# TWENTIETH
# ILLINOIS
# CUSTOM
# SPRAY
# OPERATORS
# TRAINING
# SCHOOL

SUMMARIES OF PRESENTATIONS

JANUARY 24 & 25, 1968

URBANA, ILLINOIS

Cooperative Extension Service
University of Illinois
College of Agriculture, Urbana.
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 College of Agriculture, Agricultural 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.

# 1968 PESTICIDE DEALERS' AND APPLICATORS' CLINICS

We invite you as a pesticide dealer or applicator 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. We look forward to seeing you at the meeting and discussing problems of mutual interest. Following are the dates and locations for the clinics and the program that will be presented:

| *Date* | *City* | *Location* |
|---|---|---|
| February 13 | Effingham | Ramada Inn |
| February 14 | Benton | Holiday Inn |
| February 15 | Collinsville | Round Table (0.4 mile south of junction I-70 and 157; west side 157) |
| February 16 | Jacksonville | Black Hawk Motel |
| February 20 | Bloomington | Sinorak (Junction 51 and 66; south edge of city) |
| February 21 | Galesburg | Huddle Drive-In (North 150, east side) |
| February 22 | Dixon | Lincoln Manor Motel |
| February 23 | Joliet | Rossi Autumn Acres Motel (Southeast corner junction 66 and 52) |

*A registration of $2.00 per person will be charged to cover the cost of the reference packet and other incidental expenses.*

9:30 a.m.

## Registration and Get Acquainted

10:00 a.m.

## PROGRAM

Insect Situation. . . . . . . . . . . . . . . . . . . . . . . . . . *Steve Moore*

Maintenance of Application Equipment. . . . . . . . . . . . . . . . . . *Jack Butler*

The Alfalfa Weevil Problem. . . . . . . . . . . . . . . . . . . . . . . *Pete Petty*
(Effingham, Benton, and Collinsville)

The Rootworm Problem
(Jacksonville, Bloomington, Galesburg, Dixon, and Joliet)

New Developments in Weed Control for Corn . . . . . . . . . . . . . . *Ellery Knake*

The Illinois Custom Spray Operators' Licensing Law. . . . . . . . *Juett Hogancamp*

12:00-1:00 p.m.

## LUNCH

Planning for Corn Soil Insect Control . . . . . . . . . . . . . . . . . *Pete Petty*

Fungicides for Agronomic Crops. . . . . . . . . . . . . . . . . . . . . *Mike Britton*

Looking Ahead on Soybean Insects. . . . . . . . . . . . . . . . . . . . *Steve Moore*

Programming Weed Control for Soybeans . . . . . . . . . . . . . . . . . *Ellery Knake*

Examination for Custom Spray Operators License will be given by Mr. Juett Hogancamp of the State Department of Agriculture. You will not need to take the examination if you already have a 1967 license. Your 1967 Custom Spray Operators License may be renewed by mail through the State Department of Agriculture, Division of Plant Industries, Emerson Building, Springfield, Illinois.

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Prepared by the Pesticide Dealers and Applicators Clinic Committee:

*M.P. Britton*
*B.J. Butler*
*E.L. Knake*
*Steve Moore*
*H.B. Petty*

## 1968 SMALL-PACKAGE DEALER CLINICS

Many of you have attended one of our pesticide dealers clinics where information about agricultural pesticides was discussed. In 1968 there will be a similar series of clinics and also a series primarily for the nonagricultural or small-package dealer. Other dealers are welcome to attend. Specialists from plant pathology, horticulture, and entomology will appear on the program. Following are the dates, locations, and program for the clinics:

| *Date* | *Time* | *City* | *Location* |
|---|---|---|---|
| January 29 | 10:00 a.m. | Rockford* | Sabre and Saddle Restaurant<br>4500 East State and North Alpine Road |
| January 30 | 10:00 a.m. | Hinsdale* | Spinning Wheel Restaurant<br>421 East Ogden Avenue |
| January 31 | 6:00 p.m. | Rock Island | Holiday Inn |
| February 1 | 7:00 p.m. | Edwardsville | Agricultural Extension Office<br>900 Hillsboro |
| February 2 | 10:00 a.m. | Rolling Meadows*<br>(North Cook Co.) | Holiday Inn<br>Junction of 62 and 53 |
| March 4 | 6:30 p.m. | Peoria | Hagers Restaurant<br>North 88 |

* There is an advance registration fee of $4.50 for the clinics at Rockford, Hinsdale, and Rolling Meadows. This cost includes coffee at registration and lunch at noon. For more details on these three meetings, contact the extension adviser in the counties or Mr. Stanley Rachesky, 250 LaSalle Hotel, Chicago. The Rock Island meeting will be in cooperation with extension specialists from Iowa State University, and Jack Kenney, Extension Adviser, 1188 Coaltown Road, East Moline, is in charge of advance registration.

## PROGRAM

*THEME:* Turf and Ornamental Pesticide Needs of Your Customer

*Topics*

Specific Ornamental Pest Problems
- Diseases/Weeds/Insects

Management Tips That Will Help Solve Your Customer's Pest Problems
- Understanding Your Customer's Pests on Ornamentals and Turf
- Increasing a Pesticide's Effectiveness
- Nonchemical Control

Your Ornamental Pesticide Inventory--Is It Up to Date?
- Fungicides/Insecticides/Herbicides

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Small-Package Dealer Clinic Committee

*M.P. Britton* · *R.H. DeLano*
*J.D. Butler* · *Stanley Rachesky*
*M.C. Carbonneau* · *Roscoe Randell*

# FORMAL PROGRAM

Illini Union Building, Illini Room

*WEDNESDAY MORNING, JANUARY 24, 1968*

*F.B. Lanham, Presiding*

8:15 Registration Begins

9:00 Colored Slides of Pests and Related Subjects

9:50 Insect Situation. . . . . . . . . . . . . . . . *R. Randell, D. Kuhlman, and S. Moore, III*

Brief Review of Recommendations: Herbicides. . . . . . . . *E.L. Knake*

Changes in Insecticide Suggestions. . . . . . . . . . . . *H.B. Petty*

Your University . . . . . . . . . . . . . . . . . . . . *J.W. Peltason*

Weed Control Systems for Corn . . . . . . . . . . . . . *M.D. McGlamery*

Weed Control Systems for Soybeans . . . . . . . . . . . . . . *L.M. Wax*

Regulation of Pesticide Products in the U.S.. . . . . . . . . *H.G. Alford*

Effectiveness of Several Organic Phosphate Insecticides Applied as Ultra-Low-Volume Aerial Sprays Against Northern Corn Rootworm Beetles on Corn. . . . . . . . . . *D.E. Kuhlman*

1967 Corn Rootworm Research . . . . . . . . . . . . . . . *R.E. Sechriest*

12:25 Lunch

*WEDNESDAY AFTERNOON, JANUARY 24, 1968*

*M.D. Thorne, Presiding*

1:30 Characteristics of Illinois Soils Important to Pesticide Application . . . . . . . . . . . . . . . . . . *J.D. Alexander*

Herbicide Performance as Affected by Soil Characteristics . . . . . . . . . . . . . . . . . . . . . . *F.W. Slife*

Herbicide Residues in Soils . . . . . . . . . . . . . . . . *J.T. Sheets*

Residue Research With the Organophosphorus and Carbamate Insecticide . . . . . . . . . . . . . . . . . . *W.H. Luckmann*

Aldrin-Dieldrin Residue Patterns in Soybeans. . . . . . . . *H.B. Petty*

3:00 Coffee Break

*George Sprugel, Presiding*

3:20 Seed Treatment Fungicides for 1968. . . . . . . . . . . . . *M.P. Britton*

Incorporation Methods for Herbicides. . . . . . . . . . . . .*W.C. Lovely*

Preharvest Weed Control in Soybeans . . . . . . . . . . . . . . *L.M. Wax*

Chemical Weed Control Survey in Illinois, 1967. . . . . . . . . *C. Cross*

Responses of Avians to Methyl Parathion in a Hayfield . . *W.R. Edwards*

Preplant Application of Corn Herbicides . . . . . . . . . *M.D. McGlamery*

4:55 Adjourn

*THURSDAY MORNING, JANUARY 25, 1968*

*W.M. Bever, Presiding*

8:30 Slides of Pests and Related Subjects

9:00 Site of Preemergence Herbicide Uptake . . . . . . . . . . . *E.L. Knake*

A Changing Agriculture and Insect Populations . . . . . . . . *H.B. Petty*

Pesticide Accident Reports. . . . . . . . . . . . . . . . . . . *R. Randell*

Insecticide Residues and Agricultural Exports . . . . . . . . *H.B. Petty*

Water Weed Control. . . . . . . . . . . . . . . . . . . . . *R.C. Hiltibran*

10:15 Coffee Break

*W.O. Scott, Presiding*

10:35 Ultra-Low-Volume (ULV) Herbicide Applications. . . . . . . . .*W.C. Lovely*

ULV Treatments for the True Armyworm. . . . . . . . . . . . . . . *S. Moore*

Interactions of Soil-Applied Herbicides and Other Pesticides. . . . . . . . . . . . . . . . . . . . . . . . . . . .*J.T. Sheets*

How Applicators Can Avoid Honey Bee Problems. . . . . . . . .*E.R. Jaycox*

Alfalfa Weevil Research Results . . . . . . . . . . . . . .*E.J. Armbrust*

Surfactants for Herbicide Sprays. . . . . . . . . . . . . . . . . *F.W. Slife*

Atrazine as a Postemergence Spray . . . . . . . . . . . . . . *E.L. Knake*

12:40 Adjourn

# TABLE OF CONTENTS

Page

# INSECT SITUATION, 1967

*R. Randell, D. Kuhlman, S. Moore, III*

*HIGHLIGHTS*

There were many insect problems on field crops during 1967, but two insects were especially prominent. Alfalfa weevil, which continued to move northward, was found in all but 4 counties in the northwest corner of the state. It was especially damaging to alfalfa fields in the southern third of the state. Corn rootworms damaged many cornfields, especially in the northern half of the state.

True armyworms in wheat, black cutworms, and corn flea beetles in young corn were present in many sections of the state during May and June. Woolly bear caterpillars and rootworm adults caused concern during July and August.

Western corn rootworms moved eastward into 10 new counties during 1967. They are now present in 20 counties in the state. The cereal leaf beetle was again found in several counties, and eradication spray programs were conducted by federal and state regulatory agencies.

Insecticide use on field crops increased again this year by about 12 percent over 1966. The largest increase was for corn-soil insect control, 14 percent over 1966. An estimated 6,730,845 acres of field crops were treated in 1967, with a saving to the farmers of $34,261,152 over and above treatment costs (Table 1). Table 2 shows the breakdown as to method of application. For 1967, airplane application amounted to 5.5 percent of the acreage, commercial ground applicators treated 14.7 percent, and individual farmers treated 79.8 percent.

Again as in the past few years, county Extension advisers answered a questionnaire on the use and methods of application of insecticides in their county. The information summarized in Tables 1 to 5 was obtained from these questionnaires. Each county Extension adviser received an average of 611 inquiries concerning insects, of which 400 pertained to agricultural insects and 211 to home and garden insects.

Extension advisers listed the following insects as those about which they received the most inquiries (in order by importance):

1. Corn rootworm
2. True armyworm
3. Alfalfa weevil
4. European corn borer
5. Black cutworm
6. Flea beetle
7. Corn leaf aphid
8. Subterranean termite
9. Clover leaf weevil
10. Roaches
11. House flies
12. Bagworm
13. Leafhoppers
14. Ants
15. Mosquito
16. Sod webworm
17. Livestock flies
18. Crickets
19. Fall armyworm
20. Boxelder bug

## *CORN INSECTS*

### *Corn Soil Insects*

Corn soil insects accounted for the greatest use of insecticides. Over 90 percent of the total amount of chemicals used was for this purpose. Approximately 55 percent of the corn acreage in the state was treated during 1967, with a saving to the farmers of $31,021,465. Incidence of rootworm resistance to chlorinated hydrocarbon insecticides increased during the year. There was an increase in the use of organic phosphates and carbamate insecticides, and this trend will continue in future years. Chlorinated hydrocarbon insecticides (aldrin and heptachlor) were used on 94 percent of the corn acreage treated. Granules were still the preferred form of soil insecticide, accounting for 65 percent of the total usage.

*Table 1. Acres of Field Crops Treated With Insecticides and Estimated Profit From Treatment, Illinois, 1967*

| Crop and insect | Acres treated | Estimated profit[1/] |
|---|---|---|
| *Corn* | | |
| Armyworms | 26,490 | $ 39,735 |
| Corn flea beetle | 49,191 | 245,955 |
| Corn rootworm adults | 47,115 | 188,460 |
| Corn leaf aphid | 38,771 | 193,855 |
| Cutworms | 97,694 | 586,164 |
| European corn borer | 65,365 | 158,413 |
| Grasshoppers | 6,087 | 6,087 |
| Soil insects | 6,204,293 | 31,021,465 |
| TOTAL. . . . . . . . . . . . . . | 6,535,006 | 32,440,134 |
| *Wheat* | | |
| Armyworms | 89,134 | 356,536 |
| *Clover and alfalfa* | | |
| Alfalfa webworm | 3,771 | 22,826 |
| Alfalfa weevil | 58,287 | 116,574 |
| Clover leaf weevil | 6,845 | 10,268 |
| Grasshoppers | 9,684 | 14,526 |
| Meadow spittlebug | 4,507 | 6,761 |
| Pea aphid | 4,905 | 9,810 |
| Potato leafhopper | 6,797 | 13,594 |
| Variegated cutworm | 604 | 1,208 |
| TOTAL. . . . . . . . . . . . . . | 95,400 | 195,567 |
| *Fence rows, ditch banks, road sides, etc.* | | |
| Grasshoppers | 11,305 | 33,915 |
| 1967 Total. . . . . . . . . . . . . . | 6,730,845 | $34,261,152 |
| 1966 Total. . . . . . . . . . . . . . | 6,011,083 | $29,593,337 |

1/ Over and above treatment costs.

*Table 2. Percent of Total Field Crops Treated by Commercial and Private Applicators in Illinois, 1957-67*

| Year | Percent of total acreage treated: Airplane application | Ground application: Commercial | Ground application: Individual |
|---|---|---|---|
| 1957 | 16.4 | 30.1 | 53.5 |
| 1958 | 3.0 | 19.5 | 77.5 1/ |
| 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 |

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

*Table 3. Number of Acres Treated, by Method, for Certain Insects in Illinois, 1967*

| Insect | Acres treated by: Airplane application | Ground application: Commercial | Ground application: Individual |
|---|---|---|---|
| Clover & alfalfa treatment | 17,815 | 31,453 | 30,597 |
| Corn soil treatment | 202,683 | 894,611 | 5,106,999 |
| European corn borer | 23,176 | 23,185 | 19,004 |
| True armyworm | 90,333 | 11,069 | 14,222 |
| TOTALS | 334,007 | 960,318 | 5,170,822 |

*Table 4. Percent of Acreage Treated With Soil Insecticides Applied in Various Forms, 1957-67*

| Year | In fertilizer | As spray | As granules |
|---|---|---|---|
| 1957 | 71 | 23 | 6 |
| 1958 | 52 | 28 | 20 |
| 1959 | 44 | 26 | 30 |
| 1960 | 29 | 23 | 48 |
| 1961 | 35 | 21 | 44 |
| 1962 | 26 | 22 | 52 |
| 1963 | 22 | 23 | 55 |
| 1964 | 20 | 15 | 65 |
| 1965 | 14 | 15 | 71 |
| 1966 | 14 | 12 | 74 |
| 1967 | 13 | 22 | 65 |

*Table 5. Number of Corn Acres Treated With Different Types of Soil Insecticides, 1963-67*

| Year | Chlorinated hydrocarbons | Organic phosphates and carbamates |
|---|---|---|
| 1963 | 4,049,318 | ... |
| 1964 | 4,009,303 | 81,822 |
| 1965 | 4,544,432 | 189,352 |
| 1966 | 5,116,605 | 326,592 |
| 1967 | 5,601,572 | 602,721 |

The amount incorporated with fertilizer was 13 percent. Some 22 percent was applied as a spray. The amount applied as a spray increased in 1967, probably due to the shortage of the granular form.

*Black Cutworms*

Black cutworms were not as serious in 1967 as in previous years, in spite of early wet weather. Damage that occurred was generally confined to untreated fields and row-treated (aldrin or heptachlor) fields. An estimated 87,114 acres of corn were replanted because of cutworm injury. Postemergence treatments were applied to 97,694 acres.

Black cutworms are usually a problem somewhere each year in the state. Since many moths migrate into our state during the spring, it is impossible to forecast the severity or location of outbreaks in 1968. Low spots, wet spots, and poorly drained areas in a cornfield are the most likely places for cutworm attack.

*Corn Leaf Aphid*

Corn leaf aphid infestations and injury were light in 1967, except for some late-planted fields. Populations were held in check during July and early August by parasites, predators, and heavy rains at a time when aphid populations would normally increase. It is estimated that 38,771 acres were treated. Outbreaks of corn leaf aphids are difficult to predict more than two weeks in advance.

*European Corn Borer*

European corn borer populations declined markedly in 1967 in the western and central sections (major problem area), but increased slightly in the west-southwest and southwest sections (Table 8).

The strong winds and beating rains that occurred in many areas of the state during second-generation moth emergence helped prevent a borer buildup (Tables 6 and 7). In addition, insect predators such as insidious flower bugs and lady beetles consumed egg masses and helped reduce borer numbers. In the area south of the line from Rock Island to Mendota and west of a line from Mendota to Petersburg to Sparta, overwintering borer populations are light, but they could cause economic losses in 1968 (Map 1).

The general incidence of borer parasites and diseases is low and should enhance borer survival over the winter. Also, early planting of corn is favorable to borer survival. Early planted fields in the problem area should be watched closely in the spring of 1968 for borer feeding, and should be treated if needed.

*Northern Corn Rootworms*

Northern corn rootworms were very abundant in many cornfields throughout the northern half of Illinois in 1967. In some fields, severe lodging was caused by extensive larval feeding on the roots. Rootworm beetles feeding on silks during the pollination period also reduced kernel set in many of these fields.

Rootworm damage was primarily in fields of continuous corn, although some fields of first- and second-year corn were damaged. Resistance to chlorinated hydrocarbon insecticides (aldrin and heptachlor) increased in 1967. An estimated 47,115 acres were treated for adult rootworm control.

*Western Corn Rootworms*

Western corn rootworms continued their eastward movement from the Illinois-Iowa border, and were found for the first time this year in Jo Daviess, Stephenson, Winnebago, Carroll, Ogle, Bureau, Stark, Peoria, Fulton, and McDonough counties. This increased to 20 the number of counties where the beetle is present (Map 2). It is suspected that there may be an occasional beetle in at least 15 counties around the fringe of the area known to be infested. Economic damage can be expected in some fields of continuous corn in the area west of a line from Galena to Dixon to Peoria to Carthage. The western corn rootworm is expected to become the primary rootworm problem in at least the northern half of the state within the next few years.

*Southwestern Corn Borer*

The southwestern corn borer continued to spread and increase during 1967 (Map 3). Moderate to severe damage in late-maturing corn is expected in the southern two tiers of counties in 1968. Thus far, little has been done to control this insect.

*Chinch Bug*

Chinch bug populations remained low during 1967, and no control measures were required. The low overwintering populations, thick stands of small grains, and wet weather during egg hatch were detrimental to chinch bug survival. The annual fall chinch bug survey (Map 4) indicates an exceptionally low overwintering population of adult chinch bugs. Problems with chinch bugs are not expected to be serious in the spring of 1968.

*Woolly Bears*

Woolly bears caused great concern during corn silking in many areas of the state. They snipped off silks similar to a scissors cut, but pollination was not affected.

*Corn Flea Beetles*

Corn flea beetles were numerous in many cornfields this spring. An estimated 49,191 acres of corn were treated. These beetles may transmit a bacterial-wilt disease (Stewart's disease) to corn, one that can reduce yields. Evidence of Stewart's disease is more common and the results more drastic in sweet corn than in field corn.

## SMALL GRAINS

### *True Armyworms*

True armyworms, favored by wet, cool springs, were present in many wheat fields throughout the state in May and June. An estimated 115,624 acres were treated for control. Thick stands of barley and wheat were often heavily infested. The worms were about two weeks behind normal in their development, and the grains began ripening before the worms reached maturity. As a result, armyworms migrated to adjacent cornfields in some instances and damaged corn.

### *Cereal Leaf Beetle*

The cereal leaf beetle has continued its spread in Illinois, being found here first in 1965 (Map 5). A few specimens were found this summer for the first time in Iroquois, Edgar, and Woodford counties; also in Will, Kankakee, and Vermilion counties.

In July, an aerial spray program was completed on approximately a mile-radius area at each site where cereal leaf beetle specimens were collected. Technical grade malathion (9.7 pounds per gallon) was applied at the rate of 4 fluid ounces per acre. This work was done by federal and state regulatory personnel under the supervision of T.J. Lanier, Supervisor, Plant Pest Control, Agricultural Research Service, USDA, and W.T. Larkin of the Illinois Department of Agriculture.

The same sites will probably be treated in the spring of 1968. By continued detection and treatment, the hope is that the insect can be prevented from becoming established in Illinois. There will be no crop damage in Illinois due to the beetle in 1968.

### *Hessian Fly*

Hessian fly populations dropped to nearly an all-time low in 1967. Average numbers of puparia per 100 tillers are given for counties surveyed in August (Map 6). The state average for 1967 is 5 puparia per 100 tillers, compared to 14 in 1966 (Table 9). The southeast section has the highest population, averaging 20 puparia per 100 tillers. Wayne County had the highest individual county average in the state, with 36 puparia per 100 tillers.

Even when fly populations are low, it is still advisable to follow control recommendations. We had reports again this year of fly damage to the Monon variety. Apparently, a new race has developed so that Monon is no longer resistant to Hessian fly, or perhaps planting of impure seed accounted for the damage.

## CLOVER AND ALFALFA INSECTS

### *Alfalfa Weevil*

The alfalfa weevil continued its northward movement in Illinois. It has now been found in all except four northwestern counties (Map 7). Alfalfa weevils caused economic damage to most alfalfa fields south of Route 40 in 1967. Some fields north of this line were also damaged and required treatment.

In 1968, we can expect moderate to heavy damage in the area south of a line from Watseka to Hardin and north of a line from Paris to Alton. Damage will be severe south of this line from Paris to Alton. The remainder of the state can expect light to noneconomic infestations. An estimated 47,159 acres were treated one time; 10,899 acres--2 treatments; and 229 acres--3 treatments. Acres saved by spraying were estimated to be 35,069.

*Clover Leaf Weevils*

Clover leaf weevils were abundant in many clover and alfalfa fields this past spring in the southern half of the state. A number of fields were severely damaged by the clover leaf weevil larvae, which closely resemble alfalfa weevil larvae. A fungus disease of the larvae helped reduce damage. An estimated 6,845 acres were sprayed.

*Meadow Spittlebug*

Meadow spittlebug populations declined. Our annual, fall, adult survey (Map 8) indicates that populations will be light to noneconomic in the spring of 1968.

## *SOYBEAN INSECTS*

Insect activity affecting soybeans decreased greatly in 1967, compared to previous years. However, as insects adapt to soybeans and greater acreages are grown, insect damage is expected to increase.

*Table 6. First- and Second-Generation Corn Borer Populations*[1/]

| | July 1962 | Oct. 1962 | July 1963 | Oct. 1963 | July 1964 | Oct. 1964 | July 1965 | Oct. 1965 | July 1966 | Oct. 1966 | July 1967 | Oct. 1967 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Northwest* | | | | | | | | | | | | |
| *Ogle | 17 | 95 | 21 | 121 | 11 | 96 | 0 | 18 | 3 | 58 | 13 | 52 |
| *Whiteside | 2 | 29 | 12 | 178 | 6 | 306 | 1 | 69 | 5 | 167 | 22 | 26 |
| Bureau | 6 | 135 | 24 | 370 | 5 | 179 | 3 | 74 | 9 | 129 | 17 | 113 |
| *Mercer | 37 | 428 | 47 | 287 | 28 | 275 | 9 | 49 | 30 | 109 | 16 | 76 |
| Average | 16 | 172 | 26 | 239 | 12 | 214 | 3 | 53 | 12 | 116 | 17 | 67 |
| *Northeast* | | | | | | | | | | | | |
| *Boone | 6 | 70 | 1 | 88 | 9 | 34 | 3 | 11 | 6 | 66 | 16 | 12 |
| *DeKalb | 8 | 81 | 7 | 160 | 0 | 132 | 0 | 31 | 1 | 21 | 1 | 13 |
| LaSalle | 5 | 66 | 7 | 258 | 7 | 190 | 0 | 46 | 2 | 88 | 4 | 87 |
| Average | 6 | 72 | 5 | 169 | 5 | 119 | 1 | 29 | 3 | 58 | 7 | 37 |
| *East* | | | | | | | | | | | | |
| *Kankakee | 3 | 152 | 5 | 52 | 4 | 79 | 1 | 28 | 0 | 56 | 1 | 41 |
| *Iroquois | 6 | 198 | 6 | 85 | 2 | 191 | 2 | 61 | 0 | 42 | 2 | 21 |
| Livingston | 6 | 81 | 2 | 83 | 10 | 163 | 1 | 32 | 0 | 84 | 13 | 65 |
| *Champaign | 0 | 10 | 0 | 14 | 1 | 9 | 0 | 10 | 0 | 8 | 0 | 7 |
| Average | 4 | 110 | 3 | 59 | 4 | 109 | 1 | 33 | 0 | 48 | 4 | 34 |
| *Central* | | | | | | | | | | | | |
| *McLean | 5 | 88 | 3 | 65 | 3 | 43 | 0 | 45 | 6 | 103 | 4 | 82 |
| Logan | 1 | 23 | 1 | 47 | 1 | 17 | 0 | 10 | 3 | 28 | 1 | 30 |
| Average | 3 | 56 | 2 | 56 | 2 | 30 | 0 | 28 | 5 | 66 | 3 | 56 |
| *West* | | | | | | | | | | | | |
| *Knox | 21 | 190 | 20 | 193 | 8 | 56 | 3 | 45 | 4 | 232 | 14 | 136 |
| *McDonough | 3 | 192 | 29 | 144 | 4 | 123 | 11 | 98 | 2 | 153 | 9 | 93 |
| Average | 12 | 191 | 25 | 169 | 6 | 90 | 7 | 72 | 3 | 193 | 12 | 115 |
| *West-Southwest* | | | | | | | | | | | | |
| Christian | 1 | 24 | 0 | 15 | 1 | 15 | 0 | 23 | 1 | 15 | 2 | 74 |
| Sangamon | 2 | 20 | 0 | 10 | 2 | 12 | 0 | 8 | 0 | 15 | 0 | 16 |
| Macoupin | 4 | 149 | 1 | 24 | 1 | 120 | 2 | 73 | 9 | 84 | 2 | 53 |
| Greene | 2 | 85 | 0 | 18 | 1 | 78 | 4 | 81 | 11 | 167 | 14 | 147 |
| Average | 2 | 70 | 0.3 | 17 | 1 | 57 | 2 | 46 | 5 | 70 | 5 | 73 |
| Overall average | 7 | 111 | 10 | 116 | 5 | 111 | 2 | 43 | 5 | 86 | 8 | 60 |

1/ Asterisks indicate 11-county comparison (see Table 7).

*Table 7. Average First- and Second-Generation Corn Borer Populations (11-County Comparison)*[1/]

| Year | First generation | Second generation |
|---|---|---|
| 1957 | 6 | 63 |
| 1958 | 16 | 103 |
| 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 |

1/ Starred counties, Table 6.

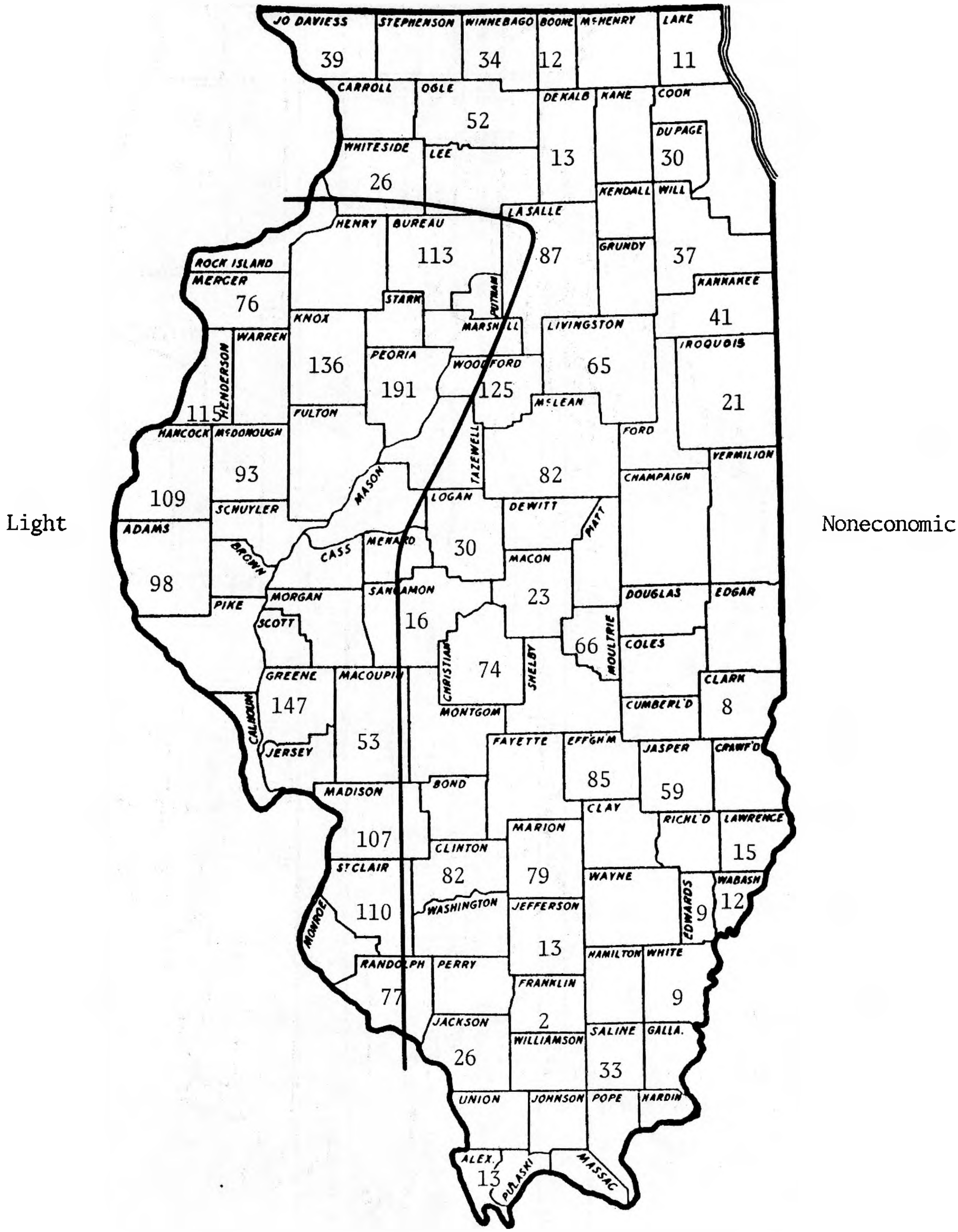
*Table 8. Corn Borer Fall Population Surveys in 36 Counties, 1957-1967 (County Averages Expressed in Borers Per 100 Stalks of Corn)*

| | 1957 | 1958 | 1959 | 1960 | 1961 | 1962 | 1963 | 1964 | 1965 | 1966 | 1967 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Northwest* | | | | | | | | | | | |
| Jo Daviess | 90 | 94 | 114 | 68 | 46 | 98 | 70 | 146 | 17 | 69 | 39 |
| Winnebago | 43 | 57 | 83 | 131 | 51 | 114 | 214 | 93 | 28 | 54 | 34 |
| Ogle | 50 | 124 | 211 | 125 | 49 | 95 | 121 | 96 | 18 | 58 | 52 |
| Whiteside | 65 | 165 | 184 | 76 | 131 | 29 | 178 | 306 | 69 | 167 | 26 |
| Bureau | 77 | 158 | 208 | 36 | 97 | 135 | 370 | 179 | 74 | 129 | 113 |
| Mercer | 171 | 164 | 100 | 132 | 111 | 428 | 287 | 275 | 49 | 109 | 76 |
| Average | 83 | 127 | 150 | 95 | 81 | 150 | 207 | 183 | 43 | 98 | 57 |
| *Northeast* | | | | | | | | | | | |
| Boone | 59 | 36 | 64 | 75 | 47 | 70 | 88 | 34 | 11 | 66 | 12 |
| Lake | 57 | 57 | 39 | 24 | 12 | 13 | 15 | 59 | 10 | 33 | 11 |
| DeKalb | 40 | 99 | 200 | 57 | 126 | 81 | 160 | 132 | 31 | 21 | 13 |
| DuPage | 111 | 55 | 59 | 65 | 34 | 53 | 58 | 45 | 11 | 33 | 30 |
| Will | 39 | 36 | 75 | 92 | 76 | 101 | 119 | 78 | 16 | 38 | 37 |
| LaSalle | 115 | 101 | 120 | 55 | 127 | 66 | 258 | 163 | 46 | 88 | 87 |
| Average | 70 | 64 | 93 | 61 | 70 | 64 | 116 | 90 | 21 | 47 | 32 |
| *East* | | | | | | | | | | | |
| Kankakee | 63 | 48 | 107 | 59 | 133 | 152 | 52 | 79 | 28 | 56 | 41 |
| Iroquois | 44 | 47 | 61 | 122 | 109 | 198 | 85 | 191 | 61 | 42 | 21 |
| Livingston | 21 | 93 | 85 | 129 | 59 | 81 | 83 | 163 | 32 | 84 | 65 |
| Vermilion | 30 | 34 | 11 | 41 | 14 | 42 | 14 | 11 | 17 | 16 | 11 |
| Champaign | 25 | 24 | 3 | 13 | 5 | 10 | 14 | 9 | 10 | 8 | 7 |
| Average | 37 | 49 | 53 | 73 | 64 | 97 | 50 | 91 | 30 | 41 | 29 |
| *Central* | | | | | | | | | | | |
| Peoria | 114 | 81 | 53 | 160 | 121 | 237 | 110 | 106 | 66 | 708 | 191 |
| Woodford | 97 | 168 | 121 | 205 | 122 | 131 | 210 | 154 | 81 | 493 | 125 |
| McLean | 18 | 134 | 118 | 247 | 49 | 88 | 65 | 43 | 45 | 103 | 82 |
| Logan | 34 | 98 | 12 | 54 | 18 | 23 | 47 | 30 | 10 | 28 | 30 |
| Macon | 31 | 31 | 28 | 29 | 12 | 23 | 14 | 17 | 6 | 5 | 23 |
| Average | 59 | 102 | 66 | 139 | 64 | 100 | 89 | 70 | 42 | 267 | 90 |
| *West* | | | | | | | | | | | |
| Henderson | 189 | 146 | 87 | 136 | 117 | 174 | 150 | 223 | 106 | 285 | 115 |
| Knox | 102 | 203 | 108 | 135 | 53 | 190 | 194 | 56 | 45 | 232 | 136 |
| Hancock | 244 | 192 | 64 | 278 | 35 | 142 | 206 | 102 | 89 | 171 | 109 |
| McDonough | 78 | 149 | 65 | 193 | 48 | 192 | 144 | 123 | 98 | 153 | 93 |
| Adams | 159 | 138 | 175 | 207 | 62 | 129 | 118 | 179 | 73 | 502 | 98 |
| Brown-Cass | 87 | 98 | 109 | 91 | 41 | 67 | 88 | 117 | 84 | 148 | 58 |
| Average | 143 | 154 | 101 | 173 | 59 | 149 | 150 | 133 | 83 | 249 | 102 |
| *West-Southwest* | | | | | | | | | | | |
| Sangamon | 83 | 35 | 14 | 90 | 13 | 20 | 10 | 12 | 8 | 15 | 16 |
| Christian | 55 | 73 | 36 | 114 | 21 | 24 | 15 | 15 | 23 | 15 | 74 |
| Madison | 45 | 29 | 33 | 111 | 77 | 150 | 56 | 30 | 126 | 90 | 107 |
| Average | 61 | 46 | 28 | 105 | 37 | 65 | 27 | 19 | 52 | 40 | 66 |
| *Southwest* | | | | | | | | | | | |
| St. Clair | 45 | 9 | 9 | 38 | 13 | 89 | 108 | 46 | 98 | 96 | 110 |
| Average | 45 | 9 | 9 | 38 | 13 | 89 | 108 | 46 | 98 | 96 | 110 |
| *East-Southeast* | | | | | | | | | | | |
| Moultrie | 27 | 53 | 9 | 29 | 6 | 30 | 23 | 4 | 13 | 22 | 66 |
| Clark | 10 | 16 | 27 | 20 | 12 | 20 | 21 | 16 | 151 | 74 | 8 |
| Jasper | 3 | 18 | 16 | 49 | 53 | 102 | 25 | 24 | 40 | 44 | 59 |
| Lawrence | 10 | 31 | 29 | 41 | 8 | 44 | 22 | 28 | 62 | 48 | 15 |
| Average | 13 | 20 | 20 | 35 | 20 | 49 | 23 | 18 | 67 | 47 | 37 |
| AVERAGE, ABOVE 36 COUNTIES. . . | 70 | 86 | 79 | 98 | 59 | 101 | 106 | 95 | 49 | 120 | 61 |
| AVERAGE, ALL COUNTIES SURVEYED. . . . . . . . . . . . | 66 | 73 | 74 | 101 | 56 | 99 | 98 | 100 | 57 | 112 | 57 |

