proper protective clothing.

A. No specific restriction when used as recommended.

B. Do not apply after tassel emergence.

C. Do not feed treated forage to dairy animals. Do not feed sprayed forage or granular-treated corn silage to livestock fattening for slaughter nor granular-treated stover within 28 days of slaughter.

D. Do not feed treated forage to dairy animals, livestock fattening for slaughter, or poultry.

E. Once per cutting.

F. Not after boot stage.

G. Apply no more than twice per season with at least 14 days between applications.

H. Do not graze treated wheat.

I. Does not have label approval.

J. Do not apply more than once per season regardless of method of application.

K. Livestock may be grazed immediately following application or may be fed green forage immediately following cutting.

L. If grass pastures are to be cut for hay, allow 21 days between application of water solution or 30 days for oil solution.

M. Once only per season when plants are 3-12 inches tall.

FIELD CORN

Insects	Time of attack	Insecticide ¹	Lb. active ingredient per acre	Placement	Timing of application (See table of limitations)
Corn rootworms ² (NHE-26)	June-August	BUX ten	1	Soil Surface	As -7inch band ahead of planter press wheel. Basal treatments with BUX ten, Dasanit or phorate are effective. See page 3 for details.
		carbofuran	1		
		Dasanit	1		
		Dyfonate	1		
		phorate	1		
Seed-corn maggot	At germination	diazinon	See page 3	On seed	For use see page 3.
Seed-corn beetle					
Wireworm (NHE-43)	May-July	May be partially controlled by rootworm insecticides, particularly Dasanit, Dyfonate, and phorate (Thimet). Information is not available for the other insecticides.			
White grub (NHE-23)	May-October	Information is not available for the control of these two pests with the newer insecticides. For 1970, use reserve supplies of aldrin and heptachlor for this purpose as discussed on page 2.			
Grape colaspis (NHE-25)	May-July				
Sod webworm (NHE-42)	May-June	carbaryl	1	At base of plant	At time of initial attack.
Billbugs Cutworm (NHE-38)	May-June	carbaryl	2-3	At base of plant	When damage is first seen; use 20 gal. of finished spray per acre. Cultivation immediately after application will be helpful.
		diazinon	2		
		toxaphene	3		
		trichlorfon	1		
Gardensymphylan	May-July	Dyfonate	1 in row at planting 2 broadcast before planting		If suspected as a problem, use dyfonate for soil insect control.
Grasshopper (NHE-74)	June-September	carbaryl	$\frac{3}{4}$	Over row as spray	As needed. For ensilage corn use carbaryl, diazinon, or malathion.
		toxaphene	1½		
Flea beetle (NHE-36)	May-June	carbaryl	$\frac{3}{4}$	Over row as spray	When damage becomes apparent on small corn.
		toxaphene	1½		
Armyworm (NHE-21)	May-June	carbaryl	1½	Over row as spray	At first migration or when damage first becomes apparent.
		malathion	1		
		toxaphene	1½		
		trichlorfon	1		
Fall armyworm (NHE-34)	June; August-September	carbaryl	1½	In whorls	Granules preferred for whorl. When silking (see earworm).
		diazinon	1		
		toxaphene	1½		
Chinch bug (NHE-35)	June-August	carbaryl	1	Spray at base of plant	At beginning of migration. Also apply strip in adjacent grain.
Thrips (NHE-39)	June	carbaryl	1	On foliage as spray	When severe wilting and discoloration are noticed.
Corn leaf aphid (NHE-29)		diazinon granules	1	In whorl	Just before tasseling when aphids are appearing on individual plants. Preventive treatment.
		phorate granules	1		
		malathion	1		
		diazinon methyl parathion ³	$\frac{1}{4}$		
Corn rootworm adults	Late July, early August	carbaryl	1	Overall spray or directed towards silk	When silking is not over 50% and there are more than an average of 5 beetles per ear. Only to protect pollination.
		malathion	1		
		diazinon	1		
		methyl parathion ³	$\frac{1}{4}$		
Corn borer, first generation	June-July	carbaryl granules	1½	On upper $\frac{1}{3}$ of plant and into whorl	When tassel ratio is 30 to 50, and 75% or more plants show recent borer feeding in whorl.
		diazinon granules	1		
		parathion granules	$\frac{1}{2}$		
		bacillus thuringiensis			
Corn borer, second generation	Mid-August	carbaryl	As for first generation	From ear upward	At first hatch when there are 1 or more egg masses per plant.
		diazinon	$\frac{1}{2}$		
		parathion ³			
Corn earworm Seed corn only (NHE-33)	July-August	carbaryl	1½	Spray ear zone, seed corn only	2 applications at 3- to 5-day intervals, starting at 30-50% silk. 25 gal. of finished spray per acre.
		Gardona	1½		

¹ See page 4 for insecticide restrictions. ² Mocap is suggested for trial use only. Landrin will be recommended if labeled. ³ By experienced applicators only.

SOYBEANS

Insect	Time of attack	Insecticide ¹	Lb. active ingredient per acre	Placement	Timing of application (See table of limitations)
Bean leaf beetle (NHE-67)	May-June, August	carbaryl ² toxaphene ³	1 1½	On foliage	When leaf feeding becomes severe, but before plants killed and pods eaten.
Clover root curculio adult (NHE-71)	May-June	carbaryl ² toxaphene ³	1 1½	On marginal rows	When clover is plowed, beetles migrate to adjacent beans.
Grasshopper (NHE-74)	June- September	carbaryl ² toxaphene ³	¾ 1½	On foliage	When migration from adjacent crops begins.
Flea beetle	May-June	carbaryl ² toxaphene ³	1 1½	On foliage	Seedlings usually attacked. Treat when needed.
Green clover worm (NHE-75) and webworm (NHE-42)	August	carbaryl ² malathion	1 1	On foliage	When damage appears and small worms are numerous between blossom and pod fill.
Mites	June-August	carbophenothion ⁴ azinphosmethyl ⁴	¾ ½	On foliage	As needed on field margins and entire field.
Stink bugs	July and August	carbaryl ² malathion	1 1	To foliage	As needed but when stink bugs are numerous.
Thrips Leafhoppers	June-August	malathion	1	To foliage	As needed.

¹ See page 4 for insecticide use restrictions on soybeans.

² Carbaryl should not be used at more than 1 lb. per acre. Higher rates may damage plants.

³ For use on dairy farms only when alternate material is not available and when insect emergency exists. Do not apply as foliage sprays or dusts to or adjacent to dairy pasture, hay, or forage crops.

⁴ To be applied only by experienced operators or those wearing protective clothing.

STORED GRAIN (Corn, Wheat, and Oats)

Insect	Time of attack	Insecticide and dilution ¹	Dosage	Placement	Suggestions (See table of limitations)
Angoumois grain moth (earcorn) (NHE-62)	April-October (Southern ½ of Illinois)	malathion 57% E.C., 3 oz. per gal. water	Apply to runoff	Spray surface and sides in April and August	Plant tight husk varieties. Shelled corn is not affected by Angoumois moth.
Meal moths and surface infestations only (NHE-63)	April-October	malathion 1.0% dust malathion 57% E.C., 3 oz. per gal. water	30 lb. per 1,000 sq. ft. 2 gal. per 1,000 sq. ft.	Spray or dust on surface	Clean and spray bin with 1.5% malathion to runoff before storage. Store only clean dry grain.
General					
Internal and external feeders (NHE-64, 65) Rice and granary weevils	April-October	malathion 1.0% dust malathion 57% E.C., 1 pt. per 3-5 gal. water	40-60 lb. per 1,000 bu. 3-5 gal. per 1,000 bu.	Spray or dust uniformly as grain is binned	Clean and spray bin with 1.5% malathion to runoff before storage. Store only clean dry grain.
Flat grain beetle Saw-toothed grain beetle Rusty grain beetle Foreign grain beetle Cadelle beetle Flour beetle		liquid fumigant; use with caution and avoid breathing vapors	3-5 gal. per 1,000 bu.	On surface; repeat if necessary	Clean and spray bin with 1.5% malathion to runoff before storage. Store only clean dry grain. Apply in late July and September in the southern half of Illinois; apply in mid-August in the northern half of Illinois. Use surface treatment of malathion as recommended for meal moths.

¹ Use only "premium grade" malathion on grain. Malathion vaporizes and is lost rapidly when grain is heat-dried.

Note: E.C. = emulsion concentrate.

SMALL GRAINS

Insect	Time of attack	Insecticide ¹	Lb. active ingredient per acre	Placement	Timing of application (See table of limitations)
Grasshopper (NHE-74)	June-August	carbaryl toxaphene ²	$\frac{3}{4}$ $1\frac{1}{2}$	On entire plant	Control early while grasshoppers are small.
Chinch bug (NHE-35)	June-July	carbaryl	1	At base of stalk	Treat strip in grain as needed to protect corn from migrating bugs.
Armyworm (NHE-21)	May-June	carbaryl toxaphene ² trichlorfon	1 $1\frac{1}{2}$ $\frac{3}{4}$	On foliage	When worms are still small and before damage is done.
Greenbug English grain aphid	May-June	demeton ³ parathion ³	$\frac{3}{4}$ $\frac{3}{4}$	On foliage	When needed.
Hessian fly	Sept.-October; April-May	disulfoton phorate	$\frac{1}{2}$ $\frac{1}{2}$	In drill row	Use granules in a grass-seeder for susceptible varieties planted early.

¹ See page 4 for insecticide use restrictions.

² For use on dairy farms only when alternate material is not available and when insect emergency exists. Do not apply as foliage sprays or dusts to or adjacent to dairy pasture, hay, or forage crops.

³ To be applied only by experienced operators or those wearing protective clothing.

CLOVER AND ALFALFA

Insect	Time of attack	Insecticide ¹	Lb. active ingredient per acre	Placement	Timing of application ² (See table of limitations)
Alfalfa weevil (NHE-89)	March-June	azinphosmethyl ^{3, 4}	$\frac{1}{2}$	On foliage	Observe carefully after March 15 and when 25% of the tips are being skeletonized treat immediately; two treatments may be necessary on first cutting; regrowth following first cutting may need protection. By ground, use a minimum of 20 gal. of finished spray per acre (10 gal. on stubble) or 4 gal. by air. Do not apply during bloom. Instead cut and remove hay.
		methyl parathion ³	$\frac{1}{2}$		
		malathion ⁵ with methoxychlor	$\frac{3}{4}$ $\frac{3}{4}$		
		diazinon ⁵ with methoxychlor ⁵	$\frac{1}{2}$ 1		
		Imidan malathion ⁶	1 $1\frac{1}{4}$		
Methyl parathion at $\frac{1}{2}$ lb. per acre applied in November kills over-wintering weevils and greatly reduces egg laying the following spring.					
Clover leaf weevil (NHE-12)	March-April	malathion	1	On foliage	When larvae are numerous and damage is noticeable, usually early to mid-April.
Spittlebug (NHE-13)	Late April, early May	methoxychlor	$\frac{3}{4}$	On foliage	When bugs begin to hatch and tiny spittle masses are found in crowns of plants.
Aphid (NHE-14 and 19)	April-May	demeton ³ diazinon malathion	$\frac{1}{4}$ $\frac{1}{2}$ 1	On foliage	When aphids are becoming abundant.
Leafhopper (NHE-22)	Early July	carbaryl methoxychlor	1 1	On foliage	When second-growth alfalfa is 1 to 6 inches high, or as needed.
Garden webworm (NHE-42)	July-August	carbaryl toxaphene ⁷	1 $1\frac{1}{2}$	On foliage	When first damage appears. Use toxaphene only on new fall seedlings.
Cutworm (NHE-77)	April-June	carbaryl	$1\frac{1}{2}$	On foliage	Cut, remove hay, and spray immediately.
Armyworm (NHE-21)	May-June, September	carbaryl malathion	$1\frac{1}{2}$ 1	On foliage	Only when grasses are abundant.
Seed crop insects	July-August	toxaphene ⁷	$1\frac{1}{2}$	On foliage	No later than 10% bloom.
Grasshopper (NHE-74)	June-September	carbaryl	$\frac{3}{4}$	On foliage	When grasshoppers are small and before damage is severe.
		diazinon	$\frac{1}{2}$		
		malathion	1		
		naled	$\frac{3}{4}$		
Sweet clover weevil (NHE-15)	April-May	toxaphene ⁷	$1\frac{1}{2}$	On foliage	When 50% of foliage has been eaten. New seedlings only.

¹ See page 4 for insecticide use restrictions.

² Before applying insecticides, be certain to clean all herbicides out of equipment. During pollination, apply very late in day.

³ To be applied only by experienced operators or those wearing protective clothing.

⁴ Water temperature should be above 55°F.

⁵ Use no less than these amounts.

⁶ Use only when air temperature is above 60°F.

⁷ Not for use on dairy farms. Do not apply as foliage sprays or dusts to fields adjacent to dairy pasture, hay, or forage crops.

TOXICITY AND PERSISTENCY RATINGS FOR INSECTICIDES¹

Insecticide	Toxicity to			Persistency as a residue
	Warm-blooded animals	Fish	Honey bees ²	
aziphosmethyl	1	6	1	3
carbaryl	4	6	1	3
carbophenothion	1	6	3	2
demeton	1	3	3	3
diazinon	3	2	1	3
Gardona	2	1	2	1
malathion	5	3	1	6
methoxychlor	6	1	4	4
methyl parathion	1	6	1	6
naled	3	2	3	6
parathion	1	2	1	3
phorate	1	6	3	3
toxaphene	3	1	5	1
trichlorfon	4	6	4	5

¹ A rating of 1 indicates high toxicity or persistence of residue; a rating of 6 indicates low toxicity (relatively safe) and little persistency.

² When applied at the optimum time to avoid bee-kill.

FOR YOUR PROTECTION: Always handle insecticides with respect. The persons most likely to suffer ill effects from insecticides are the applicator and his family. Accidents and careless, needless overexposure can be avoided. Here are a few rules that if followed will prevent most insecticide accidents:

1. Wear rubber gloves when handling insecticide concentrates.
2. Do not smoke while handling or using insecticides.
3. Keep your face turned to one side when opening, pouring from, or emptying insecticide containers.
4. Leave unused insecticides in their original containers with the labels on them.
5. Store insecticides out of reach of children, irresponsible persons, or animals; store preferably in a locked building. Do not store near livestock feeds.
6. Wash out and bury, burn, or haul to the refuse dump all empty insecticide containers.
7. Do not put the water-supply hose directly into the spray tank.
8. Do not blow out clogged nozzles or spray lines with your mouth.
9. Wash with soap and water exposed parts of body and clothes contaminated with insecticides.
10. Do not leave puddles of spray on impervious surfaces.
11. Do not apply to fish-bearing or other water supplies.
12. Do not apply insecticides, except in an emergency, to areas with abundant wildlife.
13. Do not apply insecticides near dug wells or cisterns.
14. Do not spray or dust when weather conditions favor drift.
15. Observe all precautions listed on the label.
16. To avoid bee kill, apply insecticides after bee activity has been completed for the day; use the least toxic materials. *Warn beekeepers that you are applying insecticides.*

1970 Suggested Insecticide Guide

Insect Control BY THE HOMEOWNER

Much has been said about the effects of pesticides, particularly insecticides, on the health and well-being of the American people. The homeowner, however, is also aware that he is constantly faced with a horde of insects, intent upon destroying his property or making his life uncomfortable. Occasionally he can avoid or reduce the destruction wrought by some pests without using an insecticide, but to control most insects, he must rely on an insecticide. This will provide the satisfactory control that he demands.

By careful use of insecticides, the homeowner can enjoy reasonable freedom from insects without endangering either himself, his family, or his pets. He must recognize, however, that insecticides are designed to destroy one group of animals — insects — and can be harmful to other animals, including man himself, if used with disregard of normal safety precautions. It is up to each insecticide user to handle, apply, and store insecticides safely to reap their benefits without suffering from their dangers. For further information on safe use of pesticides Circular 906 is available from the College of Agriculture at Urbana.

Read the labels and follow instructions carefully. A few million dollars were spent on research to discover the information they contain.

The suggestions in this publication list certain insecticides to control insect pests of food, fabric, structures, man and animals, lawns, shrubs, trees, flowers, fruits, and vegetables. Others might control the insect, but we have tried to suggest only the safest materials and have tried to simplify the list of insecticides that the homeowner needs. However, with the wide variety of problems and situations, several insecticides are required to meet the needs of the homeowner. Many people prefer to employ the services of a professional exterminator or custom applicator rather than to become involved with selection and application of an insecticide.

The names used in these tables are the common coined chemical names, not the trade names, and as such may not be familiar to you. The common name for *Cygon* is *dimethoate*, for *DDVP* it is *dichlorvos*, for *Dylox* it is *trichlorfon*, for *Kelthane* it is *dicofol*, and for *Sevin* it is *carbaryl*. If there is no coined chemical name, the trade name is used but is capitalized.

Insecticides can be purchased from garden centers, drug, hardware, grocery, and seed stores, and from exterminators and other sources.

In using these tables always read the footnotes before using the insecticides. They list precautions and other pertinent information.

Leaflets on specific insects, their life history, habits, damage, and cultural control methods are available from the county extension adviser or by writing to Office of Agricultural Publications, University of Illinois College of Agriculture, Urbana, Illinois 61801. They are indicated in tables by NHE or Circular numbers.

Other circulars on insect control are:

Circular 897 — Insect Control for Commercial Vegetable Crops and Greenhouse Vegetables;

Circular 898 — Insect Control for Livestock and Livestock Barns;

Circular 899 — Insect Control for Field Crops;

Circular 1004 — Pest Control in Commercial Fruit Plantings.

These are available from the county offices or the College of Agriculture at Urbana.

These suggestions are revised annually. Suggestions sometimes change during the year, so these are subject to change without notification.

These suggestions were prepared by entomologists of the University of Illinois College of Agriculture and the Illinois Natural History Survey.

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN COLLEGE OF AGRICULTURE COOPERATIVE EXTENSION SERVICE
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JOHN B. CLAR, Director, Cooperative Extension Service, University of Illinois at Urbana-Champaign.