*Table 9. Hessian Fly Populations, by Sections, July 1957-1967*

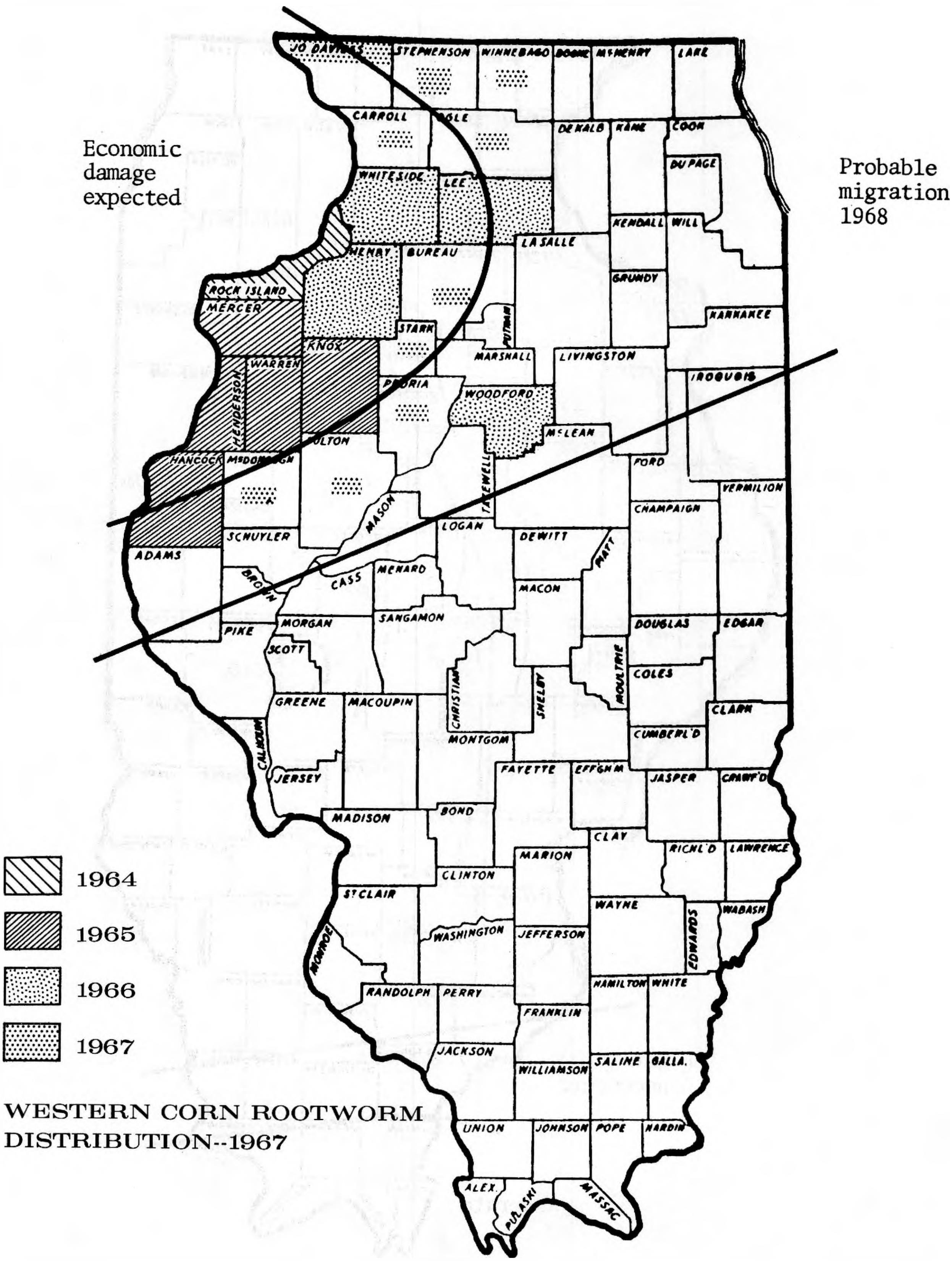
| Section | Flaxseeds per 100 tillers | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1957 | 1958 | 1959 | 1960 | 1961 | 1962 | 1963 | 1964 | 1965 | 1966 | 1967 |
| West | 2.2 | 1.6 | 8.0 | 4.4 | 1.5 | 10.8 | 7.5 | 2.2 | 2.0 | 7.2 | 2.5 |
| Central | 2.0 | 0.8 | 20.8 | 4.7 | 2.0 | 3.3 | 4.0 | 1.6 | 0.0 | 2.1 | 1.0 |
| East | ... | 1.6 | 0.8 | 6.9 | 1.5 | 5.2 | 3.0 | 0.0 | 2.0 | 0.0 | 0.5 |
| West-southwest | 4.9 | 3.4 | 16.4 | 18.0 | 21.2 | 24.1 | 10.5 | 1.9 | 1.1 | 15.9 | 3.7 |
| East-southeast | 7.6 | 6.2 | 10.0 | 10.0 | 3.8 | 12.4 | 2.5 | 4.2 | 0.4 | 25.6 | 4.2 |
| Southwest | 6.7 | 2.9 | 5.4 | 10.7 | 7.7 | 11.9 | 1.2 | 10.1 | 3.7 | 8.8 | 2.8 |
| Southeast | 9.7 | 0.2 | 6.2 | 15.7 | 3.6 | 10.9 | 3.0 | 1.0 | 0.8 | 22.6 | 13.0 |
| State average | 6.3 | 2.9 | 9.2 | 11.4 | 8.0 | 11.2 | 4.8 | 3.4 | 1.5 | 14.4 | 5.3 |

*MAP 1. EUROPEAN CORN BORER PROSPECTS, 1968*

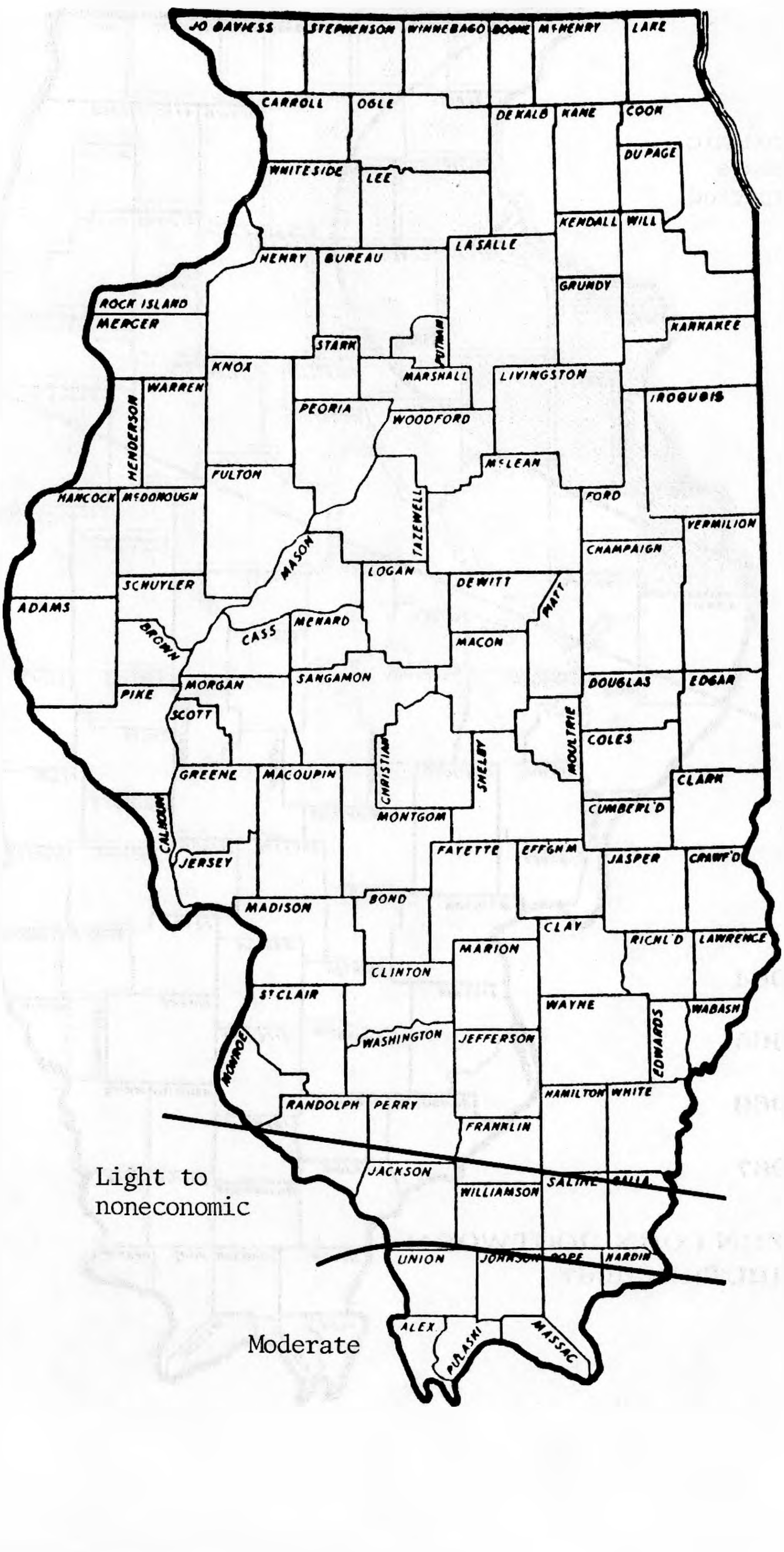



*Average number of borers per 100 stalks of corn*

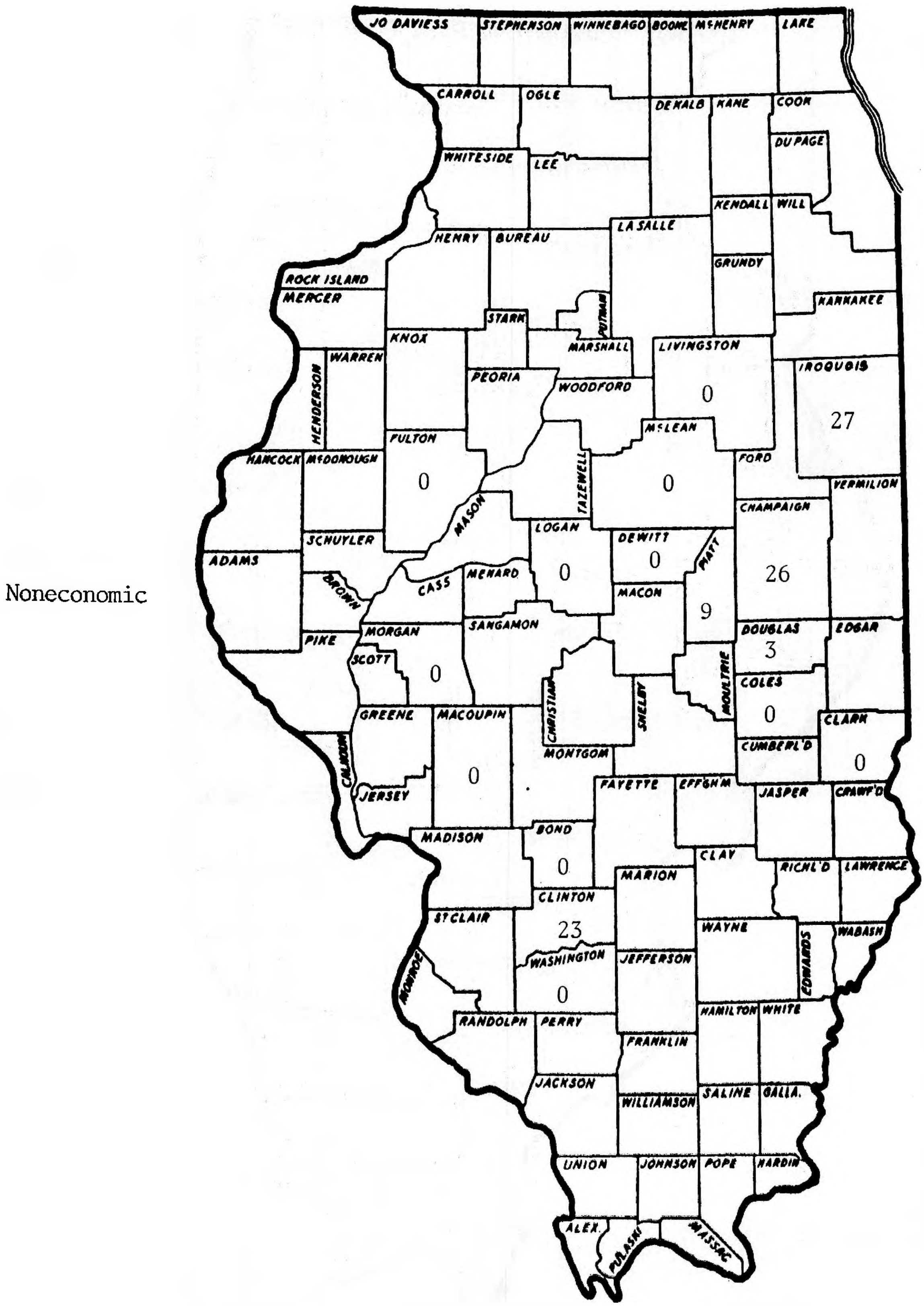
*MAP 2. WESTERN CORN ROOTWORM PROSPECTS, 1968*



*MAP 3. SOUTHWESTERN CORN BORER PROSPECTS, 1968*

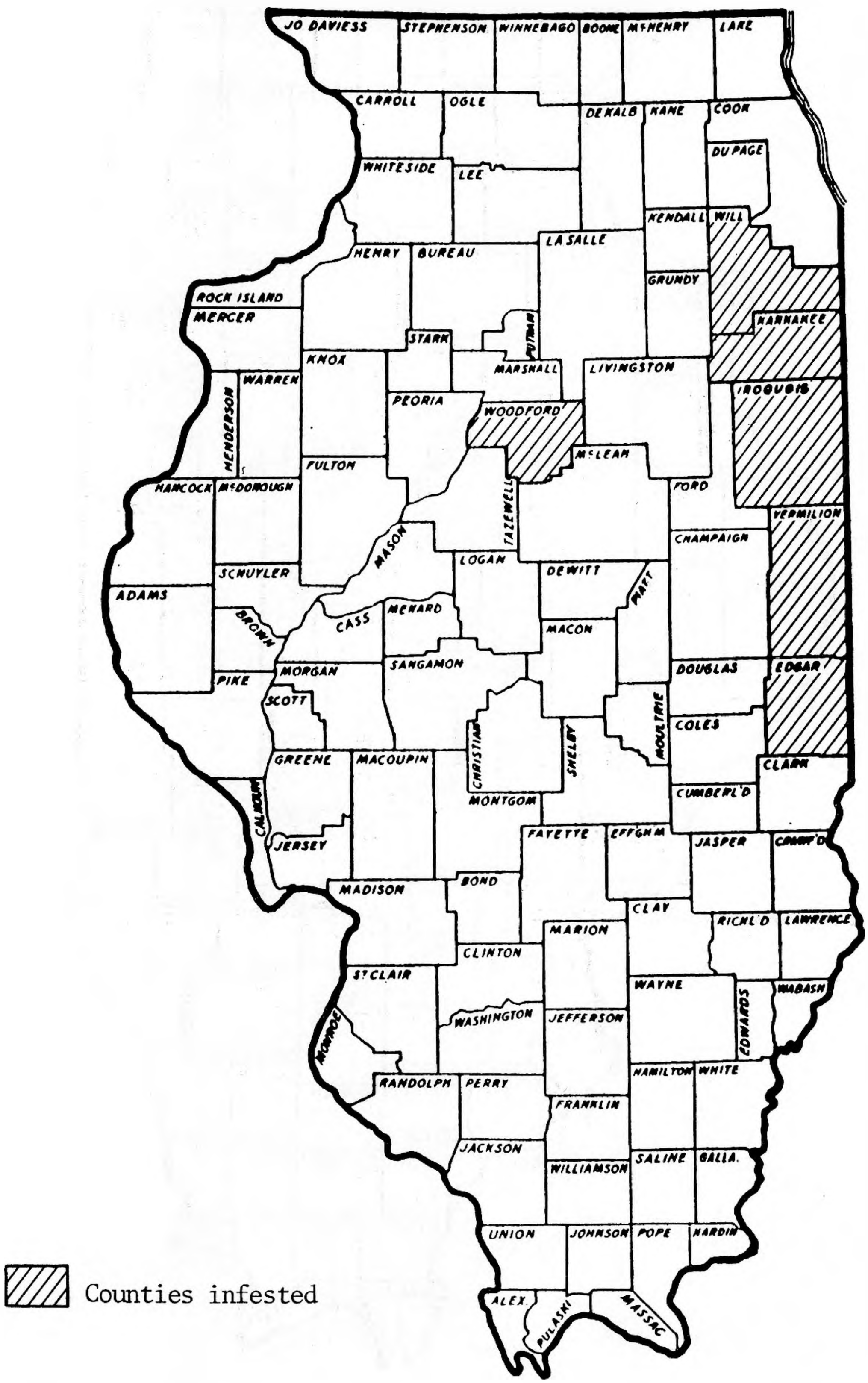


*MAP 4. CHINCH BUG PROSPECTS, 1968*

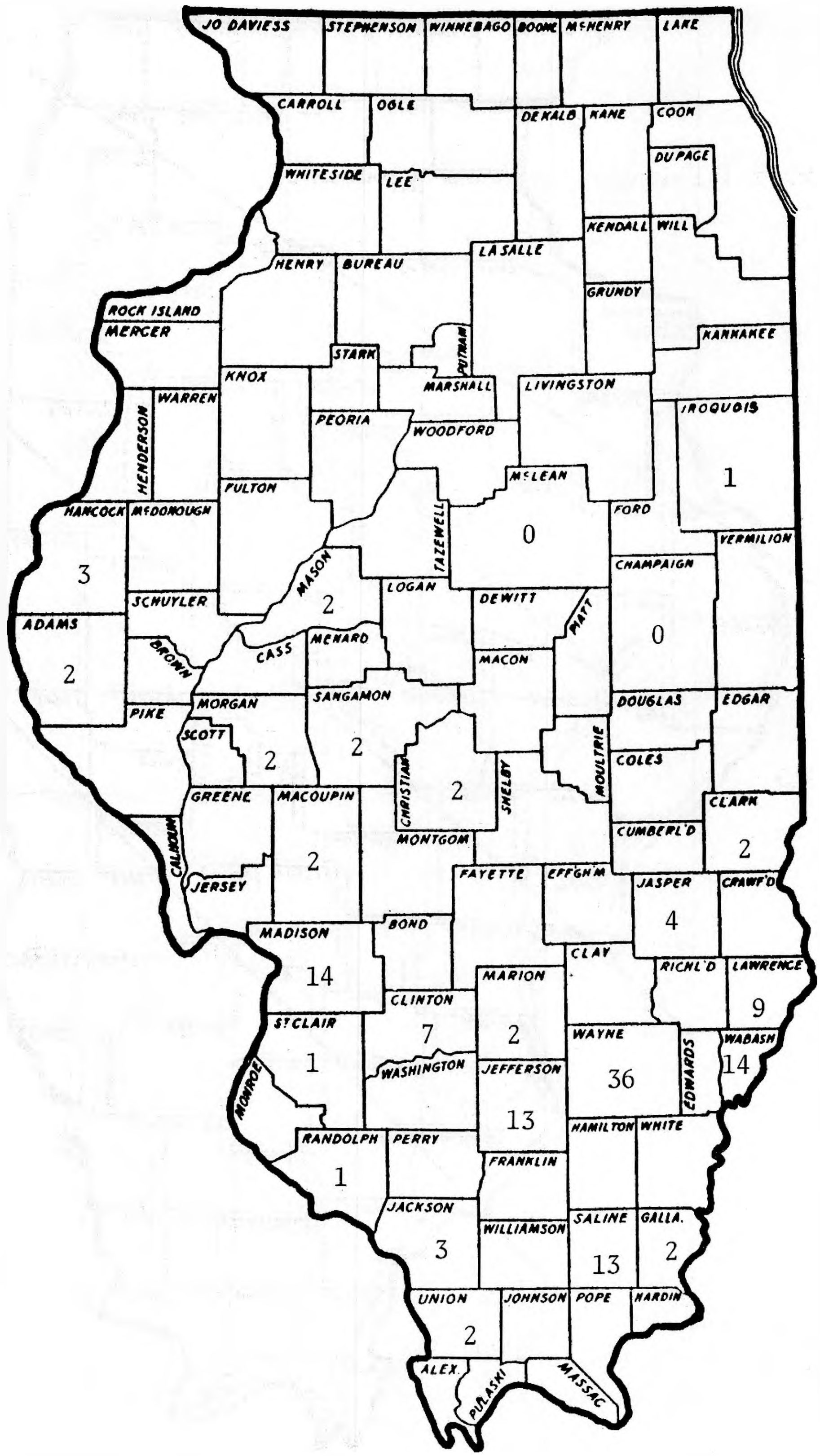



*Average number of hibernating adults per square foot of grass*

*MAP 5. CEREAL LEAF BEETLE SITUATION, 1967*

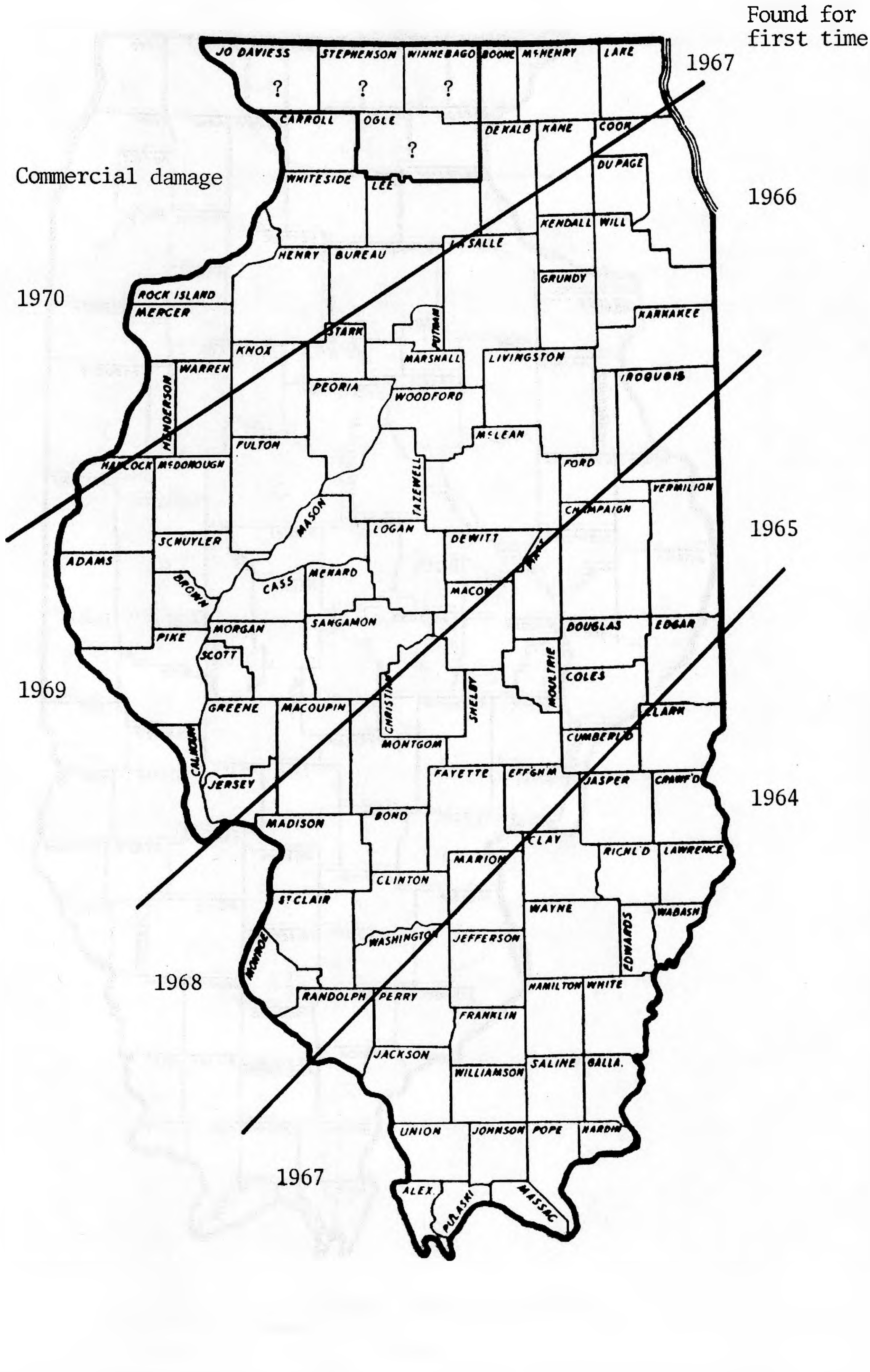


*MAP 6. HESSIAN FLY POPULATIONS, SUMMER, 1967*

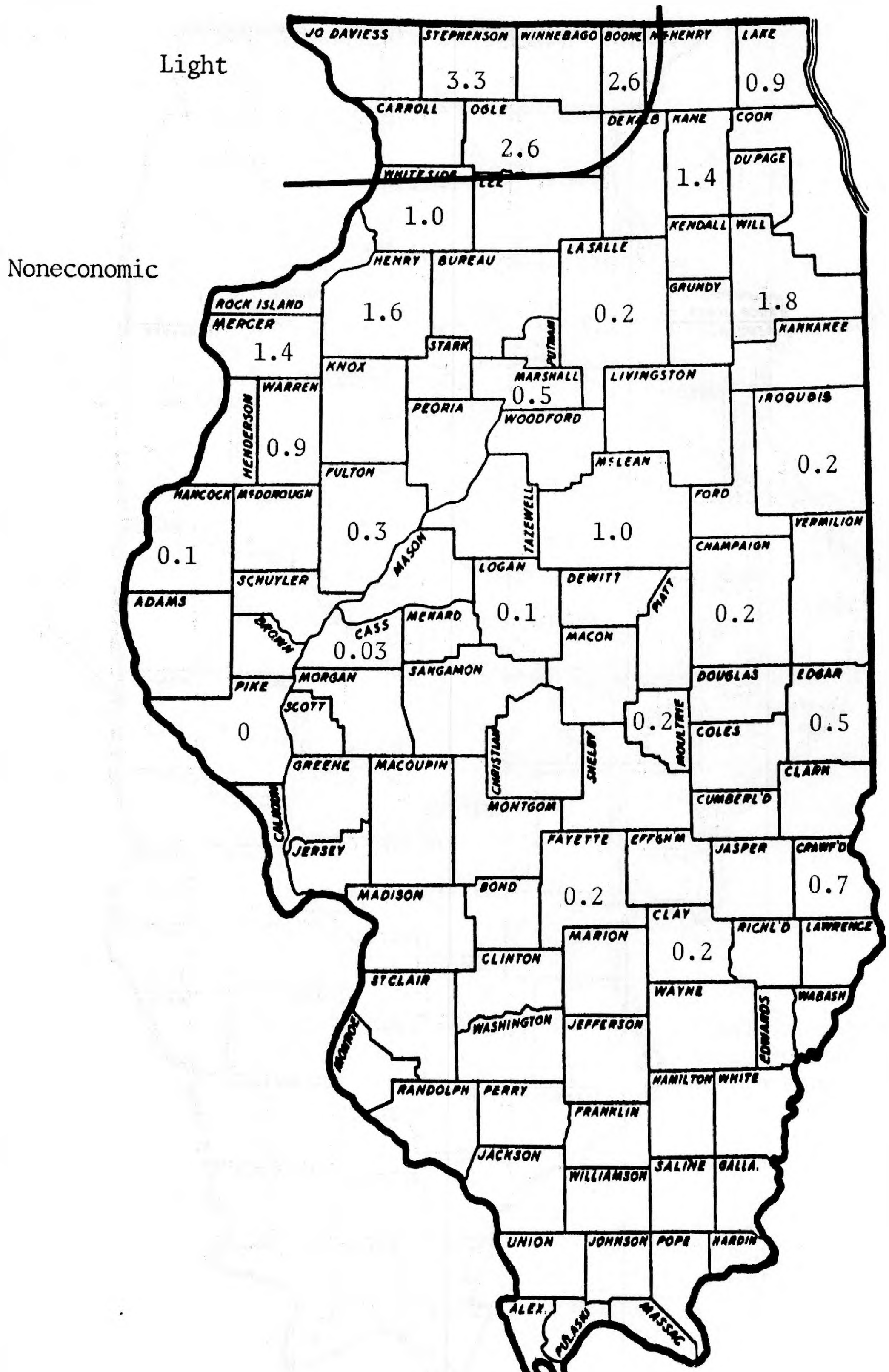



*Average number of puparia per 100 tillers*

*MAP 7. ALFALFA WEEVIL SITUATION, 1968*



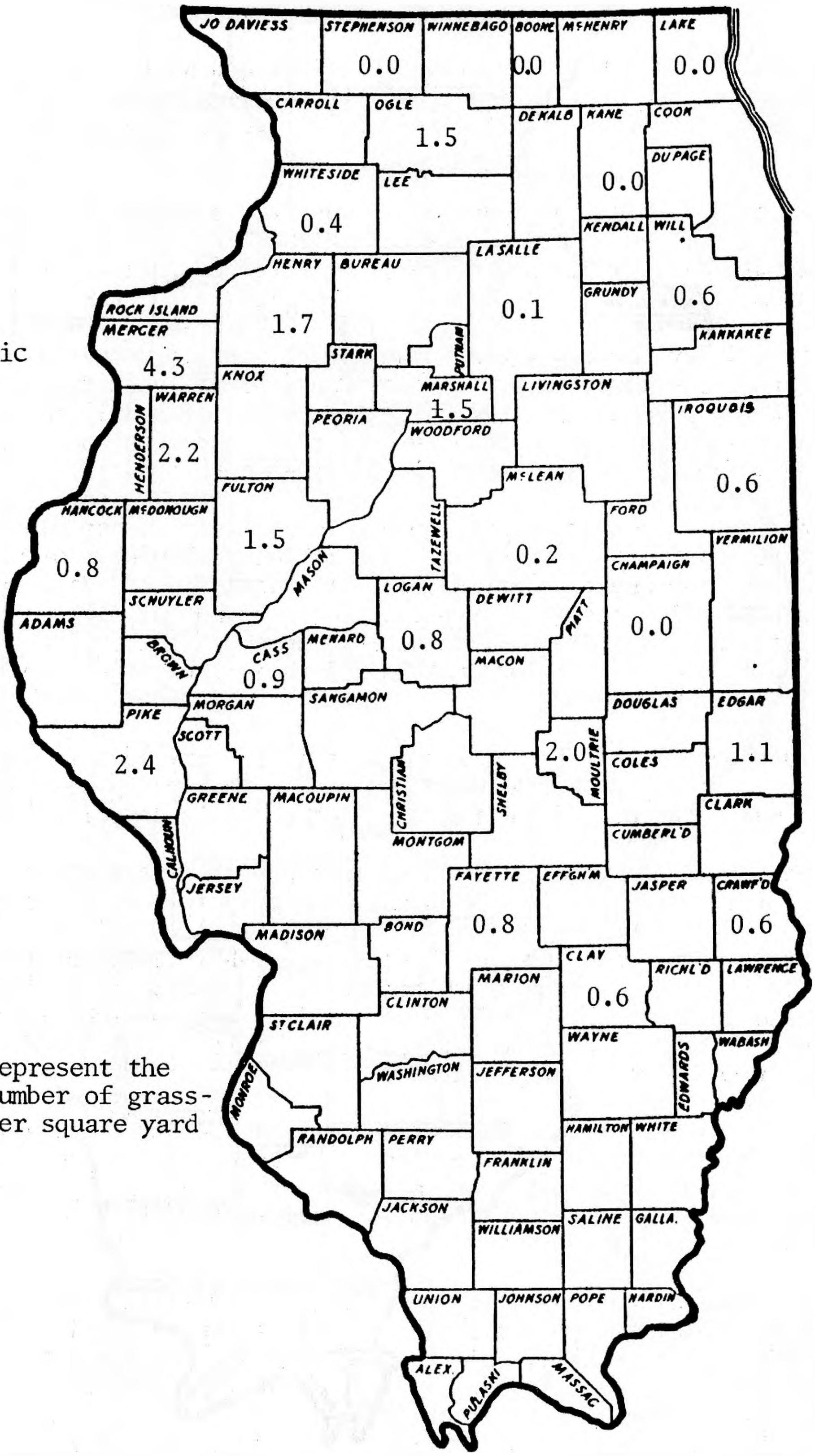
*MAP 8. MEADOW SPITTLEBUG PROSPECTS, 1968*




*Average number of adults per sweep*

*MAP 9. GRASSHOPPER PROSPECTS, 1968*

Noneconomic




Figures represent the average number of grass-hoppers per square yard

## CHANGES IN INSECTICIDE SUGGESTIONS

*H.B. Petty*

Illinois Circulars 897, 898, 899, and 900 (included with this Abstract) list insecticide suggestions for the major insect problems concerning field crops, vegetable crops, livestock, and the household. We wish to emphasize the following major points:

1. Suggestions were based on November 15-approved uses. Changes that may occur during 1968 will be announced periodically by the University of Illinois and the Illinois Natural History Survey, but these circulars will not be reprinted until 1969.

2. We caution dairy farmers against the use of most chlorinated hydrocarbons on their farms to reduce the present residues, or at least to prevent any increase in the present level in dairy products. If a dairyman uses aldrin or heptachlor as a soil insecticide on his corn, under no conditions should he graze any of his cattle on such fields after corn harvest.

3. We emphasize the potential problem of aldrin-dieldrin and heptachlor-heptachlor epoxide residue in soybeans grown in a field, following 5 or more years of soil insecticide use in a cornfield. It is still uncertain, but 3 years may be more desirable than 5. For the present, do not plant beans in 1968 in a field treated with aldrin or heptachlor annually from 1963 through 1967. Do not use aldrin or heptachlor in this field in 1968; then, you can grow beans in 1969.

4. Do not use chlorinated hydrocarbons as soil insecticides for soybeans. If aldrin or heptachlor were applied to corn in the spring and the corn crop was lost (adverse weather, flooding, or other causes), do not replant to soybeans.

5. Toxaphene is the only chlorinated hydrocarbon that we suggest for possible use as a foliar treatment on soybeans, and only then with reservations.

6. All western corn rootworms in Illinois are highly resistant to aldrin and heptachlor. Northern corn rootworm beetles collected from randomly selected fields showed low to high resistance in 55 percent of the fields from which beetles were collected. The seriousness of this situation decreases as one moves east and south in the state.

   We expect a great increase in aldrin-heptachlor rootworm resistance complaints in 1968. In some areas, this may possibly amount to complete control failures. Thus, we suggest a phosphate or carbamate (BUX ten) as a planter treatment or an early June basal treatment, subject to the qualifications in Illinois Circular 899.

7. We do not know of an insecticide available in quantities that will control resistant rootworms when applied by planter to early planted corn. Although other materials have label approval, we suggest that dyfonate, phorate, and BUX ten be used at planting for midseason plantings, and we anticipate only "get-by" protection at that. For late-planted corn, we would add diazinon to this list, and would feel confident that these materials will provide protection. We do not like to list dates because of great variations in weather

from year to year. However, in this instance, early planting is generally considered to be prior to May 5 or 10; midseason between May 10 and May 20 or 25; and late planting, after May 20 or 25. These are approximate dates only.

8. To control rootworms on early planted corn, we suggest a basal application of an insecticide during cultivation, with a special applicator on the cultivator. The three most effective insecticides we have viewed for this purpose are phorate, diazinon, and disulfoton granules.

9. Rootworm adults feed on silks and affect pollination. Control will be profitable when 5 to 10 or more beetles per ear are present and when less than 50 percent of the ears have silked.

10. For alfalfa weevil control, stubble burning may be used. But this will only enable the grower to avoid the first insecticide application in the spring. This method may not be effective in the northern half of Illinois. We suggest malathion and methoxychlor or diazinon and methoxychlor mixtures for alfalfa weevil control, but not methoxychlor alone. We have reduced our terminal feeding measure for treatment from 50 to 25 percent.

## WEED CONTROL SYSTEMS FOR CORN

*M.D. McGlamery*

A systematical approach to the complex field of weed science is essential to determine and prescribe the best method or methods of control. The first step is to identify the weed problem and determine the causes of the problem.

A taxonomical approach to identification would be helpful, but few of us are trained in systematical botany. We use the familiarity approach; that is, we recognize weeds that are common or that we know by close association. These are often known by a local nickname such as watergrass and bluevine. Usually these nicknames convey meaning to one person, but may have a different connotation to the next person. We must become more specific in our identification.

An understanding of the environment in which different weeds are found would be helpful. Some weeds are a problem only in certain geographical areas. Johnsongrass is a problem in the southern part of Illinois, while Canada thistle and quackgrass are problems in the northern part of the state. Giant foxtail is established more in the central part of the state. Wild gourd is a pest in some fields in Pike and Calhoun counties, between the Illinois and Mississippi rivers.

Certain weeds are often identified with given areas in a field. Wirestem muhly is found mainly in fencerows and field edges, while nutgrass is usually associated with wet, poorly drained areas in a field. Wild cane is usually found in river overflow areas.

Weeds also differ in their germination pattern and environmental conditions for best growth. Lambsquarter usually germinates earlier in cooler soils than most of the annual weeds. Thus it would be expected to be more of a problem in cooler soils and earlier plantings. Smartweed and barnyard grass are usually associated with wet years, indicating a close relationship between soil moisture and germination. Many weed species, such as giant foxtail, appear to stop germinating after soil temperatures reach a certain point, so initial control for 4 to 6 weeks is the prime essential. Other weeds, such as panicum and crabgrass, will germinate quite late in the season and can become established even after initial control was obtained.

We must also look at the cultural system of the crop. Early planting of corn will cause more problems with weed control than late planting. Narrow rows can help in shading, but they can also prevent late cultivations. Row widths below 20 inches may prevent cultivation or require a change of tire size. Minimum tillage may prevent the use of preplant incorporated herbicides and may create a seedbed too rough for even distribution of granular herbicides.

The cropping system or rotation will affect the weed-control system. Some herbicides can cause injury to following crops because of soil residue. It is easier to control rhizome Johnsongrass during a wheat-soybean rotation than with continuous corn, while quackgrass is easier to control with continuous corn.

Soybeans and Treflan are a better program for wild cane than corn and Eptam. Large broad-leaved weeds, such as jimsonweed, morningglory, and cocklebur, can be controlled in corn with 2,4-D, but they can be problems in soybeans.

Soil texture and organic matter also must be scrutinized. Atrazine and Lorox work quite well at low rates on soils of low organic matter, while Ramrod and Randox may be comparatively ineffective on these soils. On soils high in organic matter, preemergence Ramrod may be more effective than Atrazine, and Atrazine may function better as an early postemergence. Rates of some herbicides need to be adjusted for soil type.

Climatic conditions affect herbicide performance. Atrazine failure is usually attributable to dry conditions, but it usually performs quite well under moist to wet conditions. Ramrod has provided fair to good control of annual grasses under fairly dry to moist conditions, but poor control has been obtained with it under extremely wet conditions. Randox and Knoxweed can be lost by hydrolysis and volatility when applied to moist soils. Preemergence herbicides that contain 2,4-D alone or in combination, such as Knoxweed, Roundup, and Limit, have performed fairly well under optimum rainfall conditions, but have been failures under extremely wet conditions because of leaching of the 2,4-D.

Once the weed problem has been identified and the conditions under which the problem exists are known, then you can better formulate a system of cultural and chemical practices to control the problem weeds. Cultural methods of weed control were primarily used in the past. These include mechanical weed control with the cultivator and rotary-hoe, as well as date of planting and seedbed preparation. The principles involved in cultural weed control are still valid, but we have often modified the crop culture and interfered with cultural weed control. We do not control the early flushes of weeds by seedbed preparation if we plant the corn early. Narrow rows interfere with the use of the row cultivator. Soybean planting often interferes with the timely use of the rotary-hoe on corn.

Cultural methods of weed control have not outgrown their usefulness, but must be considered in the light of other alternatives. Over 95 percent of our corn and soybean acreage is still cultivated and rotary-hoed, but also over 50 percent of the acreage is treated with a preemergence herbicide. Many farmers are using a combination of both cultural and chemical weed control. Some farmers are using mechanical weed control alone and a few are using just chemical weed control. Timeliness in the use of the rotary-hoe is still essential with herbicides. Too often farmers wait for their herbicide to take effect and the weeds get too large for effective control with the rotary-hoe. Studies have shown that rotary-hoeing does not greatly alter the herbicidal effectiveness, so if your herbicide isn't working and the weeds are starting to emerge, it would probably be wise to rotary-hoe the field.

If we decide that chemical weed control will be a part of our program, then we must examine available equipment and formulations. Many farmers have granular herbicide attachments on their planter, but some herbicides are not available as granules. Atrazine and Lorox are not available as granules. If you decide to use an unformulated combination then granules cannot be used. Randox, Randox-T, and Ramrod are preferred as granules because these herbicides in liquid form are very irritating to the skin and eyes. Wettable powders require hydraulic (jet) or mechanical agitation to maintain a uniform suspension. Bypass agitation is usually sufficient for emulsifiable concentrates and other liquid formulations. Farmers often prefer the convenience of granule attachments on planters, but broadcast application is usually done by spraying.

We must choose a herbicide to fit the weed problem. If the main problem is giant foxtail then we could use one of the grass-specific herbicides such as Ramrod, but if we have a mixture of broad-leaved weeds and grasses then we would either want to use a broad-spectrum herbicide or a combination of chemicals. These mixtures can be applied at one time as formulated combinations or farmer-mix combinations.

We can also have mixtures of herbicides applied with different times and placements. A mixture in time would be the use of a preemergence or preplant herbicide before or at planting, then using a postemergence herbicide later. The 1966 Herbicide Survey of the Crop Reporting Service indicated that some farmers are using both preemergence and postemergence herbicides on corn. Another example of a split application in time is the use of Atrazine on quack-grass where half of the Atrazine is applied in the fall before plowing and half is applied preemergence to the next crop.

Combinations of herbicide in placement could be of two types--placement in breadth, such as broadcasting one chemical and banding another, as well as placement in depth, such as incorporating one chemical and leaving one on the surface. A combination placement in breadth can be illustrated by the seed corn growers who broadcast Atrazine and band Ramrod. A combination of placement in depth would be the use of Sutan incorporated and Lorox surface applied.

The selection of an herbicide in a control system must be based on effectiveness for a given situation considering soil type, climatic conditions, cropping system, prevailing weeds, cultural conditions, available equipment and formulations, and time and placement of application. Thus it is impossible to prescribe a given control system without knowing some of these factors.

If a farmer decided he wanted to use a preplant herbicide then his choice would probably be Atrazine or a combination of Atrazine and Sutan, if Sutan is cleared. Both of these programs have been fairly effective, but the combination has been more effective if there is no cultivation, and if crabgrass and panicum emerge late. The combination also would be better on heavy soils than Atrazine alone.

If a farmer is going to use a granular preemergence herbicide and wants just grass control, Ramrod would be his best choice on the medium to heavy soils. If he wants a broad-spectrum herbicide he will have to choose one of the formulated combinations. If he has a liquid attachment on his planter then his choice is broadened to include Atrazine and some of the unformulated combinations.

If a farmer has a weed problem after corn planting either because of failure of the preplant or preemergence herbicide or failure to use an herbicide, he can either use cultural control or one of the postemergence herbicides. If the problem is only broad-leaved weeds, he can choose either 2,4-D or Banvel-D. The latter is suggested only where there are problems of smartweed and velvetleaf. If grasses are also present the best choice would be the timely use of Atrazine and oil. Other options would be the use of one of the late-directed postemergence herbicides such as Lorox and Dalapon.

# WEED-CONTROL SYSTEMS FOR SOYBEANS

*L.M. Wax*

In recent years, the discovery of several new herbicides has markedly increased the number of chemical treatments available for weed control in soybeans. However, none of these treatments is without limitations. No single treatment provides the necessary control under all conditions. The effectiveness of these herbicides is influenced by a multitude of variables. Some of the more important factors affecting herbicide performance are weed species, soil organic matter and texture, and soil moisture and rainfall. As knowledge concerning the importance of these variables increases, it may be possible to recommend a certain treatment for a particular weed problem. This will require that the farmer-manager correctly identify his problem, in terms of the variables affecting herbicide performance.

Recommendations for control of specific problems should, however, become part of an overall system for weed control in the current crop, or in crops grown in rotation or growing concurrently in adjacent fields. Several methods of weed control are discussed below. Many of the treatments or practices provide good weed control when used alone; however, good cultural practices combined with chemical weed control and timely cultivation usually result in a better long-range system of weed control.

Although herbicide treatments will control many of the weeds found in soybeans, they often do not control certain perennial and broadleaf annual weeds in soybeans. Such problem weeds as quackgrass, Canada thistle, wild sweet potato, trumpetcreeper, climbing milkweed, annual morningglory, cocklebur, and jimsonweed are seldom controlled in soybeans; but they can be controlled selectively in corn. A careful mapping of fields prior to planting, according to weed species and degree of infestation, may be time well spent.

Planting clean seed of high viability in a warm soil helps to insure rapid emergence and an unbroken stand. Such a soybean stand can help to shade out late weeds, if early weed control is attained with mechanical or chemical means.

If properly used, the rotary hoe and sweep cultivator provide a reasonable degree of weed control. The rotary hoe is used on about 3/4 of the Illinois soybean acreage; the sweep cultivator, on almost all of the soybeans.

Flame cultivation has been evaluated in several states in recent years; it is currently used only in certain areas. Under favorable conditions, it may control small annual grass and broadleaf weeds in soybeans.

*Preplanting Herbicides*

Trifluralin (a,a,a-trifluoro-26,-dinitro-N,N-dipropyl-p-toluidine) or nitralin [4-(methylsulfonyl)-2,6-dinitro-N,N-dipropyl-aniline], incorporated in the soil before planting, will control the major, annual grasses in soybeans and some broadleaf weeds, such as pigweed and lambsquarter. On the dark prairie soils, almost twice as much nitralin as trifluralin has been required for comparable grass control. On lighter soils, about 1 1/2 times as much nitralin as trifluralin is needed for equal control. Our most satisfactory results with both of these chemicals have been obtained by incorporating them by two diskings.

Occasionally, both of these chemicals cause soybean injury in the form of root-pruning and delayed emergence. The injury has frequently been associated with root diseases when cold, wet weather occurred shortly after planting.

Vernolate (S-propyl dipropylthiocarbamate), incorporated in the soil before planting, will control most annual grasses and some broadleaf weeds in soybeans. However, it may injure soybeans by delaying their emergence. In our tests, vernolate has been most effective when incorporated into the soil by disking; however, the injection of vernolate in parallel lines beneath the soil surface without incorporation has shown some promise.

*Preemergence Herbicides*

Amiben (-amino-2,5-dichlorobenzoic acid) will control most annual grasses and several broadleaf weeds when rainfall after application is adequate. Occasionally, soybeans are injured; however, except on very light soils, crop tolerance is usually adequate. CDAA (2-chloro-N,N-diallylacetamide), one of the first effective chemicals for the control of giant foxtail, provides fairly short-lived control of most annual grass weeds and some broadleaf weeds on dark prairie soils. Although propachlor (2-chloro-N-isopropylacetanilide) will control most annual grasses and some broadleaf weeds for a somewhat longer time than CDAA, it is cleared only for use on soybeans raised for seed. It has been more effective on dark heavy soils than on the lighter soils. Several other preemergence herbicides, such as linuron [3-(,4-dichlorophenyl)-1-methoxy-1-methylurea], are registered for use in soybeans and provide fair to good control of most annual grasses and some broadleaf weeds under optimum conditions.

*Postemergence Herbicides*

Annual grass weeds can be controlled in soybeans with either of several preplanting or preemergence herbicides; however, certain broadleaf weeds that are troublesome in soybeans are seldom controlled with these treatments. Some broadleaf weeds that escape control by preplanting or preemergence treatments may be controlled by herbicides applied after the weeds emerge.

Chloroxuron [N'-4(4-chlorophenoxy)-phenyl-N,N-dimethylurea] plus surfactant will usually provide fair to good control of jimsonweed, annual morningglory, cocklebur, smartweed, and ragweed--if applied before the weeds are over 2 inches tall. Fair control of velvetleaf with chloroxuron can be obtained if the application is made before the plants are over 1 inch tall. Chloroxuron may injure soybeans initially, causing delayed maturity; however, recovery is usually made with little loss in yield.

A postemergence application of 2,4-DB[4-(2,4-dichlorophenoxy) butyric acid] will control cocklebur in soybeans. Soybeans are often damaged, but usually recover with only minor yield reduction. Generally, any reduction in yield is less than what would likely be sustained if severe infestations of cocklebur were not treated.

## REGULATION OF PESTICIDE PRODUCTS IN THE U.S.

*H.G. Alford*

Few, if any, products are more closely regulated than those intended for use as pesticides. The Federal Insecticide, Fungicide, and Rodenticide Act, which is administered by the U.S. Department of Agriculture, regulates those products that are sold in interstate commerce.

The following is a brief summary of the Federal law and its requirements:

*Title:* Federal Insecticide, Fungicide, and Rodenticide Act, as amended (61 Stat. 163; 7 U.S.C. 135-135k).

*Enforcement Agency:* Pesticides Regulation Division, Agricultural Research Service, U.S. Department of Agriculture, Washington, D.C. 20250.

*Coverage:* Algaecides, Germicides, Fungicides, Herbicides, Insecticides, Nematocides, Plant Defoliants, Plant Desiccants, Plant Regulators, Rodenticides, Amphibians and Reptile Poisons or Repellents, Bird Poisons or Repellents, Fish Poisons or Repellents, Mammal Poisons or Repellents, and Invertebrate Animal Poisons or Repellents which are marketed or shipped in interstate commerce, imported, exported, or sold in the District of Columbia or any of the territories.

*Duration of Registration:* Registration is effective for a period of five years from date of registration, at which time it is cancelled or extended for an additional five years.

*Registration Requirements*

To conform with the Act, a label must show:

Name of product.

Name and address of manufacturer, registrant, or person for whom manufactured.

Net contents.

Ingredient statement: Name and percentage (by weight) of each active ingredient, and total percent of inert ingredients, or name of each active and each inert ingredient in descending order and relative abundance in each category and the total percentage of inert ingredients.

Warning or caution statement: The label of any economic poison must show warnings pertaining to (1) ingestion, (2) skin absorption, (3) inhalation, and (4) flammability or explosion.

The required signal word such as "DANGER," "WARNING," or "CAUTION," and the statement "Keep Out of Reach of Children" must appear on the front panel and meet the minimum type size requirements. The front panel of the label of economic poisons which are highly toxic to man must show: (1) "POISON" in red on a contrasting background, (2) "DANGER," (3) skull and crossbones, and (4) statement of antidote, including directions to call a physician immediately (in immediate vicinity of skull and crossbones and "POISON").

The registration number assigned to the product.

Directions for use which are adequate to protect the public (optional on label, may appear on accompanying printed or graphic matter).

Other required information:

Data to support any or all claims on the labeling.

A complete statement of the composition of the product including the percentage by weight of each of the active and inert ingredients, if such information does not appear on the label.

Any pertinent information about inert ingredients.

Any other information pertaining to physical or biological properties of the product, etc.

*Enforcement*

The Act prohibits the shipment in interstate commerce of products which are not registered or are adulterated or misbranded. Surveillance of products is maintained through the obtaining of samples of products that are marketed throughout the United States for purposes of label review and the analyzing and testing of such products for chemical composition and effectiveness. Products which are in violation of the Act may be seized and criminal action may be instituted against the shipper of such products.

*Registration Procedure*

To obtain registration, a manufacturer must submit copies of his labeling and adequate research data to support all the claims made for the product. The labeling and supporting data are carefully reviewed by specialists to determine the following:

1. Will the product be effective against the pests named on the labeling and can it be used effectively without causing damage to the crops or objects to which it is applied?

2. Does the label bear warning and caution statements which are adequate when complied with to prevent injury to the user or other persons or beneficial animals which are exposed?

3. Will the directed use of the product leave residues on harvested food or feed? If the product is proposed for use in a manner which is likely to result in residues on food or feed, it is not accepted until a tolerance or exemption has been granted by the Food and Drug Administration.

If all the specialists involved are convinced that the product can be used effectively and safely without leaving illegal residues on food or feed when all label warnings and directions are carefully followed, it is acceptable for registration.

# EFFECTIVENESS OF SEVERAL ORGANIC PHOSPHATE INSECTICIDES APPLIED AS ULTRA-LOW-VOLUME AERIAL SPRAYS AGAINST NORTHERN CORN ROOTWORM BEETLES ON CORN

*D.E. Kuhlman and S. Moore, III*

*Purposes*

1. To determine the effectiveness of diazinon, malathion, SD 8447 (Gardona), and trichlorfon (Dylox) applied as ultra-low-volume aerial sprays against northern corn rootworm beetles in corn.

2. To determine the yield effect caused by northern corn rootworm beetles feeding on silks prior to and during pollination.

*Materials and Methods*

The test work was conducted in two 40-acre cornfields on the Dean Otterbach farm in Bureau County. These particular fields were brought to our attention by Mr. Halsey Miles, Bureau County Extension Adviser, who had been contacted by Mr. Otterbach regarding the rootworm problem.

The fields were adjacent: the west field in 4th-year corn, the east field in 3rd-year corn. Insecticide usage consisted of a broadcast application of 1.4 pounds of actual aldrin, incorporated ahead of each corn crop.

Diazinon (7.8 pounds per gallon), malathion (9.7 pounds per gallon), SD 8447 (4 pounds per gallon), and trichlorfon (4 pounds per gallon) supplied by the basic manufacturers were the insecticides used. The undiluted insecticide concentrates were applied at the following rates:

| Insecticide | Fluid oz./A. | Lb. actual/A. |
|---|---|---|
| Diazinon | 7.2 | 0.44 |
| Malathion | 5.0 | 0.38 |
| SD 8447 | 16.4 | 0.51 |
| Trichlorfon | 11.8 | 0.37 |

The insecticides were applied from a Stearman airplane piloted by Mr. Lillard Hedden of Pekin, using a gravity flow ultra-low-volume applicator manufactured by the Independent Crop Dusting Company of Carmel, California. The applications were made between 6:15 a.m. and 10:30 a.m. on July 30--under calm conditions (0 m.p.h. wind) for the malathion and diazinon treatments, and with a 3-4 m.p.h. northwest wind for the SD 8447 and trichlorfon treatments.

The ultra-low-volume applications were made in 50-foot swaths, 5 feet above the corn, at a flying speed of approximately 100 m.p.h.

Plot sizes were as follows:

| 4th-year corn | 3rd-year corn |
|---|---|
| South check, 60 rows | East check, 70 rows |
| Malathion, 125 rows | Trichlorfon, 230 rows |
| Diazinon, 132 rows | |
| SD 8447, 64 rows | |

Pretreatment beetle counts were made on 100 plants randomly selected in each field on July 29. The 4th-year corn averaged 6.5 northern corn rootworm beetles per plant, and the 3rd-year corn averaged 7.3 beetles per plant. Beetles found in the silks, plus those on the remainder of the plant comprise the total number of beetles per plant.

Posttreatment beetle counts were made in each plot on 50 randomly selected plants at 24 hours, 48 hours, 72 hours, 5 days, and 8 days after treatment.

*Results and Discussion*

Malathion, diazinon, and SD 8447 gave satisfactory results in controlling rootworm beetles for 72 hours after the initial application (Table 1). However, beetle counts increased rapidly after 72 hours in the treated plots. SD 8447 was slightly more effective than either malathion or diazinon at 5 and 8 days after treatment. The migration of adults from untreated strips and nearby fields into treated plots tended to shorten the period of effective protection.

Even though the insecticides were applied under calm conditions, slight air movement caused the spray to drift into the south check plot. Posttreatment beetle counts in the south check were reduced somewhat as a result of this drift, and they did not exceed pretreatment counts until 4 days following treatments.

Evening temperatures for the period of July 31 to August 7 ranged from 60° to 65° F. Daytime temperatures ranged from 84° to 88° F. for the same period. Rainfall amounted to 1.0 inch for the period, with 0.3 inch falling within 24 hours after the initial treatment. The precipitation probably hastened the deterioration of all four insecticides.

Soil samples taken on the day of treatment (July 30) showed an average of 26 rootworms per plant yet to emerge (including larvae, pupae, and unemerged adults); while at 5 days after treatment, 17 rootworms per plant were still left to emerge. Thus, 5 days following treatment, beetles were still being controlled to some extent in the treated plots.

Trichlorfon was applied to a 23-acre plot in a 3rd-year cornfield bordered on the east and west sides by 7-acre untreated checks. A northwest wind of 4 m.p.h. caused drift onto the check plots, reducing beetle counts substantially. Trichlorfon was not as effective for beetle control, compared to malathion, diazinon, and SD 8447.

*Pollination Damage by Rootworm Beetle Feeding*

To determine the effect of northern corn rootworm beetles feeding on silks prior to and during pollination, yield comparisons of treated versus untreated plots were made for three different corn varieties (Table 2). The plots were the same as those used for the evaluation of the ultra-low-volume insecticides. At the time the insecticides were applied, silking percentages for the three varieties were 65, 53, and 24 percent, respectively. The number of rootworm beetles averaged 6.5 to 7.3 per plant.

The results of this study indicate that pollination is reduced by beetles feeding on silks when approximately 50 percent of the plants, or less, have silked. This corresponds to data presented at the 1966 CUSTOM SPRAY OPERATORS' TRAINING SCHOOL by Porter Martin, et al., who reported that control of rootworm beetles was profitable when 5 or more were present per ear and the field was at least 25 percent (but not more than 75 percent) silked.

The critical period for pollination damage from adults feeding on the silks is during the time the silks are beginning to emerge. If silk emergence is slow, a small number of beetles will affect pollination. On the other hand, pollination injury is less likely to occur when silk emergence is rapid, even though beetle counts may be high.

Silking in Variety 3 was slow. Although the number of beetles per plant in the untreated plot exceeded the treated plot by only 1.5 beetles, this number was sufficient to inflict damage (a yield reduction of 10 percent). Had beetle control been perfect, the yield difference would have been greater.

In our test, controlling adult rootworms was not beneficial when 65 percent, or more, of the plants had silked. However, when comparable beetle populations were controlled at the 53- and 24-percent silk stage, yield savings of 12 and 10 percent resulted.

In our observations, beetles preferred silks that were beginning to turn brown over fresh, newly emerging silks. However, in the absence of fully-developed silks, beetles concentrated in fresh, new silks for their food supply. Consequently, when silks are just beginning to appear and beetles are abundant, conditions are suitable for pollination damage. A field in which 75 percent of the plants are silked will contain many silks that are brown or beginning to turn brown. These sites are more attractive to rootworm adults, reducing the number found in newly emerging fresh silks where pollination is just beginning.

From this data we believe control would be profitable when 5 or more beetles are present per ear and less than 50 percent of the plants have silked.

*Table 1. Comparative Effectiveness of Several Organic Phosphate Insecticides Applied as Ultra-Low-Volume Aerial Sprays Against Northern Corn Rootworm Adults in Corn in Bureau County, 1967*

| | Number of northern corn rootworm adults per plant | | | | | |
|---|---|---|---|---|---|---|
| | Pre- | Posttreatment | | | | |
| Insecticide | treatment | 24 hr. | 48 hr. | 72 hr. | 5 days | 8 days |
| 4th-Year Corn | | | | | | |
| Check | 6.5 | 4.0 | 4.4 | 5.5 | 10.4 | 11.9 |
| Malathion | | 0.14 | 0.7 | 0.8 | 4.3 | 7.6 |
| Diazinon | | 0.18 | 0.4 | 0.9 | 2.9 | 7.8 |
| SD 8447 | | 0.1 | 0.3 | 0.4 | 1.8 | 5.1 |
| 3rd-Year Corn | | | | | | |
| East check | 7.3 | 1.5 | 2.6 | 3.0 | 8.0 | 10.3 |
| Trichlorfon | | 0.6 | 1.1 | 2.2 | 5.4 | 10.5 |

*Table 2. Pollination Damage by Northern Corn Rootworm Beetles as Related to Plant Development*

| Variety | Development at treatment (percent silked) | Percent silked 3 days after treatment | Yield per acre Untr. | Yield per acre Tr. | Average number beetles per plant Untr. | Average number beetles per plant Tr. | Diff. |
|---|---|---|---|---|---|---|---|
| 1 | 65 | 84 | 145.0 | 148.0 | 4.6[1/] | 0.5[1/] | 4.1 |
| 2 | 53 | 79 | 129.7 | 148.9 | 4.6[1/] | 0.5[1/] | 4.1 |
| 3 | 24 | 44 | 111.3 | 124.0 | 3.8[2/] | 2.3[2/] | 1.5 |

1/ Average for 3 days after treatment.
2/ Average for 5 days after treatment.

## 1967 CORN ROOTWORM RESEARCH

*R.E. Sechriest*[1/]

Corn rootworms became a limiting factor to successful corn production in many Illinois cornfields this year. During 1968, the problem is expected to dramatically increase in all of the northern half of Illinois. Control of this insect will be necessary if a steady increase in production is to be maintained.

Experiments on corn rootworm larvae have been continued this year, in order to further check on recommended insecticides and evaluate promising new ones. Experiments were evaluated on northern corn rootworms at El Paso and on western corn rootworms at Aledo. The populations of westerns were about double those of the northerns as was the rainfall; thus, the data from Aledo indicate the results under heavy population pressure and adverse environmental conditions.

Experiment 1 at El Paso contained the 1967-recommended insecticides applied at planting time on May 18, 1967. Table 1 shows the significant results obtained for number of larvae per 4 hills, root damage rating, and lodging. No significant differences were observed in original stand count or yield. Adequate rainfall allowed the badly lodged plants to survive, since the brace roots were able to find moisture. Thimet, BUX ten, and diazinon had significantly fewer larvae, which is reflected in the root damage rating. A rating of 4 would be no feeding, and a rating of 1 would be no roots left on the plant. A rating of 3 would be on the borderline between economic and noneconomic damage. BUX ten, phorate (Thimet), and diazinon performed best in this experiment.

Experiments 2 and 3 show the data obtained by using promising new insecticides (Tables 2 and 3). Phorate (Thimet) and diazinon were included as standards for comparison. Carbaryl (Sevin) gave no control in the Aledo experiment. Mobam and phorate (Thimet) as planting time treatments were a little weak in the root damage rating, but the lodging and yield data were not different statistically from the other good treatments. The variations are greater in Experiment 3 than in Experiment 2 because of differences in the insects and environmental conditions. Most emphasis, then, must be placed on Experiment 3.