VEGETABLE INSECTS

Insects	Crop	Insecticide	Suggestions
Aphids (NHE-47) Leafhoppers (NHE-22) Mites (NHE-58) Thrips	Most garden crops	malathion	Apply on foliage to control the insects. Aphids and leafhoppers transmit plant diseases; early control is important. Mites web on the underside of leaves; apply insecticide to underside of leaves early before extensive webbing occurs.
Blister beetles (NHE-72) Cutworms (NHE-77) Flea beetles (NHE-36) Grasshoppers (NHE-74) Leafhoppers (NHE-22) Picnic beetles (NHE-40)	Most garden crops	carbaryl	For cutworms, attach collars of paper, aluminum foil, or metal at planting for small numbers of plants, or apply insecticide to base of plants at first sign of cutting. Control grasshoppers in garden borders when hoppers are small. For picnic beetles, pick and destroy overripe or damaged vegetables.
Wireworms (NHE-43) and other soil insects (NHE-23, 27)	Most garden crops	diazinon	When tearing up sod for a garden, apply to soil and rake in before planting.
All cabbage worms (NHE-45)	Cabbage and related crops, salad crops, and leafy vegetables	carbaryl or malathion	Presence of white butterflies signals start of infestation. Control worms when small. It is almost impossible to raise cole crops in Illinois without controlling these pests.
Hornworms	Tomatoes	carbaryl	Handpicking usually provides satisfactory control.
Earworms (NHE-33)	Tomatoes and sweet corn	carbaryl	Apply to late-maturing tomatoes 3 to 4 times at 5- to 10-day intervals from small-fruit stage. Apply at fresh-silk stage to early and late corn every 2 days 4 to 5 times.
Colorado potato beetles	Eggplant, potatoes, tomatoes	carbaryl	Apply as needed. Insects usually present only in late May and June.
Potato leafhoppers (NHE-22)	Potatoes, beans	carbaryl or malathion	Apply 3 to 4 times at weekly intervals starting in late May or early June. Late potatoes and beans require additional treatments. Most serious pest of potatoes and beans in Illinois.
Bean leaf beetles (NHE-67)	Beans	carbaryl	Leaves are riddled in early plantings. Apply once or twice as needed.
Mexican bean beetle	Beans	carbaryl	Except for southern Illinois, only a pest of late beans. Apply insecticide to underside of leaves.
Cucumber beetles (NHE-46)	Vine crops	carbaryl or malathion	Apply as soon as beetles appear in spring. When blossoming begins, apply insecticide late in the day so as not to interfere with pollination by bees.
Squash vine borers	Squash	carbaryl	Make weekly applications to crowns and runners when plants begin to vine. Apply late in day.
Squash bugs (NHE-51)	Squash and pumpkins	carbaryl	Apply as soon as small nymphs are seen and as needed. Does not kill large nymphs and mature bugs. Apply late in day.
Corn borer	Sweet corn	carbaryl	Apply 4 times every 3 days to whorl and ear zone of early corn when feeding appears on whorl leaves.

Days to Wait Between Application and Harvest

	Collards, kale, and other leafy crops	Beans	Lettuce	Cabbage and related crops	Sweet corn	Onions	Vine crops ¹	Tomatoes	Pumpkin	Eggplant	Peas	Potatoes
carbaryl	14	0	14	3	0	..	0	0	0	0	0	0
malathion	7	1	14	7	5	3	1	1	3	3	3	0

¹ Only apply insecticide late in the day after blossoms have closed to avoid bee kill.

Amount of Insecticide for Volume of Spray

	1 gal.	6 gal.	100 gal.	Commercial dust
carbaryl 50% W.P.	2 tbl.	¼ cup	2 lb.	5%
malathion 50-57% E.C.	2 tsp.	4 tbl.	1 qt.	4%

Apply 1 ounce of actual diazinon per 1,000 square feet. To do this mix ¼ pint (4 fluid ounces) of 25% diazinon emulsion in enough water to cover 1,000 square feet, usually 2 to 3 gallons of water. Rake into soil.

Note: E.C. = emulsion concentrate; W.P. = wettable powder.

FRUIT INSECTS

Insects	Crop	Insecticide ¹	Suggestions ²
Apple maggot (NHE-108) Codling moth (NHE-98) Green fruit worm Leaf rollers	Apple	malathion methoxychlor diazinon	Apply once just ahead of bloom and repeat every 10 to 14 days after bloom until July 15. Continue spray program in northern Illinois until August 15 for apple maggot control.
Aphids	Most fruits	diazinon malathion	Apply when aphids first appear on leaves.
Apple tree borers	Apple	carbaryl	Spray trunks of young trees beginning in June for 2 to 3 applications. Keep young trees vigorous.
Plum curculio (NHE-101)	Apple, peach, apricot, plum, and cherry	methoxychlor malathion	Use methoxychlor just before bloom and repeat every 10 to 14 days for 3 applications. Do not spray during bloom.
Scale (NHE-100)	Most fruits	malathion	Apply in May during crawler stage. Dormant oil spray may be applied in spring before leaf buds open.
Oriental fruit moth (NHE-99)	Peach and apricot	methoxychlor malathion	Make first application at petal fall. Repeat every 10 to 14 days. Malathion can be added to suppress mites. First generation damages terminal hosts, second and third enter fruit.
Peach tree borers (NHE-112)	Peach, apricot, plum, and cherry	carbaryl	Thoroughly spray trunk and limbs of peach trees beginning about June 1. Repeat every 2 to 3 weeks through July.
Tarnished plant bug Stink bug	Peach and apricot	malathion methoxychlor	Make first application at petal fall, plus 2 more applications 10 to 14 days apart.
Mites	Most fruits	malathion dicofol	Either malathion or dicofol should be included in the spray mixture to prevent mite buildup.
Periodical cicada	Apple and peach	carbaryl	Apply spray every 7 to 10 days.
Raspberry fruit worm Raspberry cane borers	Raspberry	methoxychlor malathion	Apply just before buds open and repeat in 2 weeks.
Grape berry moth	Grape	malathion methoxychlor diazinon	Apply to first generation larvae immediately after bloom and apply sprays again 35 to 45 days later for second brood.
Strawberry leafroller Strawberry weevil Strawberry crown borers	Strawberry	diazinon malathion methoxychlor	Apply once before bloom and again after bloom. If leafroller remains a problem after harvest, make an additional application.

¹ There are multi-purpose or all-purpose fruit sprays available commercially for use by the home fruit grower. These mixtures usually contain 2 fungicides for disease control and 2 insecticides. The insecticides differ in that one is a short-duration, quick-killing chemical such as malathion and the other is a more residual insecticide such as methoxychlor. These two insecticides will effectively control most large and small fruit insects if used throughout the growing season. Sometimes, a miticide has to be added for more effective mite control. Carbaryl thins or reduces the number of apples on a tree if used earlier than three weeks after bloom.

² Dates of application refer to central Illinois. In southern Illinois apply two weeks earlier and in northern Illinois two weeks later.

Days to Wait Between Application and Harvest

	Apples and pears	Peaches and apricots	Plums	Cherries	Grapes	Raspberries	Strawberries
carbaryl (Sevin)	1	3	3	1	1	7	1
diazinon	14	20	10	10	10	..	5
dicofol (Kelthane)	7	14	7	7	7	2	2
malathion	3	7	3	7	3	1	3
methoxychlor	7	21	7	7	14	3	3

Amount of Insecticide for Volume of Spray

	1 gal.	6 gal.	100 gal.
carbaryl 50% W.P.	2 tbl.	¾ cup	2 lb.
diazinon 25% W.P.	2 tbl.	¾ cup	2 lb.
dicofol 18.5% W.P.	2 tbl.	¾ cup	2 lb.
malathion 25% W.P.	1½ tbl.	½ cup	1½ lb.
methoxychlor 50% W.P.	2 tbl.	¾ cup	2 lb.

Note: E.C. = emulsion concentrate; W.P. = wettable powder.

TREE AND SHRUB INSECTS

Insects	Insecticide	Suggestions ¹
Aphids (NHE-7)	diazinon malathion	Spray foliage thoroughly with force. Repeat as needed.
Bagworms (NHE-6)	carbaryl diazinon malathion	Spray foliage thoroughly. Apply June 15. Later sprays are less effective.
Borers (NHE-8)		Wrap trunks of newly set trees with heavy paper for first two years or until trees are growing vigorously. Provide adequate water and fertilizer for vigorous growth. No chemical control suggested.
Catalpa sphinx	carbaryl malathion	Spray foliage when feeding or worms are first noticed.
Eastern tent caterpillars	Same as for catalpa sphinx	Spray when nests are first noticed.
Elm leaf beetle (NHE-82)	carbaryl	Spray as soon as damage is noticed.
European pine shoot moths and Nantucket pine moth (NHE-83)	dimethoate	Spray ends of branches thoroughly in early June for European species and in mid-May for Nantucket species.
Fall webworms	carbaryl diazinon malathion	Spray when first webs appear; clip off and destroy infested branches or burn out webs.
Galls (NHE-80, 81)		
Elm cockscomb	diazinon	Spray foliage thoroughly when buds are unfolding.
Hickory	malathion	
Maple bladder		
Hackberry blister	diazinon malathion	Spray foliage thoroughly in late May. Kills psyllids in galls.
Cooley spruce	diazinon	Apply in late September or October or early spring just before buds swell.
Eastern spruce	malathion	
Green-striped mapleworms	Same as for catalpa sphinx	Spray as soon as damage is noticed.
Leaf miners	diazinon	Spray foliage thoroughly when mines first appear. Repeat treatment in 10 to 12 days.
Birch	malathion	
Boxwood		
Hawthorn		
Oak		
Mealybugs	malathion	Spray foliage thoroughly and with force. Repeat in two weeks.
Mimosa webworms (NHE-109)	carbaryl malathion	Spray foliage thoroughly when first nests appear (June, July). A repeat treatment may be needed.
Mites (NHE-58)	chlorobenzilate dicofol	Pay particular attention to underside of leaves. Apply 2 or 3 times at weekly intervals.
Oak kermes	malathion	Spray foliage thoroughly about July 1 to kill the crawlers.
Periodical cicadas (NHE-113)	carbaryl	Spray all branches thoroughly when adults appear. Repeat in 7 to 10 days.
Sawflies	Same as for fall webworms	Spray as soon as worms or damage is evident.
Scale (NHE-114)	malathion	Spray foliage thoroughly in early April for <i>Fletcher</i> and <i>European elm scale</i> ; in late May for <i>pine needle</i> and <i>sweet gum scale</i> ; in early June for <i>scurfy</i> , <i>oyster shell</i> , and <i>euonymous scale</i> ; in early July for <i>cottony maple</i> , <i>Juniper</i> , and <i>dogwood scales</i> ; in mid-July for <i>spruce bud scale</i> ; and again in early August for <i>oystershell scale</i> .
Putnam	dormant oil diluted	Apply when plants are still dormant in late winter. Do not use on evergreens.
San Jose	according to label	For tulip tree scale, a malathion spray in late September or in early spring is also effective.
Tulip tree		

¹ Treatment dates are listed for central Illinois. In southern Illinois apply 2 weeks earlier and in northern Illinois 2 weeks later.

TREE AND SHRUB INSECTS (continued)

Insects	Insecticide	Suggestions ¹
Spring cankerworms	Same as for catalpa sphinx	When leaf buds open in spring, while worms are still small.
Spruce budworms	Same as for fall webworm	Spray when caterpillars are noticed.
Sycamore lace bugs	carbaryl malathion	Spray when nymphs appear, usually in late May.
Thrips	Same as for aphids	Mainly on privet. Spray foliage thoroughly.
Yellow-necked caterpillars	Same as for catalpa sphinx	Spray foliage when worms are small.
Zimmerman pine moths	malathion	Spray in mid-August and again two weeks later. In each spray use twice the amount of malathion suggested in the chart below.

¹ Treatment dates are listed for central Illinois. In southern Illinois apply 2 weeks earlier and in northern Illinois 2 weeks later.

Amount of Insecticide Needed for Volume of Spray

	1 gal.	6 gal.	100 gal.		1 gal.	6 gal.	100 gal.
carbaryl 50% W.P. ¹	2 tbl.	¾ cup	2 lb.	chlorobenzilate 25% W.P.	1 tsp.	2 tbl.	2 lb.
diazinon 25% E.C. ²	2 tsp.	4 tbl.	1 qt.	dicofol 18.5% E.C.	2 tsp.	4 tbl.	1 qt.
lindane 20% E.C.	1 tsp.	2 tbl.	1 pt.	dimethoate	2 tsp.	4 tbl.	1 qt.
malathion 50-57% E.C. ³	2 tsp.	4 tbl.	1 qt.				

¹ Do not use on Boston ivy. ² Do not use on ferns or hibiscus. ³ Do not use on canaert red cedar.

Note: E.C. = emulsion concentrate; W.P. = wettable powder.

LAWN INSECTS

Insects	Insecticide ¹	Dosage per 1,000 sq. ft. ²	Suggestions
True white grubs (NHE-23)	chlordane 45% E.C.	½ cup	This treatment provides 5-year protection. In established sod, apply as granules or spray to small area and then water in very thoroughly before treating another small area. For new seedings, mix in soil before planting. Do not plant vegetable root crops in treated soil for 5 years.
Annual white grubs	40% W.P.	5 oz.	
Japanese beetle larvae	10% G.	1 ¼ lb.	
Green June beetle larvae	5%	2 ½ lb.	
Ants (NHE-111)			
Ants (NHE-111)	diazinon 25% E.C.	¾ cup	Apply as spray or granules and water in thoroughly. For individual nests pour 1% diazinon in nest. Seal in with dirt.
Cicada killer and other soil-nesting wasps (NHE-57, 79)	2% G.	5 lb.	
Sod webworms	carbaryl 50% W.P.	½ lb.	As sprays, use at least 2.5 gal. of water per 1,000 sq. ft. Do not water for 72 hours after treatment. As granules, apply from fertilizer spreader.
Millipedes and sowbugs (NHE-93, 115)	5% G.	4 lb.	
	diazinon 25% E.C.	¾ cup	
	2% G.	5 lb.	
	trichlorfon 50% W.P.	4 oz.	
	5% G.	2 ½ lb.	
Armyworms	carbaryl 50% W.P.	2 oz.	Apply as sprays or granules. Use 5 to 10 gal. of water per 1,000 sq. ft.
Cutworms	5% G.	1 lb.	
Chinch bugs			
Leafhoppers	carbaryl 50% W.P.	2 oz.	Apply as a spray.
	methoxychlor 25% E.C.	2 oz.	
Chiggers	diazinon	1 tbl.	Spray grass thoroughly.
Mites	dicofol 18.5% E.C.	1 tbl.	Spray grass thoroughly, 2 to 2.5 gal. of water per 1,000 sq. ft.
	malathion 50-57% E.C.	1 tbl.	
Slugs (NHE-84)	Slug baits	Scatter in grass	Apply where slugs are numerous.

¹ E.C. = emulsion concentrate; W.P. = wettable powder; G. = granules.

² To determine lawn size in square feet, multiply length times width of lawn and subtract non-lawn areas including house, driveway, garden, etc. Do not allow people or pets on lawn until the spray has dried.

FLOWER INSECTS

Insect	Insecticide ¹	Dosage	Suggestions
Ants, soil-nesting wasps, and sowbugs (NHE-17, 79, 93, 111)	Same as for ants under lawn insects on page 5.		
White grubs	Same as for white grubs under lawn insects on page 5.		
Aphids, mealybugs, lacebugs, scales, and white flies (NHE-7, 114)	malathion 50-57% E.C.	2 tsp. per gal. water	Spray foliage thoroughly. Repeat treatments may be needed.
Blister beetles (NHE-72)	carbaryl 50% W.P.	2 tbl. per gal. water	Spray foliage. Repeat treatments may be needed.
Cutworms (NHE-77)	diazinon 25% E.C. diazinon 2% granules	6 oz. per 2-3 gal. water 5 lb. per 1,000 sq. ft.	Spray 1,000 sq. ft. soil at base of plants. Do not spray on plant foliage. Small numbers of plants can be protected with collars of paper, aluminum foil, or metal.
Grasshoppers (NHE-74)	carbaryl 50% W.P. malathion 50-57% E.C.	2 tbl. per gal. water 2 tsp. per gal. water	Spray foliage and also adjacent grassy or weedy areas.
Iris borer	dimethoate 23.4% E.C.	4 tsp. per gal. water	Apply when irises are in bloom, but not on blooms and make only one application. Add a small amount of liquid detergent to spray mix to improve coverage on leaves.
Leaf-feeding beetles	carbaryl 50% W.P.	2 tbl. per gal. water	Spray foliage. Repeat treatments if needed.
Leaf-feeding caterpillars	Same as for leaf-feeding beetles		
Plant bugs and leafhoppers	Same as for leaf-feeding beetles		
Slugs (NHE-84)	Metaldehyde		Apply as a bait to soil. Remove old leaves, stalks, poles, boards, and other debris where slugs like to hide and lay eggs.
Spider mites (NHE-58)	chlorobenzilate 25% W.P. dicofol 18.5% E.C.	1 tsp. per gal. water 2 tsp. per gal. water	Pay particular attention to underside of leaves when spraying. Apply 2 or 3 times at weekly intervals.
Springtails	malathion 50-57% E.C. malathion 4% dust	2 tsp. per gal. water	Spray foliage and soil. Apply to soil at base of plants.
Stalk borers (NHE-24)	Same as for leaf-feeding beetles		Spray foliage thoroughly and frequently.
Thrips	Same as for leaf-feeding beetles		Spray foliage carefully.

¹ Do not use oil-base sprays on plants. Do not use malathion on African violets. Do not use carbaryl on Boston ivy. Do not use diazinon on ferns. Repeated use of carbaryl foliage sprays may cause mite or aphid infestations to increase and become damaging. Do not use insecticides during full bloom.

Note: E.C. = emulsion concentrate; W.P. = wettable powder. An emulsion concentrate is a chemical pesticide dissolved in a solvent to which an emulsifier has been added. It can then be mixed with water to the desired strength before being used.

READ THE LABEL AND STUDY THE PRECAUTIONS ON PAGE 8

ANIMAL AND NUISANCE INSECTS

Insects	Insecticide ¹	Method of application	Suggestions
Flies, mosquitoes, gnats (NHE-16, 94)	<i>Outdoors:</i> malathion 0.5% Purchase E.C. and dilute with water	Spray shrubbery, flowers, and tall grass, and around doorways and refuse containers.	Dispose of refuse twice each week. Eliminate standing water in eaves troughs, old tires, toys, tin cans, etc.
	<i>Indoors:</i> pyrethrin 0.1% space spray or 20% dichlorvos resin strips ²	Use fine mist or fog of pyrethrin or 1 resin strip per 1,000 cu. ft.	Use screening and keep repaired.
Fleas (NHE-107)	carbaryl 5% dust	Dust areas inside and outside the home where the pet rests.	Dust pets as needed. For cleanup of ticks indoors use 0.5% diazinon.
Brown dog tick	malathion 4% dust		
Chiggers and ticks (NHE-56)	diazinon	8 oz. per 10,000 sq. ft. of lawn.	For people use DEET as a repellent.
Hornets, wasps, bees, spiders (NHE-17, 79, 116)	dichlorvos 0.5% O. ² malathion 1% O. or 4% dust	Treat nests of bees, wasps or hornets after dark. For soil nests treat as for ants (p. 5 under lawn insects).	For spiders same as for ants (p. 5). For wasp or bee nests in partitions remove exterior siding, spray nests, remove nest and replace siding.
Cluster flies (NHE-1)	20% dichlorvos resin strips ²	1 strip per 1,000 cu. ft. in attic or room.	Seal cracks around windows, eaves, and siding to prevent entry.
Elm leaf beetles (NHE-82)	dichlorvos 0.5% O. ² pyrethrin 0.1% O.	Spray on insects for quick kill or collect with vacuum when found indoors.	Spraying Chinese elm trees with carbaryl for elm leaf beetle larvae in the summer will help. Removal of seed-bearing boxelder trees is also helpful.
Boxelder bugs (NHE-9)			
Clover mites (NHE-2)	chlorobenzilate 0.25% dicofol 0.05% Purchase E.C. and dilute with water	Spray outside of the house from ground up to windows and adjacent 10 ft. of lawn.	Remove grass and weeds from 18-inch strip next to foundation. Vacuum, or spray with 0.1% pyrethrin in house.
Millipedes, centipedes, or sowbugs (NHE-93)	diazinon carbaryl trichlorfon	Spray outside foundation and at least 3 ft. of adjacent soil.	Treat entire lawn as for webworms if pests are abundant. Collect with vacuum when found indoors.
Picnic beetle	carbaryl 50% W.P.	2 tbl. per gal. water.	Apply to garbage pails and other decaying vegetable refuse frequented by these beetles.
Springtails	malathion 50-57% E.C. malathion 4% dust	2 tsp. per gal. water.	Spray foliage and soil next to house.
Drainflies (NHE-91)	<i>Outdoors:</i> malathion 0.5%	Spray shrubbery, tall grass, and refuse containers.	Use chemicals only after solving sanitation problems. Clean out overflow drains, drain traps, and cellar drains. Pour boiling water or rubbing alcohol into overflow drain to eliminate maggots.
	<i>Indoors:</i> pyrethrin 0.1% space spray or 20% dichlorvos resin strip ²	Use fine mist or fog of pyrethrin or 1 resin strip per 1,000 cu. ft.	
Larder beetles	None		Removal of source such as dead animal carcasses.

¹ SPECIAL NOTE: Whenever possible purchase especially prepared ready-to-use forms of insecticides for indoor use. Do not use oil-base sprays on plants or near open flames. Do not spray or dust food, food-handling surfaces (counters, chopping boards, etc.), or cooking and eating utensils.

² Do not use in pet shops or if tropical fish are present. Do not use in kitchens, restaurants, or areas where food is present. Do not use in nurseries, or rooms where infants, ill, or aged persons are confined.

Note: E.C. = emulsion concentrate; W.P. = wettable powder; O. = oil solution (usually available in pressurized spray can).

FOOD, FABRIC, AND STRUCTURAL INSECTS

Insects	Insecticide ¹	Method of application	Suggestions
Ants (NHE-111, Cir. 887) Crickets Spiders (NHE-116)	diazinon 0.5% chlordane 2%	Spray runways and outside foundation.	To prevent insect migrations into house, use E.C. diluted with water and spray completely around outside foundation wall and adjacent 4-inch strip of soil. Indoors: use diazinon oil-base spray.
Cereal insects (NHE-11) Drugstore beetle Cigarette beetle	diazinon 0.5% O.	Spray or dust inside food cabinets and shelves.	Discard infested packages. Brush out or vacuum food cabinets and shelves.
Roaches (NHE-3, 4, 5)	diazinon 0.5% O. Baygon 0.5% O.	Spray runways and hiding places.	More complete treatment is needed for successful control of brown-banded roach. Repeat treatments may be needed in 2 or 3 weeks.
Clothes moths and carpet beetles (NHE-87) Tissue paper beetle	diazinon 0.5%	Spray storage areas and any infested places.	Recently cleaned or washed woolens may be safely stored in insect free chests and plastic bags. Air and brush other woolens in bright sunlight before storing, or treat lightly with diazinon.
Silverfish (NHE-86)	diazinon 0.5% O.	Spray runways.	Baits using 1 part sodium fluoride plus 9 parts pancake flour are also effective.
Termites (NHE-57)	chlordane 1% dieldrin 0.5% Purchase E.C. and dilute with water or oil	Soak 6-inch width of soil down to footing around and beneath building, 1 gal. per 2 cu. ft. of soil.	Remove termite mud tubes connecting wood to soil. Eliminate wood-to-soil contacts. Ventilate to keep unexcavated areas dry.
Powder-post beetles (NHE-85)	chlordane 2% O. pentachlorophenol 5% O.	Spray or brush on infested wood several times.	Pentachlorophenol is a wood preservative also, but it has a strong persistent odor.
Carpenter ants (NHE-10)	chlordane 2% O. or 5% dust dieldrin 0.5% O. or 1% dust	Spray or dust nest entrances.	Use foundation sprays as recommended for ants.

¹ Purchase especially prepared ready-to-use forms of insecticides for indoor use. Do not use oil-base sprays on plants or near open flames. Do not spray or dust food, food-handling surfaces (counters, chopping boards, etc.) or cooking and eating utensils.

Note: E.C. = emulsion concentrate; W.P. = wettable powder; O. = oil solution (usually available in pressurized spray cans).

FOR YOUR PROTECTION

Always handle insecticides with respect. After all, the people most likely to suffer ill effects from insecticides are the applicator and his family. Accidents and careless, needless overexposure can be avoided. From 1960 through 1968 there were 24 deaths in Illinois caused by accidental ingestion of pesticides: 15 from insecticides, 5 from rodenticides, and 4 due to a herbicide. Of these 24, ten were from baits.

Each year more than 750 Illinois children under 12 years of age are rushed to a doctor because of suspected pesticide ingestion or excessive exposure. A study of such cases in 1968 showed that 46 percent of the children obtained the pesticide while it was in use and 16 percent obtained it from storage (the source was not known in the rest). Fifty-nine percent involved insecticides used as baits. All these accidents could have been prevented. The following suggestions for safe use of pesticides are designed to prevent such unfortunate careless accidents.

1. Store insecticides out of reach of children, irresponsible persons, or animals; store preferably in a locked cabinet.

2. If you use a bait around or in the home, place it after the children have retired and pick it up in the morning before they get up. Furthermore, place it out of their reach. At present we do not encourage use of baits for insect control.

3. Put insecticide containers back in the storage area before applying insecticide. Small children have found open bottles by the water tap.

4. Avoid breathing insecticide sprays and dusts over an extended period. This is particularly true in enclosed areas such as crawl spaces, closets, basements, and attics.

5. Wash with soap and water exposed parts of body and clothes contaminated with insecticide.

6. Wear rubber gloves when handling insecticide concentrates.

7. Do not smoke while handling or using insecticides.

8. Do not blow out clogged nozzles with your mouth.

9. Leave unused insecticides in their original containers with the labels on them and in locked cabinets.

10. Wash out and bury or burn and haul to the refuse dump empty insecticide containers.

11. Do not leave puddles of spray on impervious surfaces.

12. Do not apply insecticides to fish ponds.

13. Do not apply insecticides near dug wells or cisterns.

14. Do not apply insecticides in vicinity of beehives or on blooming plants.

15. Observe all precautions listed on the label.

16. To avoid bee kill, apply insecticides after bee activity has been completed for the day; use the least toxic materials. *Warn beekeepers that you are applying insecticides.*

Herbicide Guide 1970

FOR COMMERCIAL VEGETABLE GROWERS

WEED GROWTH reduces vegetable growers' income in the United States by millions of dollars annually as a result of lower yields, poorer quality, and added labor in harvesting and processing the crops.

This guide should be used together with the grower's knowledge of soil types and the crop and weed history of the area to be treated. The decision of whether to use herbicides or other means of weed control depends in part on the severity of past weed infestations. Several herbicides may be suggested for some crops. These herbicides have shown good control with no injury to the vegetables under test conditions. Not all herbicides cleared for use on a species are necessarily listed. Where the choice of more than one herbicide is suggested, the decision rests with the grower and is based on his knowledge of past weed infestation and cost of material. When using an herbicide for the first time, a small-scale trial is advised.

These suggestions for chemical weed control in vegetables are based on research at the Illinois Agricultural Experiment Station, the U.S. Department of Agriculture, and other research institutions. The University of Illinois and its agents assume no responsibility for results from the use of these herbicides, whether or not they were used in accordance with suggestions,

recommendations, or directions of the manufacturer or any governmental agency.

Reading the label of the herbicide container is the most profitable time you spend in weed control. Use of the material and methods of use depend on registration of the herbicide by the federal Food and Drug Administration. Do not use any herbicide *unless the label states that it is cleared for the use on the crop to be treated.*

Where mixtures of chemicals are applied the *user* will assume the responsibility for freedom from residues if such applications are not labeled by the FDA as a mixture.

Suggestions sometimes change during the growing season based on FDA clearances after date of issue. These suggestions are printed only once each year, and are therefore subject to change without notification. Changes during the year are released in the Illinois Vegetable Farmer's Letter.

In 1970 some herbicides may not be available for use because of loss of a no-tolerance residue basis. Watch for notice of these herbicides (as they are identified by the FDA) in the Illinois Vegetable Farmer's Letter. The Letter is available from the Department of Horticulture, University of Illinois, Urbana 61801.

NOTE: In the suggestions table on the following pages, the trade names of the herbicides are usually used. The list immediately below shows trade names and their corresponding common names.

Common name	Trade name	Common name	Trade name
amiben	Amiben, Vegiben	metabromuron	Patoran
atrazine	Aatrex	monuron	Telvar
benfen	Balan	MCPA	Numerous
bensulide	Prefar	MCPB	Numerous
butylate	Sutan	naptalam	Alanap
CDA	Radox	nitralin	Planavin
chloroxuron	Tenoran	nitrofen	TOK
CIPC	Chloro IPC	PEBC	Tillam
dalapon	Dowpon	propachlor	Ramrod
diuron	Karmex	pyrazon	Pyramin
DCPA	Dacthal	simazine	Princep
DNPB (dinitro)	Sinox PE, Premerge	sodium TCA	TCA
diphenamid	Dymid, Enide	trifluralin	Treflan
EPTC	Eptam	Petroleum solvent	Stoddard Solvent
linuron	Lorox	2,4-D (amine)	Numerous

USE THESE SUGGESTIONS IN 1970 ONLY

Crop	Herbicide	Rate of active ingredient per acre actually covered ¹	Weeds controlled	Best time of application (based on crop stage)	Remarks, cautions, limitations
Asparagus (seedlings)	Amiben	3 lb.	Annuals	Immediately after seeding	Irrigation or rainfall after treatment will give maximum control.
Asparagus (established plantings)	Dowpon	5-10 lb.	Perennial grass	End of harvest season following disking	Apply when grass weeds are 3 to 4 inches tall. Direct spray under fern growth.
	Telvar	3 lb.	Annuals	In spring before spears emerge and immediately following harvest	Apply Telvar after disking. Do not exceed 6 lb. per growing season.
	Karmex	3 lb.	Annuals		Apply Karmex after disking. Do not exceed 4.8 lb. per growing season. Do not replant treated area to any other crop for 2 years after last application.
	Princep	3-4 lb.	Annuals	In spring and after harvest	Apply after disking. Do not treat during last year in asparagus because of residue. With Telvar, Karmex and Princep—usually weed infestation will be reduced and spring application will be sufficient after first year.
Beans, lima and dry	Amiben	3 lb.	Annuals	Immediately after seeding	Field may be rotary-hoed without destroying herbicide action. Do not feed foliage to livestock.
	Amiben plus Randox	2 lb. +2 lb.	Annuals	Immediately after seeding	Gives sustained annual grass control.
	Treflan	0.75 lb.	Annuals ²	Preplant soil application Incorporate with soil immediately	Plant crop immediately or within 3 weeks after application. Can be used up to 1 lb. on dry beans.
Beans, dry	Planavin	1-1.5 lb.	Annuals	Preplant soil application Incorporate with soil	Use only on sandy soil.
Beans, snap	Eptam	3 lb.	Annual grasses and nutgrass ⁴	Preplant soil application Incorporate with soil immediately	
	Treflan	0.5-0.75 lb.	Annuals ²	Preplant soil application Incorporate with soil immediately	Plant crop immediately or within 3 weeks after application.
	Planavin	1-1.5 lb.	Annuals	Preplant soil application Incorporate with soil	Use only on sandy soil.
	Sinox PE or Premerge	3-4 lb.	Annuals	Apply immediately before crop emergence	Use on "second crop" snap beans to control broad leaved weeds. May not control smartweed and annual grasses. Do not use on light sandy soil as injury may result.
Beets, garden and sugar	Pyramin	4 lb.	Annuals	Preemergence or after beets emerge and before weeds have 2 true leaves	Where grasses are a severe problem, use 4 lb. Pyramin +4-6 lb. TCA.
	TCA	8 lb.	Annual grasses	Preemergence	Do not use treated tops for food.
Broccoli	Treflan	0.5-1 lb.	Annuals ² (primarily grass)	Preplant soil application Incorporate with soil immediately	Transplant after application to 3 weeks later.
Brussels sprouts	Planavin	1-1.5 lb.	Annuals (primarily grass)	Preplant soil application Incorporate with soil	Transplant after application. Use only on sandy soil.
Cabbage	TOK ⁷	3-5 lb.	Broad-leaved weeds ⁸	One to 2 weeks after crop emergence or transplanting, while weeds are in seedling stage	
Cauliflower					
Carrots	Stoddard Solvent	60-80 gal.	Annuals	After 2 true leaves have appeared (do not apply to carrots or parsnips after they are ¼ inch diameter, since oily taste may result)	Most effective when sprayed on cloudy days or during high humidity, and when weeds are not more than 2 inches high. May not control ragweed. Do not apply within 40 days of harvest.
Celery					
Dill					
Parsnips					
Parsley					
Carrots	TOK	3-5 lb.	Broad-leaved weeds ⁸	While weeds are in seedling stage	
Celery					
Parsley					
Carrots	Treflan	0.5-1.0 lb.	Annuals ² (primarily grass)	Preplant soil incorporation Incorporate with soil immediately	Seed after application to 3 weeks later.
	Tenoran	4 lb.	Broad-leaved weeds	After true leaves formed on carrots; before weeds are over one inch tall	FOR TRIAL USE ONLY IN 1970. Do not apply within 60 days before harvest.
Carrots	Lorox	2 lb.	Annuals	Preemergence or post on carrots only after crop is 2-6 inches tall	Do not feed treated foliage to livestock or replant treated area for 4 months. Do not use on parsnips on sandy soil. Use ¾ rate on carrots on sandy soil.
Parsnips		1½ lb.			
Cucumbers	Alanap	3-5 lb.	Annuals ⁴	Immediately after seeding or transplanting	Do not use on cold soil. Rainfall or irrigation after treatment gives maximum control.
Muskmelons		3-3.5 lb.		After transplanting or vining	Use granular form. Keep away from foliage.
Watermelons					

¹ Based on active ingredients (actual amount of active herbicide in material or acid equivalent). Use lower rate on sandy soil and higher rate on clay and loam soils. When using a band application over the row, adjust amount of material applied to the part of an acre treated. See Illinois Circular 791.

² May not control ragweed. ³ May not control ragweed, smartweed, and velvetleaf. ⁴ May not control smartweed. ⁵ May not control smartweed and velvetleaf. ⁶ May not control crabgrass. ⁷ Use of 50% wettable powder is suggested for cabbage. ⁸ May not control ragweed or chickweed. Grass control is sometimes marginal.

<i>Crop</i>	<i>Herbicide</i>	<i>Rate of active ingredient per acre actually covered¹</i>	<i>Weeds controlled</i>	<i>Best time of application (based on crop stage)</i>	<i>Remarks, cautions, limitations</i>
Cucumbers Muskmelons Watermelons (continued)	Prefar	4-6 lb.	Annuals	Preplant soil incorporation Incorporate with soil immediately	Is primarily a grass killer. May not control lambsquarter. Consult label for sensitive crops within 18 months after application. Do not use in double cropping when followed by snap beans the same growing season.
	Prefar plus Alanap	3-4 lb. +2-3 lb.	Annuals	Preplant soil incorporation for Prefar; Alanap as an immediate post seeding application	Should have value for broad spectrum weed control in cucumbers for mechanical harvest. Consult label for sensitive crops within 18 months after Prefar application.
Lettuce	Balan	1.5 lb.	Annuals	Preplant soil incorporation Incorporate with soil immediately	Is primarily a grass killer. Seed after application to 3 weeks later. Do not plant wheat, barley, rye, grass, onions, oats, beets, or spinach for 12 months after application.
Onions	Dacthal	6-10 lb.	Annuals ² (primarily grasses)	Immediately after seeding or transplanting	May not kill smartweed or common ragweed. Can be used on seeds, sets, or seedlings.
	Chloro-IPC	3-6 lb.	Use to enhance broad-leaf control (especially smartweed)	On seeded onions: loop stage or after 3- to 4-leaf stage	In the later sprays, direct at base of onion plant. If more than one application is applied do not exceed 6 lb. per acre for the season. Use lower rates in cool, wet weather. Use no later than 30 days before harvest.
	Tenoran	4 lb.	Broad-leaved weeds	After 2 to 3 onion leaves have formed, before weeds are over 1 inch tall	Do not apply within 90 days of harvest.
	TOK	3-4 lb.	Use to enhance broad-leaf control	When weeds are in seedling stage and not over 1 inch tall; DO NOT APPLY TOK AT SEEDING; USE AS A POST EMERGENCE TREATMENT	Use a single application of E.C. or W.P. per growing season. Do not apply E.C. until onions are in the 2-3 leaf stage.
Peas	Treflan	0.5-0.75 lb.	Annuals ²	Preplant soil incorporation Incorporate with soil immediately	Seed after application to 3 weeks later.
	MCPB	1 lb.	Broad-leaved weeds and Canada thistle	When peas are 3-7 inches tall and no later than 4 nodes prior to pea blossom	May delay maturity 1 to 4 days. Use at least 20 gal. of water per acre. Do not feed vines to livestock. MCPA is more effective on mustard. MCPB is less injurious to peas.
	MCPA	¼-½ lb.			
Potatoes, Irish	Eptam	3-5 lb.	Annual grasses and nutgrass ⁴	Preplant soil application Incorporate with soil immediately	Use lower rate on sandy soil.
	Lorox	1-2 lb.	Annuals	At very start of potato emergence	Use 1 lb. rate on light sandy soil. Plant tubers at least 2 inches deep. Do not replant treated area to other crops for 4 months after treatment.
	Patoran	2-3 lb.	Annuals	At very start of potato emergence	FOR TRIAL USE ONLY IN 1970. Do not apply within 90 days before harvest.
	Dowpon	6 lb.	Quackgrass	Before plowing in spring; wait 4 days before plowing and planting	Not for fields intended for red-skinned varieties.
Potatoes, sweet	Dacthal	8-10 lb.	Annuals ³	Immediately after planting	May not control smartweed or common ragweed. Preferred on sandy soils.
	Amiben	3 lb.	Annuals	Immediately after planting	Preferred on loam soils. Do not feed foliage to livestock.
Spinach	Chloro-IPC	1-3 lb.	Annuals	Immediately after seeding	Use 1 lb. if the temperature is below 60°.
Squash Pumpkins	Alanap	3-3.5 lb.	Annuals ⁴	Immediately after seeding	Use granular form on transplants. Do not use early when soil is cold. Moisture is necessary for good control. Use 3-lb. rate on sandy soils.
	Amiben	3-4 lb.	Annuals	As soon after seeding as possible	Use on loam soils.
Summer squash	Prefar	4-6 lb.	Annuals	Preplant soil application Incorporate with soil immediately	Is primarily a grass killer. May not control lambsquarter. Consult label for sensitive crops within 18 months after application.
Sweet corn	Aatrex	2-3 lb.	Annuals, annual and perennial grasses ⁶	Preemergence, apply no later than 3 weeks after seeding Shallow cultivation may improve weed control during dry weather	Grow corn a second year without Aatrex treatment. This chemical has a high soil residue. Do not plant other vegetable crops on a sprayed area until a second year of corn has been grown. Use Aatrex only where quackgrass is a problem. Residue hazard decreased when banded or in combination with Ramrod or Sutan. Can be combined with crop oils for post emergence application as an emergency measure. This may increase residue to following year. Preemergence use preferred.
	Ramrod	4-5 lb.	Annuals	Preemergence	Use on loam soils.
	Sutan	3-4 lb.	Primarily annual grasses	Preplant soil application Incorporate with soil	Use on sandy soil and where nutgrass is a problem.
	Aatrex plus Ramrod	1.5 lb. +2.5 lb.	Annuals and perennial grasses	Preemergence	Use to reduce Aatrex residue.