The effectiveness of the insecticides can be greatly increased by a basal application the first of June. In Table 3, the root rating was significantly increased by the June 14 treatment, and 11 percent less lodging resulted. Table 4 shows the results of Experiment 4, where diazinon and phorate (Thimet) were applied postemergence. In each case, one of the row treatments was hoed-in immediately; the other was left on the surface for 4 days, at which time the field was completely cultivated. The broadcast diazinon was also cultivated-in after the 4 days. When possible, immediate incorporation (cultivation) was best, but significant benefit resulted where there was no immediate incorporation. If another wet year occurs, good results can be expected even with broadcast granular treatment, followed by cultivation as soon as possible.

Experiment 5 tested the effectiveness of time and method of application in relation to fertilizer (Table 5). The insecticide was applied on fertilizer, and it was applied by the side-boot method at planting time. When insecticide was applied by that method, no significant corn rootworm control was realized. The material must be applied on both sides of the row (2 inches) for effective results. Root-damage ratings in the broadcast liquid disulfoton (Di-Syston) plot were significantly better than those in the untreated plot. With narrower corn rows, this may be the application method of the future. In both root-damage rating and lodging, diazinon applied as a band of granules produced significantly better results than those in the untreated plot. The high percent of lodging was due to severe wind; but even then, significant differences were present.

*Conclusions*

Dyfonate, phorate (Thimet), BUX ten, and diazinon granules are recommended at planting for rootworm control, subject to the qualifications in Illinois Circular 899. Also, Mobam, Dasanit, and Landrin may be suggested, pending federal label approval.

Carbaryl (Sevin), parathion (Niran), and disulfoton (Di-Syston) applied at planting gave varied control; at this time, they cannot be suggested for the best control of corn rootworm larvae under adverse environmental conditions or medium-to-heavy insect populations.

The application of insecticide with fertilizer has not given control of corn rootworms, when applied by the side-boot (one-side of the row) method.

Insecticide effectiveness for rootworm control may be improved by application during cultivation the first of June. Phorate, diazinon, and disulfoton (Di-Syston) are recommended for this postemergence basal application.

*Table 1. Results of Five Insecticides Tested on Northern Corn Rootworms at El Paso, Illinois*[1/]

| Insecticide | Form. | Lb./A. | Larvae per 4 hills | Root rating | Percent lodging |
|---|---|---|---|---|---|
| BUX ten | 10G | 1 | 24a[2/] | 3.97a | 46a |
| Thimet | 15G | 1 | 39a | 3.90a | 52a |
| Diazinon | 14G | 1 | 21a | 3.80a | 81x |
| Di-Syston | 10G | 1 | 48 | 3.70a | 75x |
| Niran | 10G | 1 | 45 | 3.58 | 73x |
| Untreated | ... | ... | 91x | 2.70x | 80x |

1/ Planted May 18, 1967.
2/ Figures followed by "a" are not significantly different from the best treatment; those by "x," from the untreated at the 5-percent level.

*Table 2. Data Obtained From Northern Corn Rootworms in a Field Experiment, Using New Promising Insecticides at El Paso, Illinois*[1/]

| Insecticide | Form. | Lb./A. (banded) | Root rating | Percent lodging |
|---|---|---|---|---|
| Dyfonate | 10G | 1 | 4.0a[2/] | 60a |
| Furadan | 10G | 3/4 | 4.0a | 48a |
| Mobam | 10G | 1 | 3.5x | 70ax |
| Mocap | 10G | 1 | 3.9a | 65ax |
| Dasanit | 10G | 3/4 | 3.87a | 60a |
| Landrin | 10G | 3/4 | 4.0a | 55a |
| Sevin | 20G | 2 | 4.0a | 59a |
| Diazinon | 14G | 1 | 3.93a | 68ax |
| Thimet | 15G | 1 | 3.93a | 64ax |
| Untreated | ... | ... | 3.27x | 87x |

1/ Planted May 17, 1967.
2/ Figures followed by "a" are not significantly different from best treatment; those by "x," from untreated at the 5-percent level.

*Table 3. Data from Western Corn Rootworm Field Where Promising New Insecticides Were Used at Planting Time at Aledo, Illinois*[1/]

| Insecticide | Form. | Lb./A. (banded) | Root rating | Percent lodging | Bu./A. |
|---|---|---|---|---|---|
| Furadan | 10G | 3/4 | 3.87a[3/] | 2a | 87a |
| Mocap | 10G | 1 | 3.27a | 3a | 80a |
| Mobam | 10G | 1 | 2.8x | 9a | 83a |
| Dasanit | 10G | 3/4 | 3.33a | 3a | 80a |
| Landrin | 10G | 3/4 | 3.4a | 6a | 76a |
| Sevin | 20G | 2 | 2.3x | 66x | 49x |
| Thimet | 15G | 1 | 2.73x | 13a | 79a |
| Thimet (basal)[2/] | 15G | 1 | 3.87a | 2a | 78a |
| Diazinon | 14G | 1 | 3.27a | 6a | 86a |
| Untreated | ... | ... | 2.1x | 58x | 51x |

1/ Planted May 19, 1967.
2/ One treatment was applied June 14, 1967; all others were applied at planting time on May 19, 1967.
3/ Figures followed by "a" are not significantly different from the best treatment; those by "x," from untreated at the 5-percent level.

*Table 4. Basal Cultivator Treatment for Western Corn Rootworm Control at Aledo, Illinois*[1/]

| Insecticide | Form. | Lb./A. | Incorporated | Root rating | Percent lodging | Bu./A. |
|---|---|---|---|---|---|---|
| Thimet | 15G | 1 row | yes | 3.2a[2/] | ... | 93a |
| | | 1 row | no | 3.0a | 8a | 69 |
| Diazinon | 14G | 1 row | yes | 2.6a | ... | 98a |
| | | 1 row | no | 2.8a | 13a | 82a |
| | | 2 broadcast | no | 3.0a | 4a | 77a |
| Untreated | ... | ... | ... | 1.4x | 88x | 39x |

1/ Planted May 17, 1967, treated June 14, 1967, field cultivated June 18, 1967.
2/ Figures followed by "a" are not significantly different from best treatment; those by "x," from untreated at the 5-percent level.

*Table 5. Data from El Paso, Where Insecticides Were Applied by Different Methods Including Fertilizer Impregnated with the Insecticide*

| Application method | | Evaluation method | |
|---|---|---|---|
| Broadcast (preplant) | Planter[1/] | Root rating | Percent lodging |
| Poly-N, atrazine, uran | 75 lb. dry starter, with 1 percent dasanit/A. | 3.0x[2/] | 82.2x |
| Poly-N, atrazine, uran | 1 lb. Di-Syston 4E in liquid starter/A. | 3.18x | 91.0x |
| Poly-N, atrazine, uran | 75 lb. dry starter with 1 percent Di-Syston/A. | 3.05x | 93.0x |
| Poly-N, atrazine, uran 4 lb. 4E di-syston/A. | Liquid starter | 3.55 | 96.0x |
| Poly-N, atrazine, uran | Liquid starter 1 lb./A. diazinon 14G banded | 3.75 | 64.5 |
| Poly-N, atrazine, uran | Liquid starter | 2.95x | 90.0x |

1/ Fertilizer applied only on one side of the row (side-boot), planted May 17, 1967.
2/ Figures followed by "x" are not significantly different from untreated at the 5-percent level.

# CHARACTERISTICS OF ILLINOIS SOILS IMPORTANT TO PESTICIDE APPLICATION

*J.D. Alexander*

The *organic matter* and *clay* content of the plow layer are important soil characteristics relative to pesticide application because of the exchange capacity that they possess. In general, higher exchange capacities require higher rates of pesticide for effective control.

*Organic matter* in soils is characterized by *dark color, very high cation-exchange capacity* (600-700 m.e. per 100 grams), and *very fine particle size.* The content of organic matter in surface soil can be estimated by the use of color charts, such as the Munsell color charts used in soil classification work. Initial statistical analyses indicate a high correlation between the percent of organic matter and color. Work is in progress on the assignment of the percent of organic matter to particular colors.

*Clay* in soils is defined as that mineral material less than .002 mm. or 2 microns in size, composed primarily of clay minerals--negatively charged alumino-silicates--having varying degrees of cation exchange capacity depending on the type of clay mineral. The more clay-sized material in a soil, the higher the cation-exchange capacity.

*Illite* and *montmorillonite* are two major types of clay minerals in Illinois soils. Illite, having 10 to 40 m.e. per 100 grams of cation exchange capacity, is found primarily in the glacial till soils of northeastern Illinois. Glacial till is material deposited by glaciers that were present during the Ice Age. In Illinois, the tills are classified into 5 textural groups, ranging from gravelly loam to clay. *Montmorillonite,* having 80 to 150 m.e. per 100 grams of cation-exchange capacity, is associated with the loess derived soils in the rest of the state. Loess is essentially silt-sized mineral material deposited by wind.

The contents of organic matter and clay may vary widely in the same field, particularly in the northern two-thirds of Illinois where a light-colored timber soil may lie directly adjacent to a dark-colored prairie soil. A more-common occurrence in prairie areas is the difference in clay contents associated with the silt loam soil on the higher ground and higher-clay silty clay loam soil in the lower ground. Organic-matter contents also tend to be higher in the low ground.

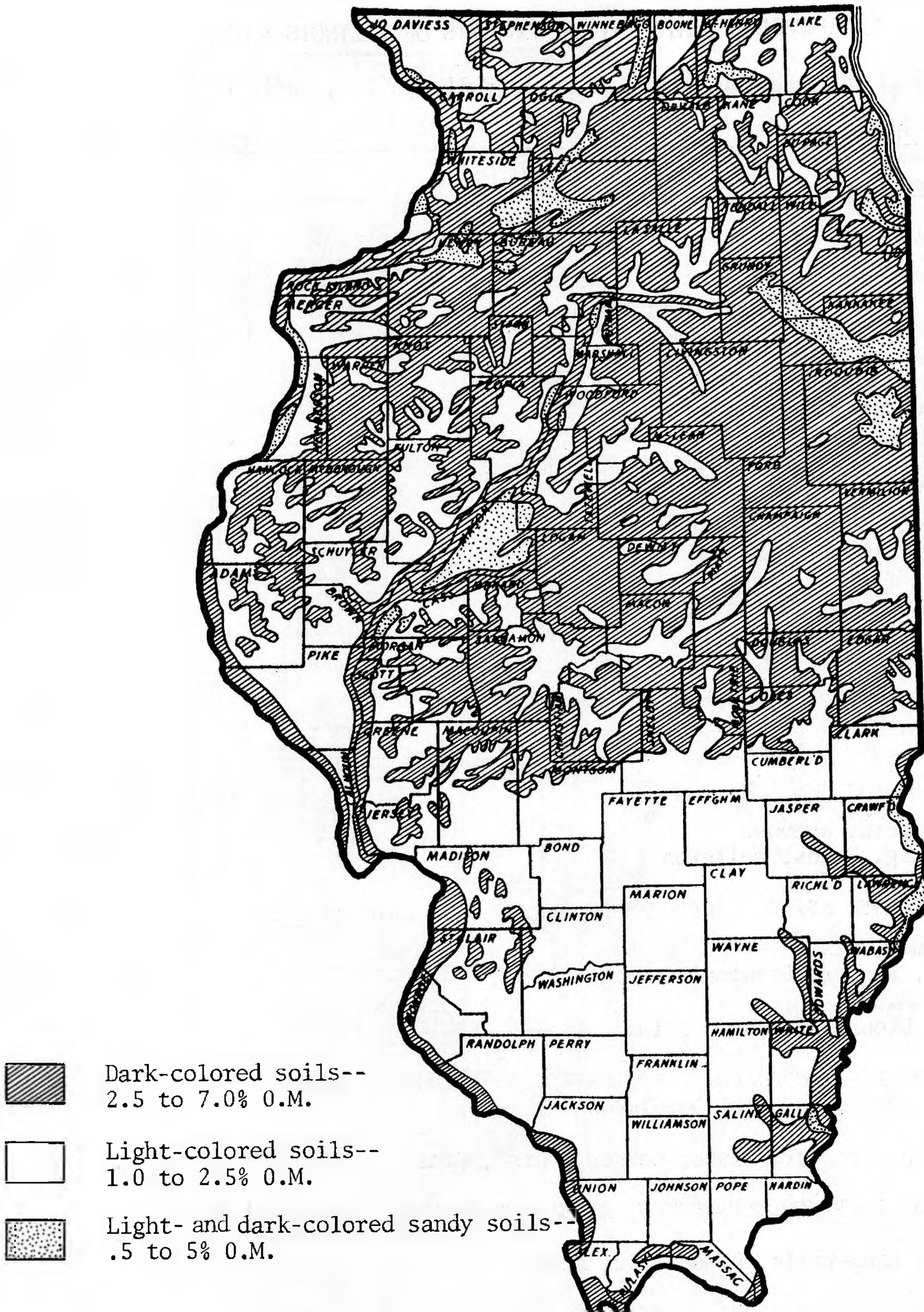
Surface organic-matter contents of Illinois soils by soil-association areas are listed on page 38. Averages and ranges are given. Each soil-association area contains a number of soils. Local variation in organic-matter content in a particular field must be further assessed. This table is keyed to a new publication *Soils of Illinois*, University of Illinois Agricultural Experiment Station Bulletin 725, August, 1967. This bulletin is available from your county extension adviser or from the College of Agriculture, University of Illinois, Urbana. Included in this bulletin is a colored soil-association map, plus a description of each soil-association area and the soils included in each.

The map on page 39 gives a general, statewide picture of the organic matter content in Illinois soils. Detailed soil maps and reports are available for a number of counties in the state. In addition to understanding the characteristics of the entire soil profile these maps and the report are useful in determining the organic matter and clay contents in any part of a field.

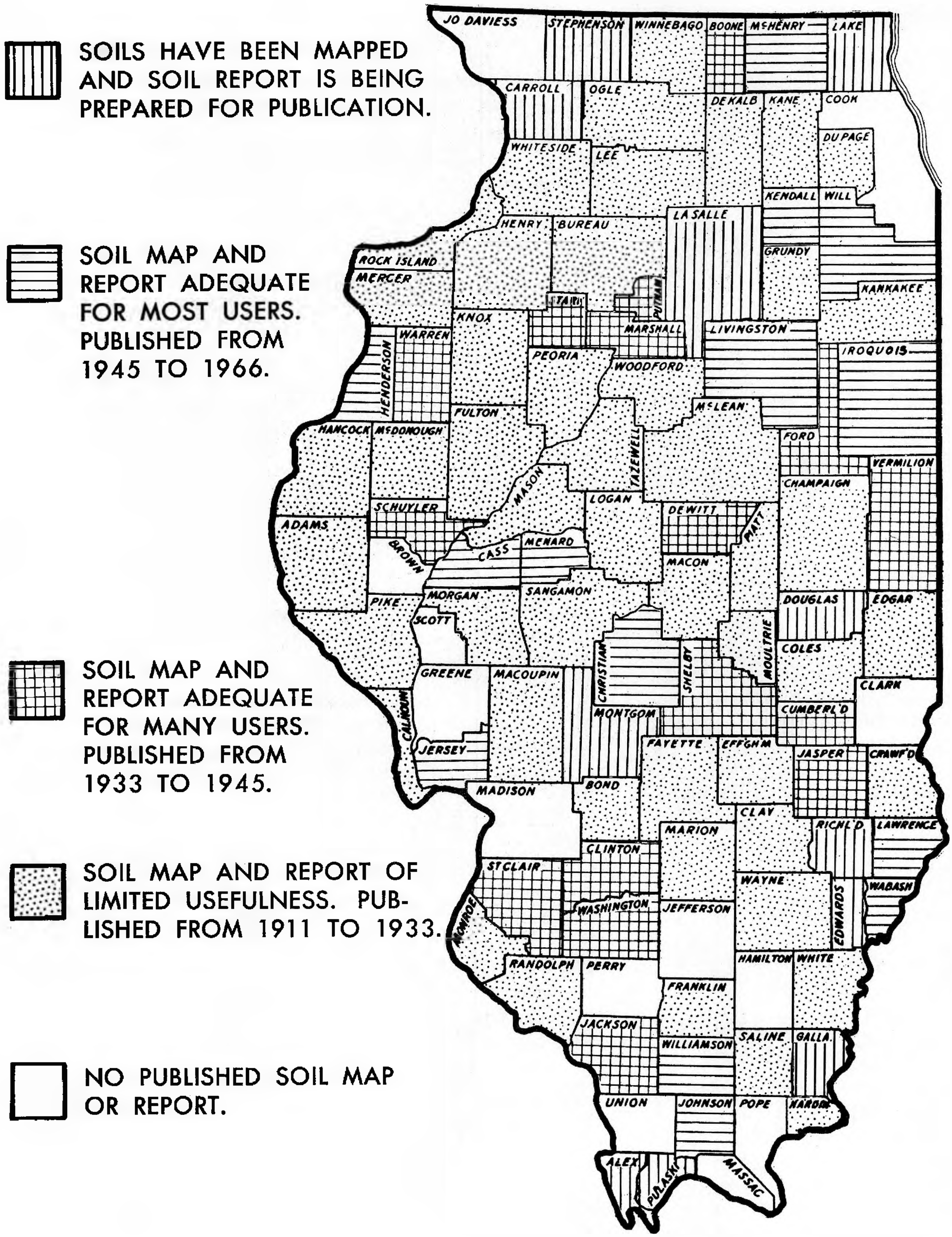
## SURFACE ORGANIC MATTER CONTENTS OF ILLINOIS SOILS

(By Soil-Association Areas Listed in Bulletin 725, *Soils of Illinois*)

| *Soil-association area* | | *Percent organic matter* | |
|---|---|---|---|
| *Symbol* | *Soil Names* | *Average* | *Range* |
| | *DARK-COLORED SOILS, DEVELOPED PRIMARILY FROM LOESS* | | |
| A | Joy, Tama, Muscatine, Ipava, Sable | 4.5 | 3.5-7.0 |
| B | Sidell, Catlin, Flanagan, Drummer | 4.5 | 3.5-7.0 |
| C | Wenona, Rutland, Streator | 4.5 | 3.5-7.0 |
| D | Harrison, Herrick, Virden | 4.5 | 2.5-6.0 |
| E | Oconee, Cowden, Piasa | 3.0 | 1.5-4.5 |
| F | Hoyleton, Cisne, Huey | 2.5 | 1.5-3.0 |
| | *DARK-COLORED SOILS, DEVELOPED PRIMARILY FROM GLACIAL TILL* | | |
| G | Warsaw, Carmi, Rodman | 4.0 | 3.5-5.0 |
| H | Ringwood, Griswold, Durand | 4.5 | 3.5-7.0 |
| I | LaRose, Saybrook, Lisbon | 4.5 | 3.5-7.0 |
| J | Elliott, Ashkum, Andres | 4.5 | 3.5-7.0 |
| K | Swygert, Bryce, Clarence, Rowe | 4.5 | 3.5-7.0 |
| | *LIGHT-COLORED SOILS, DEVELOPED PRIMARILY FROM LOESS* | | |
| L | Seaton, Fayette, Stronghurst | 2.0 | 1.0-2.5 |
| M | Birkbeck, Ward, Russell | 2.0 | 1.0-2.5 |
| N | Clary, Clinton, Keomah | 2.0 | 1.0-2.5 |
| O | Stooky, Alford, Muren | 2.0 | 1.0-2.5 |
| P | Hosmer, Stoy, Weir | 1.5 | 1.0-2.0 |
| Q | Ava, Bluford, Wynoose | 1.5 | 1.0-2.0 |
| R | Grantsburg, Robbs, Wellston | 1.5 | 1.0-2.0 |
| | *LIGHT-COLORED SOILS, DEVELOPED PRIMARILY FROM GLACIAL TILL* | | |
| S | Fox, Homer, Casco | 2.0 | 1.5-2.5 |
| T | McHenry, Lapeer, Pecatonica | 2.0 | 1.5-2.5 |
| U | Strawn, Miami | 2.0 | 1.5-2.5 |
| V | Morley, Blount, Beecher, Eylar | 2.5 | 2.0-3.0 |
| | *DARK- AND LIGHT-COLORED SOILS, DEVELOPED PRIMARILY FROM MEDIUM- AND FINE-TEXTURED OUTWASH* | | |
| W | Littleton, Proctor, Plano, Camden, Hurst, Ginat | Dark 4.5<br>Light 2.0 | 3.5-7.0<br>1.5-3.5 |
| | *DARK- AND LIGHT-COLORED SOILS, DEVELOPED PRIMARILY FROM SANDY MATERIAL* | | |
| X | Hagener, Ridgeville, Bloomfield, Alvin | Dark 2.5<br>Light 1.0 | 1.5-5.0<br>.5-1.5 |
| | *DARK- AND LIGHT-COLORED SOILS, DEVELOPED PRIMARILY FROM MEDIUM-TEXTURED MATERIAL ON BEDROCK* | | |
| Y | Channahon, Dodgeville, Dubuque, Derinda | Dark 3.5<br>Light 2.0 | 2.5-6.0<br>1.5-2.5 |
| | *DARK- AND LIGHT-COLORED SOILS, DEVELOPED PRIMARILY FROM ALLUVIUM* | | |
| Z | Lawson, Beaucoup, Darwin, Haymond, Belknap | Dark 4.5<br>Light 2.5 | 3.5-5.0<br>1.5-3.5 |




*Organic matter in the surface of Illinois soils*




*Organic matter contained in Illinois soils*

# HERBICIDE PERFORMANCE AS AFFECTED BY SOIL CHARACTERISTICS

*F.W. Slife*

It is an established fact that soil-applied herbicides are greatly influenced by soil characteristics. The problem is further complicated by the fact that the amount of rainfall that follows preemergence applications or incorporated treatments can modify or intensify the effect caused by soil characteristics.

Most of the soil-applied herbicides in use today have some water solubility, and the general correlation exists that herbicides with high water solubility are leachable in soil and those with low solubility move more slowly. For example, atrazine, which is approximately 70 parts per million soluble in water, moves through soil more slowly than amiben, which is 700 parts per million soluble. It would therefore theoretically require two-tenths of an inch of rainfall to dissolve all of a 3-pound broadcast application of atrazine but only two-hundredths of an inch to dissolve amiben at the same rate.

These figures indicate then that even though water solubility of a chemical does tend to indicate leachability of the chemical in soil, there are much more important factors involved. These factors are the capacity of the soil to hold or bind the herbicide molecule and thus modify the solubility effect. Both the clay content and the organic matter content have tremendous effect on the binding of soil-applied herbicides and therefore affect leaching, residue, and herbicide performance.

It is difficult to study the relative influence of organic matter and clay content since in most situations their levels are similar. Soils high in organic matter are generally high in clay content, while soils low in organic matter are generally low in clay content. Most research workers have correlated herbicide performance with organic matter content, and it is probably the most important factor affecting performance and persistence. At this point in our use of herbicides, it does not seem critical to know the exact organic matter content of each field, but it is important to know the general level.

Within limits, some herbicides will perform well on all soils by simply adjusting the rate of chemical applied. An example is Treflan, which appears to perform well in sandy or sandy loams at 1/2 pound per acre. Organic matter in these soils is generally less than 0.5 percent. At 3/4 pound per acre, Treflan performs well on soils with 2 to 4 percent organic matter, and 1 pound per acre seems sufficient for Illinois soils with more than 4 percent organic matter. Thus an increased rate is used to offset the increased absorptive capacity of the soil.

Atrazine follows the same general pattern. It will perform well at a 1-pound rate on soils with 0 to 1 percent organic matter, while 2 pounds are needed on soils with 1 to 3 percent organic matter, and 3 pounds are needed on 3- to 5-percent soils. Above 5 percent 4 pounds will perform more satisfactorily than 3, but there may be low areas where the organic matter is 7, 8, or 9 percent, and in these areas at least 5 pounds would be needed to perform satisfactorily. Since atrazine does not have label approval for more than 4 pounds, some other method of weed control may be more satisfactory.

Randox is an example of a chemical so leachable that it performs best on soils above 4 percent organic matter. On soils with organic matter below 4 percent, it frequently is diluted so much with rainfall that it performs poorly.

The performance of herbicides on soils is greatly modified by the character of the rainfall that follows application. Atrazine applied to a sand at a 1-pound rate may give adequate weed control under normal rainfall patterns, but under very heavy rains it may be diluted to the point where it is not satisfactory. Atrazine applied at a 4-pound rate to a soil with an organic matter content of 7 percent may give variable control under normal rainfall patterns, but will be a perfect treatment under heavy rains.

Herbicide selection based on soil characteristics should be made for average rainfall patterns and not the extremes. We must admit, however, that we never seem to have an average year.

Combinations of chemicals can be used to modify the effect of soil characteristics on herbicide performance. For example, Ramrod plus atrazine may be more desirable than atrazine alone on soils with high organic matter.

Incorporating herbicides that have low volatility may modify the soil characteristics slightly, but at present this method does not seem to be as suitable as selecting a more soluble or less soluble herbicide for a particular soil.

Herbicide users should be encouraged to try several different treatments when several are available. If they would record rainfall patterns for several weeks after treatment and do this over several years, the information could be very useful in their selection of the best treatment for their soils and weed problem.

In areas of the state where several very diverse soil types appear in one field, the selection of an herbicide becomes difficult. The treatment can be corrected somewhat if the herbicide is broadcast, but it is almost impossible to adjust the rate or change the chemical where band application is used on the planter.

# HERBICIDE RESIDUES IN SOILS

*T.J. Sheets*

Technological developments in agriculture are often accompanied by undesirable side effects that must be circumvented or overcome. We know the utility and value of herbicides for weed control in corn, but we are also aware of a few problems associated with the use of some of the very best ones.

Although several detrimental side effects are possible, herbicide residues in soils are known to cause only one significant problem: injury to sensitive crops the season after spraying. In this discussion, we will consider herbicide residues in soils with emphasis on persistence of atrazine and Randox-T from one season to the next.

First, however, one point should be made about residual activity of herbicides. It is this characteristic or property of chemicals, in addition to their toxicity to weeds, that makes them effective preemergence herbicides. More precisely, weed control for 6 to 10 weeks or more, in most situations if not all, is due to the herbicidal activity of persisting residues. Persistence in the soil is therefore a desirable characteristic of a chemical that is to be used as a preemergence herbicide. Problems develop when, under certain soil and climatic conditions, residues persist too long.

## *LOSS OF HERBICIDES FROM SOIL*

Several processes, acting singly or in some combination of two or more, bring about loss of a herbicide from soil. Processes usually associated with loss of herbicidal activity are adsorption, volatilization, leaching, microbial decomposition, chemical and photochemical decomposition, and uptake by plants. Adsorption to soil doesn't remove herbicides but renders them inactive. Leaching displaces them downward in the soil profile and may or may not remove them. The other processes reduce residues.

Of the several processes, microbial decomposition is most important; and if herbicides do not disappear rapidly by another process, most and probably all are utilized ultimately by soil microorganisms as a source of food and are decomposed. In fact, the leaching rate of many herbicides is so slow that they are reduced to an insignificant concentration by the action of soil microorganisms and other processes before movement to great depths in soils occurs.

Residue levels in soils at any particular time are determined by the rate at which one or more of the processes that contribute to the loss of herbicides take place. If we knew how to control these processes, we could take full advantage of residual-type herbicides without hazard to sensitive crops grown the season after spraying.

## *INJURY FROM CARRY-OVER RESIDUES*

Although we don't have the complete answer, several management practices are known to influence residue levels.

### *Band Versus Broadcast Application*

About three times as much herbicide is applied to each acre when sprays are broadcast as when they are applied as bands over the rows. In consequence, three times as much residue will remain within the acre that is treated. With herbicides like atrazine and Randox-T, we are working near the threshhold level of residues with band applications. Increasing the total residue per acre by a factor of three might increase greatly incidence of injury to oats and soybeans. Broadcast applications of these two herbicides should be used with caution or avoided entirely, especially in northern Illinois, where more herbicide is needed for weed control than in the southern area of the state.

*Plowing and Disking*

Thorough mixing of the soil after corn harvest and before planting sensitive crops the next year lessens the likelihood of injury. In most situations, plowing is better than disking. Where band applications are used, the sprayed soil should be mixed with unsprayed soil in the middle to dilute the residue. Fall plowing followed by one or more diskings would be beneficial but costs may limit the number of cultural operations.

*Surface Application Versus Incorporation*

Incorporation of herbicides improves weed control and extends the period of effect. The lengthening of the period of good weed control, in particular, is due largely to consistent placement and retention of the herbicide in the zone where weed seeds are germinating. Incorporation may therefore increase the chances of injury to sensitive crops the next season, especially if the herbicide is broadcast. The increase in residue from incorporation of atrazine and Randox-T applied as bands probably would be negligible once thorough plowing and disking have diluted the residue with the unsprayed soil in the middles.

*Application Rate and Time*

We do not have a foolproof method for prescribing an exact rate of application of a herbicide needed to control weeds in a particular soil. Such precision may be possible in the future if we need it, but it is a long way off. We do know that rates should be adjusted to different soil types. You use less atrazine in southern Illinois than in northern Illinois. Experience and good judgment can help the individual farmer to adjust rates up or down to arrive at an amount needed for specific soils. The critical point is, don't apply more than needed to control weeds.

The later in the season that an application is made, the greater the likelihood of carry-over. Thus postemergence applications at the same rates used for preemergence weed control might cause a greater residue the following spring than preemergence applications. Both preemergence and postemergence applications of atrazine or Randox-T to the same soil in one year would, most assuredly, be hazardous.

*Selection of Herbicide and Crop-Rotation Sequence*

Another approach to reducing or eliminating injury from residues of herbicides such as atrazine and Randox-T involves long-term planning of the sequence of crops and herbicides in rotations. Rotation of herbicides when corn follows corn should be a good practice that would greatly lessen or eliminate any chance for buildup, and a wider spectrum of weeds usually would be controlled also (Table 1).

Sensitive crops like soybeans and oats should not be planted the year after atrazine unless experience has shown that injury is unlikely. Generally, soybeans are a little less susceptible to atrazine than oats, and less injury would be expected from the same level of residue. Where atrazine has been used for two years or more in succession on the same soil, injury is more likely to occur than where it has been used for one year only. The last year corn is grown before switching to a sensitive crop, Randox and 2,4-D are suggested in your "Guide for Weed Control in Field Crops" instead of atrazine or Randox-T (Table 1).

*Table 1. Rotation of Herbicides on the Same Crop*

| | Crop | Preemergence herbicide | Postemergence herbicide |
|---|---|---|---|
| First year | Corn | Atrazine + Ramrod | None |
| Second year | Corn | Randox-T | None |
| Third year | Corn | Randox | 2,4-D |
| Fourth year | Soybeans | Amiben | None |

When crops are rotated in a 3- or 4-year pattern, an effective herbicide with short residual life should be selected for use during seasons preceding crops that are injured by low concentrations of atrazine and Randox-T (Table 2).

*Table 2. Rotations of Crops and Herbicides*

| | Crop | Preemergence herbicide | Postemergence herbicide |
|---|---|---|---|
| First year | Corn | Randox | 2,4-D |
| Second year | Soybean | Amiben | None |
| Third year | Small grain-legume | None | 2,4-D |
| Fourth year | Corn | Atrazine | None |

When herbicides are used each year and for several years on the same soil, the numbers of weed seeds in the soil will decrease. After several years of effective weed control, it may be possible to eliminate herbicide applications for one or more seasons if the weed population becomes low.

*Selection of Formulation*

More injury to sensitive rotational crops occurred after use of atrazine granules than after the wettable powder formulation.

*Adsorption, Leaching, and Possible Problems*

The main, and perhaps the sole reason for the difference in rates required to give weed control between northern and southern Illinois is greater adsorption (or binding) of herbicides to the soils of the north than to those of the south. Adsorption also prevents or greatly reduces movement of herbicides into the soil. In the north atrazine residues probably remain mostly in the plow layer. On light sandy soils, herbicides such as atrazine may be moved by rainfall or irrigation water before decomposition occurs. Residues of atrazine have been found at depths of 2 to 3 feet in Illinois. The rate of loss of herbicides from depths below the plow layer may be much slower than in surface soils. If these suppositions are true, the potential for buildup of residues over years of use may pose a greater problem on light soils than on heavy soils. We don't really know what the potential is for buildup of residues below the plow layer. We believe the chances for such occurrences are small; but, to be on the safe side, farm practices should be aimed toward minimizing the amounts and frequencies of herbicide applications.

Randox-T is moved downward in soil more rapidly than atrazine. Therefore the same or greater potential for buildup in subsoils exists for Randox-T as for atrazine.

Until we have a more complete understanding of leaching and decomposition rates of herbicides in soils, we must remain alert to detect any problems that develop. With cautious concern for potential problems, advantages can be taken of the benefits of weed control with herbicides without much damage of injury to sensitive rotational crops or buildup of residues in soils.

## RESIDUE RESEARCH WITH THE ORGANOPHOSPHORUS AND CARBAMATE INSECTICIDES

*W.H. Luckmann*

There is a definite change in the types of insecticides now being used in Illinois, and we can expect that more of the organophosphorus and carbamate types of chemicals will be used in the future. This change in use is due in part to the fact that many of our most destructive insects have developed resistance to the chlorinated hydrocarbon insecticides and that legal implications are restricting the use of chlorinated hydrocarbon insecticides on many crops and farms. To keep abreast of this trend, we are conducting research with the newer chemicals to evaluate their persistence in soils and in the terrestrial and aquatic environment. Laboratory analysis of many of these organophosphorus and carbamate insecticides is extremely complicated, and as we found with aldrin, heptachlor, and DDT, the metabolites are frequently more important than the original chemical.