(See footnotes on page 2.)

<i>Crop</i>	<i>Herbicide</i>	<i>Rate of active ingredient per acre actually covered¹</i>	<i>Weeds controlled</i>	<i>Best time of application (based on crop stage)</i>	<i>Remarks, cautions, limitations</i>
Sweet corn (continued)	Sutan plus Aatrex	3 lb. +1 lb.	Annuals and perennial grasses	Preplant soil incorporation Incorporate with soil immediately	Use where nutgrass is a problem and to reduce Aatrex residue.
	2,4-D (amine)	½ lb.	Annuals	Postemergence	Preferably, apply before corn is 6 inches tall. If corn is over 12 inches reduce rate to ¼ lb.
Tomatoes, direct-seeded	Dymid, Enide	4-6 lb.	Annuals	Preemergence	Do not plant other food crops on treated areas for 6 months.
	Tillam	4 lb.	Annuals	Preplant soil incorporation Use a 2-4 inch incorporation	Direct seed as soon after application as possible.
Tomatoes and Peppers, transplanted	Dymid, Enide	4-5 lb.	Annuals	After transplanting	Use 4 lb. on light soils.
	Vegiben	3-4 lb.	Annuals	Within 2 days after transplanting	Use granular formulation only. Do not use on sandy soils.
	Treflan	0.5-1 lb.	Annuals ²	Preplant soil application Incorporate with soil immediately	Some reduction of growth may be possible under growth stress conditions or if rates are higher than suggested for soil type.
	Planavin	1-1.5 lb.	Annuals	Preplant soil application. Incorporate with soil	Use only on sandy soil.

(See footnotes on page 2.)

CALIBRATION OF APPLICATION EQUIPMENT

Accurate calibration and uniform coverage are essential for desirable and economical results.

Spray Equipment

The pressure at which the spray is applied is critical and should be between 20 and 60 pounds per square inch. Higher pressures, such as those frequently used in applying other pesticides, are unsatisfactory.

A rate of 40 to 60 gallons per acre is a good range for liquid application. The amount of herbicide per acre must be controlled closely by careful calibration.

University of Illinois Circular 837, "Calibrating and Maintaining Spray Equipment," provides detailed information on calibrating spray equipment.

Granular Equipment

Check application rate when changing materials and with changes of weather as flow rate may vary between morning and afternoon. University of Illinois Circular 839, "Calibrating and Adjusting Granular Row Applicators," supplies additional details on calibration of granular applicators.

CLEANING OF APPLICATION EQUIPMENT

Spray Equipment

It is important to keep spraying equipment clean to avoid crop contamination or injury and to preserve the equipment. It is recommended that sprayers used for 2,4-D or like compounds *not* be used for applying insecticides, fungicides, or other postemergence herbicides on other crops. When cleaning a sprayer, thoroughly wash the tank, pump, lines, boom, and nozzles. The spray pump should be in operation to circulate the cleaning solution through the sprayer. Water will rinse out many preemergence materials, but persistent herbicides require the use of cleaning agents. The addition of one gallon of household ammonia or 5 pounds of sal soda to 100 gallons of water will aid in removing herbicide residues from sprayers.

Copper residues from fungicides may reduce the effectiveness of certain herbicides, particularly the dinitros. To remove copper residues, add one gallon of vinegar or 5 percent acetic acid to every 100 gallons of water, and let it stand in the sprayer for *two hours only*. Drain the sprayer immediately and rinse thoroughly with water.

Granular Equipment

Granular equipment is easier to clean and maintain than spray equipment. The units should be removed and dumped, or run in an open position and cleaned with forced air. A good tire pump will do the job. Rotate the delivery mechanism to insure adequate removal of granular particles. Store in a dry place.

*1970 Suggested
Fungicide
Guide*

**Fungicide Guide for
COMMERCIAL
VEGETABLE GROWERS**

Vegetable fungicide tolerances and intervals approved by the Food and Drug Administration and the U.S. Department of Agriculture as of January 1, 1970 are presented in this publication. The tables on pages 2 and 3 give the tolerances in parts per million (ppm) and the number of days between the last application at normal rate and the harvest or they give the date of last application that will keep residues within tolerances set by the FDA. The listing of a chemical for a crop does not necessarily constitute recommendation for control of a disease on that crop by the Illinois Cooperative Extension Service and the Agricultural Experiment Station. Specific recommendations are given on pages 4 to 7.

In some instances a tolerance (ppm) has been set but a definite interval has not been established. The absence of an interval does not necessarily mean that the fungicide may not be used on that crop. Use of the fungicide would require such restrictions as "do not apply after first blooms appear" or "do not apply after edible parts form."

In a few cases the interval and dosage have been established, but the allowable ppm residue has not been determined. Here again this does not mean that the fungicide may not be used on that crop. It does mean, however, that until a tolerance is established it must be

considered to be zero. Zero tolerances are reviewed each year. Some are cancelled as the manufacturer supplies the USDA with additional data.

Growers must follow a disease control program that will assure the production of vegetables with no excessive fungicide residues. Vegetables marketed with residues exceeding FDA tolerances may be injurious to consumers, may be confiscated, and may cause the grower to be brought to court.

Growers have nothing to fear from the law so long as they use fungicides and other pesticides according to the current label only on the *crops specified*, in the *amounts specified*, and at the *times specified*. The safe grower keeps a record of the products and trade names used, the percentage of active ingredients, dilutions, rates of application per acre, and dates of application. The record sheet provided on page 8 is a convenient place to keep such information.

This circular will be revised each year. Be sure you have the most up-to-date copy.

For additional information, read Report on Plant Diseases No. 1,000 (revised), "Fungicide, Nematocide, and Preservative Tolerances and Use Restrictions Approved by the USDA as of January 1, 1970." It is available in all county extension offices.

Prepared by Malcolm C. Shurtleff, M. B. Linn, and Edward E. Burns, Department of Plant Pathology

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN COLLEGE OF AGRICULTURE COOPERATIVE EXTENSION SERVICE
Urbana, Illinois Circular 999 December, 1969

Issued in furtherance of Cooperative Extension Work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture.
JOHN B. CLAAR, Director, Cooperative Extension Service, University of Illinois at Urbana-Champaign.

FUNGICIDE USES FOR VEGETABLES, APPROVED BY USDA, JANUARY 1, 1970^a

Crop	FDA-permitted tolerance							
	Captan (D ^e) (See ppm below)	Dyrene, 10 ppm	Ferbam, 7 ppm	Folpet, 15-50 ppm	Maneb, 7 or 10 ppm	Maneb & zinc ion ^b (See ppm below)	Zineb, 7 or 25 ppm	Ziram, 7 ppm
Asparagus	root dip	..	..	..	A ^c	(0.1 ppm), A ^c	B ^e , ph	..
Beans (dry, lima, snap)	(25 ppm-pp ^e), 0 ^d	..	4 ^d , B ^c	..	4 ^d	..	7 ^d , pp	4 ^d (snap)
Beet, garden	(2 ppm-root), 100 (ppm-greens), 0	..	..	..	..	..	7 (tops)	7 (tops)
Broccoli	(2 ppm-pp)	..	plant bed	..	3 or trim and wash	..	7	7
Brussels sprouts	(2 ppm-pp)	..	..	..	0	..	7	0
Cabbage	(2 ppm-pp)	..	plant bed	..	7	..	7	7
Cantaloupe (muskmelon)	(25 ppm), 0, ph ^e	0	0	(15 ppm), 0	0	(0 ppm in edible parts), 0 ^d	0	0
Carrot	(2 ppm), 0	..	7 (tops)	..	0	(2 ppm), 7, B (tops)	7 (tops)	7 (tops)
Cauliflower	(2 ppm-pp)	..	..	..	0	..	7	7
Celery	(50 ppm), 0	0 (strip and wash)	0 (strip and wash)	(50 ppm), 7	0 (strip and wash)	(10 ppm), 7	0 (strip and wash)	0 (strip and wash)
Chinese cabbage	..	..	..	..	..	..	7	..
Corn, sweet and pop	(2 ppm no husks), 10, B	..	..	..	0, B	..	0, B	..
Cucumber	(25 ppm), 0, ph	0	0	(15 ppm), 0	0	(7 ppm), 0	0	0
Eggplant	(25 ppm), 0	..	..	..	0	..	0	0
Endive, escarole	..	..	..	..	7 and wash	..	7	..
Kale, collard	(2 ppm-pp)	..	..	..	7 and wash	..	7	0
Kohlrabi	..	..	..	..	0	..	half grown	7
Lettuce	(100 ppm), 0	..	plant bed	(50 ppm), 0	7 (strip and wash)	..	5 (head); 7 (leaf)	..
Mustard green	(2 ppm-pp)	..	..	..	7	..	7	..
Onion	(50 ppm green, 25 dry), 0, ph	(1 ppm), 0 (dry)	..	(15 ppm dry), 0	0	(0.5 ppm dry), 7	7 (green)	0 (dry)
Pea	(2 ppm)	..	..	..	..	..	10, pp	7
Pepper	(25 ppm), 0	..	plant bed	..	0	(10 ppm) until fruit buds form	0	0
Potato, Irish ^e	(25 ppm), 0, ph	(1 ppm), 0	0	..	0, (0.1 ppm)	(10 ppm), 0, B	0 and seed	0
Potato, sweet ^e	..	..	vine cut- ting dip	..	..	..	..	..
Pumpkin	(25 ppm), 0	0	..	(15 ppm), 0	0	(10 ppm) until ed- ible parts show	0	0
Radish	..	..	..	..	..	..	0	0
Rhubarb	(25 ppm), 0	..	..	..	0	..	..	0
Spinach	(100 ppm), 0	..	..	..	7 and wash	..	7	0
Squash	(25 ppm), 0	0	0	(15 ppm), 0	0	(7 ppm), 0-summer	0	0
Sugar beet ^e	..	..	..	..	10 (45 ppm), B	(65 ppm-tops) 14 (2 ppm-roots) 10, B	..	..
Swiss chard	..	..	..	..	..	..	7	..
Tomato	(25 ppm), 0	0	0	(25 ppm), 0	0, C	(7 ppm), 0	0	0
Turnip, rutabaga	(2 ppm-pp)	..	0	..	7	..	0 (roots); 7 (tops)	0
Watermelon	(25 ppm), 0	0	0	0	0	0 ppm in edible parts	0	0

^a No tolerances have been set for these fungicides on dill, horseradish, okra, parsley, and parsnip.

^b Maneb and zinc ion are sold as Dithane M-45 and Manzate 200.

^c The following abbreviations are used:

A = Post-harvest application to ferns only or to young plantings that will not be harvested.

B = Do not feed treated tops or forage to dairy animals or animals being finished for slaughter.

C = To avoid damage, do not use on tender young plants.

D = Do not use treated seed for food or feed.

ph = Cleared for use as a post-harvest dip at 0.12 percent (0.25 percent for captan on cantaloupe and cucumber).

pp = Cleared for use as a preplanting soil treatment only.

ppm = parts per million.

^d Number indicates number of days between last application and harvest; 0 = up to harvest. (Numbers in parentheses refer to ppm.)

^e Tolerances are not needed for pesticides applied only to the foliage and not translocated to the tubers or roots.

LABEL INFORMATION ON FUNGICIDES OF LESS GENERAL USE

Fungicide (tolerance)	Crops and use restrictions	Fungicide (tolerance)	Crop and use restrictions
Copper, fixed, neutral, and basic (including Bordeaux mixture)	Exempt if used in accordance with good agricultural practices. Not exempt if used at time of or after harvest. See label.		seed-piece dip. Plant immediately after drying.
Diammonium ethylene bisdithiocarbamate (Amobam) (7 or 25 ppm ^a as Zineb)	Celery, Corn, Potato, Squash, Tomato — to harvest; Onion, Spinach — 7 days ^b ; Lettuce — 5 days (head), 7 days (leaf).	Nabam, 93% WP ^a (Dithane A-40)	Used <i>with</i> iron, manganese, or zinc salts the tolerances for ferbam, maneb, or zineb apply.
Botran	Greenhouse tomato — to harvest. Do not drench seedlings or newly set transplants. Carrot, Sweet potato — post-harvest dip or spray, see label; Garlic, Onion — soil application before seeding or spray to soil around sets or bulbs. <i>Do not plant spinach</i> as follow-up crop in treated soil. Leaf lettuce (greenhouse) — 14 days (do not apply to wilted plants or seedlings). Celery — 7 days; Cucumber (greenhouse) — see label; Rhubarb (greenhouse) — 3 days; Irish potato — 14 days (do not feed to livestock).	Oxyquinoline sulfate (Fulex A-D-O, Sunox, Wilson's Anti-Damp)	Soil treatment. Preplanting or as seedlings emerge. (1 oz. of 67.5% solution in 20 gallons of water. Apply 1 quart per square foot).
Dexon	Cleared <i>only</i> for seed-treatment use on Beans, Beets, Corn, Cucumbers, Peas . Do not use treated seed for food, feed, or oil purposes. In-furrow treatment at time of planting for Sugar beets . Slurry seed treatment for planting in light soils or soils high in clay or organic matter.	Polyethylene polymer (Polyram) (0 ppm)	Cantaloupe, Celery, Cucumber, Potato, Sugar beet, Tomato — no time limitations; Potato — seed-piece treatment. Do <i>not</i> feed Sugar beet tops to meat or dairy animals; Celery — remove excess residues by stripping, trimming, and washing.
Difolatan	Irish Potato — no-residue basis; no limitations on time before harvest is required. Corn — seed treatment only. Do <i>not</i> use for food or feed, or with oil.	PCNB (Terraclor, Brassicol, Fungiclor) (0 ppm)	Beans — base of plants <i>before</i> blossoming, soil and seed treatment at planting, or foliar spray. Do <i>not</i> feed treated Bean vines to livestock. Broccoli, Brussels sprouts, Cabbage, Cauliflower — transplant solution (¾ pint per plant) or row treatment before transplanting; Lettuce (head) — band treatment when plants are 2 to 3 inches tall, and then 10 and 20 days later; Pepper, Potato, Tomato — soil treatment at or before planting; Tomato (greenhouse) — transplant solution (½ pt. of 0.2% per plant).
Dinocap (Karathane)	Cantaloupe (Muskmelon), Cucumber, Honeydew melon, Pumpkin, Squash, Watermelon — 7 days.	Sodium dimethyldithiocarbamate (Sodam)	Used with ferric or zinc sulfate. See Ferbam or Ziram.
Hexachlorophene (Nabac) (0 ppm)	Cucumber — 3 days; Pepper, Tomato — 5 days, or premergence application.	Streptomycin	Celery, Pepper, Tomato — plant beds only (200 ppm spray); Potato — seed-piece treatment only (100 ppm dip or dust).
Nabam, 18-22% liquid	Used <i>with</i> iron, manganese, or zinc salts the tolerances for ferbam, maneb, or zineb apply. When used <i>without</i> iron, manganese, or zinc salts, use to harvest on Beans, Cabbage, Cantaloupe (Muskmelon), Celery, Cucumber, Eggplant, Pepper, Squash, Tomato, Watermelon, Onion — 7 days on green onions, no time limitations on others. Potato —	Sulfur, lime, and lime-sulfur	Exempt when used in accordance with good agricultural practices. <i>Caution</i> — these fungicides are often combined with other pesticides that may not be exempt from tolerance restrictions. See label.
		Thiram, TMTD (7 ppm)	Tomato — to harvest; Onion — Furrow treatment; Celery — 7 days (strip, trim, and wash); Sweet potato — preplant root dip. Seed treatment: Beans, Corn, Okra, Onion (bulb and set), Peanut, Tomato . (<i>Warning: Do not use treated seed for food or feed, or with oil.</i>)

^a ppm = parts per million; WP = wettable powder.

^b Number of days between last application and harvest.

CONDENSED FUNGICIDE RECOMMENDATIONS FOR DISEASES OF COMMERCIAL VEGETABLE CROPS FOR 1970

Vegetable	Diseases	Fungicide (lb./A.) ^a	Remarks
Asparagus	Rust (RPD934) ^b , leaf and branchlet blights	Zineb, maneb, maneb and zinc ion, or Polyram (2-3 lb./A.)	Apply to non-harvested fields <i>throughout</i> season to August 15; to harvested fields <i>after</i> cutting only. Apply at 7- to 10-day intervals. May combine with insecticides to control asparagus beetles, cutworms, etc. (Cir. 897) ^b . Polyram on ferns only.
Beans (garden, wax, and lima)	Seed decay (RPD915), damping-off, and seed-borne stem blights and root rots	Thiram or captan <i>plus</i> insecticide (e.g., dieldrin or lindane)	Treat seed any time if not previously treated by producer. Plant <i>only certified</i> , western-grown seed in warm soil above 65° F.
	Bacterial blights	Fixed copper (2-3 lb. metallic/A.)	Apply at weekly intervals. Plant disease-free seed.
	Rust, anthracnose, fungus leaf spots, pod and stem spots	Maneb or zineb (2-3 lb./A.)	Apply at 7- to 10-day intervals during moist weather. Combine with insecticides to control bean beetles, aphids, leafhoppers, blister beetles, etc. (Cir. 897).
	Mosaics		Use insecticides to control aphids (NHE-47) ^b that transmit the viruses. Kill aphids <i>before</i> they feed (Cir. 897). Control weeds in and around fields (Cir. 907).
	White mold	PCNB 20 (20 lb./A.) or PCNB 75 (5 lb./A.)	Apply to base of plants just before bloom. Do not feed treated vines to livestock.
Beets (garden and sugar), Mangel, Mangold, Spinach, Swiss chard, New Zealand spinach	Seed rot (RPD915), damping-off, and seed-borne leaf spot and anthracnose	Thiram or captan	Treat seed any time or buy treated seed. To control damping-off apply captan (5-7 lb. of 50% WP in 25-30 gal. water/A. or 25-30 lb. of 10% dust/A. in furrow at planting time.
	Cercospora leaf spot (RPD951), downy mildew	Maneb, Polyram, or zineb (2-3 lb./A.) or fixed copper (2-3 lb. metallic/A.)	Apply every 1 to 2 weeks during rainy periods. May combine with insecticides to control aphids, leafhoppers, caterpillars, leaf miners, etc. (Cir. 897).
	Mosaics, virus yellows		Use insecticides to control aphids (NHE-47) and plant bugs that transmit the viruses. Kill insects <i>before</i> they feed (Cir. 897).
Broccoli, Brussels sprouts, Cauliflower, Cabbage, Chinese cabbage, Collard, Horseradish, Mustard, Kale, Kohlrabi, Radish, Rutabaga, Peppergrass, Watercress	Seed rot (RPD915), damping-off, black rot (RPD924), blackleg (RPD955), radish black root (RPD948), alternaria blight	Hot water, then thiram or captan	Buy western-grown seed. Sow <i>only</i> seed treated with hot water. Control cabbage root maggots, cutworms, cabbage worms, etc. (Cir. 897). Four-year rotation with non-crucifer crops.
	Wirestem (<i>Rhizoctonia</i>) (RPD902), damping-off, seed rot (RPD916), botrytis blight (RPD942)	PCNB-captan mixture 2787	Dust or spray on soil just before, at, or after planting seed. Follow manufacturer's directions.
	Clubroot (RPD923)	PCNB 75 or Daconil 2787 (3 lb./50 gal.)	Apply in transplant water or starter solution, ½ to ¾ pt. per plant (about 400 to 600 gal./A.).
	Downy mildew, leaf spots, white rust (RPD960), anthracnose, botrytis blight (RPD942)	Maneb or zineb (2-3 lb./A.)	Apply at 5- to 7-day intervals (3-5 days for radish) in wet weather. Use maneb in seedbed (2 lb./100 gal.). Good coverage important. May need spreader-sticker. May combine with insecticides to control aphids, cabbage worms, etc. (Cir. 897).
	Mosaics, black ringspot		Use insecticides to control aphids (NHE-47) and cabbage worms (NHE-45) that transmit the viruses. Kill insects <i>before</i> they feed — especially in seedbeds (Cir. 897).
	Brittle root or curly-top (primarily horseradish)		Use insecticides to control leafhoppers that transmit the virus (Cir. 897). Apply when leafhoppers are <i>first</i> noticed. Additional applications may be necessary if infestation is severe.
Carrot, Parsnip	Seed rot (RPD915), damping-off	Thiram or captan	Treat seed any time. May combine with insecticides.
	Aster yellows (RPD903)		Use insecticides to kill leafhoppers that transmit the virus, <i>before</i> they feed (Cir. 897). Begin when plants are 2-3 inches tall; apply weekly for 4 weeks. Control weeds in and around plantings (Cir. 907).
	Cercospora leaf spot, alternaria leaf blight (RPD938)	Maneb or zineb (2-3 lb./A.)	Apply at 5- to 10-day intervals in rainy periods. Thorough coverage essential. Start around June 15.

^a Dosages: The quantity of material listed is the pounds of active (actual) ingredient to be applied to 1 acre unless stated otherwise (i.e., 3 lb./A.; 2 lb. 50% WP; 20 lb. 5% dust). Abbreviations used: A = acre; WP = wettable powder; pt. = pint(s); gal. = gallon(s); T. = tablespoon(s) (level); sq. ft. = square foot or feet.

^b RPD = Report on Plant Diseases; NHE = Natural History Entomology publication. General references: Illinois Circular 802 (revised), Vegetable Diseases; Circular 893, Soil Disinfestation Methods and Materials; Circular 897, Insect Control for Commercial Vegetable Crops and Greenhouse Vegetables; and Circular 907, Herbicide Guide for Commercial Vegetable Growers. Materials available in County Extension Offices.

CONDENSED FUNGICIDE RECOMMENDATIONS (continued)

Vegetable	Diseases	Fungicide (lb./A.)	Remarks
Celery, Celeriac, Dill, Parsley	Seed rot (RPD915), damping-off, seed-borne blights	Hot water, then thiram or captan	Treat seed just before planting or buy treated seed. If damping-off starts, spray plants and soil 2 to 3 times, 5-7 days apart. Use zineb (1 T./gal.). Three-year-old seed is free of late blight.
	Leaf blights and leaf spots	Maneb, thiram, zineb, or Dyrene (2-3 lb./A.)	Use ziram, ferbam, or thiram (2 T./gal.) in seedbed. Apply every 7-10 days in field except during very dry weather.
	Mosaics, calico, ringspot		Use insecticides to control aphids (NHE-47) that transmit the viruses. Kill aphids <i>before</i> they feed (Cir. 897). Control weeds in and around plantings.
	Aster yellows (RPD903)		Use insecticides to control leafhoppers that transmit the virus. Kill insects <i>before</i> they feed. Control weeds in and around plantings (Cir. 907).
Corn (sweet and pop)	Seed rot (RPD915), seedling blights, seed-borne root and stalk rots, leaf blights	Captan, difolatan, or thiram <i>plus</i> dieldrin or lindane	Treat seed any time or buy seed treated with both a fungicide and an insecticide (NHE-27).
	Bacterial wilt (RPD907)		Apply insecticides over row to control flea beetles (NHE-36) that transmit the wilt bacteria (Cir. 897). One to 6 sprays may be needed, 3 to 5 days apart. Start the day <i>before</i> corn comes up.
Cucumber, Muskmelon (Cantaloupe), Pumpkin, Squash, Watermelon, Chayote, Gherkin	Seed rot (RPD915), damping-off, angular and alternaria leaf spots, fusarium wilt, gummy stem blight or black rot, anthracnose, scab	Captan or thiram <i>plus</i> insecticide (e.g., dieldrin)	Sow <i>only</i> certified, western-grown seed. Watering after planting with captan 50W (2 lb./100 gal. at 1 gal./125 sq. ft., every 5-7 days) controls damping-off. May combine with insecticides (Cir. 897) to control seed-corn maggots (NHE-27) in seedbed.
	Bacterial wilt (RPD905)		Use insecticides to control cucumber beetles (NHE-46) that transmit the causal bacteria. Kill beetles <i>before</i> they feed (Cir. 897). Applications needed from young seedlings to mature plants. Thorough coverage is essential.
	Anthracnose (RPD920), downy mildew (RPD927), scab (RPD928), blossom blight, leaf spots and blights (RPD918), fruit spots and rots, gummy stem blight or black rot	Maneb, maneb plus zinc ion or zineb (2-3 lb./A.); or difolatan (2½ pt./50 gal./A.)	Use captan or ziram (2-3 lb./100 gal.) on young plants. Apply at 7- to 10-day intervals from seedling emergence to vining. Start maneb or zineb <i>after</i> vines begin to run. Repeat at 5- to 10-day intervals to 7-10 days before harvest; keep new growth protected. May combine with insecticides to control cucumber beetles, aphids, vine borer, pickle worm, etc. (Cir. 897).
	Angular leaf spot (RPD919)	Fixed copper (2-3 lb. metallic/A.) or soluble copper (TC-90, Cal-Cop 10)	Apply at 5- to 7-day intervals in warm, wet weather; or mix with zineb or maneb (2 lb./A.). Begin when plants start to vine or disease <i>first</i> appears.
	Mosaics (RPD926)		Use insecticides to control aphids (NHE-47) and beetles (NHE-46) that transmit the viruses (Cir. 897). Kill insects <i>before</i> they feed. Control weeds (Cir. 907).
	Powdery mildew (RPD925)	Karathane WD (8 oz./100 gal.) <i>plus</i> spreader-sticker	Dust or spray. Thorough coverage essential. Repeat 5-10 days later. Do not apply within 7 days of harvest.
	Eggplant	Seed rot (RPD915), seed-borne anthracnose, phomopsis blight (RPD949), and verticillium wilt (RPD950)	Hot water, then thiram or captan	Treat seed just before planting.
Seed rot, stem blight, damping-off (RPD916)		Captan, zineb, or ziram (1-2 lb./100 gal.)	Seedbed or flat spray, 5 gal./100 sq. ft. Repeat at 5- to 7-day intervals.
Blight (phomopsis, alternaria, cercospora) (RPD949), anthracnose		Maneb, zineb, ziram, or captan (3 lb./A.)	Start when disease is first evident, <i>or</i> when first fruits are half mature. Repeat at 7- to 10-day intervals. <i>Do not use copper fungicides on eggplant.</i> May combine with insecticides (Cir. 897).
Lettuce, Endive, Escarole, Salsify	Seed rot (RPD915), damping-off (RPD916), gray mold (RPD942)	Captan, then PCNB-captan mixture	Dust seed lightly with captan 75. Then apply PCNB-captan as dust or spray just before or just after seeding. For <i>field use only</i> .
	Bottom rot, and drop, stem, or crown rot	PCNB 75 (2½-3 lb. in 125 gal./A.), or PCNB-captan mixture	<i>Use on head lettuce only.</i> Begin when plants are 2-3 inches tall. Repeat 10 and 20 days later. Follow manufacturer's directions.
	Aster yellows (RPD903), white heart		Use insecticides to control leafhoppers that transmit the virus. Kill leafhoppers <i>before</i> they feed (Cir. 897). Applications needed throughout season. Dust or spray weed borders.
	Mosaics (RPD946)		Use insecticides to control aphids (NHE-47) that transmit the viruses. Kill aphids <i>before</i> they feed (Cir. 897). Sow <i>only</i> mosaic-indexed seed. Control weeds in and around plant-growing areas (Cir. 907). Keep new and old beds as far apart as possible.

CONDENSED FUNGICIDE RECOMMENDATIONS (continued)

Vegetable	Diseases	Fungicide (lb./A.)	Remarks
	Gray mold (RPD942), downy mildew, other fungus leaf spots, white rust	Maneb or zineb (2-3 lb./A.)	Apply at 5- to 7-day intervals in cool, damp weather. Do not apply within 10 days of harvest. May combine with insecticides to control aphids, leafhoppers, flea beetles, etc. (Cir. 897).
Okra	Seed rot (RPD915), damping-off	Thiram or captan	Seed treatment. Apply any time.
Onion, Garlic	Smut (RPD933), seed decay (RPD915), damping-off, seed-borne purple blotch	Thiram or captan	Apply to seed any time (RPD933). For <i>onion sets</i> , use 1 lb. (100% active) to 20 lb. seed; for <i>bulb onions</i> , wet seed with Methocel sticker then treat with 8 lb. thiram 75 or captan 75 to 8 lb. seed. For <i>pickling and green bunching onions</i> , same as for bulb onions; but use half dosage. Control seed- and bulb-feeding insects (Cir. 897).
	Blast (RPD931), downy mildew, purple blotch, gray mold blight (RPD942), neck rot (RPD930)	Maneb, maneb and zinc ion, zineb, or Dyrene (1½-3 lb./A.) plus spreader-sticker	Apply every 5 to 7 days in moist weather. May combine with insecticides to control thrips, onion maggots, cutworms, etc. (Cir. 897).
	Yellow dwarf, mosaics		Use insecticides to control aphids (NHE-47) that transmit the viruses. Kill aphids <i>before</i> they feed (Cir. 897). Keep new and old plantings <i>as far apart</i> as possible.
Pea, Lentil	Seed decay (RPD915), damping-off, seed-borne foot rots, ascochyta and mycosphaerella blights (RPD945), fusarium wilts (RPD912), and bacterial blights	Thiram or captan <i>plus</i> insecticide (e.g., dieldrin or lindane)	Treat seed any time or buy seed treated with fungicide-insecticide. Sow certified, western-grown seed. Where captan or thiram are used, friction may reduce seeding rate; add graphite (1 oz./bu.).
	Leaf and stem spots or blights (RPD945)	Zineb or ziram (2 lb./A.)	Apply weekly in rainy weather where diseases have been severe in past.
	Mosaics (RPD947), streaks, stunt, mottle, wilt		Use insecticides to control aphids (NHE-47) and other insects that transmit the viruses. Kill insects <i>before</i> they feed (Cir. 897). Also treat field borders.
	Powdery mildew	Karathane WD (5-8 oz./100 gal.) or sulfur-lime dust (4-6 ratio) 30 lb./A.	Do not apply at air temperature above 80° F. or when plants are in flower. Two applications, a week apart, when mildew <i>first</i> appears, should be sufficient.
Peanut	Seed rot (RPD915), seedling blights	Thiram, difolatan, or captan	Treat seed anytime. Do not use treated seed for food, feed, or oil.
Potato, Irish	Seed-piece decays (RPD915), and seed-borne verticillium wilt (RPD950)	Captan, thiram, maneb, Polyram, zineb or difolatan	Apply as dust or dip to cut and uncut tubers. Follow manufacturer's directions. Tubers should be well corked over. Plant in warm (over 50° F.) soil.
	Blackleg (RPD943)	Streptomycin	May combine with treatment for seed-piece decays. Use uncut, B-size, certified seed.
	Early blight (RPD935), late blight (RPD936), and minor leaf spots and blights	Maneb, maneb and zinc ion, difolatan, or Polyram (2-3 lb./A.)	Apply at 4- to 10-day intervals. If rainy, shorten interval; if dry, lengthen. For "finish-up" sprays use fixed copper (3 lb. metallic/A.). May combine with insecticides (Cir. 897).
	Common scab (RPD909), and black scurf (<i>Rhizoctonia</i>)	PCNB (various formulations)	May help on <i>mineral</i> soils. Work into top 4-6 inches of soil at or before planting. Follow manufacturer's directions carefully.
	Mosaics, leaf roll, mottle, purple-top, yellow dwarf, etc.		Use insecticides to control aphids (NHE-47), leafhoppers (NHE-22), etc., that transmit the viruses. Kill insects <i>before</i> they feed (Cir. 897).
Rhubarb	Root and crown rots	Fixed copper (3 lb. metallic/A.)	Drench crowns early in spring and after harvest. Plant <i>only</i> in <i>well-drained</i> soil.
	Leaf and stalk spots, anthracnose	Thiram, maneb, fixed copper or captan (2-3 lb./A.)	Avoid applications from 2 weeks before harvest until cutting is completed. May combine with insecticides (Cir. 897).
	Mosaics, ringspots		Use insecticides to control aphids (NHE-47) that transmit the viruses. Kill aphids <i>before</i> they feed (Cir. 897).
Sweet potato	Black rot (RPD953), fusarium wilt (RPD954), scurf (RPD957)	Mercuric chloride, Semesan Bel, or phenyl mercury	Dip disease-free roots or sprouts just before planting. Follow manufacturer's directions. Seedbed disinfestation (Cir. 893). Three- to 4-year rotation. Strict sanitation.

CONDENSED FUNGICIDE RECOMMENDATIONS (concluded)

Vegetable	Diseases	Fungicide (lb./A.)	Remarks
	Fusarium wilt (RPD954), foot rot (RPD958), scurf (RPD957)	Same as for black rot or use zineb, thiram, or ziram (1 1/2 oz./gal.)	Dip roots and base of sprouts just before planting. Do <i>not</i> rinse after treatment. Seedbed disinfection (Cir. 893). Four- to 5-year rotation. Strict sanitation in seedbed and field.
	Storage rots (RPD952)	Botran (as post-harvest dip or in wash water)	Helps reduce transit and market losses caused by rhizopus soft rot and black rot.
Tomato, Pepper	Seed decay (RPD915), seed-borne bacterial spot (RPD910), speck and canker (RPD962), early blight (RPD908), septoria blight, anthracnose, fusarium wilt (RPD929), leaf mold (RPD941)	Hot water then captan or thiram	Treat seed, buy treated seed, or certified, disease-free transplants (Cir. 912).
	Bacterial spot (RPD910)	Fixed copper-streptomycin mixture	Start when seedlings emerge and apply every 5 days. In <i>field</i> , use fixed copper (2-3 lb. metallic/A.) plus maneb or maneb and zinc ion (2 lb./A.).
	Damping-off (RPD916) and seedling blights, collar rot (RPD908)	Captan-PCNB mixture	Dust or spray in seedbed. Apply as plants emerge so spray runs down stems. Repeat every 4 to 7 days until 10 days before transplanting. Follow the manufacturer's directions.
	Septoria blight (RPD908), early blight, anthracnose, late blight (RPD913) and buckeye rot, gray leaf spot, leaf mold (RPD941)	Maneb, maneb and zinc ion, Polyram, or zineb (2 1/2-4 lb./A.); or difolatan (2 1/2 pt./100 gal./A.)	Apply every 7 to 10 days <i>after</i> first fruit clusters form. Five or more sprays may be necessary, depending on weather. Combine with insecticides to control flea beetles, climbing cutworms, hornworms, fruit flies, etc. (Cir. 897). <i>Soil surface spray of maneb after last cultivation improves anthracnose control.</i>
	Mosaics (RPD917)		Use insecticides to control aphids (NHE-47) and beetles that transmit the viruses. Kill insects <i>before</i> they feed (Cir. 897). Control weeds in and around plant-growing area (Cir. 907). Set out certified, virus-free transplants or start with virus-free seed.
	Blossom-end rot (RDP906)	Calcium nitrate (4-6 lb./A.)	Application of 4 or more consecutive sprays in the regular schedule may reduce losses. Start when fruits are the size of grapes. Irrigate to maintain uniform soil moisture.
	Cloudy spot (RPD914)		Use insecticides to control stink bugs that produce cloudy spot by feeding punctures (Cir. 897).
(General diseases that attack most vegetable crops)	Damping-off (RPD916) and seedlings blights; gray mold (RPD942) or botrytis blight	After planting apply captan, thiram, or zineb (1 T./gal.); ferbam or ziram (2 T./gal.)	Disinfest seedbed soil (Cir. 893), then apply seed treatment (RPD915). Then apply sprays or drenches after planting. Apply <i>only</i> if damping-off appears in seedbed and when seedlings need water. (<i>For crucifers, pepper, peas, beans, tomato, lettuce</i> , add PCNB to other fungicides to give broad-spectrum control.) Use at least 5 gal. per 1,000 sq. ft. of bed. Repeat at 5- to 7-day intervals when temperature is below 75° F.
	Root knot and other nematodes; fusarium wilts of various crops (RPD901,904,912,929,954)	Heat or chemicals may be used. Consult Cir. 893 for names, general precautions, and directions	Disinfest seedbed soil (heat preferred, if available). Follow manufacturer's directions exactly. Fumigants work best in light, loose soils, free of trash, clods, and lumps. Avoid recontamination of treated soil. Best to apply fumigants during the fall that precedes planting. In general, soils must be at least 55° F. at the 6-inch depth with a time lapse of 21-28 days between treating and seeding. Some require gas-tight plastic covers.
	Root and stem or crown rots of various crops (RPD902,911,922,923,932,948,953)		
	Verticillium wilt (RPD950)		

1970 Weed Control Guide

University of Illinois
at Urbana-Champaign
College of Agriculture
Cooperative Extension Service

This guide for using weed control chemicals is based on research results at the University of Illinois Agricultural Experiment Station, other experiment stations, and the U.S. Department of Agriculture. Although not all herbicides commercially available are mentioned, an attempt has been made to include materials that were tested and showed promise for controlling weeds in Illinois. Consideration was given to the soils, crops, and weed problems of the state.