Preliminary work has involved the soil application of some insecticides such as diazinon, parathion, phorate (Thimet), carbaryl (Sevin), and dimethoate. The chemicals were applied at dosages up to 20 pounds per acre, and crops were grown on these treated soils in 1966 and 1967. The results of this work are still being processed at the time this manual was prepared, but knowledge to date will be presented.

The hypothesis that these newer organophosphorus and carbamate insecticides are less persistent may or may not be true. The persistence of some metabolites and the rapidity of converting from one compound to another will be discussed. The physical and chemical characteristics of the soil on the farm may be real factors in the persistence and toxicity of some of these chemicals. Safety overshadows chemical performance, and safety will be one of the principal factors in recommending chemicals in Illinois.

## ALDRIN-DIELDRIN RESIDUE PATTERNS IN SOYBEANS

*H.B. Petty*

We know that oil crops tend to "pick up" aldrin-dieldrin and heptachlor-heptachlor epoxide from the soil. When we use these as soil insecticides in corn and then follow that crop with soybeans, we obviously will have a very slight residue in the beans. As reported for the past two years, we can find these products in minute amounts in soybeans in proportion to use of them in corn soil, but the amounts have been negligible. Furthermore, residues have not been found in processed oil. Our 1967 survey results were not completed in time to include them, so please fill in the tables below regarding percent of fields with various residue levels in soybeans.

*Number of Fields in Residue Ranges, 3-Year Average*

| Residue range | Number | Percent |
|---|---|---|
| 0.0-0.01 | | |
| 0.01-0.02 | | |
| 0.02-0.03 | | |
| 0.03-0.04 | | |

# SEED TREATMENT FUNGICIDES FOR 1968

*M.P. Britton*

## *THE CONTROL OF LOOSE SMUT OF WHEAT AND BARLEY*

The true loose smuts of wheat and barley cannot be controlled by the mercury seed-treatment fungicides. The fungus is inside the embryo of the seed; hence, fungicides placed on the outside of the seed do not come into contact with the fungus. Consequently, we have had to rely on hot water treatment or anaerobic water soaks to control the loose smut diseases.

A new fungicide, VITAVAX (2,3-Dihydro-5-carboxanilido-6-methyl-1,4-oxathiin), has shown systemic activity against the loose smut fungus and other plant pathogenic fungi. Essentially, complete control of loose smut has been obtained by treating the seed of barley and wheat with Vitavax at a rate of 2 to 4 ounces of a 75-percent active formulation per 100 pounds of seed. The 75-percent wettable-powder formulation can be applied as a dry dust or with spray-mist or slurry seed-treating equipment. Vitavax is a product of UniRoyal, Inc. Label clearance has been obtained for seed treatment of barley and wheat that will be grown for the production of seed for planting purposes only. Until full label clearance has been obtained, plants grown from treated seed should not be consumed by man or animals.

At present, subacute animal-toxicity tests have been completed. The acute oral $LD_{50}$ for rats is 3,200 mg./kg.; the acute $LD_{50}$ for rabbits is greater than 8,000 mg./kg. Two-year feeding studies are in progress.

Preliminary research reports indicate that Vitavax may also control loose and covered smut of oats, bunt (stinking smut) of wheat, onion smut, covered kernel smut of sorghum, and seed rots and seedling blights of wheat and sorghum.

## *MERCURY SEED-TREATMENT FUNGICIDES*

The mercury seed-treatment fungicides have been used for many years to control the smut diseases of cereals that occur as the result of infection from spores or mycelium carried on the outside of the seed, such as covered smut of barley and oats, semi-loose smut of barley, loose smut of oats, and stinking smut (bunt) of wheat. They also control seed rots and seedling blights. These fungicides have been used on a no-residue basis. As of December 31, 1967, these products cannot be used unless the manufacturer has been able to obtain an extension of time in which to obtain data on residues for the establishment of finite tolerances (Table 1). During the extension of time, the product may be used as before, unless the manufacturer changes the use recommendations. Therefore, the products made by the manufacturers granted extensions will be available for the treatment of spring-seeded and fall-seeded small grains in 1968.

## *CAPTAN AND THIRAM SEED-TREATMENT FUNGICIDES*

The Pesticides Regulation Division, U.S. Department of Agriculture, Agricultural Research Service, has announced that the fungicides Thiram and Captan, used as seed treatments, have been determined to be nonfood uses; therefore, registration of products for these uses may be continued in the absence of finite tolerances.

*Table 1. Generally Available Mercury Seed-Treatment Chemicals for Wheat, Oats, Barley, and Rye*

| Material 1/ | Rate oz./bu. | Granted extension for use in 1968 Yes | No |
|---|---|---|---|
| Ceresan M | 1/2 | | |
| Ceresan M-DB | 2 | | |
| Ceresan L | 1/2 to 3/4 | | |
| Chipcote 25 | 1/4 | | |
| Chipcote 75 | 3/4 | | |
| Ortho LM Seed Protectant | 1/4 | | |
| Ortho LM (dry) | 1/2 | | |
| Panogen 15 | 1/2 2/ | To Jan. 1, 1969 | |
| Panogen PX | 2 | To Jan. 1, 1969 | |

1/ There are other mercury seed treatment fungicides. They have not generally given as good control under severe conditions nor have they been as widely available or as generally tested as the materials listed above.

2/ The manufacturer no longer recommends 3/4 oz.

# PREHARVEST WEED CONTROL IN SOYBEANS

*L.M. Wax*[1/]

Preharvest spraying for weed control in soybeans is not a new process. Research on this problem in the early forties showed that soybeans could be defoliated with some of the treatments used for cotton defoliation. Later, as more chemical desiccants and defoliants became available, interest and research concerning their use on soybeans increased.

Research with several chemicals showed that the harvest date for weed-free soybeans could be advanced by only three or four days without reducing soybean yields. With moderately heavy weed stands in soybeans, chemicals applied to mature soybeans and green weeds resulted in earlier drying of the weed stems and leaves, facilitating earlier and more efficient soybean harvest. However, with extremely heavy weed stands in soybeans, satisfactory penetration of the weed canopy was very difficult to obtain, either with ground or aerial spray equipment.

Each year there are questions about preharvest weed control in soybeans, but most questions arise during years such as 1967 when excessive rains interfered with normal weed control practices. In such cases, an effective desiccant applied to green weeds at soybean maturity might allow earlier and more efficient soybean harvest. In some areas, this would facilitate sowing wheat at the appropriate time. Several chemicals evaluated in recent years are effective desiccants on standing crops and weeds. Although some treatments may be used on soybeans raised for seed, no chemical is currently registered for preharvest defoliation or desiccation of soybeans used for purposes other than seed.

Preharvest sprays for weed control in soybeans may have some potential in some years when other means of weed control either failed or were not used. The control of weeds at harvest is at best only an emergency measure, as considerable yield reduction has undoubtedly already occurred.

Far more effective weed control in soybeans is possible through the use of preplanting, preemergence, or early postemergence herbicide treatments combined with good cultural practices and timely cultivation.

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1/ Agronomist, Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture, in cooperation with the Illinois Agricultural Experiment Station, University of Illinois, Urbana, Illinois.

# CHEMICAL WEED CONTROL SURVEY IN ILLINOIS, 1967[1/]

*C. Cross*

The Illinois Cooperative Crop Reporting Service conducts an annual survey on chemical weed control practices used by Illinois farmers. This survey began on an annual basis in 1964, at a time when herbicide use was increasing rapidly. The survey provides data on trends in use for both cultural and chemical weed control practices, relation between size of farm and herbicide use, specific herbicides used, extent of use, methods of application, and performance.

The questionnaire used for the 1967 survey was mailed to 8,115 crop reporters throughout Illinois. The list represented about 1 of every 16 farmers in the state, distributed in proportion to the number of farms in each township. About 25 percent of the questionnaires were filled out and returned by respondents or a total of 2,010.

Detailed data from the 1967 survey will be presented. The published report is expected to be available at the time of the custom spray school.

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1/ Abstract.

# RESPONSES OF AVIANS TO METHYL PARATHION IN A HAYFIELD

*W.R. Edwards and R.R. Graber*

The alfalfa weevil *(Hypera postica)* was first reported in southern Illinois in 1964. The larvae appear in alfalfa fields in April and are numerous until early June. High populations will take an entire first cutting of alfalfa. Since 1964, the alfalfa weevil has spread rapidly. Today, it poses a serious threat to future production of alfalfa in Illinois.

Economic entomologists of the Illinois Natural History Survey predict that next spring, 1968, farmers south of a line extending between Urbana and Hardin will not, for all practical purposes, harvest a usable crop of alfalfa unless they have followed some program of weevil control. Control costs depend on the magnitude of the infestation, the chemical or control used, and the number of treatments. Thus, annual control costs may range from $3.50 to $12.00 per acre. They predict that the acreage of alfalfa harvested annually in Illinois will be reduced 30 to 50 percent in the next 2 to 3 years, and that virtually all of the remainder will have to be treated annually 15 days prior to the first cutting.

Because hayfields comprise the last major stronghold for nesting of a number of prairie birds, and because methyl parathion is so highly toxic (about 8 times DDT), and is regarded as the best chemical for weevil control, Dr. Graber felt it important to study the effects of parathion before large acreages had been sprayed.

Today I am reporting the observations of Dr. Graber and myself on the responses of the avian Fauna of two hayfields to one aerial application of methyl parathion at a rate of 0.5 pound technical material per acre in 1966 and 1967.

Observations were of two general types. The first involved field studies to determine the number and behavior of passerines using treated and control hayfields, particularly in treated hayfields. At the time of spraying, migratory peaks had largely passed, and the breeding population of birds on the study fields appeared to be stabilized.

The second phase of the study involved caged game birds--in 1966, ringneck hens and quail of both sexes; in 1967, quail only. The game birds were obtained from the Illinois State Game Farms.

Game birds were divided into three groups: (1) treated, (2) field control, and (3) pen control. Treated birds were exposed to spraying in elongated oval pens 10 by 4 by 3 feet, made of 1-inch chicken mesh. Field-control birds were held in similar cages erected in control fields. Pen-control birds were retained in holding pens at the University of Illinois South Farm. Game birds were placed in the field pens about 2 hours prior to spraying, where they remained for approximately 72 hours.

On May 23, 1966, and May 16, 1967, 0.5 pound of methyl parathion was applied per acre. In 1966, winds at the time of spraying were 10 to 15 m.p.h.; in 1967, they were 1 to 3 m.p.h. In 1966, coverage was considered good; in 1967, it appeared excellent. In both instances, passerines were observed to flush and fly through the spray as the plane passed overhead.

In 1966, 1.7 inches of rain fell on the treated field the night after treatment. In 1967, the only measurable rain during the first 12 days after treatment was 0.04 inch; that came 2 days after spraying.

## *FINDINGS*

### *Changes in Territorial Behavior*

Birds returned to their territorial perches within seconds after the passing of the spray plane, resumed singing and other apparently normal acts of behavior.

However, a phenomena which we term a "behavioral slump" was apparent within 30 minutes following treatment in 1967. In 1966, Dr. Graber noted this phenomena the morning after treatment.

Birds such as dickcissels and redwings survived and were on their perches and capable of flight when flushed. However, singing and acts of territorial aggression, if done at all, were weak and apathetic. The silence of these birds was astounding.

While the behavioral slump was noted in all species, it was most prolonged in four species: (1) the grasshopper sparrow, (2) the eastern meadowlark, (3) the bobolink, and (4) the savannah sparrow. These species have the common behavioral traits of spending much time on the ground and nesting on the ground in hayfields. On the other, redwings and dickcissels hand nest and perch well above ground level. Because of their ground-dwelling habits, the first four mentioned species are considered to have a special ecological susceptibility to the toxic mist that filtered down through the dense alfalfa forming--in effect, a gas chamber near the ground where those species abide and seek shelter.

The phenomena of the behavioral slump persisted for about 24 to 70 hours. It was most evident about 48 hours after treatment. Thereafter, breeding behavior again appeared normal.

### *Changes in Passerine Populations*

Prior to treatment, passerine populations were high in both treated and control fields. In 1966, Dr. Graber noted 70 territorial males representing 6 species on the 20-acre treated plot.

In 1966, the number of territorial males, with the single exception of grasshopper sparrows, was not reduced after treatment (Figure 1). This small prairie sparrow was neither heard nor seen again in the treated field. By contrast, the pair of grasshopper sparrows only 100 yards away in the adjacent control field were easily located both before and after treatment. Dr. Graber attributed the disappearance of the grasshopper sparrows to the possible, special ecological susceptibility to parathion.

In 1967, the number of male redwings and dickcissels again remained constant, before and after treatment in both treated and control fields (Figure 2). By contrast, the number of grasshopper sparrows (Figure 3) in the treated field evidenced a pronounced drop, which coincided with treatment. However, the number of these birds in control fields also declined at the same time. The only ready explanation is that on May 16, 1967, the populations of grasshopper sparrows still contained migratory individuals. Whether or not the decline on the treated area may also, in part, represent a response to treatment is unknown.

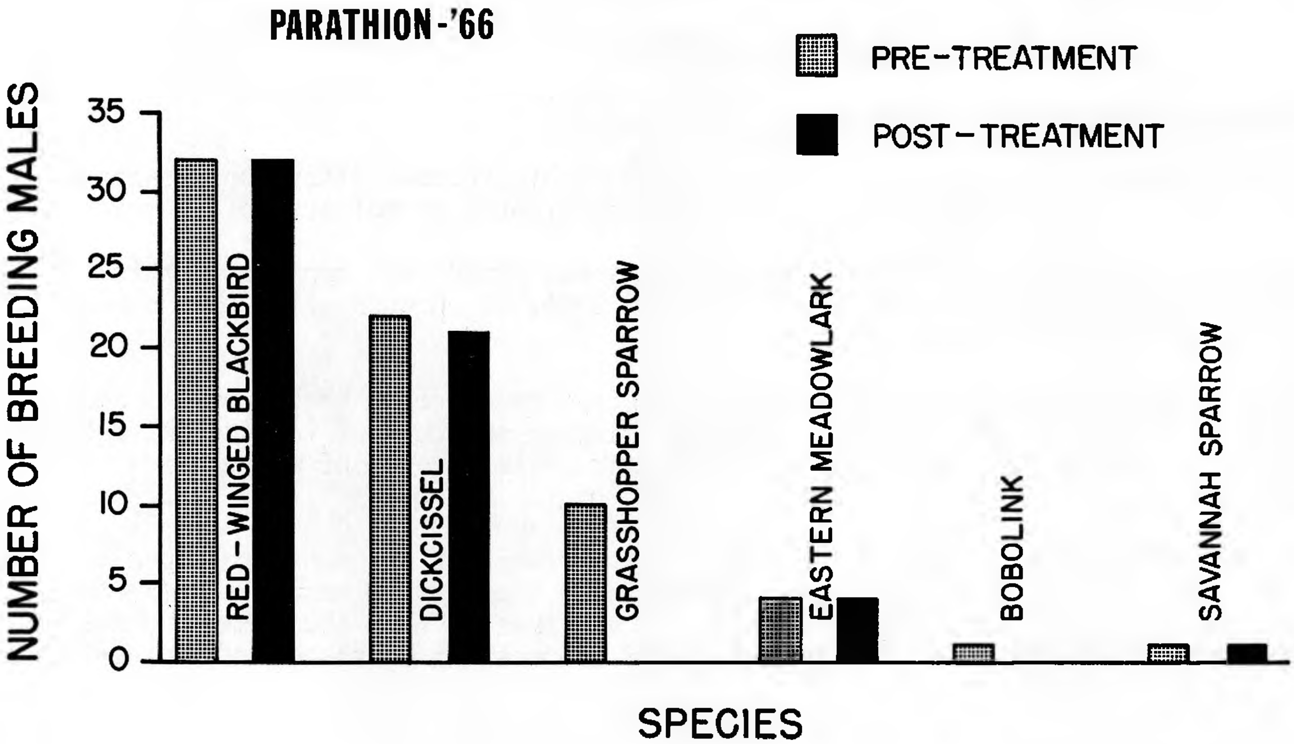



*Figure 1*

*Responses of Game Birds*

*Mortality:* In 1966, 1 of 19 quail exposed to parathion died. This bird, a hen, died 3 days after treatment. In 1967, none of the 16 exposed birds died during the course of the summer. Considering that only 1 of the 35 treated birds died and the possibility that factors such as handling or exposure to the heavy rain following treatment in 1966 could have contributed to her death, it appeared that parathion applied at the recommended rate did not produce an appreciable mortality of quail.

Of the 10 hen pheasants comprising the treated group in 1966, 2 died. However, these birds survived for periods of 18 to 20 days, respectively. Again, a lack of mortality soon after treatment.

*Quail weights:* Data on the weights of both cock and hen quail evidenced a pronounced response to treatment (Figures 4 and 5).

However, recovery was rapid, and all birds continued to gain weight during June and early July while maintaining egg production.

Considering the magnitude of the weight loss (about 20 percent), one wonders how close we came to killing the treated quail. I suspect it would not have taken a much heavier application (perhaps only 0.75 pound per acre) to have realized severe mortality in the quail and perhaps the free-living passerines.

*Egg laying:* The rate-of-lay of quail and pheasant hens was quite low for all groups in 1966. This was considered to be largely the result of the inadequate pen facilities available that year.

In 1967, quail hens were paired individually with cocks in 2- by 4-foot outdoor pens; records of egg laying were kept for each hen. A comparison of the total number of eggs laid after May 19 (when the treated and field-control groups were returned to the holding pens) revealed that an average of 64.4 eggs had been laid per female. There were no apparent differences in the average rates of lay among the three groups (Figure 6).

The average of 63.6 eggs by treated females represents four 16-egg clutches. It does not appear that exposure to parathion impaired egg production in the treated group.

Data on egg laying by pheasant hens in 1966 revealed a reduced rate-of-lay by females in the treated group for the first 4 days following their return to the holding pen. This reduced rate-of-lay was not evident in the control birds. After the fourth day, no significant differences were noted. Thus, the parathion probably caused a brief reduction in egg laying in pheasant hens, which did not persist more than about a week.

Incubation of a sample of 1,310 quail eggs (Table 1) failed to indicate any significant difference in hatchability between eggs from treated and control birds.

## *SUMMARY*

With the possible exception of grasshopper sparrows, avians in alfalfa hayfields exposed to an aerial application of 0.5 pound of methyl parathion per acre received a severe physiological blow--but not a mortal one.

It appeared that stricken birds had regained normal behavior by 3 to 4 days after treatment and that game birds were reproducing viable eggs 8 to 12 days after treatment, in some instances sooner.

In no way do we wish to minimize the potential hazard to bird or man where insecticides are used. However, it appears that where insecticides will be used, parathion and related compounds should be recommended and used in preference to the more stable chlorinated hydrocarbons. It goes without saying that minimum recommended dosages should always be used.

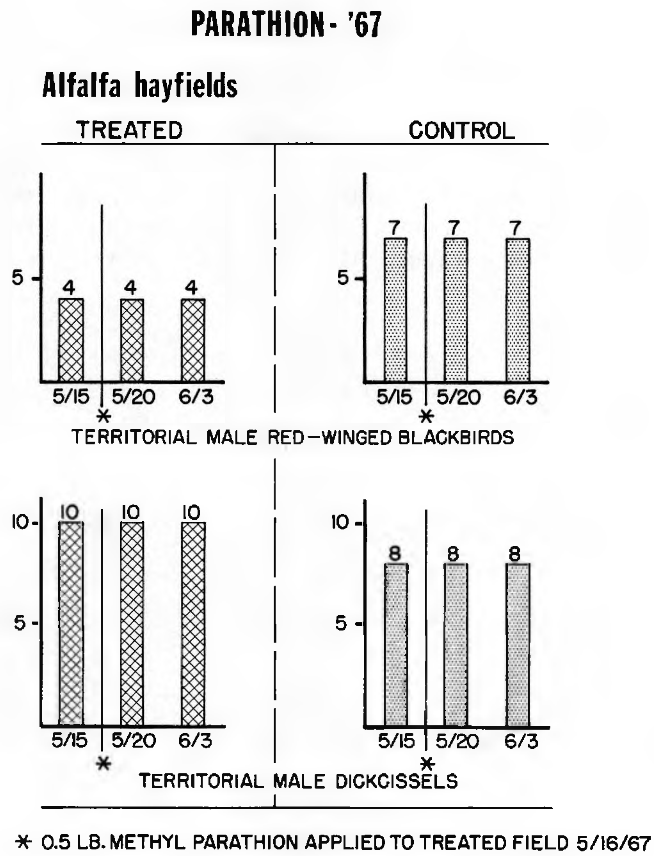



*Figure 2*

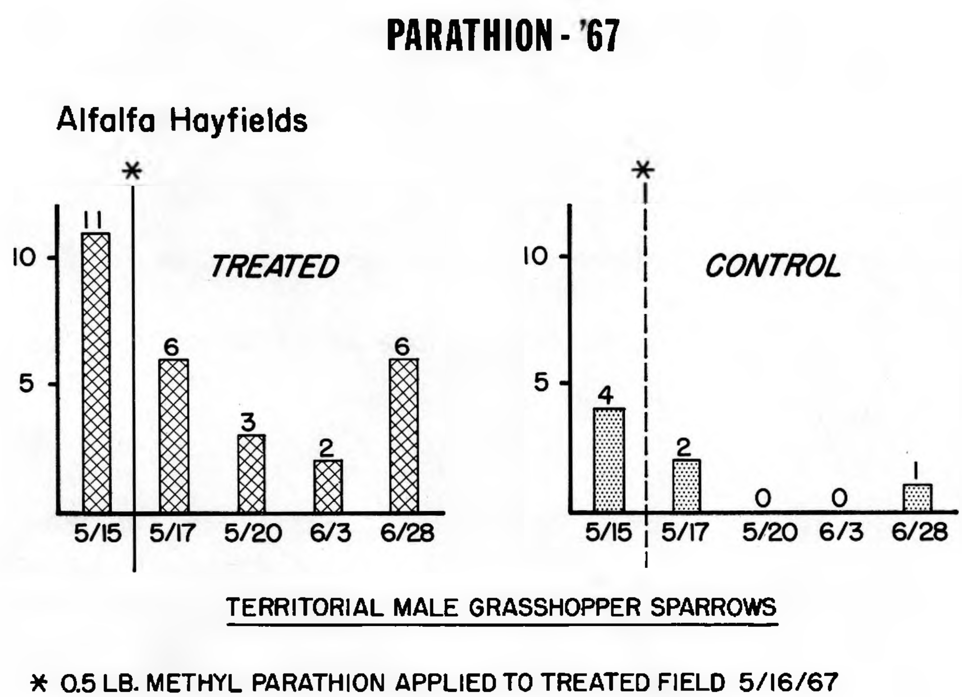



*Figure 3*

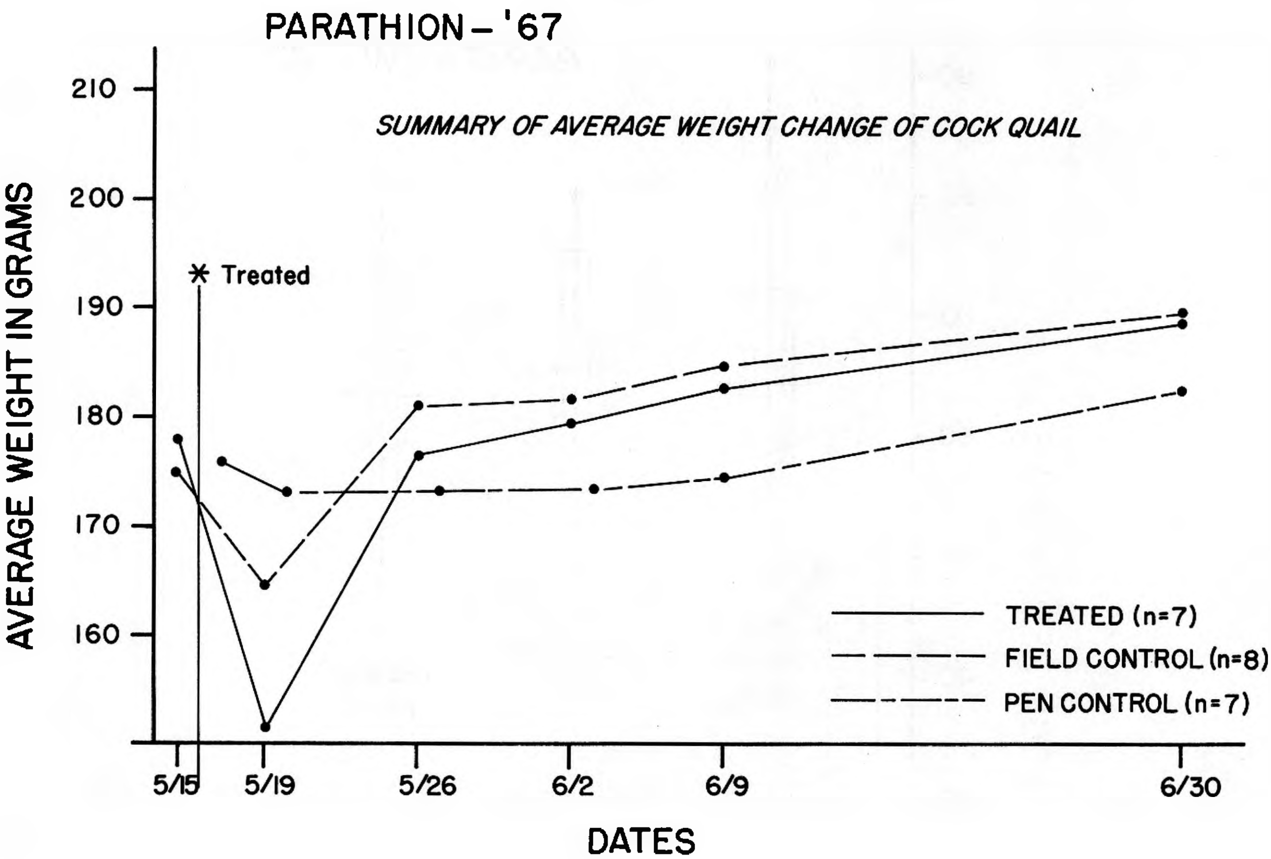



*Figure 4*

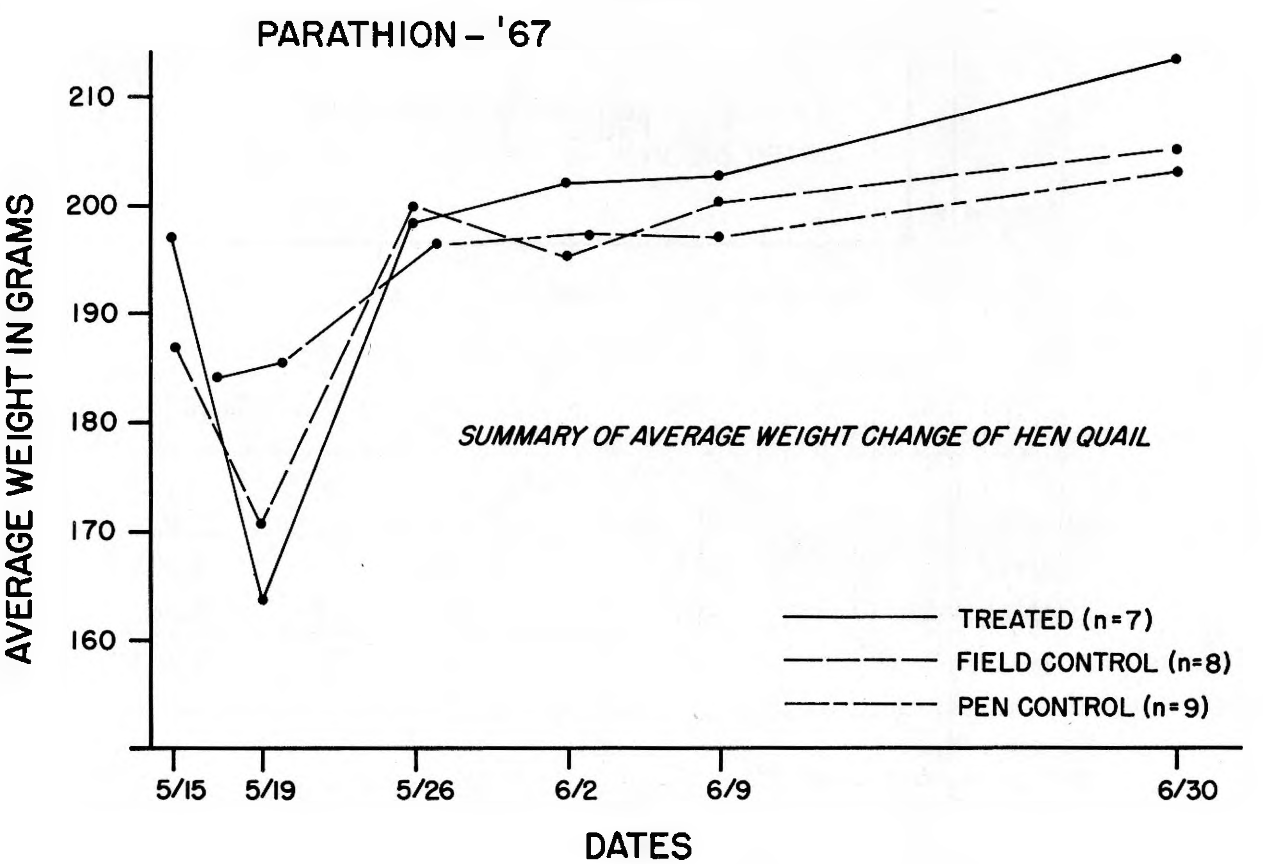



*Figure 5*

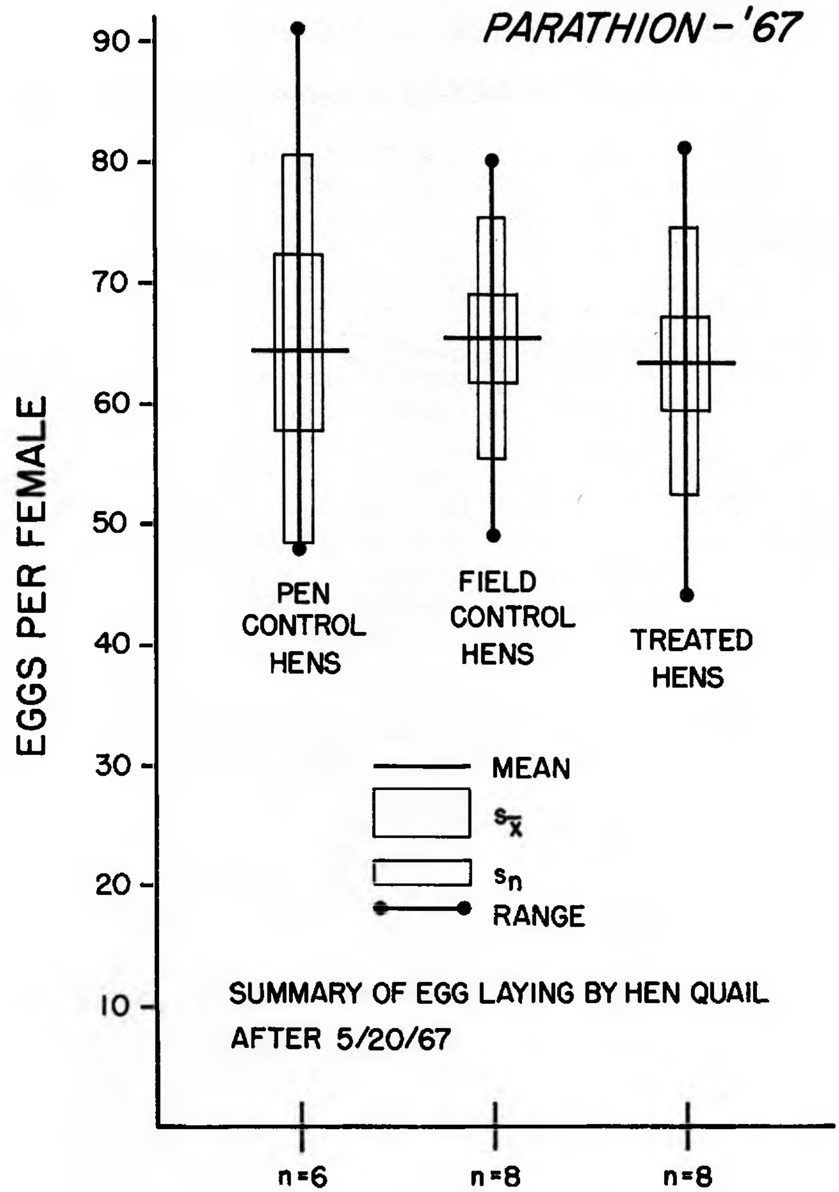



*Figure 6*

*Table 1. Parathion 1967: Hatchability of Quail Eggs*

| | Number of eggs | | |
|---|---|---|---|
| Sample | Set | Hatched | $\hat{p}$ |
| Treated | 441 | 302 | 0.685 |
| Control | 869 | 580 | 0.667 |
| Totals | 1,310 | 882 | 0.673 |

$\chi^2 = 0.66$ ns
Ref $\chi^2$ 0.05 = 3.84

# PREPLANT APPLICATION OF CORN HERBICIDES

*M.D. McGlamery*

Farmers in the Corn Belt are showing an interest in applying herbicides before planting (preplant). Preplant application is useful for herbicides such as Eptam and Sutan that require thorough incorporation. It also allows a dissipation and diffusion period before planting for herbicides such as Eptam and Treflan, which have fairly close crop tolerance. Other agronomic reasons for preplant application of herbicides are: faster planting because of the separation of weed control and planting operations, and an increased probability of rainfall adequate for herbicide "activation." A nonagronomic advantage of preplant applications is the lengthening of the application and sales season for herbicide dealers.