The field of chemical weed control is still relatively new. The herbicides now available are not perfect. Factors such as rainfall, soil type, and method of application influence herbicide effectiveness. Under certain conditions some herbicides may damage crops to which they are applied. In some cases chemical residues in the soil may damage crops grown later.

When deciding whether to use a herbicide, consider both the risk involved in using the herbicide and the yield losses caused by weeds. If you do not have much of a weed problem and if cultivation and other good cultural practices are adequate for control, do not use herbicides. Much of the risk can be decreased by following these precautions:

- Use herbicides only on those crops for which they are specifically approved and recommended.
- Use no more than recommended amounts. Applying too much herbicide may damage crops, may be unsafe if a crop is to be used for food or feed, and is costly.
- Apply herbicides only at times specified on the label. Observe the recommended intervals between treatment and pasturing or harvesting of crops.
- Wear goggles, rubber gloves, and other protective clothing as suggested by the label. Some individuals are more sensitive than others to certain herbicides.
- Guard against possible injury to nearby susceptible plants. Droplets of 2,4-D, MCPA, 2,4,5-T, and dicamba sprays may drift for several hundred yards. Take care to prevent damage to such susceptible crops as soybeans, grapes, and tomatoes. If it is necessary to spray in the vicinity of such crops, the amine form of 2,4-D is safer to use than the volatile ester form, but even with the amine form, spray may drift to susceptible crops. To reduce the chance of damage, operate sprayers at low pressure with tips that deliver large droplets and high gallonage output. Spray only on a calm day or make sure air is not moving toward susceptible crop plants and ornamentals. Some farm liability insurance policies do not cover crop damage caused by the ester form of 2,4-D.
- Apply herbicides only when all animals and persons not directly involved in the application have been removed. Avoid unnecessary exposure.

- Return unused herbicides to a safe storage place promptly. Store them in original containers, away from unauthorized persons, particularly children.

- Since manufacturers' formulations and labels are sometimes changed and government regulations modified, always refer to the most recent product label.

Where trade names are used in this publication, rates refer to the amount of commercial product. Where common or generic names are used, rates refer to the amount of active ingredient. Unless otherwise stated, rates are given on a broadcast basis. Proportionately less should be used for band applications.

This guide is for your information. The University of Illinois and its agents assume no responsibility for results from using herbicides, whether or not they are used according to the suggestions, recommendations, or directions of the manufacturer or any governmental agency.

Names of Some Herbicides

Trade	Common (generic)
AAtrex.....	atrazine
Alanap Plus, Whistle, Solo.....	naptalam plus chlorpropham
Amiben.....	amiben
Amino triazole, Weedazol.....	amitrole
Ammate-X.....	ammonium sulfamate
Atlacide.....	sodium chlorate plus calcium chloride
Banvel.....	dicamba
Bladex.....	SD15418
Brominil, Buctril.....	bromoxynil
Butoxone, Butyrac, and others.....	2,4-DB
Chloro IPC.....	chlorpropham
Cytrol, Amitrol-T.....	amitrole-T
Dacthal.....	DCPA
Dowpon.....	dalapon
Dymid, Enide.....	diphenamid
Dybar.....	fenuron
Eptam.....	EPTC
Knoxweed.....	EPTC plus 2,4-D
Lasso.....	alachlor
Londax.....	propachlor plus linuron
Lorox.....	linuron
Milogard.....	propazine
Planavin.....	nitralin
Primaze.....	prometryne plus atrazine
Princep.....	simazine
Ramrod.....	propachlor
(Several).....	dinoseb
(Several).....	MCPA
(Several).....	sodium chlorate
(Several).....	2,4-D
(Several).....	2,4,5-T

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Sutan	butylate
Tenoran	chloroxuron
Tordon	picloram
Treflan	trifluralin
Urab	fenuron TCA
Urox	monuron TCA
Vernam	vernolate

For clarity, trade names have been used frequently. This is not intended to discriminate against similar products not mentioned by trade names.

Herbicide Application Rates

The performance of some herbicides is influenced considerably by the organic-matter content of soil. You can estimate the organic-matter content of most Illinois soils by using the "Color Chart for Estimating Organic Matter in Mineral Soils in Illinois" (AG-1941), available from your county extension adviser or the Publications Office, College of Agriculture, University of Illinois, Urbana, Illinois 61801. For a more precise determination of organic matter, obtain a laboratory analysis.

After you know the approximate organic-matter content of soil, Table 1 can be used for selecting herbicide rates. Using this guide should help you select rates to provide adequate weed control and minimize herbicide residue.

Corn

For most effective weed control in corn, well in advance of planting plan a program that includes both

cultural practices and herbicide applications. If weeds are not serious, cultural practices alone are sometimes adequate. Prepare seedbeds to kill existing weed growth and provide favorable conditions for germination and early growth of corn. Working the soil several times is not essential if weeds can be destroyed during final seedbed preparation. Working the seedbed excessively may intensify the weed problem and contribute to crusting. A relatively high plant population and perhaps narrow rows provide enough shading to discourage weed growth.

Early cultivations are very effective for killing weeds. The rotary hoe or harrow works best if you use it after weed seeds have germinated and before or as soon as the weeds appear above the soil surface. Use row cultivators while the weeds are still very small. Set the shovels for shallow cultivation to prevent root pruning and to bring fewer weed seeds to the surface. Throwing soil into the row can help smother weeds in the row. However, if a herbicide has given good control in the row, it is sometimes best not to move soil or weeds from the middles into the row. Where you use a preemergence herbicide, if it is not sufficiently effective, cultivate with the rotary hoe or row cultivator while the weeds are still small enough to control.

Even where herbicides are used, most farmers still use a rotary hoe or harrow for an early cultivation, followed by one or two row cultivations as needed. Some farmers, especially those with narrow rows, high populations, and large acreages, broadcast herbicides and sometimes eliminate cultivation if control is adequate.

Weigh the added expense of broadcasting herbicides against other factors, such as time saved at a critical season. Research indicates that *if weed control is adequate* and the soil is not crusted because of excessive seedbed preparation or other factors, there often is little or no yield increase from cultivation on most Illinois soils. One or two cultivations are, however, often beneficial for controlling certain weed species that are not controlled by the herbicide.

The popularity of preemergence herbicides is partly caused by the need for improved control of weeds, especially annual grasses which became more severe as farmers switched from checking to drilling and hill-dropping corn. Preemergence herbicides also offer a relatively convenient and economical means of providing early weed control and they allow faster cultivation.

You can mix some herbicides with other agricultural chemicals for application. You can apply some to the surface, but must incorporate others into the soil. You can apply some either way. Time of application depends partly on what herbicide you use.

Plan well in advance to select a weed-control program that is most appropriate for your soil, crops, weed problems, farming operations, and personal desires. Be prepared to modify your plans as required during the season.

Table 1.—Suggested Herbicide Rates for Illinois Soils

Percent organic matter	Pounds of active ingredient per acre on a broadcast basis				
	atrazine	trifluralin	linuron	nitralin	alachlor
1	.8 ^d	½	½	¾	1½
2	1.6 ^d	¾	1	1	2
3	2.4	¾	1½	1½	2½
4	3.2 ^a	1	2	1½ ^b	2½
5+	4.0 ^{a, c}	1	3 ^a	... ^b	2½

	Commercial formulation per acre on a broadcast basis				
	AAAtrex 80% wettable powder	Treflan liquid (4 lb./gal.)	Lorox 50% wettable powder	Planavin liquid (4 lb./gal.)	Lasso liquid (4 lb./gal.)
	pounds	quarts	pounds	quarts	quarts
1	1 ^d	½	1	¾	1½
2	2 ^d	¾	2	1	2
3	3	¾	3	1½	2½
4	4 ^a	1	4	1½ ^b	2½
5+	5 ^{a, c}	1	6 ^a	... ^b	2½

^a If you use more than 3 pounds per acre of active atrazine, do not follow with any crop except corn or sorghum the next growing season.

^b Adapted mainly to soils with less than 4 percent organic matter.

^c Since results are variable on soils with 5 percent or more organic matter, consider another herbicide or a herbicide combination. Rates indicated for 5 percent or more organic matter are the maximum rates cleared.

^d On soils with 1 to 2 percent organic matter it may sometimes be preferable to increase the rate of atrazine above that indicated. A slightly higher rate may be desirable where atrazine is incorporated, under unfavorable weather, or for improved control of some weeds.

Preplant Herbicides for Corn

Some herbicides may be applied before planting where you wish to commit yourself to broadcast application.

Preplant applications offer an opportunity to make some herbicide application before the busy planting season. This could be particularly advantageous for custom applicators and for farmers with large acreages. It would allow fewer attachments on the planter. The weather will often dictate the actual time for application, so where preplant applications are planned, you should also have an alternate plan in case preplant applications are not possible.

Preplant-incorporated applications offer an opportunity for applying herbicide, insecticide, and fertilizer at the same time if the chemicals are compatible and if the incorporation gives the proper placement for each chemical.

AAtrex (atrazine) is the major corn herbicide available for preplant application. Although early spring and even fall applications have been tried, research indicates that for corn the closer to planting time you apply AAtrex, the more successful the application is likely to be. Make applications no earlier than two weeks before planting.

Apply AAtrex to the soil surface or incorporate it lightly with a shallow disking or similar operation. The field cultivator has been successfully used for incorporation, but results have not always been quite as good as with a disk. Depth and thoroughness of incorporation will depend on many factors, such as type of equipment, depth of operation and other adjustments, speed, soil texture, and soil physical condition when incorporating.

With so many factors involved, exact specifications for incorporation cannot be given. However, one principle to keep in mind is that the deeper the herbicide is incorporated and the more soil it is mixed with, the more diluted it will be. With excessive incorporation and dilution the effectiveness of the herbicide may be decreased. As a rule of thumb, incorporation devices such as a disk usually move the herbicide only to about half the depth at which the implement is operated.

The major reason for incorporating some herbicides is to reduce loss of herbicide from the soil surface. Since loss of AAtrex is not very rapid, incorporation is not essential. Moving herbicide into soil where there is sufficient moisture for weeds to absorb the chemical may be another advantage for incorporating some herbicides.

AAtrex is very effective for control of many broad-leaved weeds and is often quite satisfactory for control of annual grass weeds. However, under unfavorable conditions it may not adequately control some annual grasses such as giant foxtail, crabgrass, and panicum.

Considerable research has been done attempting to find another herbicide that could be combined with AAtrex to improve grass control.

Sutan (butylate) plus atrazine has been successfully used as a preplant-incorporated treatment. This combination has its greatest adaptation to soils above 3 percent organic matter. Sutan can often improve the control of annual grass weeds and the combination gives much better control of broad-leaved weeds than Sutan alone.

For the "tank mix" combination, ½ gallon of Sutan plus 1¼ to 2 pounds of AAtrex 80W per acre broadcast is suggested. Injury to corn from this combination has not been a serious problem thus far, but occasionally injury may occur.

Sutan (butylate) may be used alone as a preplant incorporated treatment at a rate of ⅓ gallon per acre broadcast. Sutan is primarily for control of grass seedlings and may be helpful for control of fall panicum, Johnsongrass from seed, wild cane, and nutsedge. Although it has not been a serious problem thus far, corn may occasionally be injured by Sutan. *It is important to apply Sutan accurately and uniformly to avoid injury.* If you use Sutan alone or in combination with AAtrex, incorporate it immediately after application.

Sutan is cleared for field corn, sweet corn, and silage corn, but not for hybrid corn grown for seed.

Preferred Preemergence Herbicides Applied at Planting

AAtrex (atrazine) is one of the most popular herbicides for corn. It controls both broad-leaved and grass weeds, but is particularly effective on many broadleaves such as smartweed. Corn has very good tolerance to pre-emergence applications of AAtrex. It is most effective on the light soils that are relatively low in organic matter, but is also effective on soils with more organic matter if you increase the rate. Do not exceed the rates specified on the label. For help in selecting AAtrex rates on the basis of organic-matter content of the soil refer to Table 1.

AAtrex will often persist long enough to give weed control for most of the season. Unless you take proper precautions, enough AAtrex may remain in the soil to damage some crops the following season. Where you apply AAtrex in the spring, do not follow that fall or the next spring with small grains, small seeded legumes, or vegetables. If you use AAtrex 80W at a broadcast rate above 3¾ pounds per acre (or comparable rates in a band) do not plant any crop except corn or sorghum the next growing season.

Soybeans planted where AAtrex was used the previous year may show some effect, especially if you used more than the recommended amount or on ends of fields where some areas received excessive amounts. Applying AAtrex

relatively late the previous year and planting soybeans early allows less time for loss of AAtrex residue and increases the possibility of injury to soybeans. Minimizing tillage before planting soybeans also increases the possibility of AAtrex residue affecting soybeans.

You can use AAtrex on most types of corn, including field corn, silage corn, seed-production fields, sweet corn, and popcorn. For use on corn, AAtrex is available from the manufacturer only as a wettable powder for spray application. Mix adequately, provide adequate agitation, and follow other precautions on the label to assure uniform application.

Ramrod (propachlor) has given very good control of annual grass weeds on soils above 3 percent organic matter. On soils with less than 3 percent organic matter, Lasso would be more appropriate than Ramrod. In addition to annual grasses, Ramrod usually controls pigweed and may give some control of lambsquarter.

Most of the commonly grown corn hybrids have good tolerance to Ramrod. It is cleared for field corn, silage corn, hybrid-seed-production fields, and sweet corn.

Ramrod is available as a 65-percent wettable powder and as 20-percent granules. Either formulation of Ramrod can be irritating to skin and eyes. Some individuals are more sensitive than others. Twenty pounds of the granules or 6 pounds of the wettable powder are equivalent to 4 pounds of active ingredient, which is the recommended rate per acre on a broadcast basis. Use proportionately less for band applications.

A good program is to use Ramrod either as a spray or as granules at planting time to control annual grass weeds and follow with an early postemergence application of 2,4-D to control broad-leaved weeds.

Ramrod plus atrazine, each at a reduced rate, has generally given good control of both annual broad-leaved and grass weeds. This combination is best adapted to soils with over 3 percent organic matter. For "tank-mixing" this combination, 4½ pounds of Ramrod 65-percent wettable powder plus 2 pounds of AAtrex 80W wettable powder is the suggested amount for soils with over 3 percent organic matter.

A prepackaged wettable powder combination of Ramrod plus atrazine is available. Use it at a rate of 6 to 8 pounds per acre.

The reduced rate of AAtrex will control many broad-leaved weeds, such as smartweed, but may give marginal control of velvetleaf. The reduced rate of Ramrod in the mixture is adequate for control of most annual grasses. The mixture controls broad-leaved weeds better than Ramrod alone and often controls annual grass weeds better than AAtrex alone. It reduces the AAtrex residue problem, and gives more consistent control on the darker soils or with limited rainfall than AAtrex alone.

Lasso (alachlor) is similar to Ramrod in some re-

spects. Although Lasso has performed well on soils with more than 3 percent organic matter, it is not likely that it will entirely replace Ramrod for corn on these soils in the immediate future. Being less soluble than Ramrod, Lasso may require slightly more moisture initially, but weed control may last a little longer. Lasso performs better than Ramrod on soils with less than 3 percent organic matter. Like Ramrod, Lasso is intended primarily for control of annual grass weeds. Following Lasso with a postemergence application of 2,4-D to control broad-leaves gives more complete weed control. Lasso appears promising for control of nutsedge.

Lasso is available as a 4-pound-per-gallon liquid concentrate and as 10-percent granules. Lasso may be used for field corn, hybrid seed corn, and silage corn. At least 12 weeks must elapse following treatment with Lasso before immature corn forage can be harvested or fed to cattle. Refer to Tables 1 and 2 and to the product labels for suggested rates.

Although Lasso is less irritating than Ramrod, the precautions listed on the label should be taken when handling Lasso.

Princep (simazine) usage for corn has been largely replaced by AAtrex. However, Princep, used alone or in combination with AAtrex may give more control of fall panicum than AAtrex alone. Princep may also give some control of wild cane. Being less soluble than AAtrex, Princep may have more residual activity. The major use for Princep would be on soils with less than 3 or 4 percent organic matter.

Bladex (SD 15418) is a new triazine corn herbicide which is similar in some respects to AAtrex. If cleared for corn in 1970, Bladex likely would be introduced as an 80-percent wettable powder primarily in the area with soils relatively low in organic matter.

Research thus far suggests that corn has relatively good tolerance to Bladex. Rates of Bladex may sometimes need to be higher than with AAtrex. Length of control and residual activity may be a little less than with equal rates of AAtrex. Bladex should be applied to the soil surface and not incorporated. Combinations of Bladex with other corn herbicides may offer some potential for the future. Bladex likely will be for preemergence use only.

Less Preferred Preemergence Herbicides Applied at Planting

Because of greater possibility of crop injury or less weed control, the following preemergence herbicides for corn are not considered as satisfactory as those discussed above.

Knoxweed is a combination of Eptam (EPTC) and 2,4-D. It is cleared for use on field corn, sweet corn, and silage corn. Do not use it on seed production fields. Knoxweed has given rather erratic weed control, depending on rainfall and soil moisture. More consistent weed

control is likely when rain occurs soon after application. The possibility of corn injury from Knoxweed has not been a serious problem but does exist. Knoxweed has presented no hazard to crops the next season. It is available in both liquid and granular forms. Do not use on peats, mucks, or sands.

2,4-D ester preemergence for corn controls broad-leaved weeds and gives some control of grass weeds. Weed control is rather erratic. There is some chance of injury to the corn. Use only the ester form for preemergence, since the amine form is more subject to leaching. 2,4-D ester is available in both liquid and granular forms.

A combination of **Lorox (linuron) plus atrazine** has been available as a prepackaged, wettable-powder mixture or you can "tank-mix" it on the farm for preemergence use on field corn. Especially on the relatively light-colored soils with low organic matter this combination has often given satisfactory weed control. Using a reduced rate of Lorox in the combination reduces, *but does not eliminate*, the possibility of corn injury. Do not use the combination containing Lorox on sandy soils or injury may result. This combination may give more control of panicum than atrazine alone.

Londax, a combination of Lorox and Ramrod, has clearance for use on field corn for grain or silage. It contains linuron and propachlor in a ratio of 1 to 2 parts respectively of active ingredient. The 45-percent wettable powder formulation contains 15 percent linuron and 30 percent propachlor. The 15-percent granular formulation contains 5 percent linuron and 10 percent propachlor. Rates should be very carefully selected on the basis of soil texture and organic-matter content. Maximum rates are 1½ pounds of linuron plus 3 pounds of propachlor per acre on a broadcast basis. This combination has given relatively good weed control. Control of broad-leaved weeds is better than with Ramrod alone. However, the addition of Lorox *increases the chance of crop injury*. Applications should be made very accurately and uniformly to help avoid crop injury.

Primaze is a combination of atrazine and another triazine compound, prometryne. Although weed control from this combination has been fairly good, *there is increased chance of corn injury with prometryne in the combination*. This combination was introduced commercially in hopes of reducing the atrazine residue problem.

Amiben and Lorox (linuron) each have label clearance for preemergence use on corn, but the risk of corn injury is considered too great to recommend their use for this purpose in Illinois.

Postemergence Herbicides for Corn

2,4-D provides one of the most economical and effective treatments for many broad-leaved weeds in corn.

For greatest effectiveness, apply 2,4-D when weeds are small and easiest to kill. You can apply the spray broad-

cast over the top of the corn and weeds until corn is about 8 inches high. After that height, use drop extensions from the boom down to the nozzles. These "drop nozzles" help keep the 2,4-D off the top of the corn and decrease the possibility of injury. You can direct the nozzles toward the row where most of the weeds will be. However, if you direct the nozzles toward the row, adjust the concentration of the spray so that excessive amounts are not applied to the corn.

Each year some corn is damaged by 2,4-D. It is virtually impossible to eliminate all cases of 2,4-D damage. The chemical usually makes corn brittle for a week or ten days. If struck by a strong wind or by the cultivator, some corn may be broken off. Some stalks may "elbow" or bend near the base. Other symptoms of 2,4-D injury are abnormal brace roots and "onion-leaving," a condition in which the upper leaves remain tightly rolled and may delay tassel emergence.

Spraying 2,4-D during very cool, wet weather when corn plants are under stress, or spraying during very hot, humid weather may increase the possibility of corn injury from 2,4-D.

Some inbreds and some hybrids are more easily injured by 2,4-D than others. It is usually best not to use 2,4-D on inbreds unless you are certain they have a high tolerance. Single crosses may or may not be more sensitive than double crosses, depending on the sensitivity of the inbred parents. Doublecross hybrids and three-way crosses also vary in their sensitivity depending on their genetic makeup.

To help avoid damage to corn, be sure to apply 2,4-D at no more than the recommended rate. The suggested rates per acre for broadcasting are: ⅙ pound of low-volatile ester; ¼ pound of high-volatile ester; or ½ pound of amine.

The ester forms of 2,4-D can volatilize and the vapors move to nearby susceptible plants to cause injury. Since the amines are not so volatile they are less likely to injure nearby desirable plants. However, when spraying either the ester or amine forms, spray particles can drift to nearby susceptible plants.

Here is an easy way to calculate the amount of 2,4-D needed. If using a formulation with 4 pounds of 2,4-D per gallon, each quart will contain 1 pound; each pint ½ pound; and each half-pint ¼ pound. It would take 1 pint of amine formulation to get ½ pound of 2,4-D. A gallon of 2,4-D amine (with 4 pounds of 2,4-D per gallon) would be enough to broadcast 8 acres (4 lb./gal. ÷ ½ lb./A. = 8 acres). A gallon of 2,4-D containing 4 pounds of 2,4-D high-volatile ester would be enough to broadcast 16 acres (4 lb./gal. ÷ ¼ lb./a. = 16 acres).

It is important to spray weeds when they are small and easiest to kill and before they have competed seriously with the crop. However, you can use high-clearance equipment relatively late in the season if you wish, especially for control of late-germinating weeds. Many of

the weeds that germinate late are not very competitive with corn, but control would decrease production of weed seeds. Do not apply 2,4-D to corn from tasseling to dough stage.

Amines are salts that are dissolved to prepare liquid formulations and when mixed with water they form clear solutions. Esters of 2,4-D are formulated in oil and when mixed with water they form milky emulsions.

Dacamine and Emulsamine are amine forms of 2,4-D that are formulated in oil and are called oil-soluble amines. Since they are formulated in oil like the esters they are said to have the effectiveness of the esters, but to retain the low-volatile safety features of the amines.

The active ingredient in the various formulations of 2,4-D is still 2,4-D and when you adjust rates appropriately to provide both weed control and crop safety the various formulations are usually similar in their effectiveness.

Banvel (dicamba) is suggested only for emergency use. You can use it as a postemergence spray over the top of field corn until corn is 3 feet high. Rates are $\frac{1}{4}$ to $\frac{1}{2}$ pint ($\frac{1}{8}$ to $\frac{1}{4}$ pound active ingredient) per acre on a broadcast basis. Use proportionately less if placed only over the row.

Banvel is similar to 2,4-D in some respects, but controls smartweed better than does 2,4-D. Corn injury can occur with either Banvel or 2,4-D. *Banvel has often affected soybeans in the vicinity of treated cornfields and has presented a much more serious problem than 2,4-D.* Although soybean yields may not always be reduced, they can be if injury is severe enough. Banvel can also affect other susceptible broad-leaved plants, such as vegetables and ornamentals.

Do not make more than one postemergence application of Banvel per season. You can use Banvel on field corn for grain or silage, but do not graze or harvest for dairy feed before the ensilage stage (milk stage). Use extreme care not to allow Banvel onto desirable plants either by direct application, from contaminated sprayers, or by movement through the air from treated areas.

Because of the limited advantage of Banvel over 2,4-D and the greater risk of injury to other crops in the vicinity, Banvel is usually not recommended. If you anticipate a smartweed problem in corn, AAtrex preemergence or very early postemergence usually gives good control with much less risk of injury to other nearby plants.

AAtrex (atrazine) can be applied as an early post-emergence spray to corn up to 3 weeks after planting, but before weed seedlings are more than $1\frac{1}{2}$ inches high. Most annual broad-leaved weeds are more susceptible than grass weeds. The addition of 1 gallon of oil formulated especially for this purpose has generally increased the effectiveness of early postemergence applications of AAtrex. *On the relatively light-colored soils of Illinois, a regular preemergence application of AAtrex will likely*

remain more popular than postemergence AAtrex because AAtrex preemergence applications usually give better control with less herbicide on such soils.

On the relatively dark soils of the state there is some interest in the AAtrex-oil treatment. Research and field experience suggest that for those relatively dark soils, $2\frac{1}{2}$ pounds of AAtrex 80W plus 1 gallon of oil may sometimes be just as effective, and sometimes more effective, than a preemergence application of $3\frac{3}{4}$ pounds of AAtrex 80W. However, a preemergence application is usually preferred.

As with many herbicide applications, the results with AAtrex and oil will be influenced by many factors, and results are not always consistent. For control of annual grasses, it is especially important to apply early when grasses are small.

The early postemergence application with AAtrex and oil may be of particular help where rainfall is less certain, on the darker soils, and where soil conditions are too wet for cultivation.

Although corn has displayed excellent tolerance to AAtrex alone, corn has sometimes shown a general stunting where oil was added. There have been a few cases of fairly severe injury to corn where AAtrex and oil have been used. Weather conditions, stage of growth, rate of growth, genetic differences, and rate of herbicide used with oil seem to be some of the factors involved.

Certain other additives might be used instead of oil to enhance the postemergence activity of AAtrex. One of these is Tronic. Although results with Tronic have not been quite as consistent as with oil, results were often quite similar. An advantage for Tronic would be the need for handling less volume — 1 pint of Tronic per 25 gallons of spray solution.

Directed Postemergence Applications for Corn

Directed sprays are sometimes considered for emergency situations when grass weeds become too tall for control with cultivation. By the time help is sought, the weeds are often too large for directed sprays to be very practical or successful. Since present directed sprays cannot be used on small corn, some other means of control must be used early. Early control with only preemergence herbicides and cultivation is often quite adequate, leaving no need for the directed sprays. Since weeds begin competing with corn quite early, place primary emphasis on early control measures, such as use of preemergence herbicides, rotary hoeing, and timely cultivation.

Directed postemergence may have some potential for controlling some relatively late-germinating grasses, such as fall panicum.

Dowpon (dalapon) may be applied as a directed spray when corn is 8 to 20 inches tall from ground to whorl. Direct Dowpon toward the row using the equivalent of 2 pounds of product on a broadcast basis ($\frac{2}{3}$ pound in a 14-inch band over 40-inch rows). Dowpon is primarily for control of grass weeds, but 2,4-D can be

added for control of broad-leaved weeds. With this treatment, use extreme caution to keep the Dowpon off the corn plant as much as possible to avoid injury. Do not let spray contact more than the lower half of the stalk and do not direct the spray more than 7 inches above the ground. Use "leaf lifters." Other precautions are given on the label. Dowpon does not give a quick kill, but can stunt the grass and reduce formation of weed seeds. Do not use Dowpon on corn grown for seed.

If excessive amounts of Dowpon contact the corn leaves, the chemical can be translocated (moved) inside the plant and may cause stunted and deformed plants, twisted leaves, short ear husks, and abnormal ears. Because of the risk of injury, Dowpon is not usually recommended in Illinois for application to corn.

Lorox (linuron) may be applied as a directed spray after corn is at least 15 inches high (to top of free-standing plant), but before weeds are 8 inches tall (preferably not over 5 inches). This height difference may not occur in some fields and when it does it will usually last for only a few days so the application needs to be very timely. Lorox can control both grass and broad-leaved weeds. Cover the weeds with the spray, but keep it off the corn as much as possible. Corn leaves that are contacted can be killed and injury may be sufficient to affect yields.

Consider this an emergency treatment. Refer to the label for further information and other precautions. A rate of 4 pounds of Lorox 50W on a broadcast basis or proportionately less in a directed band is suggested, but less Lorox may sometimes be adequate, especially for small weeds. Surfactant WK should be added at the rate of 1 pint per 25 gallons of spray mixture.

Soybeans

For soybeans Illinois farmers usually plow the seedbed and use a disk, field cultivator, or similar implement at least once to destroy weed growth and prepare a relatively uniform seedbed for planting. Planting in relatively warm soils helps soybeans begin rapid growth and compete better with weeds. Good weed control during the first three to five weeks is extremely important. If weed control is adequate during that early period, soybeans usually compete quite well with most of the weeds that begin growth later.

Rotary hoeing is very popular for soybeans. It not only helps control early weeds, but it aids emergence if the soil is crusted. To be most effective, use the rotary hoe after weed seeds have germinated, but before the majority of weeds have emerged. Operate the rotary hoe at 8 to 12 miles per hour and weight it enough to stir the ground properly. The soil must be moved sufficiently to kill the tiny weeds.

Following one or two rotary hoeings, use the row cultivator one or two times. Adjust the row cultivator properly

and operate it fast enough to move soil into the row to smother small weeds. Avoid excessive ridging which would make harvesting difficult.

It is often said that soybeans in narrow rows provide more shade and compete better with weeds. However, with narrow rows there is more row area where weeds are difficult to control. So a good weed-control program is just as important for narrow-row beans.

There is some interest in "solid drilling" of soybeans in 7- to 10-inch rows. However, you cannot expect present herbicides to control weeds adequately 100 percent of the time. For most situations it is preferable to keep the rows wide enough so you can use cultivation as required.

Use of preemergence herbicides for soybeans has increased rapidly. Over half of the soybean acreage in Illinois is treated with a preemergence herbicide. Whether you should use herbicides for soybeans will depend on the seriousness and nature of your weed problem, as well as your preference for various alternative methods of weed control. Preemergence herbicides are often extremely helpful in obtaining the necessary early control in the row. They can allow a reduction in the number of cultivations, allow faster cultivation, and reduce the amount of ridging needed to smother weeds in the row.

Even though you have used a preemergence herbicide, if it appears doubtful that it will give adequate control, use the rotary hoe while weeds are still small enough to be controlled. Use row cultivation as needed before weeds in the row become too large to be smothered.

When selecting a preemergence herbicide for soybeans, consider the kind of weeds likely to be present. Many of the preemergence herbicides for soybeans are particularly effective for controlling annual grasses. The majority give good control of pigweed, and many will also control lambsquarter. Most do not give good control of annual morningglory, and control of velvetleaf, jimsonweed, and cocklebur is rather erratic.

Many of the preemergence herbicides for soybeans may occasionally cause injury to the soybean plants. Fortunately, soybeans usually have the ability to outgrow modest amounts of early injury, and usually the benefits from weed control provided by the herbicide are much greater than any adverse effects from the herbicides. There may occasionally be exceptions and anyone using herbicides should realize there are some risks involved.

Where you use herbicides for soybeans, it is particularly important to use high-quality seed of disease-resistant varieties. Soybeans that are under stress and do not begin vigorous growth appear to be more subject to herbicide injury. And soybeans that are injured by a herbicide are likely to be more subject to disease. Any one of these factors alone may not be too serious, but several of them acting together could be.

Preplant Herbicides for Soybeans

Treflan (trifluralin) is one of the most effective herbicides for controlling annual grasses such as foxtail. It is also the major soybean herbicide suggested for controlling wild cane and Johnsongrass seedlings. Treflan may also control pigweed and lambsquarter, but does not give good control of most other broad-leaved weeds commonly found in Illinois soybean fields.

Treflan has given satisfactory control of susceptible weeds a high percentage of the time. Soybean injury is possible with Treflan. It may cause tops to be stunted and may cause a reduction in the number of lateral roots in the treated zone. Compared with the advantages of Treflan for controlling annual grasses, the injury from Treflan on a statewide basis is not considered a serious problem. However, in some individual fields where the stand of soybeans is reduced and plants are injured, the problem may be considered significant. Following instructions for rate and method of application is very important in reducing the possibility of injury.

You can apply Treflan just before planting or anytime during 10 weeks before planting. Incorporate it into the soil immediately after application, by using a disk or similar implement to reduce loss from the soil surface. Cross-disk a second time at right angles to the first disking to obtain more uniform distribution. This will help give more uniform weed control and reduce possibility of soybean injury. You can delay the second disking until anytime before planting, and using it for final seedbed preparation just before planting usually improves control.

The disk probably will incorporate the chemical to only about $\frac{1}{2}$ the depth of operation. Disking about 4 inches deep to mix the majority of the chemical into about the top 2 inches usually works best. Having a harrow attached behind the disk is often helpful.

You can use implements other than the disk if they adequately mix the chemical into the top 2 inches. The field cultivator is usually not recommended for incorporating Treflan. Results with the field cultivator sometimes have been acceptable, but are usually not as good as with the disk. The degree of incorporation may vary considerably depending on type of implement, adjustment, speed, soil moisture, soil texture, and other soil physical conditions.

The rate of Treflan is between $\frac{1}{2}$ and 1 quart liquid ($\frac{1}{2}$ to 1 pound of active ingredient) per acre on a broadcast basis. Select the rate on the basis of soil type as indicated on the label. After determining the organic-matter content of your soil by estimation or by laboratory analysis you can also use Table 1 as a guide for selecting appropriate rates for most Illinois soils. For most of the light-colored silt loams in Illinois use $\frac{1}{2}$ to $\frac{3}{4}$ quart per acre; for the dark-colored silty clay loams, and clay loams with over 3 percent organic matter use $\frac{3}{4}$ to 1 quart per acre.

Treflan is also available in granular form. The granules have not been as popular as the liquid, but appear to be comparable in performance.

In a few cases Treflan residue has carried over to injure corn the following year. In many of these fields the soybean stubble had not been plowed with a moldboard plow. Some areas apparently had excessive applications.

Research also suggests some possibility of Treflan residue affecting small grain. Using no more than recommended rates and making careful applications no later than early June should reduce, but may not eliminate, the possibility of injury to subsequent crops.

Planavin (nitralin) is similar to Treflan in the kinds of weeds controlled. However, research indicates that in Illinois higher rates of Planavin are usually needed to provide about the same control obtained with Treflan.

On some of the light-colored silt loams of the southern part of Illinois, $\frac{3}{4}$ pound per acre of active ingredient of Planavin ($\frac{3}{4}$ quart of liquid or 1 pound of 75-percent wettable powder) appears to be appropriate. Higher rates are needed as organic matter increases (see Table 1).

Planavin is cleared up to 1 $\frac{1}{2}$ pounds per acre of active ingredient, but it is not well adapted to the darker soils of the northern part of Illinois. Planavin can be applied within 6 weeks before planting. Incorporate soon after application into the top 1 to 1 $\frac{1}{2}$ inches of soil with a disk operated shallow or with similar equipment.

Preferred Preemergence Herbicides Applied at Planting Time

Amiben has been one of the most popular herbicides for soybeans. It controls the majority of annual grass and broad-leaved weeds in soybeans most of the season. The major exception is annual morningglory. Control of velvetleaf, jimsonweed, and cocklebur is somewhat erratic. Amiben occasionally injures soybeans, but damage is usually not very severe. When it occurs, injury appears as malformed roots and stunting of the tops.