Preplant application of herbicides has some disadvantages. Broadcast application is necessary, so the cost will be higher. There is a loss of planting flexibility in that cropping plans cannot be changed after the herbicide is applied unless the herbicide is cleared for use on the crops you want to plant. Increased rates of herbicides are often needed to lengthen the persistence and insure weed control. This may increase the soil residue problem and increase the cost. Early planting of corn leaves little time in the spring for preplant application.

A herbicide that is to be applied before planting should possess several properties. Long persistence (life in the soil) may be necessary if there is an extended period between herbicide application and crop planting. Medium to low water solubility would be desirable to prevent leaching losses. The herbicide must be able to withstand some incorporation in case further tillage operations are necessary before planting. Good physiological crop tolerance is necessary to prevent germination injury if the herbicide reaches the seed zone by leaching or incorporation.

The suitability of an herbicide for preplant application depends on several factors, such as soil type, climatic conditions, date of application, and incorporation. The Atrazine label now carries preplant information. Sutan, when cleared, will probably be used as a preplant incorporated herbicide. Lasso (CP-50144) has rated fair in trials for preplant application as long as there isn't an extended period between application and planting. Some combinations of Caparol, Lasso, and Sutan with Atrazine have also showed promise for use as preplant herbicides (Table 1).

There is always the question of when to make preplant herbicide applications. Fall application is one possibility, and Atrazine and Simazine now have federal clearance for fall application on corn. Winter or early spring application on frozen ground would be another possibility if the weather is not too cold to prevent the use of aqueous sprays. Spring application after thawing depends either upon aerial application or the soil drying and firming enough to support ground equipment. It can be seen from Table 2 that giant foxtail *(Seteria faberii)* control with Atrazine improved as the date of herbicide application was moved closer to the date of planting. These results differ somewhat from those reported from some other areas.

The herbicide rate could be adjusted to partially counteract the time effect if additional persistence is all that is needed. In Table 3 it can be seen that in 1966 when Atrazine was applied at 3 and 4 pounds per acre on March 17, April 5, and May 2 on a Drummer silty clay loam, it took 4 pounds per acre at each earlier date to equal 3 pounds per acre at the next later date for grass control.

*Table 1. Effect of Date and Method of Application of Various Herbicides on Drummer Silty Clay Loam*

| Herbicide | Rate (lb./acre) | Date: Method: | 4-18-67 PPI1/ | 5-4-67 PPI1/ | 5-5-67 PE1/ |
|---|---|---|---|---|---|
| | | | (Percent grass control) | | |
| Atrazine | 3 | | 68 | 78 | 71 |
| Atrazine | 4 | | 92 | 89 | |
| Sutan | 4 | | 58 | 94 | |
| Sutan + Atrazine | 3 + 1 1/2 | | 48 | 96 | |
| Atrazine + Caparol | 1 1/2 + 1 1/2 | | 60 | 70 | 78 |
| Atrazine + Ramrod | 1 1/2 + 3 | | 65 | 70 | 90 |
| Atrazine + Lasso | 1 1/2 + 1 1/2 | | 46 | 84 | 96 |

1/ PPI = preplant incorporated; PE = preemergence.

*Table 2. Effect of Date of Application of 3 Lb./Acre of Atrazine on Giant Foxtail Control*

| Date applied | Method of application | Percent control 4-25-67 | Percent control 6-20-67 |
|---|---|---|---|
| 11-17-66 | Preplant surface | 25 | 2/ |
| 11-17-66 | Preplant incorporated | 30 | 2/ |
| 1-20-67 | Preplant surface | 40 | 2/ |
| 4-4-67 | Preplant surface | 92 | 60 |
| 4-4-67 | Preplant incorporated | 97 | 75 |
| 5-5-67 | Preemergence surface | 1/ | 80 |
| 6-20-67 | Postemergence with oil | 1/ | 67 |

1/ Rated before application.
2/ Treatments were so weedy that they were cultivated.

*Table 3. Effect of Date and Rate of Atrazine Application on Giant Foxtail Control on Drummer-Flanagan Silty Clay Loam*

| Date applied | Percent giant foxtail control 3 lb./acre | Percent giant foxtail control 4 lb./acre |
|---|---|---|
| | *1966* | |
| 3-17-66 | 69 | 74 |
| 4-5-66 | 76 | 83 |
| 5-2-66 | 83 | 89 |
| | *1967* | |
| 4-3-67 | 72 | 84 |
| 4-18-67 | 68 | 92 |
| 5-4-67 | 78 | 89 |

The 1967 results are not as clear because a severe crust formed after the plots were planted and they had to be rotary-hoed twice to allow corn emergence, but the 4-pounds-per-acre rate always gave better control than the 3-pounds-per-acre rate.

If the herbicide is applied immediately before planting, then incorporation will have more effect on control than will the time between application and planting. Table 4 shows the effect of soil type upon the difference between immediate preplant incorporation and preemergence applications. The Cisne silt loam is a low-organic-matter (1 1/2- to 2-percent) claypan soil in southern Illinois. The Proctor silt loam is a medium-organic-matter soil (3 to 4 percent), while the Drummer silty clay loam is high with 6 to 8 percent organic matter. The Proctor and Drummer soils are both central Illinois prairie soils.

The greatest difference between preplant and preemergence treatments was with Sutan-D, where the incorporated treatments gave better control. This was to be expected because of the volatility of the Sutan. Ramrod, Lasso treatments alone and with Atrazine showed an incorporation dilution effect on the Drummer soil. Preemergence or preplant Ramrod did not give satisfactory control on the Cisne soil. This can be explained by the excessive rainfall. It rained 2.2 inches within 1 week and 6.68 inches within one month after application.

*Table 4. Effect of Soil Type and Time of Application (Incorporation) of Herbicide on Giant Foxtail Control*

| Herbicide | Time[1/] | Cisne silt loam | Proctor silt loam | Drummer silty clay loam |
|---|---|---|---|---|
| Atrazine | PPI | 100 | 100 | 78 |
| Atrazine | Pre | 100 | 100 | 71 |
| Ramrod | PPI | 45 | 97 | 74 |
| Ramrod | Pre | 55 | 100 | 96 |
| Lasso (CP-50144) | PPI | 98 | | 88 |
| Lasso (CP-50144) | Pre | 100 | | 98 |
| Sutan-D (R-1910+2,4-D) | PPI | 98 | 100 | |
| Sutan-D (R-1910+2,4-D) | Pre | 73 | 80 | |
| Atrazine + Caparol | PPI | 96 | 100 | 70 |
| Atrazine + Caparol | Pre | 100 | 97 | 78 |
| Atrazine + Ramrod | PPI | 93 | 100 | 70 |
| Atrazine + Ramrod | Pre | 98 | 100 | 91 |

1/ PPI = preplant incorporated (disc) one day before planting.
Pre = preemergence application; broadcast immediately after planting.

# SITE OF PREEMERGENCE HERBICIDE UPTAKE[1/]

*E.L. Knake*

We have frequently said that preemergence herbicides should be applied to the soil surface and that rainfall is needed to move the chemical near the germinating weed seed. Since we commonly associate roots with soil, we have sometimes assumed that soil-applied herbicides are active primarily in the root zone. Quoting from a recent product label, "Sufficient moisture (usually 1" to 2") in the form of rainfall or irrigation is necessary after treatment to carry the chemical into the root zone of germinating weeds...."

We have, in the past, largely by-passed the possibility of herbicide uptake by emerging shoots, even though we have recognized the effectiveness of some of the same herbicides when applied to the foliage of plants after emergence.

Some have suggested that increasing planting depth of the crop seed may decrease the possibility of crop injury from some preemergence herbicides.

Increasing interest in herbicide incorporation and the development of various devices for regulating the placement of soil-applied herbicides suggest the need for more fundamental knowledge on the site of herbicide uptake for both crop and weed species. If we know the most effective site for herbicide uptake by the plant, we can more logically select the most appropriate placement for the herbicide.

By "effective site of uptake" we mean the place where the herbicide contacts or is absorbed by the plant sufficiently to cause lethal effects. A herbicide may be taken up at certain sites without causing significant lethal effects. For example, a herbicide may be absorbed by roots but it may be degraded before it reaches the site of lethal activity. A herbicide may even exert some noticeable effect on the primary roots of a young grass seedling; but this may be of little significance if other roots can be formed elsewhere soon enough for continued growth of the plant. For a herbicide to be most effective for control of seedlings, it must kill the tops.

Actually our studies only indirectly suggest the sites for effective uptake. We have not determined the precise sites or the degree of penetration. Some action may be more of a contact type, with little absorption.

But by placing the herbicide in various zones, we have obtained information that suggests the general locations of the effective sites of uptake. This is providing the specifications we need to determine most appropriate placement.

We previously reported on work with six of our major herbicides in controlling green foxtail. In 1967 we studied the effect of placement on control of giant foxtail, using eleven herbicides. We selected giant foxtail because it is our most serious annual grass weed in Illinois and our primary reason for using preemergence herbicides.

1/ Abstract.

We placed herbicide-treated soil in the shoot zone, root zone, shoot and root zone, and seed zone. By shoot we mean any portion of the plant above the seed, including first internode or mesocotyl and the crown where roots also develop after about 1 1/2 weeks. Root zone refers to that portion of the plant below the seed--mainly the primary roots. Studies were conducted under carefully controlled conditions in the greenhouse. The technique used minimized moisture and herbicide movement in the soil. At the end of two weeks foxtail tops were harvested and dry weights used as a measure of herbicide effectiveness.

The herbicide concentration used was the $ED_{50}$ established previously as the amount of herbicide required to reduce the dry weight of tops 50 percent when herbicide and foxtail seed were both mixed in soil to a depth of 3 inches.

All of the eleven herbicides caused a significant reduction in dry weight of tops when placed in the shoot zone. When placed in the root zone, only amiben caused a significant reduction in dry weight of tops. Most herbicides were just as effective, or more so, in the shoot zone as in the seed zone. The only herbicides that were more effective in the seed zone than in the shoot zone were amiben and NPA (Alanap).

This study suggests that for controlling giant foxtail most of our present preemergence herbicides probably do not need to be placed very deep, but rather kept relatively shallow where they can be absorbed by the emerging shoot.

Because the emerging shoot is in a very moist microclimate and has a cuticle that is probably not very well developed, it is apparently easily affected by soil-applied herbicides.

This helps explain what most of us have been observing in the field for several years. Moderate rainfall moved a herbicide into the soil a little and provided sufficient moisture for uptake by the emerging shoot. But excessive rainfall moved the more soluble herbicides past the shoot zone, perhaps into the root zone, and effectiveness was reduced.

Although incorporation may reduce surface loss of herbicides and thereby allow some to be more effective, a dilution effect occurs with increasing depth of incorporation. And, if a herbicide is most effective in the shoot zone, it would seem logical to keep it relatively shallow where it will be more concentrated when the emerging shoot contacts it.

The amount of soil moisture required for herbicide absorption is another aspect we are studying. We have commonly emphasized the importance of rainfall for moving the herbicide into the soil. However another important function of rainfall is to provide sufficient moisture for absorption of the herbicide. Perhaps we should consider soil moisture of primary importance and rainfall, as it affects soil moisture, of secondary importance. Perhaps instead of indicating moisture needs in terms of inches of rainfall, we should characterize the needs with soil moisture terminology.

We sometimes say that rainfall "activates" a herbicide. The herbicide is already quite active when applied and usually we don't change it chemically or physically to make it more active. But it can be placed where there is likely to be adequate moisture for absorption by the weed seedlings.

We may be able to physically place some herbicides in the soil instead of depending on rainfall for this positioning. But there is some evidence suggesting that some herbicides may be adsorbed less onto the soil complex and be more readily available for absorption by weeds if moved into the soil with moisture rather than mechanically mixed with relatively dry soil first. These relationships vary for different herbicides and each needs to be considered individually.

If adequate soil moisture is necessary for absorption of the herbicide, then incorporation to a depth sufficient to reach the required moisture may be beneficial. Especially under relatively dry conditions, benefits from having the herbicide in sufficiently moist soil may mask the dilution effect caused by increased depth of incorporation.

Although there is some interest in equipment for subsurface herbicide application, our studies suggest that for control of foxtail use of such equipment would likely be limited to the more volatile materials on soil with a physical condition that would permit adequate dissipation of the chemical. Subsurface application of a relatively immobile herbicide below the effective site of uptake does not appear desirable.

The studies on effective site of uptake suggest that the methods we have been using for applying preemergence herbicides have probably been essentially correct. This new information doesn't call for any drastic changes. But it does provide a clearer understanding of fundamental concepts and a means for evaluating the feasibility of new proposed changes for application methods.

Studies thus far on site of uptake for soil-applied herbicides have been primarily with grass species. Future studies may indicate differences for various crop and weed species and may suggest opportunities for improving selectivity.

# A CHANGING AGRICULTURE AND INSECT POPULATIONS

*H.B. Petty*

Definite changes in insect populations may be occurring because of changes in farming practices, changes which are adopted because they lead to increased yields. Such changes will continue to take place, but adjustments for insect control will be needed.

Chinch bugs are not the problem they once were. With general use of nitrogen, stands of small grains are more luxuriant than they used to be and consequently the humidity at ground level is higher. This humidity favors spread of a disease which kills the bugs. Also bugs do not survive well on plants whose nitrogen content is high. Armyworms are more common in grain than they used to be because of heavier fertilizer use; more fertilizer means more luxuriant stands of grain, and moths prefer to deposit eggs in luxuriant stands of grain where worm survival is greatest. Wireworms are at a low ebb in Illinois because aldrin and heptachlor applications to cornfields for many years have lowered the population of this pest. Corn rootworms have become more serious as we have increased our acreage of "continuous" corn.

However, a popular trend recently has been to blame insecticides whenever an insect outbreak has occurred or a different insect pest has appeared. A pest species may bloom when an insecticide kills the predators and parasites. The beneficial insect population very quickly returns to normal if we substitute a different insecticide. One application of an insecticide does not reduce insects for several years; that requires continued applications every year under agricultural conditions. Weather, although tremendously important each year, has only a temporary influence on insect populations, not a long-range effect.

Distinct and drastic changes are taking place in agricultural practices. The insect problems of tomorrow are being determined by today's changes in planting dates and rates, rotations, fertility practices, varieties, crops, use of various insecticides, herbicides, and fungicides, irrigation, minimum tillage, harvesting techniques, and other factors. Each species will either adapt to these changes or become non-existent as a pest. So some "old" insect pests will become of historical importance, and some "new" pests will appear on the scene. Many insects of minor importance or only sporadically important to our farm crops today potentially are tomorrow's pests. Mites, aphids, thrips, leafhoppers, garden centipedes, springtails, and plant bugs can serve as examples. Several caterpillars found in cornfields and soybean fields are potential pests. Although we do not have the knowledge or foresight to predict the future problems, Table 1 gives an idea of what we can expect.

## *NITROGEN APPLICATIONS*

Over 25 years ago, Bigger showed that grasshopper survival and reproduction were lowest when the grasshoppers were fed corn with a high nitrogen content. Haseman reported that chinch bugs matured slower, lived a shorter time, and produced fewer offspring when corn was grown in high nitrogen solutions. Wittwer and Haseman showed that common greenhouse thrips preferred spinach deficient in nitrogen. Concerning green bugs on oats, Arant and Jones showed the following:

| | | | | |
|---|---|---|---|---|
| Nitrogen rate per acre, lb. | 0 | 40 | 80 | 120 |
| Greenbugs per oat leaf | 38.7 | 17.7 | 21.0 | 13.1 |

*Table 1. Expected Effect of Changing Three Agronomic Practices on Corn Insect Pests*

| Corn insect pests | Effect on insect population | | | Effect on insect damage | | |
|---|---|---|---|---|---|---|
| | Continuous corn | Early planting | Use of nitrogen | Continuous corn | Early planting | Use of nitrogen |
| Seed corn beetles | 0 | 0 | 0 | 0 | + | 0 |
| Seed corn maggots | 0 | 0 | 0 | 0 | + | 0 |
| Wireworms | 0 | 0 | 0 | 0 | + | 0 |
| Black cutworms | 0 | 0 | 0 | 0 | + | 0 |
| Grape colaspis | - | + | 0 | - | + (?) | - |
| White grubs | - | 0 | 0 | - | 0 | - |
| Japanese beetles | - | 0 | 0 | - | 0 | - |
| Corn root aphids | - | + | + | - | 0 | + |
| Northern corn rootworms | + | 0 | 0 | + | - | - |
| Western corn rootworms | + | 0 | 0 | + | - | - |
| Southern corn rooworms | 0 | 0 | 0 | 0 | 0 | - |
| Billbugs | 0 | 0 | 0 | 0 | 0 | ? |
| Flea beetles | 0 | 0 | ? | 0 | + | ? |
| Thrips | 0 | 0 | + | 0 | 0 | + |
| European corn borer | 0 | + | + | 0 | + | + |
| Southwestern corn borer | 0 | - | - | 0 | - | - |
| Chinch bugs | 0 | 0 | - | 0 | - | - |
| Grasshoppers | 0 | 0 | - | 0 | 0 | - |
| Fall armyworms | 0 | 0 | 0 | 0 | - | 0 |
| Corn earworms | 0 | 0 | 0 | 0 | - (?) | 0 |
| Leafhoppers | 0 | 0 | ? | 0 | ? | ? |
| Woolly bear caterpillars | 0 | 0 | 0 | 0 | - | ? |
| Two-spotted mites | 0 | 0 | + | 0 | - | + |
| True armyworms | 0 | 0 | 0 | 0 | 0 | 0 |
| Yellow-striped armyworms | 0 | 0 | 0 | 0 | 0 | 0 |
| Corn leaf aphid | 0 | - | + | 0 | - | + |

CODE: - means practice will decrease present populations or damage, + means the practice will increase present populations or damage, 0 means no effect, and ? means unknown.

Thus these four species could become or perhaps have already become less abundant with increased use of nitrogen.

Taylor, Apple, and Berger in 1962 were unable to show any effects on reproductive capacity of potato aphids or pea aphids under conditions of either high or low nitrogen in plants.

In 1965, Branson and Simpson infested plants grown in high-nitrogen solutions and low-nitrogen solutions with 3 aphids per plant. Twenty days later high-nitrogen plants averaged 162.2 aphids per plant, while low-nitrogen plants averaged 71.9 aphids per plant. Bowling in 1962 showed the following for rice water weevil populations and nitrogen:

| | | | | |
|---|---|---|---|---|
| Nitrogen rate per acre, lb. | 0 | 40 | 80 | 120 |
| Larvae per foot of row | 25.7 | 57.2 | 73.2 | 97.2 |

Chaboussou demonstrated increased rate of mite reproduction on grapes when high rates of nitrogen were used.

But of most importance is the fact that in all experiments high-nitrogen plots outyielded low-nitrogen plots, and the damage from insects was far greater in those plots where nitrogen was low. Thus survival and reproduction of insects as well as crop yields are affected by nitrogen.

*EARLY CORN PLANTING*

Obviously European corn borer populations should increase with early planting. The more mature the corn when borer moths deposit their eggs, the greater the borer survival. Thus other things being equal, there should be an increase in corn borers.

Grape colaspis eat the tiny corn roots when corn follows clovers or lespedeza. This deprives the plant of phosphorus and the corn turns purple. Delayed planting combined with weed control during the delay has reduced damage and killed many larvae. Also, the use of a band fertilizer high in phosphate helps overcome the damage. Early planting will permit higher colaspis survival, and thus an increase in the population. Damage symptoms will be more noticeable, but exceptionally early vigorous growth because of fertilizers may minimize damage. On the other hand, pop-up fertilizers may not supply enough phosphate to overcome damage to early corn by grape colaspis larvae.

Black cutworm moths are attracted to damp or low areas of fields to deposit their eggs, regardless of planting date. Corn planted in middle to late planting season often recuperates from attack because the plants are small and the worms cut them above the growing point; 60 to 80 percent of the cut plants will recover. Since the worms cut below the growing point of larger plants, earlier corn will be killed, necessitating replanting. Early planting means greater damage, but does not affect cutworm populations.

Early planting and slow germination will mean more damage by seed corn beetles and seed corn maggots. However, early planting will help decrease damage by survival of southwestern corn borer, corn leaf aphids, larvae and adults of corn rootworms, corn earworms, fall armyworms, chinch bugs, webworms, corn root aphids, and others.

## *CONTINUOUS CORN*

Will a one-crop system or monoculture lead to an increase in insect problems? There are probably more insect problems today as the result of rotations than as a result of continuous corn. Northern and western corn rootworms are exceptions. They do build up in fields of continuous corn, are extremely damaging, and may completely annihilate a farmer's corn crop. The only successful nonchemical control of northern corn rootworm is rotation with some other crop grown for two years.

Continuous corn will have little if any effect on populations of cutworms, southern corn rootworms, seed corn beetles, seed corn maggots, European corn borers, southwestern corn borers, chinch bugs, and corn leaf aphids.

Continuous corn decreases the problems from wireworms, white grubs, Japanese beetles, grape colaspis, corn root aphids, and sod webworms, as they are more commonly pests of corn planted on grass sods.

Continuous corn may, in the future, result in heretofore unimportant insects appearing as pests.

## *USE OF PESTICIDES*

Weed control often removes insect food, forcing the insects to feed upon the cultivated crop. When no foxtail is present in a cornfield for chinch bugs to feed upon, they will undoubtedly attack corn. But if there is foxtail in a cornfield, chinch bugs may feed on the foxtail and attack the corn only after the foxtail is killed, or they may migrate across the entire field, killing the foxtail as they go but not attacking the corn. Japanese beetles feed on smartweeds when they are present, and they actually prefer smartweeds. If there are no smartweeds in a cornfield, Japanese beetles may well feed on the corn and on the silks, affecting pollination.

Wireworm populations are only a fraction of what they once were. Continual use of aldrin or heptachlor in cornfields may have greatly reduced the total population as well as individual field populations of this pest in Illinois. Chinch bugs may be at a low ebb also, because of soil insecticides. Chinch bugs deposit their eggs in grain fields in, on, or near soil level. The tiny bugs that hatch frequent the soil. Slight residues might control a high percentage of these newly hatched bugs. Sweet clover weevils frequent the soil in grain fields in search of sweet clover seedlings. They may be controlled by small residues of soil insecticides in the field. Sweet clover plants have become more numerous in fields now than they were 10 to 20 years ago. Other such examples might be cited where the use of an insecticide is general and annual.

Use of less persistent insecticides may well lead to a return of these insects as pests.

Chaboussou has shown that mite reproduction per individual female is much greater on plants treated with certain insecticides and fungicides than it is on untreated plants; other insecticides and fungicides have no effect on this reproduction. This occurs even after all natural enemies of the mites have been removed from both the untreated and treated leaves. In this case, certain pesticides may be changing the plant physiologically, favoring insect survival.

### *INSECT ADAPTABILITY*

Although white grubs are normally associated with grass sods, a species of white grub has adapted itself to a corn-soybean rotation. A strain (?) of Japanese beetles near Sheldon deposits eggs in soybean fields and not in grass sods as customary. Northern and western corn rootworms resistant to aldrin and heptachlor may become pests of second-year corn or even first-year corn. Thus rotations may in the future fail to control these species. A strain of Hessian fly has developed that attacks Monon wheat, a supposedly resistant strain.

Insects rapidly adapt to their environment--insect strains resistant to insecticides are good examples.

### *OTHER FACTORS*

Little is known about how *plant populations* affect insect populations. *Draining* wet spots may decrease black cutworm and wireworm problems. *Picker shellers* may be actually decreasing the European corn borer numbers. *Minimum tillage* may favor overwintering successes of some insects.

### *CONCLUSION*

Farmers adopt practices that increase yields, but we should understand that these practices will affect insect populations. We must be prepared to cope with the changes so that farmers can get full return on their investments. If we get a "head start" on a pest of the future, everyone will profit.

We have tried to show how a variety of practices affect insect populations. When the unexpected happens, investigate all possibilities. We invite you always to call the unexpected or unusual to our attention.

# PESTICIDE ACCIDENT REPORTS

*R. Randell*

For the past 7 years, we have summarized information supplied by Illinois poison control centers. If a child 12 years of age or under ingests or is contaminated by a hazardous substance and a downstate poison control center is contacted, the case is reported to the Illinois Department of Public Health. These cases are rarely fatal, but they do cause concern to parents and discomfort to the child. Dr. Norman Rose, Bureau of Hazardous Substances and Poison Control, Illinois Department of Public Health, Springfield, provided us with the information summarized in this report. The 1966 information on ingestion cases in Chicago was supplied by Mr. Frank Bauer, Bureau of Vital Statistics, Board of Health, Chicago.

*Where do pesticides rank as sources of hazard?* When all cases of accidental ingestion of hazardous substances by children under 12 years were totaled for Illinois during the years 1962 through 1966, we find that 6.5 percent of the cases involved pesticides. This figure has been decreasing with each successive year. The other 93.5 percent involved medicines and other substances (Table 1).

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

| | Percent of total | | | | | |
|---|---|---|---|---|---|---|
| Material | 1962 | 1963 | 1964 | 1965 | 1966 | 5-year av. |
| Medicine | 57.2 | 56.2 | 59.3 | 63.4 | 64.2 | 60.1 |
| Household preparations | 16.6 | 16.3 | 15 | 13 | 12.5 | 14.7 |
| Pesticides | 7.3 | 6.9 | 6.7 | 6.1 | 5.7 | 6.5 |
| Paints, etc. | 4.9 | 6.3 | 5 | 4.6 | 4.6 | 5.1 |
| Cosmetics | 2.7 | 3 | 3 | 2.7 | 2.8 | 2.8 |
| Miscellaneous | 11.3 | 11.3 | 11 | 11.2 | 10.2 | 11 |

*Do the accident cases fluctuate with the seasons?* Yes. More children eat pesticides and paints during the late spring, summer, and early fall than during the winter. They eat medicines more in the winter than in the summer, while they seem to get into household preparations more in the fall than at any other time (Table 2).

*Table 2. Ingestion of Hazardous Materials by Children Under 12 Years, as Reported to Poison Control Centers. Average for 1960-1966*

| Material | Jan.-June | July-August | Sept.-Oct. | Nov.-Dec. | Total |
|---|---|---|---|---|---|
| Medicine | 3,271 | 871 | 1,159 | 1,289 | 6,590 |
| Household preparations | 758 | 281 | 304 | 275 | 1,618 |
| Pesticides | 304 | 164 | 143 | 115 | 726 |
| Paints, etc. | 213 | 125 | 123 | 90 | 551 |
| Cosmetics | 153 | 47 | 53 | 54 | 307 |
| Miscellaneous | ... | ... | ... | ... | 1,180 |
| | | | | | 10,972 |

*What pests were the parents trying to control when their child ingested some of the pesticide?* Rats, mice, ants, moths, and roaches. Control substances were the pesticides primarily involved in these accidental ingestions. These materials accounted for about 82 percent of all pesticide ingestions (Table 3).

*Table 3. Ingestion of Pesticides by Children Under 12 Years, as Reported by Downstate Poison Control Centers. Average for 1961 Through 1966. Based on Pests to Be Controlled and Source of Pesticide*

| Pests | Pesticide obtained In use | Pesticide obtained From storage | Pesticide obtained Unknown | Total | Percent of total | Pesticide obtained as a bait | Percent of total |
|---|---|---|---|---|---|---|---|
| Rodents | 73 | 16 | 66 | 154 | 32.7 | 147 | 95.4 |
| Ants | 39 | 6 | 40 | 95 | 20.2 | 89 | 93.7 |
| Moths | 45 | 7 | 32 | 84 | 17.8 | 0 | 0 |
| Roaches | 26 | 9 | 19 | 54 | 11.5 | 31 | 57.4 |
| Unspecified | 7 | 9 | 12 | 28 | 5.9 | 1 | 35.9 |
| Flies | 4 | 5 | 7 | 16 | 3.4 | 4 | 25 |
| Mosquitoes | 1 | 4 | 4 | 9 | 1.9 | 0 | 0 |
| Flower pests | 2 | 4 | 3 | 9 | 1.9 | 0 | 0 |
| Weeds | 3 | 5 | 7 | 15 | 3.2 | 0 | 0 |
| Others | 2 | 2 | 3 | 7 | 1.5 | 1 | 14.3 |
| TOTAL | 202 | 67 | 193 | 471 | 100 | 273 | ... |
| Percent | 43.7 | 14.5 | 41.8 | ... | 100 | ... | 58 |

*Are certain pesticides ingested more commonly in one season than another?* Yes. Rodent-bait ingestion occurs more often in November and December than in other months. Ant-bait ingestions are most common during May through August. Moth ball ingestions occur uniformly throughout the year. Roach-bait ingestions are slightly higher during the late summer and fall months (Table 4).

*Table 4. Ingestion of Pesticides Intended for Control of Rodents, Ants, Moths, and Roaches by Children Under 12 Years, as Reported to Downstate Illinois Poison Control Centers. Average for 1961-1966*

| | Bimonthly total | | | | | |
|---|---|---|---|---|---|---|
| Pests | Jan.-Feb. | March-April | May-June | July-August | Sept.-Oct. | Nov.-Dec. |
| Rodents | 22 | 21 | 26 | 21 | 26 | 39 |
| Ants | 5 | 6 | 27 | 39 | 17 | 5 |
| Moths | 12 | 10 | 17 | 13 | 16 | 16 |
| Roaches | 5 | 8 | 8 | 10 | 13 | 9 |

*What are the most common pesticides that children accidentally ingest?* The most common are anticoagulant rodent baits. The next most common were the arsenicals, followed by naphthalene and PDB. Using only insecticide ingestion cases and disregarding rodenticides, herbicides, fungicides, and unspecified cases, we find that during the past 5 years, there were 1,204 ingestion cases involving pre-1945 insecticides, and 322 cases involving post-1945 insecticides (Table 5).

*Table 5. Cases of Pesticide Ingestion by Children Under 12 Years--1962 Through 1966, and Total*

| Pesticide | Number of cases 1962 | 1963 | 1964 | 1965 | 1966 | 5-year total |
|---|---|---|---|---|---|---|
| Anticoagulant rodenticides | 126 | 128 | 184 | 169 | 144 | 751 |
| Naphthalene & PDB | 76 | 93 | 90 | 101 | 78 | 438 |
| Arsenicals | 65 | 110 | 145 | 117 | 134 | 571 |
| Unspecified | 38 | 38 | 9 | 38 | 14 | 137 |
| DDT | 21 | 22 | 10 | 12 | 9 | 74 |
| Chlordane | 12 | 8 | 9 | 7 | 9 | 45 |
| DDVP | 12 | 2 | 2 | 1 | 2 | 19 |
| 2,4-D | 11 | 4 | 7 | 3 | 9 | 34 |
| Lindane | 10 | 11 | 11 | 13 | 11 | 56 |
| Strychnine | 9 | 7 | 5 | 5 | 6 | 32 |
| Dieldrin | 8 | 6 | 15 | 3 | 15 | 47 |
| Sodium fluoride | 8 | 7 | 4 | 8 | 3 | 30 |
| Thallium sulfate | 8 | 5 | 10 | 10 | 13 | 46 |
| Phosphorous paste | 8 | 15 | 3 | 6 | 4 | 36 |
| Pyrethrins | 8 | 0 | 2 | 16 | 12 | 38 |
| 612 and Deet | 7 | 9 | 11 | 4 | 6 | 37 |
| Boric acid | 5 | 6 | 5 | 11 | 7 | 34 |
| Diazinon | 4 | 1 | 1 | 1 | 4 | 11 |
| Ronnel | 0 | 0 | 1 | 0 | 0 | 1 |

| Pesticide | Number of cases 1962 | 1963 | 1964 | 1965 | 1966 | 5-year total |
|---|---|---|---|---|---|---|
| Rotenone | 3 | 0 | 0 | 2 | 1 | 6 |
| Malathion | 2 | 1 | 4 | 3 | 7 | 17 |
| Camphor | 2 | 0 | 0 | 0 | ... | 2 |
| Nicotine | 1 | 0 | 0 | 2 | ... | 3 |
| Methoxychlor | 1 | 0 | 2 | 0 | 4 | 7 |
| DDD | 1 | 0 | 0 | 0 | ... | 1 |
| Aldrin | 0 | 1 | 0 | 0 | ... | 1 |
| Metaldehyde | 1 | 0 | 0 | 0 | ... | 1 |
| Sodium chlorate | 1 | 0 | 0 | 0 | ... | 1 |
| Disodium pentachlorophenate | 1 | 0 | 0 | 0 | ... | 1 |
| Potassium cyanate | 0 | 1 | 1 | 0 | ... | 2 |
| Fungicides | 0 | 0 | 0 | 3 | ... | 3 |
| Fumigants | 0 | 0 | 0 | 1 | ... | 1 |
| Randox | 0 | 1 | 0 | 0 | 1 | 2 |
| Dimite | 0 | 1 | 0 | 0 | ... | 1 |
| Parathion | 0 | 0 | 1 | 0 | ... | 1 |
| Bidrin | ... | ... | ... | ... | 1 | 1 |
| Dibrom | ... | ... | ... | ... | 1 | 1 |
| TOTAL | 449 | 477 | 532 | 536 | 495 | 2,489 |

*What can parents do to prevent their children from getting into pesticides?* First, avoid using baits to control rats, mice, ants, and roaches whenever possible. If baits are the only alternative, put them where small children cannot get into them. During 1966, 461 children ate baits containing an insecticide. From 1962 through 1965, an average of 481 children per year ingested some form of pesticide bait (Table 6).