Amiben is adapted to a wide range of soil types. The manufacturer recommends 1 to 1 $\frac{1}{2}$ gallons or 20 to 30 pounds of granules (2 to 3 pounds active ingredient) on a broadcast basis per acre or proportionately less for band application. University trials have shown best weed control with 1 $\frac{1}{2}$ gallons or 30 pounds of granules per acre. If you reduce the rate, weed control may be reduced. Consider the degree of control desired, as well as the cost.

You can make a comparison of 1, 1 $\frac{1}{4}$, and 1 $\frac{1}{2}$ gallons (20, 25, and 30 pounds of granules) per acre on a field and use it as a basis for selecting rates for that field in the future. Granules and liquid perform about equally well. Amiben is easy to handle and is usually applied to the soil surface at planting time.

Ramrod (propachlor) is cleared only for soybeans grown for seed and not for soybeans that will be harvested

for food, feed, or edible oil purposes. Most of the comments on page 5 regarding Ramrod for corn apply for soybeans. Lasso is somewhat similar to Ramrod and has broader clearance for soybeans, so Lasso is usually used.

Lasso is intended primarily for control of annual grass weeds, but may also control pigweed and lambsquarter. Lasso also appears promising for control of nutsedge. Soybeans appear to have relatively good tolerance to Lasso although slight distortion of the leaves may appear early.

Lasso is less soluble than Ramrod and may require slightly more moisture initially, but can provide control a little longer than Ramrod. Lasso is not as irritating as Ramrod, but follow precautions listed on the label.

Lasso is available as a liquid with 4 pounds active ingredient per gallon and as 10-percent granules. Lasso has generally performed well on the darker soils and performs better than Ramrod on the lighter soils. Refer to Table 1 for suggested rates on a broadcast basis. Use proportionately less for band applications.

Lorox (**linuron**) has given relatively good weed control in soybeans, particularly on the light-colored silt loams. However, *the margin of selectivity between dependable weed control and crop damage is rather narrow.* Lorox performance is affected considerably by organic-matter content of the soil. For suggested rates see Table 1.

Selecting rates on the basis of organic matter and making careful applications will reduce, *but may not eliminate, the possibility of crop injury.* Do not use Lorox on sandy soils because of the risk of crop injury.

Chloro IPC (**chlorpropham**) has not commonly been used in Illinois, except in combination with other herbicides. When tested alone rates of Chloro IPC sufficient to give adequate control of most weeds have sometimes caused soybean injury. However, smartweed is particularly sensitive to Chloro IPC. For controlling smartweed in soybeans, use 3 pounds per acre of Chloro IPC active ingredient on a broadcast basis. You can use this reduced rate of Chloro IPC alone or in combination with some other herbicides that are weak on smartweed.

Less Preferred Preemergence Herbicides Applied at Planting Time

Because of the greater possibility of crop injury or less weed control, the following preemergence herbicides for soybeans are not considered as satisfactory as those previously discussed.

Alanap Plus (**naptalam plus chlorpropham**) combination has replaced the straight Alanap formerly used in Illinois. Although sometimes satisfactory, weed control from Alanap Plus has been rather erratic. Crop injury can sometimes occur. Under favorable conditions, Alanap Plus can control annual grasses, smartweed, ragweed, velvetleaf, and jimsonweed. Alanap Plus is used at the rate of 1½ gallons of liquid or 40 pounds of granules per

acre on a broadcast basis, or proportionately less when banded. This is equivalent to 3 pounds of naptalam and 2 pounds of chlorpropham active ingredient broadcast per acre. This combination has also been available under the names "Whistle" and "Amoco Soybean Herbicide." A similar product will be available under the name of "Solo."

Vernam (**vernolate**) has given good control of annual grass weeds in Illinois trials, *but some injury to soybeans may occur.* In addition to annual grasses, Vernam controls pigweed, lambsquarter, and may give some control of annual morningglory. Vernam might be considered for serious infestations of wild cane and for control of Johnsongrass seedlings where some soybean injury from the herbicide might be tolerated. Vernam may also be helpful for controlling nutsedge.

It would usually be preferable to incorporate Vernam before planting. However, granules are often banded on the surface at planting. Incorporation of granules is not essential but usually improves control, especially if rainfall is delayed. Rates of active ingredient suggested vary from 2 to 3 pounds per acre depending on soil type, formulation, and method of application.

Postemergence Applications for Soybeans

Tenoran (**chloroxuron**). Tenoran may be applied at the rate of 2 to 3 pounds of the 50-percent wettable powder in 25 to 40 gallons of water per acre with 1 pint of Adjuvan T surfactant added per 25 gallons of spray solution. This is the broadcast rate, but you can use proportionately less for directed or semi-directed band spraying. Apply from the time trifoliolate soybean leaves form and when broad-leaved weeds are less than 1 to 2 inches high.

Some non-phytotoxic oils may be substituted for Adjuvan T, using 1 gallon of oil in 25 gallons of spray solution for a directed or semi-directed spray.

Under favorable conditions Tenoran may give fairly good control of pigweed, lambsquarter, smartweed, jimsonweed, morningglory, and cocklebur. Velvetleaf is more difficult to control and should be not over 1 inch when you treat it. Although intended primarily for control of broad-leaved weeds, Tenoran may give some control of grass if you apply it under favorable conditions when grass weeds are less than ½ inch.

The major interest in Tenoran would be as a possible control for some of the broad-leaved weeds where a pre-emergence herbicide such as Treflan or Lasso had been used preemergence. Control with Tenoran has been somewhat erratic and soybeans usually show some injury at rates required for weed control. This early season injury to soybeans by Tenoran may not necessarily reduce final yields.

2,4-DB can be considered for emergency situations where cocklebur is quite serious (as in some bottomland

areas). 2,4-DB is sold under several trade names including Butoxone SB and Butyrac 175. This herbicide may be broadcast from 10 days before soybeans begin to bloom until midbloom or as a postemergence directed spray when soybeans are 8 to 12 inches tall and cockleburrs are 3 inches tall, if this height difference exists.

2,4-DB may also give fairly good control of annual morningglory and giant ragweed. But do not expect good control of most other weeds found in Illinois soybean fields. Soybeans may show early wilting followed by later curving of the stems. Some cracking of stems and some proliferated growth may occur at the base of the plants. Lodging may be increased and if excessive rates are applied or unfavorable conditions exist near time of treatment, yields may be lowered. Carefully follow application rates specified on the label.

Fencerow Control

If the vegetation in fencerows consists primarily of broad-leaved weeds, use 2,4-D at the rate of ½ to 1 pound applied in 10 or more gallons of water per acre. Two miles of fencerow, 4 feet wide equals about an acre.

Make the first application of 2,4-D in May or early June to control early weeds, and make another application in July or early August to control late weeds.

If there are grass weeds such as Johnsongrass or foxtail in the fencerow, you may mix Dowpon (dalapon) with 2,4-D for control of both broad-leaved weeds and grasses. Spray grasses before seed heads form. Use only 2,4-D where the fencerow vegetation consists primarily of broad-leaved weeds and desirable grasses. Use care to avoid injury to nearby desirable plants.

Additional Information

Readers who want additional information on weed control may obtain single copies of the following publications from the Office of Publications, College of Agriculture, University of Illinois, Urbana, Illinois 61801, or from a county extension adviser.

Weeds of the North Central States, Circular 718. (\$1.00)

Prevent 2,4-D Injury to Crops and Ornamental Plants. Circular 808.

Controlling Johnsongrass in Illinois. Circular 827.

Controlling Giant Foxtail in Illinois. Circular 828.

Controlling Quackgrass in Illinois. Circular 892.

Calibrating and Maintaining Spray Equipment. Circular 837.

Calibrating and Adjusting Granular Row Applicators. Circular 839.

Controlling Poison Ivy. Circular 850.

Using Preemergence Herbicides. Circular 932.

Color Chart for Estimating Organic Matter in Mineral Soils in Illinois. AG-1941.

Herbicide Application Rates

Table 2 lists the amount of commercial herbicides to apply per acre for liquids or granules, either broadcast or banded.

Here is a guide for calculating the amount of herbicide needed for spraying bands for various row spacings:

Row spacing (inches)	Width of band (inches)	Percent of total area covered
20	12	60
20	14	70
24	12	50
28	14	50
30	12	40
30	15	50
36	12	33
38-40	13	33
42	14	33

Formula for other situations: band width ÷ row spacing = percent of area covered.

Example: 12 inches ÷ 36 inches = ⅓ or 33 percent.

By operating your equipment over 1 acre of land you can determine how much spray is used. Do this by starting with a full tank of water and after operating on 1 acre measure the amount of water needed to refill the tank. Multiply the percentage figure from the guide above for your situation times the amount of herbicide recommended for broadcasting. The answer is the amount of herbicide to add with enough water to equal the spray volume you used per acre.

Example: 28-inch rows with 14-inch band; 1 gallon per acre of herbicide recommended if broadcast; 50 percent (from table) × 1 gallon = ½ gallon per acre needed for 14-inch bands on 28-inch rows; if you used 10 gallons per acre of spray, add ½ gallon of herbicide to each 9½ gallons of water to make 10 gallons of spray solution.

When using band treatments the amount of active chemical per row doesn't change with row spacings, but the amount of chemical applied per acre does. Table 3 shows the liquid and granular band rates for 13-inch bands on various row widths.

Table 2. — Amount of Commercial Product To Apply per Acre

Herbicide	12- to 14-inch bands over 40-inch rows		Broadcast	
	Liquid ^a	Granules ^b	Liquid ^a	Granules ^b
Corn				
AAtrex	5/6 to 1 1/4 lb.	.....	2 1/2-3 3/4 lb.	.....
Ramrod	2 lb.	7 lb. (20%)	6 lb.	20 lb.
Lasso	1/2-3/4 qt.	5-8 lb. (10%)	1 1/2-2 1/2 qt.	15-25 lb.
Knoxweed	1 1/2 pt.	7 lb. (14%)	2 qt.	20 lb.
2,4-D ester	1 pt. ^c	3 1/3 lb. (20%)	1 1/2 qt. ^c	10 lb.
Eptam	1 1/2 pt.	10 lb. (10%)	2 qt.	30 lb.
Sutan	.....	.....	3/8 gal.	40 lb. (10%)
Soybeans				
Amiben	2 qt.	10 lb. (10%)	1 1/2 gal.	30 lb.
Treflan	1/6-1/3 qt.	3 1/3-7 lb. (5%)	1/2-1 qt.	10-20 lb.
Lasso	1/2-3/4 qt.	5-8 lb. (10%)	1 1/2-2 1/2 qt.	15-25 lb.
Alanap Plus	2 qt.	14 lb. (12.5%)	1 1/2 gal.	40 lb.
Lorox ^d	1/3-2/3 lb.	.....	1-2 lb.	.....
Vernam	.....	7-10 lb. (10%)	1 1/2-2 qt.	20-30 lb.
Planavin ^d	1/4-1/3 qt.	.....	3/4-1 qt.	.....

^a For broadcasting use 10 to 30 gallons of spray solution per acre for liquid formulations. For wettable powders use 20 to 30 gallons of spray per acre.

^b The amount of granules listed is for material with the indicated amount of active ingredients.

^c For a 2,4-D formulation containing 4 pounds acid equivalent per gallon.

^d Amount for light-colored silt loam. See label for rates on other soils.

Table 3. — Liquid and Granular Band Rates for 13-Inch Bands on Various Row Widths

Broadcast rate (gallons per acre)	40-inch rows	38-inch rows	36-inch rows	30-inch rows	20-inch rows
	<i>Liquid (gallons per acre)</i>				
15	4.9	5.1	5.4	6.5	9.8
20	6.5	6.8	7.2	8.7	13.0
25	8.1	8.5	9.0	10.8	16.2
30	9.8	10.3	10.8	13.0	19.5
<i>Granular (pounds per acre)</i>					
1	1.1	1.1	1.3	2.0	2.0
2	2.1	2.2	2.7	4.0	4.0
3	3.2	3.3	4.0	6.0	6.0
4	4.2	4.4	5.3	8.0	8.0
5	5.3	5.5	6.7	10.0	10.0
6	6.3	6.7	8.0	12.0	12.0
7	7.4	7.8	9.3	14.0	14.0
8	8.4	8.9	10.7	16.0	16.0
9	9.5	10.0	12.0	18.0	18.0
10	10.5	11.1	13.3	20.0	20.0
11	11.6	12.2	14.7	22.0	22.0
12	12.6	13.3	16.0	24.0	24.0
13	13.7	14.4	17.3	26.0	26.0
14	14.8	15.5	18.7	28.0	28.0
15	15.8	16.7	20.0	30.0	30.0
16	16.9	17.8	21.3	32.0	32.0

Control of Major Weed Species With Herbicides

(This chart gives a general comparative rating. Under unfavorable conditions some herbicides rated good or fair may give erratic or poor results. Under very favorable conditions control may be better than indicated. Type of soil is also a very important factor to consider when selecting herbicides. Rate of herbicide used will also influence results. G = good, F = fair or variable, and P = poor.)

Control for Soybeans

Control for Corn

	PREEMERGENCE							POSTEMERGENCE	
	Amiben	Lasso	Treflan	Planavin	Lorox	Alanap Plus	Vernam	2,4-DB	Tenoran
Grasses									
Giant foxtail	G	G	G	G	G	F	G	P	P
Green foxtail	G	G	G	G	G	F	G	P	P
Yellow foxtail	G	G	G	G	G	F	G	P	P
Barnyard grass	G	G	G	G	G	F	G	P	P
Crabgrass	G	G	G	G	G	F	G	P	P
Johnsongrass from seed	F	P	G	G	P	P	G	P	P
Wild cane	F	P	G	G	P	P	G	P	P
Yellow nutsedge	P	F	P	P	P	P	F	P	P
Broadleaves									
Pigweed	G	G	G	G	G	G	G	P	G
Lambsquarter	G	F	G	G	G	F	F	P	F
Velvetleaf	F	P	P	P	G	F	F	P	P
Jimsonweed	F	P	P	P	F	F	P	P	F
Cocklebur	F	P	P	P	F	F	P	G	F
Annual morningglory	P	P	F	F	P	F	F	F	F
Ragweed	G	P	P	P	G	G	P	F	F
Smartweed	F	P	P	P	G	G	P	P	F
Soybean tolerance	F	G	F	F	F	F	F	F	F

	PREEMERGENCE							POSTEMERGENCE				
	AAtrex	Ramrod	Lasso	Ramrod + atrazine	Sutan + atrazine	Knoxweed	2,4-D ester	Londax	Sutan	Eptam	2,4-D	Atrazine and oil
Grasses												
Giant foxtail	F	G	G	G	G	F	F	G	G	G	P	F
Green foxtail	G	G	G	G	G	F	F	G	G	G	P	G
Yellow foxtail	G	G	G	G	G	F	F	G	G	G	P	G
Barnyard grass	G	G	G	G	G	F	F	G	G	G	P	G
Crabgrass	F	G	G	G	G	F	P	G	G	G	P	P
Johnsongrass from seed	P	P	P	P	F	P	P	P	F	G	P	P
Wild cane	P	P	P	P	F	P	P	P	F	G	P	P
Yellow nutsedge	F	F	F	F	F	P	P	P	F	F	P	F
Panicum	F	F	G	F	G	F	P	F	G	G	P	P
Broadleaves												
Pigweed	G	G	G	G	G	G	G	G	G	G	G	G
Lambsquarter	G	F	F	G	G	G	G	P	F	F	G	G
Velvetleaf	F	P	P	F	G	F	F	F	F	F	F	F
Jimsonweed	G	P	P	G	G	F	F	F	P	P	F	G
Cocklebur	G	P	P	G	G	F	G	F	P	P	G	G
Annual morningglory	G	P	P	G	G	F	G	P	P	P	G	G
Ragweed	G	P	P	G	G	F	F	G	P	P	G	G
Smartweed	G	P	P	G	G	F	F	G	P	P	F	G
Corn tolerance	G	G	G	G	F	F	F	F	F	F	F	F

EARLY REPORTS ON ROOTWORMS AND APHIDS

First Report of Northern Corn Rootworm in Illinois, 1881,

*by Cyrus Thomas [New Corn Insect—*Diabrotica longicornis* (Say)].*

"I address you at this time in regard to the larvae of some unknown insect which I find working on the corn. Since my return from the State Field-meeting (of Natural History Association) numerous complaints have been made to me in regard to a worm that was preying upon the roots of corn, and to-day, having the first leisure moment that I have had, I visited the infested fields. The field examined was a fine, rich, level prairie, thoroughly under drained with tile, and has been cultivated in corn for a number of years. The ground was clean and the crop had been well attended. The corn was a fair growth, and had just begun to ear. At first one would not think there was anything amiss with it, but on closer inspection I could see that many hills were withering, and on taking hold of them, they pulled up very easily, and the fibrous roots were found eaten away. A closer examination revealed hundreds of small white worms about half an inch long and the size of a No. 5 Klager-pin. The corn had thrown out its first row of brace-roots, and in these I found numerous worms at work. Some hills that had been attacked earlier had not developed brace-roots, but had thrown out another set of fibrous roots from the stalk, and these had been attacked by the worms. I thought the worms were the larvae of some Scarabaeidae, but could not determine. The field examined contained eighty acres, and had a large pasture adjoining it on the west. The damage in this field will, I think, amount to at least one-third of the entire crop. I examined several hills that appeared as yet unaffected, but found the worms in the brace-roots."

First Report of Corn Leaf Aphid in New York, 1856,

*by Asa Fitch [The Maize Aphid, *Aphis Maidis*, New Species].*

"In August, the person who is selecting soft corn for boiling, will sometimes come to an ear, the stem of which is entirely covered with vermin. On examining them they are perceived to be small plant-lice of a lurid green color, intermixed with slightly larger dull reddish ones, and an occasional individual is found among them having wings and a black body. They are thinly dusted over with a fine white powder, like meal, and scattered about among them are seen the empty skins which the larger ones have shed. Each individual is stationary, with its beak inserted into the stalk, sucking its nourishment therefrom. They continue upon those stems where they have once established themselves, until the corn is cut down or ripens and the sap ceases to circulate in the stalks, whereupon they perish. They occur upon no other part of the stalk except the peduncle or stem which bears the ears. And such a multitude of them as is found clustered together upon this stem, of course abstracts from it much of the sap which should go to nourish the ear and swell the kernels. Should these insects, therefore, ever become multiplied so as to infest a considerable portion of the ears in a field, it is evident they would do much injury to the crop. And like other kindered insects, it is probable they will at times become thus multiplied."