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

| | 1962 | | | 1963 | | | 1964 | | |
|---|---|---|---|---|---|---|---|---|---|
| Sources | Downstate 1/ | Chicago 1/ | Total | Downstate | Chicago | Total | Downstate | Chicago | Total |
| Baits | 246 | 129 | 375 | 302 | 184 | 486 | 366 | 194 | 560 |
| Moth balls | 82 | 43 | 125 | 95 | 58 | 153 | 90 | 48 | 138 |
| Storage | 57 | 30 | 87 | 46 | 28 | 74 | 65 | 35 | 100 |
| Disposal | 16 | 8 | 24 | 5 | 5 | 10 | 17 | 9 | 26 |
| Unknown | 72 | 39 | 111 | 61 | 35 | 96 | 16 | 8 | 24 |
| Total cases | 473 | 249 | 722 | 509 | 310 | 819 | 554 | 294 | 848 |

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

| | 1965 | | | 1966 | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Sources | Downstate 1/ | Chicago 1/ | Total | Downstate 1/ | Chicago 2/ | Total | 5-year total | Yearly av. | Percent total |
| Baits | 322 | 202 | 524 | 275 | 186 | 461 | 2,406 | 481 | 59.5 |
| Moth balls | 99 | 60 | 159 | 80 | 33 | 113 | 688 | 138 | 17.1 |
| Storage | 45 | 30 | 75 | 29 | 15 | 44 | 380 | 76 | 9.4 |
| Disposal | 9 | 7 | 16 | 15 | 6 | 21 | 97 | 19 | 2.4 |
| Unknown | 61 | 37 | 98 | 96 | 45 | 141 | 470 | 94 | 11.6 |
| Total cases | 536 | 336 | 872 | 495 | 285 | 780 | 4,041 | 808 | 100 |

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

2/ Actual Chicago figures.

When using moth balls, keep woolens in a sealed or locked container where children cannot get at them. When removing woolens from storage, be sure to dispose of the moth balls or store them in a safe place. In 1966, 113 children accidentally ingested moth balls or crystals, with a 5-year average of 138 children per year (1962-66).

Improper storage of pesticides accounted for 44 accidental ingestion cases in 1966. Improper disposal of the material or its container accounted for 21 cases during the same year.

*Fatal Illinois pesticide accidents.* Statistics on accidental deaths have been collected for the past 7 years (Table 7). During this period, there have been 5 deaths from rodenticide poisonings, 4 deaths from sodium arsenite used as an herbicide, 10 deaths from insecticides, and 3 deaths from unknown pesticides. The insecticide poisonings included 4 due to sodium fluoride, 1 to parathion, 1 to diazinon, 1 to lead arsenate, 1 to PDB, 1 to DDT, and 1 to lindane.

From 1960 through 1966, only 1 of the 22 accidental pesticide deaths was due to an agricultural accident, while the other 21 took place in or about the home. Twelve persons were killed by the pesticide while it was being used; the other 10 deaths were due to improper storage. Nine of the deaths were caused by baits.

The two deaths from herbicides during 1966 were almost identical. Children, 1 and 2 years old, tasted sodium arsenite that was in a measuring cup used during the application of the weed killer. Again, we strongly suggest that sodium arsenite not be sold for use by homeowners. All 3 deaths due to insecticide poisoning were the result of improper storage. In each case, the insecticide was stored in a bottle other than the original container.

Twenty-two deaths from pesticides during the past 7 years are a small part of the more than 32,000 accidental deaths that have occurred during this time. Proper storage, correct handling during use, and proper container disposal would probably have prevented all of these 22 deaths.

*This 4-step program will help to protect children from poisoning:*

1. Use baits properly--out of reach of children.

2. Store woolens properly--in sealed containers if you use moth balls.

3. Keep pesticides stored under lock and key and in their original container.

4. Burn empty paper pesticide bags, and stay out of the smoke. Burn out or wash out other pesticide containers; then haul them to the sanitary land fill or bury them.

These 4 steps will prevent almost all accidents with pesticides in the home.

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

| Cause or location | 1960 | 1961 | 1962 | 1963 | 1964 | 1965 | 1966 | 7-year average | Percent of total |
|---|---|---|---|---|---|---|---|---|---|
| Motor vehicles | 1,741 | 1,843 | 1,890 | 2,019 | 2,205 | 2,261 | 2,535 | 2,071 | 44.7 |
| Home accidents | 1,270 | 1,204 | 1,286 | 1,380 | 1,338 | 1,260 | 1,430 | 1,310 | 28.3 |
| Public accidents | 874 | 923 | 892 | 855 | 892 | 918 | 1,084 | 920 | 19.9 |
| Occupational accidents | 318 | 331 | 303 | 312 | 316 | 374 | 346 | 329 | 7.1 |
| TOTAL | 4,203 | 4,301 | 4,371 | 4,566 | 4,751 | 4,813 | 5,395 | 4,630 | |
| Fires--explosions | 362 | 338 | 357 | 442 | 379 | 394 | 474 | 392 | 8.5 |
| Falls on stairs | 136 | 136 | 125 | 106 | 143 | 137 | 121 | 129 | 2.8 |
| Firearms | 100 | 92 | 117 | 100 | 109 | 105 | 116 | 106 | 2.3 |
| Drugs, etc. | 49 | 70 | 81 | 98 | 86 | 101 | 117 | 86 | 1.9 |
| Barbiturates, etc. | 21 | 29 | 39 | 54 | 39 | 41 | 54 | 40 | 0.9 |
| Lead | 28 | 16 | 26 | 19 | 8 | 18 | 7 | 17 | 0.4 |
| Aspirin, etc. | 12 | 11 | 13 | 11 | 10 | 16 | 11 | 12 | 0.26 |
| Other animals | 2 | 7 | 6 | 4 | 5 | 3 | 4 | 4.5 | 0.10 |
| Lightning | 4 | 5 | 2 | 4 | 2 | 4 | 2 | 3.3 | 0.07 |
| Petroleum products | 0 | 5 | 2 | 3 | 0 | 0 | 1 | 1.6 | 0.034 |
| Insecticides | 5 | 1 | 0 | 1 | 0 | 3 | 3 | 1.9 | 0.041 |
| Rodenticides | 2 | 0 | 1 | 0 | 0 | 1 | 1 | 0.7 | 0.015 |
| Herbicides | 0 | 1 | 0 | 0 | 1 | 0 | 2 | 0.6 | 0.013 |
| Venomous stings, etc. | 2 | 0 | 0 | 0 | 1 | 3 | 1 | 1.0 | 0.022 |
| Arsenic | 1 | 1 | 0 | 0 | 0 | 1 | 4 | 1.0 | 0.022 |

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.

## INSECTICIDE RESIDUES AND AGRICULTURAL EXPORTS

*H.B. Petty*

Illinois recommendations have often been more restrictive than recommendations on the label. Our objectives have been to keep residues at the lowest possible level, even though this may be well below the residues permitted by law. We have had two objectives in mind: (1) agricultural produce for interstate shipment and (2) agricultural produce for export from the United States.

Generally, U.S. residue tolerances have been realistic; by some standards, liberal. What are the actual results in terms of American diets? The Food and Drug Administration of the Federal Health, Education, and Welfare Department conducts the much-publicized "market basket" samples in five U.S. cities. The residues in the foods prepared for the table are less than 1 percent of the legal tolerance. Tolerances, in turn, are established roughly with a safety factor of 100. R.E. Duggan, H.C. Barry, and L.Y. Johnson of the FDA reported in the *Pesticides Monitoring Journal* (Vol. 1, No. 2) that the market basket samples showed that, "the calculated levels were not seen to be approaching the acceptable daily intakes established for certain pesticide chemicals by the World Health Organization." (The acceptable daily intake is the amount of a pesticide a person could eat daily for his lifetime with no harmful effect.) Briefly, this expresses the food pesticide-residue relationship in the United States. Furthermore, many tolerances are now generally being lowered. Thus, our food supply has had and will continue to have an insignificant pesticide residue.

Let's look at exports. Most countries are starting to establish tolerances, and these tolerances are lower than ours. Agricultural economists when asked commonly say that well over one-third of our agricultural production enters foreign trade channels. If we consider the part played in our economy by this 30 percent, we can readily visualize the consternation that would result if we were unable to export certain produce because of pesticide residues. For example, the USDA reports that 23 percent of soybeans and soybean products exported from the United States in 1966 were produced in Illinois.

Most laws regulating the use of pesticides were first enacted in America. The effects of our laws governing approval, residues, side effects, and application have been and are still being studied carefully by the European and Asian countries. They will profit from our experiences; in some instances, theirs may well be more restrictive than ours.

All countries recognize the need for label approval of pesticides, but for different reasons. Spain emphasizes applicator (user and handler) safety; Italy emphasizes applicator safety and residues on food; Germany emphasizes residues on food; France emphasizes residues on food and performance; Holland emphasizes residues on food, applicator safety, water contamination, and side effects on wildlife; England emphasizes performance, residues on food, and side effects on wildlife.

The residue picture is presently under active review in England, Germany, and Holland, as well as in the United States. In addition, the European Common Market countries have established a committee on pesticide residues. The Food and Agricultural Organization (FAO) of the United Nations has this subject under study, and there is a pesticide subcommittee of the Codex Alimentarius. Many countries are patiently waiting for a model label and residue-tolerance law to be prepared by FAO, with the thought that this will provide a uniform base to which can be appended local adaptations. Belgium, Holland, and Luxemburg are already combining their efforts to standardize all pesticide requirements for these three countries. Eventually, the amounts of pesticides on major foods and feeds must be the same for all countries; if uniform tolerances are not established, they could soon be used as trade barriers.

Examining the thinking of these organizations, however, we soon see that practically all tolerances under consideration by these groups are considerably lower than ours in the United States.

Germany proposes a zero tolerance for aldrin, Aramite, chlordane, dieldrin, heptachlor, and others. Holland, on the other hand, proposes a 0.1 p.p.m. for persistent insecticides--aldrin, dieldrin, heptachlor, and chlordane. For comparison, we might select a few examples of tolerances on many vegetables and some fruits.

| | Tolerance level in p.p.m. | | | |
|---|---|---|---|---|
| Pesticide | USA | West Germany | Another European country's proposal | |
| Aldrin | 0.01-0.1 | 0 1/ | 0.1 (Aldrin, Chlordane, Heptachlor) | |
| Chlordane | 0.3 | 0 1/ | | |
| Heptachlor | 0.0-0.1 | 0 1/ | | |
| DDT | 7.0 | 1.0 | 1.0 | |
| Methoxychlor | 14.0 | 10.0 | 10.0 | |
| Lindane | 10.0 | 2.0 | 2.0 | |
| Carbaryl | 10.0 | 3.0 | 3.0 | |
| Diazinon | 0.75 | 0.5 | ? | |
| Dimethoate | 2.0 | 0.5 | 0.6 | |
| Malathion | 8.0 | 0.5 | 3.0 | |
| Azinphosmethyl | 2.0 | 0.4 | 0.5 | total (Azinphosmethyl, Ethyl parathion, Methyl parathion) |
| Ethyl parathion | 1.0 | 0.5 | 0.5 | |
| Methyl parathion | 1.0 | 0.5 | 0.5 | |
| Captan | 100.0 | 15.0 | 15.0 | |

1/ Still being questioned.

Residues on some foods may only be of national importance, and may vary from country to country. But residues permitted on foods of international importance should be reasonable and uniform for the staple commodities like rice, wheat, corn, soybeans, nuts, some fruits, and vegetables. Rates of application, the interval between application and harvest, and similar factors would vary from country to country, depending on climate, soil-cropping practices, and other variables. But an international tolerance level for each pesticide would lead to more-sensible world food production.

The food needs of the world are well documented in the form of malnutrition and starvation. Establishment of international tolerances and minimal daily intake by FAO should take these factors into consideration and be realistic. In the meantime, our tolerances are being reduced. But in face of world food supplies and our experiences with market basket samples, the tolerances in other countries could safely be raised for certain pesticides. At present, we must constantly be alert to the tolerances established on specific crops in other countries. If foreign countries want to restrict the imports of U.S. agricultural produce, they can do it in many ways. We want to prevent pesticides from being used as a "scape goat" to accomplish such objectives.

## WATER WEED CONTROL

*R.C. Hiltibran*

The reporting of new aquatic plant control data has slowed somewhat since my last report in 1964; however, during this period of time, our research efforts have continued. Several herbicides suggested by various manufacturers have been tested, but most of these have not, as yet, been made available; many were not any more effective than the aquatic herbicides we have previously discussed.

The most important development since 1964 has been the registration by the Pesticide Registration Division, U.S. Department of Agriculture, for use in the aquatic environment of two preemergent herbicides: Dichlobenil, sold under the trade name of Casoron by the Thompson-Hayward Chemical Company; and the sodium salt of 2,3,6-trichlorophenylacetic acid, sold under the trade name of Fenac by Amchem Products, Inc.

We had been considering the possible use of preemergent-type herbicides for several years, but the progress was slow. It was not until early in 1963 that we obtained some indicative results and in 1964, some positive results as to the effectiveness of these herbicides. Continued investigation permitted us to report the effectiveness of Fenac and dichlobenil in 1965 and 1966.

Fenac must be applied to the exposed pond bottom, as it is not effective as a preemergent herbicide when applied through the water. Dichlobenil can be applied either to the exposed pond bottom or through the water, although higher rates are required in the latter case. Fall drawdowns have been recommended by fishery biologists as a fish-management practice; the use of preemergent herbicides would fit into this fish-management practice.

Dichlobenil was effective at a rate of 4 pounds active per acre for the season-long control of chara, *Chara* spp., sago pondweed, *Potamogeton pectinatus*, small pondweed, *P. pusillus*, and bulrush, *Scirpus acutus*. At a rate of 8 pounds active per acre, dichlobenil gave season-long control of southern naiad, *Najas guadalupensis*, slender naiad, *N. flexilis*, and American pondweed, *P. nodosus*. For the control of leafy pondweed, however, rates of dichlobenil as high as 12 to 15 pounds active per acre may be required. We are not satisfied with these high rates, and plan to see if they can be lowered.

Fenac was effective for the control of sago pondweed at a rate of 10 pounds active per acre, and rates of 20 pounds per acre reduced the stands of southern naiad and leafy pondweed. The manufacturer recommends either 150 to 200 pounds of 10-percent granular Fenac or liquid Fenac at a rate of 10 to 13 gallons per acre, applied in 50 to 100 gallons of water. Use the higher rates in areas with histories of heavy weed infestations.

One added note here: do not use simazine or atrazine in the aquatic environment for two reasons: (1) They are not currently registered for this use, and (2) we have not found them particularly effective as preemergent herbicides in Illinois.

We have obtained excellent results with dichlobenil when applied to exposed pond bottom in December and as late as February or March. Also, we have obtained excellent results by applications through the water in March and early April. Since the seasons vary, applications in late April may be too late. There is a 60-day delay in water use that must be considered.

Diquat cation has been found to be very effective for the control of both narrowleaf cattails, *Typha angustifolia*, and broadleaf cattails, *T. latifolia*, at a rate of 2 tablespoons per 3 gallons of water. A non-ionic wetting agent such as X-77 must be used. The common household liquid detergent Joy can also be used, but such a suggestion does not imply that all liquid household detergents can be used. Due to the cationic nature of the diquat ion, strong ionic detergents would not be effective.

One question I have concerning the aquatic weed-control recommendations is how effective are the herbicides when applied throughout the state of Illinois. Recently it was brought to my attention that spatterdock *(Nuphar advena)* and waterstargrass *(Heteranthera dubia)* had not been controlled by the herbicides recommended. Since I had not undertaken any control investigations on either of these species, I was not able to offer any assistance. The complete story cannot be told here; but it will suffice to say that after checking the literature, the applicator had used the best available herbicide. Even so, the opportunity for the control of spatterdock was not good. We found that granular 2,4,5-trichlorophenoxypropionic acid (silvex) and 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) were effective; however, the spatterdock was not completely eliminated within the treated area. Liquid applications of silvex, 2,4,5-T, and 2,4-D were not effective. We need to apply the herbicides earlier in the spring in the attempt to control the spatterdock, and we still have much to be done before the control of spatterdock can be affected.

Waterstargrass was eliminated from the test areas by diquat cation at a rate of 1 p.p.m.w. We did not apply any other herbicide to test areas containing waterstargrass to determine their effectiveness on that species. It remains for us to determine if herbicides that have been recommended for the control of waterstargrass are effective in Illinois.

For several years, we have been observing many bodies of water to record the changes in aquatic plants present. In some of these bodies of water, we have attempted to alter the aquatic plant complex, but in others we have made no such attempt. We now have observations on three bodies of water for a 10-year period, and for an 8-year period on several others. Allerton Lake on the 4-H Camp grounds near Monticello has not received extensive applications of herbicides since 1958, although we have treated many small test areas since 1959. In 1959, the primary problem was sago pondweed. During 1961, 1962, and 1963, the water was extremely turbid, and the sago pondweed was not a serious problem in 1964 and 1965. Late in 1965, an extensive stand of leafy pondweed began to develop; this was the primary aquatic plant problem in 1966 and 1967. Chara has been present since our observations began in 1959. In late summer 1967, the leafy pondweed matured, and a phytoplankton algae bloom developed. In early September, the level of the lake was lowered about 10 feet; an extensive stand of chara remained.

In 1960, Miller Pond (also near Monticello) contained a heavy stand of northern watermilfoil, *Myriophyllum exalbescens*. The stand of watermilfoil decreased, but stands of sago pondweed and southern naiad developed in Miller Pond from 1961 through 1966. In 1962, a heavy stand of small pondweed was observed for the first time; it was not present again until 1967. In 1967, small pondweed infested about 95 percent of the water space. Some sago pondweed and southern naiad plants were present. In 1962, we predicted that small pondweed would again be found in Miller Pond when conditions were suitable for its growth. We expect small pondweed again in Miller Pond in the future.

We hope to learn more about these changes in aquatic plant complexes; also, we hope to be able to use this information in our control recommendations.

# ULV TREATMENTS FOR THE TRUE ARMYWORM[1/]

*S. Moore, III, and D.E. Kuhlman*

*Purpose*

To determine the effectiveness of diazinon, malathion, SD 8447 (Gardona), SD 9129 (Azodrin), and trichlorfon (Dylox) applied as ultra-low-volume aerial sprays against the true armyworm in wheat.

*Materials and Methods*

The northern half of an 80-acre field of Ben Hur certified seed wheat, located on the Curtiss Bradley farm in Gallatin County, was used for test purposes. Mr. Earl Lutz, Gallatin County Extension Adviser, located the field and assisted with plot layout and counting armyworms.

The undiluted insecticide concentrates were applied at the following dosages:

| Insecticide | Fluid ounces per acre | Pounds actual per acre |
|---|---|---|
| Diazinon | 16 | 0.98 |
| Malathion | 16 | 1.21 |
| SD 8447 | 16 | 0.5 |
| SD 9129 | 8 | 0.3 |
| Trichlorfon | 16 | 0.5 |

The insecticides were applied from a Pawnee 235 airplane adapted for ultra-low-volume spraying by the Ueding Flying Service of Vincennes, Indiana, piloted by Mr. Robert McIlvain. The applications were made between 6:00 and 7:30 p.m., May 21, under calm conditions (0-0.5 m.p.h. northeast wind) at a temperature of 70° F.

Four 50-foot swaths were applied in an east-west direction, with each insecticide at a flying height of 5 feet. An untreated strip of similar size was left for comparison. The check bordered the north edge of the sprayed plots.

Pretreatment and posttreatment counts of the number of armyworms per 2 linear feet of drill row were made in five locations in each plot. The average number of armyworms per linear foot of drill row was then computed.

*Results and Discussion*

All insecticides tested gave a nearly complete kill of armyworms within 5 days (Table 1). SD 8447 gave the highest initial kill, SD 9129 gave the lowest. Evening temperatures ranged from 55° to 65° F. during the 8 days following treatment, and armyworms moved up on the plants and fed actively each night. Daytime temperatures ranged between 70° and 90° F. during the same period. No precipitation occurred during the test period.

Ultra-low-volume aerial sprays of organic phosphate insecticides, like the ones tested, hold future promise for use in commercial control of true armyworms in wheat.

*Terms Defined*

1. ULV--"ultra-low-volume" means that the total volume of spray applied per acre is 2 quarts or less.

1/ Abstract.

2. LV--"low volume" means that the total volume of spray applied is adequate to uniformly cover the crop, but not as a full-cover spray to runoff.

3. FC--"full coverage" means that the total amount of spray applied will thoroughly cover the crop being treated to the point of runoff or drip.

*Table 1. Comparative Effectiveness of Several Organic Phosphate Insecticides Applied as Ultra-Low-Volume Aerial Sprays Against the Armyworm in Wheat in Gallatin County Illinois, 1967*

| Insecticides (north to south) | No. of armyworms per linear foot | | | | | | Percent defoliation of wheat by armyworms | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Post treatment | | | | | | Post treatment | | | |
| | Pre Tr. | 15 hr. | 36 hr. | 5 days | 8 days | Percent reduction | Pre Tr. | 15 hr. | 36 hr. | 5 days | 8 days |
| Check | 317 | 4.6 | 4.6 | 4.3 | 5.0 | 0.0 | 2 | 3 | 3 | 8 | 12 |
| Diazinon | 6.0 | 5.3 | 2.2 | 0.2 | 0.2 | 96.7 | 3 | 3 | 3 | 3 | 4 |
| SD 8447 | 10.0 | 5.0 | 2.1 | 0.0 | 0.0 | 100.0 | 5 | 5 | 5 | 5 | 5 |
| Trichlorfon | 7.7 | 4.5 | 2.0 | 0.2 | 0.0 | 100.0 | 2 | 3 | 3 | 4 | 4 |
| Malathion | 7.3 | 5.9 | 2.3 | 0.0 | 0.0 | 100.0 | 4 | 4 | 4 | 4 | 4 |
| SD 9129 | 4.7 | 4.0 | 2.2 | 0.0 | 0.0 | 100.0 | 3 | 3 | 3 | 3 | 3 |

## INTERACTIONS OF SOIL-APPLIED HERBICIDES AND OTHER PESTICIDES

*T.J. Sheets and F.T. Corbin*

Harmful effects on plant growth of herbicides and other pesticides applied at or near the same time have been observed and documented. About 6 years ago, research workers in Texas learned that cotton plants, which are not affected by diuron, phorate, and Di-Syston applied alone at rates necessary for pest control, were severely injured when the herbicide and either of the insecticides were applied at the same time. About 4 years ago, experiments by scientists of the Rohm and Haas Company showed that rice, which is normally resistant to the herbicide propanil and to the insecticides carbaryl (Sevin) and several organic phosphates applied separately, was highly susceptible to the herbicide in the presence of either of the insecticides. Observations such as these prompted a systematic survey of interactions of soil-applied herbicides and other pesticides.

Survey studies are being conducted in growth chambers. The pesticides are incorporated into small volumes of soil immediately before planting seeds of test plants. Yields of plants (corn, wheat, cotton, and cucumber) 12 days after seeding are used as a measure of effects of the pesticides.

There are four possible effects of pesticide combinations:

*Synergism:* Two pesticides acting together cause a greater reduction of plant weights than the sum of the effects of both used alone.

*Antagonism:* Two pesticides acting together cause less reduction of plant weights than the sum of the effects of both used alone.

*Additivity:* Two pesticides in combination cause the same total effect on yield as the sum of the independent effects of the two.

*Independence:* The effects on one pesticide on plant weights are unaffected by the presence of the other pesticide.

We have studied combinations of atrazine, diuron, vernolate, or trifluralin with several insecticides, fungicides, and nematocides. The results show that different plants do not necessarily respond in the same way to a pesticide combination. Diuron and parathion were additive to slightly synergistic on corn, wheat, cotton, and cucumbers. Diuron and phorate were synergistic on cotton and wheat, additive on corn, and additive to independent on cucumbers.

With cucumber as the test plant, the fungicide dexon antagonized (reduced) the effect of atrazine; however, this combination was synergistic on wheat. Combinations of vernolate and several organic phosphate insecticides interacted antagonistically on cucumbers. These two effects (antagonism of atrazine on cucumbers by dexon and antagonism between vernolate and the organic phosphates) were the most striking of all interactions observed so far.

Some field tests have been conducted, and the harmful interaction of diuron and phorate on cotton has been verified under field conditions.

Although some of the combinations have been rather thoroughly studied in the growth-chamber tests, most of the results lack confirmation in field trials. Thus, we consider the data to be preliminary and subject to change with additional testing. Also, some of the interactions were observed at rates of application in excess of those normally used in crop production. We do not know if the same or different effects will ensue from the same combinations of pesticides applied at practical rates of application. We want to stress the preliminary nature of the data and urge extreme caution in extending the interpretation to practical situations at this time.

# HOW APPLICATORS CAN AVOID HONEY BEE PROBLEMS

*E.R. Jaycox*

The complex business of pest control is further complicated by the need for protecting honey bees from pesticide losses. Of the many specialty fields of pest control, only a few (such as stored products and soil pests) are free of honey bee problems. All others, even those concerned with greenhouse and ornamental plants, must at some time consider ways to protect the beneficial insects while controlling the damaging ones. The structural pest control operator has to cope with the most difficult bee problem. In order to deal successfully with wayward honey bee colonies in buildings, he must use his knowledge of pesticides, while also serving as a carpenter and bee keeper. In Illinois, as elsewhere, honey bees are being used in increasing numbers as an agricultural tool for maximizing returns on insect-pollinated crops. This expanded use requires greater awareness of possible problems. Bee losses cannot always be avoided, but they can be minimized by cooperation and due consideration for the basic ways of reducing them.

*Consider the Crop*

Most losses of bees occur on plants in bloom that are attractive as sources of nectar and pollen. Clovers, sweet clovers, melons, squash, and pumpkins, are the ones most commonly involved. Sweet corn, not usually thought of as a "bee plant," is highly attractive when shedding pollen. Carbaryl applications on sweet corn are probably the most common cause of bee losses in Illinois.

*Consider the Material and Formulation*

Whenever possible, select materials that provide control of the pest insects with the least toxicity to honey bees. Use sprays or granules rather than dusts. However, sprays of undiluted technical materials may be more toxic than diluted ones.

*Consider the Method*

Ground application of insecticides is generally safer for bees than air application. The treatment of large areas and repeated treatments increase the hazard. Refinements of the application method, such as directing nozzles downward to keep carbaryl off sweet corn tassels, may lower the risk of damage to bees.

*Consider the Timing*

Moderately toxic materials can be used when bees are not active in the field. The period from 7 p.m. to 7 a.m. is suitable for most crops. On sweet corn and cucurbits, somewhat earlier applications can be made, because the plants are less attractive as the pollen disperses and flowers close.

*Cooperation to Avoid Problems*

The prevention of bee losses is not solely the responsibility of the pest control operator. Bee keepers, farmers, and extension advisers also have obligations in this regard. It is far better to exchange information and to cooperate before problems arise than afterwards. Broad, area-wide applications or increased local use of materials toxic to honey bees should be preceded by discussions with representatives of all interested groups. If alternative ways of protecting bees cannot be found, bee keepers need advance notice, so they will have time to move endangered colonies from the area.

Both honey bees and pesticides were essential for the production of insect-pollinated crops valued at approximately $10 million in Illinois in 1967. Apples, red clover seed, watermelons, squash, pumpkins, cantaloupes, and cucumbers are the primary ones. Consumers, farmers, pest control operators, and bee keepers all benefit from this cooperative effort.

For further information on specific problems, consult University of Illinois Circular 940, *Pesticides and Honey Bees*.

# ALFALFA WEEVIL RESEARCH RESULTS

*E.J. Armbrust*

The alfalfa weevil continues to be our most destructive forage crop insect pest. Without its control, it is impossible to grow alfalfa in weevil-infested areas.

The alfalfa 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 states west of the Rockies. It did just that for nearly 50 years; however, in 1952 the weevil was discovered in Maryland. It spread rapidly north and south and in 1964 it was found for the first time in southern Illinois.

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 larval numbers and the almost complete destruction of the first-crop alfalfa in a matter of days. For this reason, growers should make frequent checks on all their fields.

The newly hatched larvae are about 1/20 of an inch long and 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 larvae are not usually 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.

Cutting the alfalfa greatly reduces the larval numbers, but many eggs will be left in the stubble and the regrowth of the second crop may suffer heavy damage if not treated. This is especially true during dry weather when the regrowth is normally slow.

When the larvae have finished feeding, they spin delicate net-like cocoons on the plants, or 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 in late May to mid June.

The adults are snout beetles and about 3/16 inch long. They are brown in color with a broad dark stripe extending down their backs from the front of their heads to 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 and during these migratory periods they are carried great distances by the wind.

The first large number of larvae found during the early spring no doubt come from the fall-laid eggs or perhaps from overwintering larvae. In many northeastern states fall egg laying is not as extensive as in the southern states. Thus, larvae hatch over a shorter period of time in the northeast than in the south where the weevil has a head start on the alfalfa plant. Eggs will also begin to hatch at this time. The early hatching of larvae in southern Illinois leads to a prolonged larval feeding period and control is more difficult in the southern states, because one insecticide application will not outlast this feeding period.

Climatic conditions vary greatly within Illinois and the biology of the weevil within the state will vary just as much. Because of these differences, control practices in southern Illinois will no doubt be different from those in the northern part of the state.

Many alfalfa producers in the southern counties still find the insect difficult to control. The application of insecticides to alfalfa is a relatively new practice and they lack experience in the proper timing of sprays and the proper use of equipment. Those who have controlled the weevil properly have been able to produce more and better alfalfa than in past years. Along with weevil control, they are controlling many other insects that have been taking their share of the crop. It is still possible to grow and maintain alfalfa in spite of the alfalfa weevil, but this is only accomplished through an extensive control program.

The farmers of the neighboring state of Indiana are likewise faced with this destructive alfalfa pest, and we have launched a cooperative program with Purdue entomologist Dr. M.C. Wilson in order to do a better job of studying this problem in the Midwest. The alfalfa weevil is found in nearly every state, but Illinois and Indiana have a unique situation in that we are able to study the biology of the weevil over a great range from south to north. We have initiated a study to determine the biology of the weevil and its impact on crop development from north to south. Our southernmost location is at the Tennessee-Mississippi line and our northernmost location is at the Illinois-Wisconsin line.

Research involving chemical and cultural control will also be covered in this cooperative program. We have been given permission to use about 2,000 acres of alfalfa in the Vincennes-Lawrenceville area for this purpose. This will provide an opportunity for some unique large-scale control studies to determine the effects of different control practices on the population and its movement from field to field and within fields.

A series of large-scale experiments was conducted at Vincennes, Knox County, Indiana, in 1967 to evaluate experimental and registered insecticides for control of the alfalfa weevil. Our small-plot tests at Dixon Springs are included in this summary.

All sprays at Vincennes were applied at the rate of 20 gallons of spray per acre when 20 to 25 percent of the plant tips showed larval feeding damage. One test at Vincennes was timed to correspond to the normal second insecticide application to the first crop.

Of the registered materials tested, best results were obtained with 0.5 pound of actual Methyl Parathion and we feel that this treatment is superior to all other recommended treatments when you consider cost and control. Methoxychlor (1.5 pounds of actual material per acre) was a failure in all tests. Sevin was unsatisfactory at Dixon Springs. Malathion and Alfatox performed comparably. In general, Malathion appeared to give considerably higher initial kill under favorable weather conditions while Alfatox appeared to persist a few days longer. Malathion and Guthion did not give satisfactory control when used during cool, wet weather.

Our results with a mixture of Malathion and Methoxychlor were impressive and superior to those obtained with Alfatox. This might be expected since Malathion is more effective against the weevil than Diazinon, one of the components of Alfatox.

Out of the 40 or so experimental treatments tested we can list only NIA 10242 (0.5 pound), GS 13005 (0.5 pound), and in some tests Phorate (0.5 and 1 pound) as giving better control than Methyl Parathion. In some of our tests, mixtures of Guthion and Baygon (0.25 + 0.5 pound), Baytex and Baygon (0.25 + 0.5 pound), and Baygon (1 pound) showed some promise, but results were not always consistent.

Ultra-low-volume application with Malathion was a failure in three separate tests. With conventional air application, we feel that no less than four gallons of spray per acre should be applied by air and that eight gallons gives more uniform control.

Fall insecticide applications to small plots during 1966 gave no control, but we feel that this area of research needs more attention. Fall treatments may show more promise when tried on a mass area approach, because we hope this will eliminate reinfestation by adults between small plots. Adult control in either the fall or early spring seems to be the best method of attack because larval control only eliminates the problem temporarily and only as long as the insecticides are giving residual control.

Flaming of alfalfa during the winter or early spring at Dixon Springs and in the Vincennes-Lawrenceville area demonstrated that this practice will eliminate the first of the several insecticide applications necessary for satisfactory control. Because of the economics of this practice, flaming will probably not be used extensively by the producer with only a small acreage of alfalfa.

It has been said that flaming stimulates the alfalfa and improves the stand. Preliminary data show that on a 30-day cut schedule the flamed alfalfa does not attain the same height or yield as does unflamed alfalfa when other competitive factors are controlled.

# SURFACTANTS FOR HERBICIDE SPRAYS

*F.W. Slife*

Herbicidal chemicals are compounded with diluents and additives to provide formulations suitable for field use. In such formulas, additives exert a significant effect on results, though present in very small amounts. These additives are usually surfactants, a term derived from "surface active agent." This is defined by the Weed Science Society of America as a material that facilitates and accentuates the emulsifying, dispersing, spreading, wetting, and other surface-modifying properties of herbicide formulations. A wetting agent is any compound that, when added to a spray solution, causes it to contact plant surfaces more thoroughly. Thus, a wetting agent is not necessarily a surfactant. Surfactants come in a wide variety of types, and several thousand trade name surfactants are already available. Surfactants can increase herbicidal effectiveness by (a) improving plant coverage, (b) removing air films between the spray and the leaf surface, and (c) increasing the foliar absorption and translocation of the applied herbicide.

All green plants possess a thin layer of material on the surface of their leaves and stem that is a barrier to the penetration of herbicides. This material is referred to as the cuticle. The cuticle is a protective device that slows down water loss.

The cuticle is composed of waxes, cutin, and pectin. These materials are excreted from the outermost layer of cells. Plant cuticles vary in thickness, and this is determined by species and environment: Plants growing in arid regions have very thick cuticles compared to plants growing in humid regions. Within a region, the cuticle thickness varies with environment. In Illinois, during wet years when sunlight is reduced, the cuticle of plants will be thinner than in years when rainfall is limited and there is more sunlight.

The upper side of leaves of plants contain a thicker cuticle than the lower side. Although the cuticle appears to be a continuous layer of material, it in reality is not. It has thick and thin spots, and it is marred by cracks. When plants grow rapidly and the leaves are expanding at a rapid rate, the cuticle is thin and spotty; in the more mature leaves, it is thicker and more continuous. This helps explain why plants that are growing rapidly are usually more sensitive to postemergence herbicides.

The nature of the cuticle is affected greatly by humidity and rainfall. Under high humidity, the cuticle absorbs moisture and swells, and thus it may be much easier for chemicals to penetrate this barrier. For example, atrazine applied postemergence to weeds has given variable results under different environments. It has been most successful on young weeds (thin cuticle), weeds growing rapidly (thin cuticle), and high-humidity conditions (thin cuticle). It has been less successful on older plants, plants growing under less-favorable conditions, or when rainfall is limited. These latter conditions all lead to thicker cuticles.

When herbicides are applied to a leaf, they seem to have two major routes of entry through the cuticle and into the protoplasm. One is called a water route, the other a lipid route. The water route appears to occur in thin spots in the cuticle and in cracks in the cuticle. It may also occur through the stomata (small pores in the leaf), but the inside of a stomata also has a thin cuticle.

The lipid entry appears to occur directly through the cuticle. In this case, the chemical moves through the layers of wax, pectin, and cutin.

Since the cuticle is considered to be nonpolar (no charge), the herbicide formulations that carry no charge enter mainly through the cuticle; those with a charge (polar) enter mainly through the aqueous route.

2,4-D amine is a salt; therefore it becomes a polar molecule in solution with water; hence, it appears to enter mainly through the aqueous route. 2,4-D ester in water is nonpolar, and appears to enter through the lipid route. This comparison gives us the concept that the most-effective formulations are the nonpolar types. We also know that the low-volatile esters are more effective than high-volatile ones; this appears to be due to the fact that low-volatile esters are more lipid-soluble than high-volatile esters. Since they are more lipid-soluble, they enter faster, more gets inside the plant, and less is needed--compared to the high-volatile esters.

The choice of a surfactant is important, because research work indicates that some surfactants make some chemicals more effective while other surfactants have no effect or in some cases decrease the effectiveness. As indicated earlier, most herbicides contain a very small amount of surfactant added by the manufacturer. Most herbicides can benefit greatly by the addition of more surfactant. Examples are Tenoran on soybean, diuron on cotton, and postemergence atrazine on corn. The addition of the proper surfactant to these materials usually results in lowering the rate of the applied chemical by one-half. The use of additional surfactant becomes practical when the saving in the cost of the herbicides justifies the cost of the surfactant. Rates of application of 2,4-D can be slightly lowered by putting in additional surfactant. But because of 2,4-D's low cost, this would not be practical.

Some farmers and spray operators add household detergents to their herbicide solutions to increase effectiveness. Most of these appear to act as wetting agents. Even though they may wet the leaves more thoroughly, they may or may not affect the final results. The addition of a crop oil to atrazine is an example of a surfactant effect. It not only wets the plants more thoroughly, apparently it also aids in the penetration of atrazine. There are undoubtedly other surfactants that will work with atrazine to produce the same results.

Much more work needs to be done to determine the type or types of surfactants most suitable for a specific job. At the present time, the herbicide manufacturer is best qualified to give this information.

# ATRAZINE AS A POSTEMERGENCE SPRAY[1/]

*E.L. Knake*

During the past few years, considerable interest has developed in the use of certain oils with atrazine for early postemergence application. Comments here are based partly on our own research and observations and on research and observations made by others. Where there is insufficient research, especially on some of the fundamental aspects, some of the comments will be speculative and will indicate possible uses of atrazine. We hope our comments will suggest ideas and theories for further research that will allow acceptance or rejection of the possibilities indicated.

*Place for Postemergence Spraying in the Weed-Control Program*

We would prefer to place primary emphasis on controlling weeds as early as possible with preemergence applications at planting time.

Preplant application of atrazine is also generally effective and acceptance of this practice is increasing; but performance of atrazine, especially on the light-colored soils, has been so good at economical rates when applied preemergence that there seems to be little need or potential for postemergence applications.

Major interest has been centered on the use of postemergence atrazine applications on the relatively dark soils that require increasing rates as organic matter content increases. Results with atrazine applied preemergence on the darker soils are not always as good as desired, and atrazine and oil may, under some conditions, give better weed control as an early postemergence.

One interesting possibility is the use of atrazine at about a half rate in combination with another preemergence herbicide. If the preemergence combination isn't effective, an early postemergence application of a reduced rate of atrazine plus oil might then be used and the total amount of atrazine could still be kept within the full recommended rate.

To set the record straight on the effect of early weed growth on corn yields, data from one of our competition studies are presented in the table below. Although weeds start competing with corn relatively early, weeds less than 1 1/2 inches high (the recommended height for postemergence atrazine applications) probably have very little influence on final yields. The larger the weeds grow before removal, the greater the yield loss.

Effect of removing giant foxtail from corn (3-year averages):

| | Yield (bu./a.) | Loss (bu./a.) |
|---|---|---|
| No foxtail | 144 | |
| Foxtail removed when 3 inches | 143 | -1 |
| Foxtail removed when 6 inches | 142 | -2 |
| Foxtail removed when 9 inches | 139 | -5 |
| Foxtail removed when 12 inches | 137 | -7 |
| Foxtail left to maturity | 126 | -18 |

1/ Abstract.

A postemergence application may require one more trip over the field than a preemergence application. Timing is also critical. Our studies indicate it takes Foxtail about 10 days from emergence to a 1 1/2-inch height. The field must be dry enough for ground equipment, and sufficient time and equipment must be available during a time when demands on labor and equipment are already high.

If preemergence applications are not sufficiently effective, the grower still has several chemical and mechanical control methods that can be used. But by the time the grower realizes that a postemergence spray is not effective, there are not many alternatives left for good control.

*Rates of Atrazine for Postemergence*

It is well known that certain oils or other adjuvants can increase the effectiveness of atrazine. Thus the rate of atrazine could be reduced when appropriate adjuvants are added. For early postemergence application, 2 1/2 pounds of atrazine 80W plus 1 to 2 gallons of non-phytotoxic oil per acre are usually suggested on a broadcast basis or proportionately less in a band.

In some of our studies on dark soils weed control from 2 1/2 pounds of Atrazine 80W plus oil has been as good or better than 3 3/4 pounds of Atrazine 80W without oil. Results may vary with climatic factors and with kind of weeds present.

Increasing the rate does not provide a solution for controlling larger weeds. Once grass weeds are past a certain stage, control becomes very difficult regardless of rate. Although control of broadleaves over 1 1/2 inches may be noted, the primary problem is usually grass weeds and it is best to observe the manufacturer's suggestion of spraying before weeds are more than 1 1/2 inches. If broadleaved weeds are the only problem, 2,4-D would usually be more practical, except perhaps for smartweed.

Although the reduced rate of atrazine may be sufficient for initial control, the length of control may be reduced. However, this is not necessarily always true, since a reduced rate applied three weeks after planting may last as long as a higher rate applied two weeks before planting. Many variables will affect the length of residual activity.

*Effect on Residue the Next Season*

The later in the season atrazine is applied, the more chance there is of herbicide residue that may affect other crops the next season. This provides another reason for reducing the rate for postemergence application. Abide by the label recommendations to stay within the 3-week period after planting for postemergence applications. This will not only give you better weed control, but will reduce the possibility of herbicide residue the next season.

*Corn Tolerance*

Although we have had essentially no problem with atrazine alone applied to corn, injury has sometimes occurred when atrazine plus oil has been used. Usually the injury has not been severe, but occasionally it has. Several factors seem to be involved, including method and accuracy of application, genetic differences in hybrids, stage of development, growth rate, and factors that affect growth such as temperature, humidity, and moisture before and perhaps after application.

The increased possibility of corn injury when oil is added suggests another reason for reducing the rate of atrazine when applied postemergence with oil.

Applications must be accurate and uniform. Some injury has been traced to poor application procedures. Although aerial application was employed for some emergency situations, especially in Iowa in 1967, we prefer application with ground equipment. Uniform application is extremely important if weed control is to be uniform, corn injury minimized, and injury to crops the next season minimized.

Care must be used to shut off sprayers when turning at the ends of rows so you can avoid injury to corn and excessive residue in the soil.

Some growers tried adding 2,4-D to atrazine and oil. This increased the incidence of injury to corn and is not recommended. Some growers reasoned that 2,4-D might help control broad-leaved weeds, but atrazine is usually quite effective on broadleaves such as smartweed and pigweed and little or no benefit would be expected from adding 2,4-D for this purpose.

*Injury to Other Crops*

Injury to other crops from the drift of atrazine and oil has been noted. Winter wheat and soybeans adjacent to corn have been damaged. This problem does not exist with soybeans where preemergence applications are made to corn before soybeans are planted.

The drift problem may be accentuated by reducing the spray volume or increasing pressure to give smaller droplets.

The reports of relatively low spray volumes used for applying atrazine and oil in 1967 do suggest the need for more research on spray volume requirements for both preemergence and postemergence applications.

*The Action of Atrazine and Oil*

Based partly on research by various investigators, and based partly on speculation, the following is submitted for consideration.

When atrazine is applied to the soil surface, some may be lost before rain eventually moves it into the soil. It may be moved into the soil before or after weed seeds germinate and before or after weed seedlings are most sensitive to it. The soil may or may not be at an optimum moisture level for absorption of the herbicide by the emerging seedlings. Some of the atrazine may be adsorbed onto the soil complex and not be readily available to the seedlings.

Whether atrazine is applied to the soil before emergence or to the leaves after emergence, our research suggests that absorption through the shoots either during or after emergence is probably the most important consideration for some of our major grass weeds.

If soil containing atrazine remains sufficiently moist to permit absorption and if adequate atrazine is available to the seedling, control is usually satisfactory. As the seedling grows, the cuticle on the leaf becomes more developed and the plant becomes more resistant to herbicide entry. The plant may also be able to do a better job of detoxifying the herbicide that does enter, or may become more tolerant of the herbicide.

However, if a sufficient amount of the leaf surface can be covered with the herbicide and if this is kept in a liquid phase long enough to permit sufficient entry, lethal effects can occur. Applying the herbicide before the cuticle on the leaf surface is very well developed probably enhances entry. Additives may increase lethal effects if they allow more thorough coverage of the leaf surface, reduce the rate of evaporation, and enhance entry through the waxy cuticle. If an additive adversely affects certain physiological reactions, the plant may succumb more readily.

There is some research evidence suggesting that oils of certain specifications allow more thorough wetting of the leaf surface, remain in liquid phase longer than water, enhance penetration of the waxy cuticle, and reduce the respiration rate of the plant.

There is some question about the effect from atrazine that reaches the soil from postemergence applications. There is a possibility that the atrazine that reaches the soil may have some effect through roots, particularly the crown roots for grasses. Some researchers suggest that the crown roots of foxtail, which would be actively developing soon after emergence, may provide a site of entry. Further research is needed.

Both soil and foliage applications are affected by a multitude of variables and results from either application method can vary considerably.

Although most interest has been expressed by oil companies and the major herbicide considered thus far has been atrazine, there are probably other additives and other herbicides for which similar relationships exist and which merit attention. At least our 1967 research suggests such possibilities.

An adjuvant called Tronic has received some attention. In some of our 1967 trials, results with 1 pint of Tronic appeared comparable to results with 1 to 2 gallons of oil. On a statewide basis, however, results appeared to be a little more erratic with Tronic than with oil.

*Oil Specifications*

Most major producers of "non-phytotoxic" oils for use with atrazine are well aware of appropriate specifications.

Having a high percentage of unsulfonated residues means that the oil has a low percentage of the undesirable components that may be toxic to the crop. Usually 92 percent is considered a minimum for unsulfonated residues.

As viscosity increases, evaporation is slower, meaning that a liquid phase can be maintained longer. But if viscosity is too high and the oil remains on the crop too long, an extended period of reduced respiration can have an adverse effect on the crop. Oils for this application are commonly classified as approximately 70-second and 100-second oils (at 100° F.). The 100 is more viscous than the 70.

Most oils contain 1- or 2-percent emulsifier to aid in mixing, improve spreading properties, and avoid adverse effects of hard water.

It is important to keep moisture, even small amounts, out of the oil during storage.

Only oils with appropriate specifications especially prepared for this purpose should be used.

Typical suggestions for mixing atrazine, oil, and water are:

1. Add enough water for the agitation system to operate.
2. Mix atrazine and water to form a slurry and then add to the tank.
3. Fill the tank to about three-fourths of the desired level and add the oil during agitation.
4. After an emulsion has formed, finish filling the tank to the desired level.
5. Continue agitation.

VEGETABLE GROWING NO. 4
(REVISED, 1967)

# WEED CONTROL IN THE VEGETABLE GARDEN

*by H.J. Hopen*[1/]

Three general methods of weed control which 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, weed control can be accomplished by power equipment or by wheel and hand hoes.

2. Mulching or smothering of weeds

   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 an herbicide is used on small areas. The tendency is to apply additional amounts if the quantity measured out "looks" like it is not enough.

   THE IDEAL METHOD TO CONTROL WEEDS IN VEGETABLE CROPS IS WITH AN HERBICIDE FOR EACH VEGETABLE SPECIES, AS OUTLINED IN CIRCULAR 907 "HERBICIDE GUIDE FOR COMMERCIAL VEGETABLE GROWERS."

   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 Extension Specialist, University of Illinois.

If an individual is unwilling to remove weeds by hand and wants to use an herbicide in the home or commercial garden, Dacthal[2/] can be used on the following species:

| Crop | Total pounds* of 2 1/2% granular dacthal per 1,000 sq. ft. | Total pounds* of 5% granular dacthal per 1,000 sq. ft. | When to use |
|---|---|---|---|
| Snap or garden beans (not 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, 4-6 weeks after seeding** |
| Eggplant | 8-9 | 4-4.5 | Immediately after transplanting, or up to 6 weeks after transplanting** |
| Lettuce (leaf & head) | 8-9 | 4-4.5 | To the soil, 1-3 weeks after emergence** |
| Onions | 8-9 | 4-4.5 | Immediately after seeding |
| Peppers | 8-9 | 4-4.5 | To the soil, 4-6 weeks 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) |
| Tomatoes | 8-9 | 4-4.5 | To the soil, 4-6 weeks after transplanting** |
| Sweet potatoes | 8-9 | 4-4.5 | Immediately after planting |
| 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 percent granular dacthal is available in 50-pound bags.
**Must be applied to weed-free soil.

2/ Please remember that Dacthal 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.

* * * * * * * * * * *

Urbana, Illinois November, 1967
Cooperative Extension Work, University of Illinois College of Agriculture and the U.S. Department of Agriculture Cooperating. John B. Claar, Director. Acts Approved by Congress May 8 and June 30, 1914.

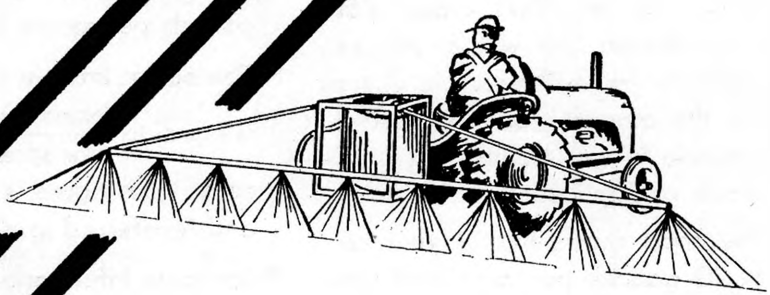
# Sprayer Calibration



· Center panels for calibrating broadcast sprayers

· Back panel for calibrating band sprayers

· Three straight lines can check the application rate



TO CHECK APPLICATION RATE draw straight lines toward the center of the chart from each end. The connecting line gives the application rate on Scale #3.

TO CHECK GROUND SPEED record the time to travel 200 feet, then find the speed on Scale #1.

TO CHECK THE NOZZLE CAPACITY record the time to fill one pint, then find the capacity on Scale #6.

TO PICK THE CORRECT NOZZLE draw two straight lines starting at the left side of the chart. The third line passes through the number of nozzles and gives the nozzle capacity on Scale #6.

TO PICK THE CORRECT TRACTOR SPEED draw two straight lines starting on the right side of the chart. The third line passes through the spray width and gives the tractor speed on Scale #1.

THE TOTAL PUMPING RATE on Scale #4 should be less than 70% of the pump capacity when using mechanical agitation. Use less than 50% when using jet agitation.

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The chart on broadcast sprayer calibration was adapted from Folder 82 prepared by W. E. Larsen, Extension Agricultural Engineer, University of Arizona, Tucson, Arizona.

For more information, get a copy of Illinois Circular 837, "Calibrating and Maintaining Spray Equipment."

UNIVERSITY OF ILLINOIS

COLLEGE OF AGRICULTURE

COOPERATIVE EXTENSION SERVICE AEng868

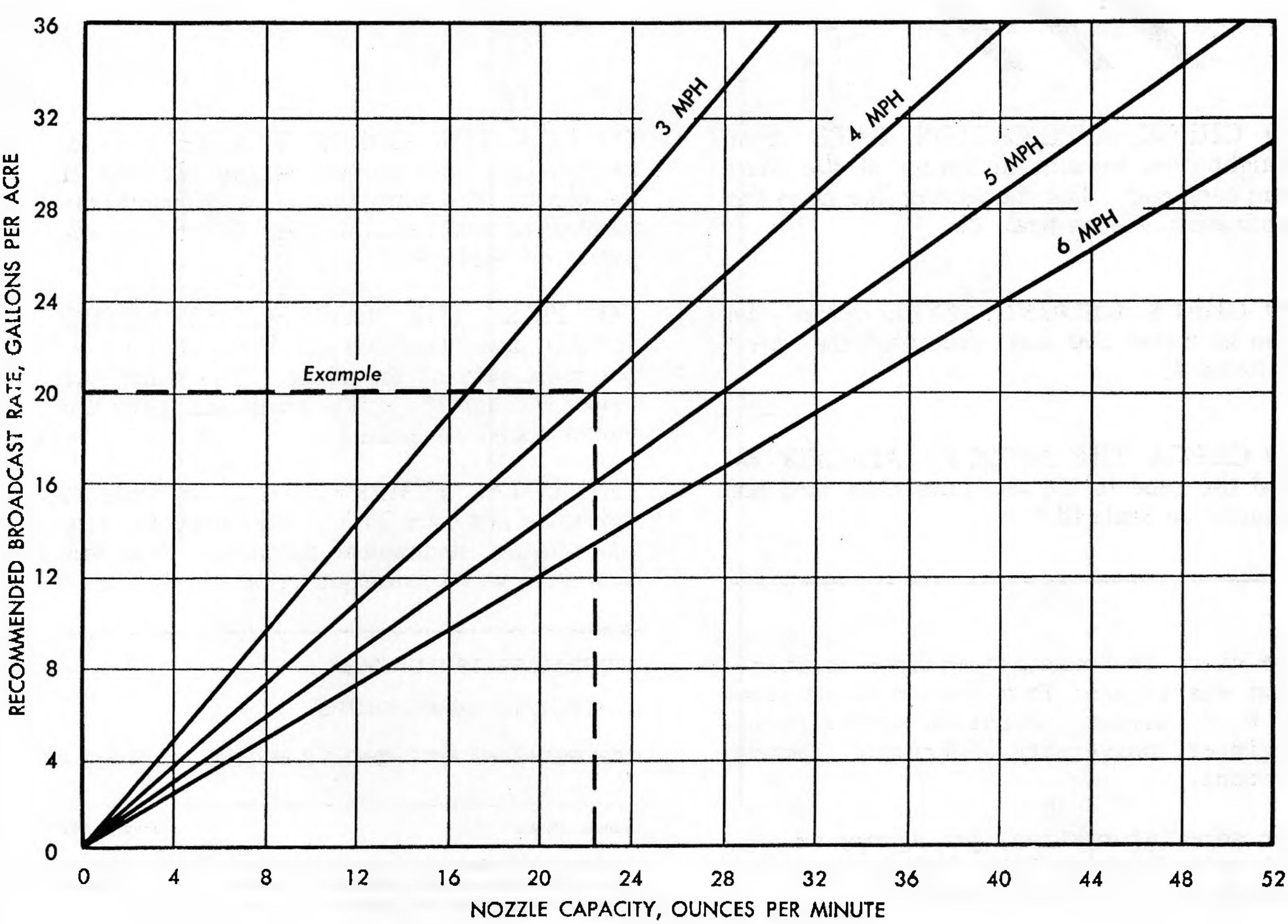
Urbana, Illinois January, 1967

Cooperative Extension Work, University of Illinois, College of Agriculture, and U.S. Department of Agriculture, cooperating. JOHN B. CLAAR, *Director*. Acts approved by Congress May 8 and June 30, 1914.

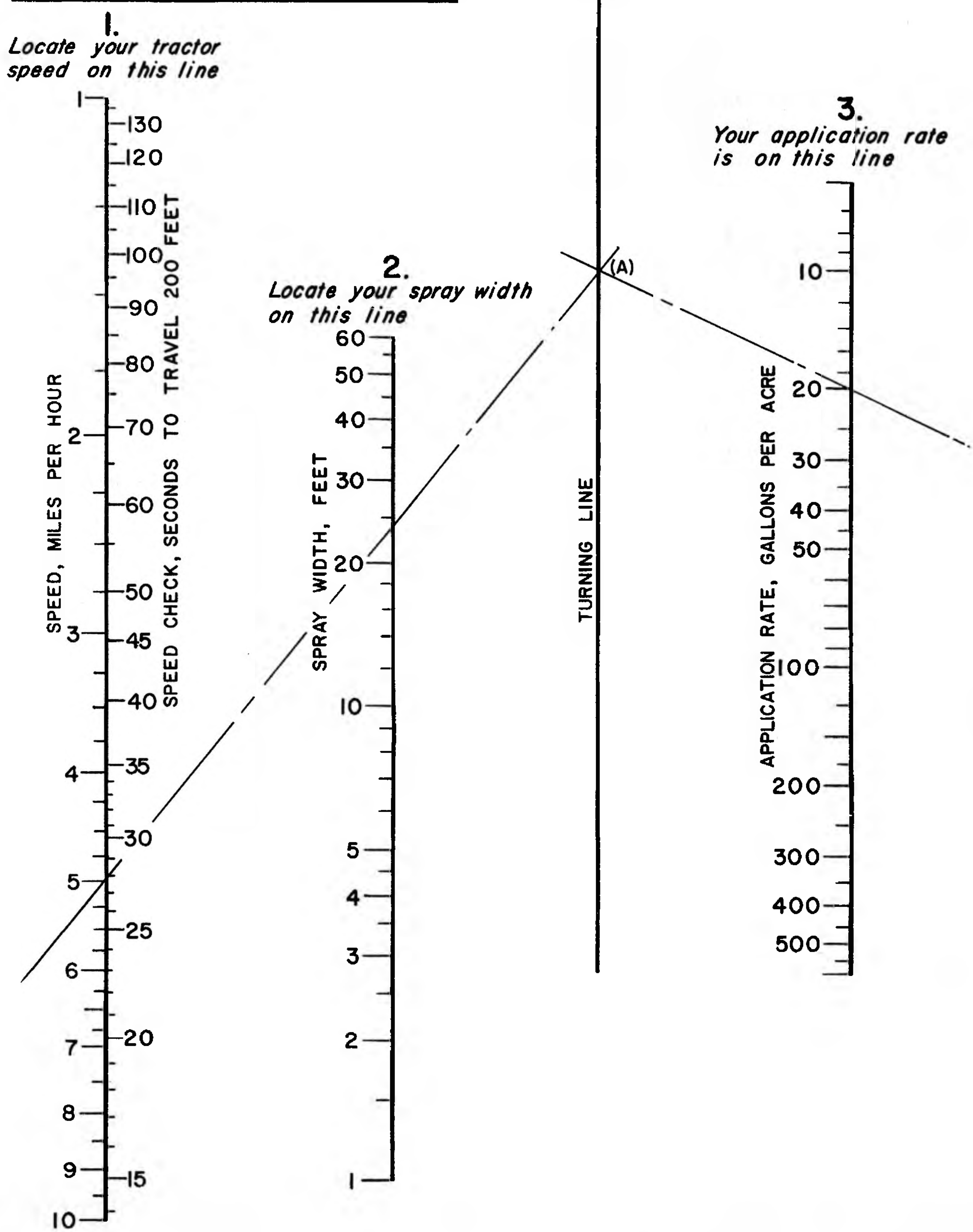
## SELECTING AND CALIBRATING NOZZLES FOR BAND-SPRAYING

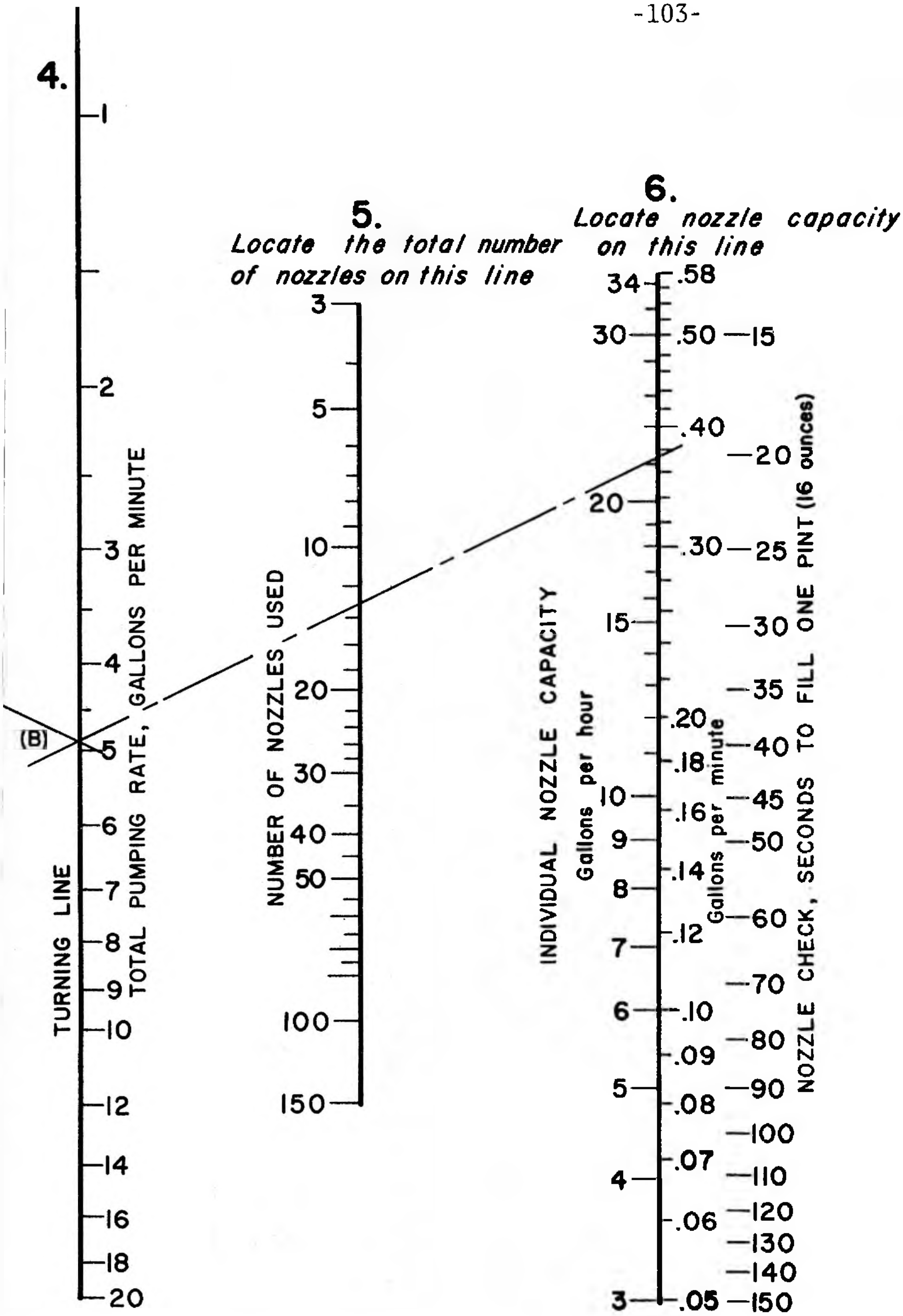
**(based on a 13-inch band, but can be used for 12- and 14-inch bands)**

- Find out the recommended rate of broadcast application, in gallons per acre, for the chemical you are using. Then locate this rate on the left-hand side of the chart.
- Follow a line straight across from this recommended rate until it crosses the line for the ground speed you will be using.
- From the point where the two lines cross, move straight down to the bottom line where you can read the nozzle capacity you will need, in ounces per minute. This is the amount you will need to collect from each nozzle in one minute when calibrating for a given rate of application.
- The example on the chart shows that if your recommended rate is 20 gallons per acre and your ground speed is 4 miles an hour, you will need a nozzle which sprays at the rate of about 22 ounces per minute.
- To select a nozzle from a manufacturer's chart, you will need to convert ounces to gallons; you can do this by multiplying the number of ounces per minute by .0078.
- Select nozzles that will keep pressure under 40 pounds per square inch to reduce wind drift.
- The actual amount of solution you will use per acre is equal to $\frac{\text{band width}}{\text{row spacing}} \times$ recommended broadcast rate. (This figure is often given on container labels and is referred to as the band-spray rate.)
- For more information, get a copy of Illinois Circular 791, "Band-Spraying Pre-Emergence Herbicides."



# SPRAYER NOMOGRAPH






EXAMPLE: WE WANT TO SPRAY AT 5 MILES PER HOUR WITH A BROADCAST RATE OF 20 GALLONS PER ACRE. THE SPRAYER COVERS A 24-FOOT SWATH USING 13 NOZZLES. WHAT SIZE NOZZLES SHOULD BE USED?

ANSWER: STARTING ON THE LEFT HAND SIDE OF THE CHART, A STRAIGHT LINE FROM 5 MILES PER HOUR THROUGH 24 FEET INTERSECTS THE FIRST TURNING LINE AT (A). A STRAIGHT LINE FROM (A) THROUGH 20 GALLONS PER ACRE INTERSECTS THE SECOND TURNING LINE AT (B). A STRAIGHT LINE FROM (B) THROUGH 13 NOZZLES GIVES A NOZZLE CAPACITY OF .37 GALLON-PER-MINUTE. TO CALIBRATE, EACH NOZZLE SHOULD SPRAY AT THE RATE OF 20 SECONDS PER PINT (16 OUNCES).

*1968 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 936 — Pest Control in Commercial Fruit Plantings.

These can be obtained from the above offices or from the College of Agriculture, Urbana.

**CIRCULAR 897 UNIVERSITY OF ILLINOIS COLLEGE OF AGRICULTURE COOPERATIVE EXTENSION SERVICE**
**In cooperation with ILLINOIS NATURAL HISTORY SURVEY Urbana, Illinois, December, 1967**

Cooperative Extension Work in Agriculture and Home Economics: University of Illinois, College of Agriculture, and the United States Department of Agriculture cooperating. JOHN B. CLAAR, *Director*. Acts approved by Congress May 8 and June 30, 1914.

## 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 | Asparagus | Beans | Broccoli | Brussels sprouts | Cabbage | Cauliflower | Horseradish[1] | Radish[1] | Turnip[1] | Onions | Eggplant | Tomatoes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| azinphosmethyl (Guthion)[2] | ... | ... | 15 | 7 | 21 | 15 | ... | ... | ... | ... | ... | ... |
| carbaryl (Sevin) | 1 | 0 | 3 | 3 | 3 | 3 | 3 | 3 | 3,14G | ... | 0 | 0 |
| carbophenothion (Trithion)[2] | ... | 7A | ... | ... | ... | ... | ... | ... | ... | ... | 7 | 7 |
| diazinon | ... | ... | 5 | ... | 7 | 5 | ... | 10 | 10 | 10 | ... | 1 |
| dimethoate (Cygon) | ... | 0C | 7 | ... | 3 | 7 | ... | ... | 14 | ... | ... | 7 |
| endosulfan (Thiodan) | ... | BC | 7 | ... | 7 | B | ... | ... | ... | ... | 1 | 1 |
| ethion | ... | ... | ... | ... | ... | ... | ... | ... | ... | I | ... | ... |
| dicofol (Kelthane) | ... | 7C | ... | ... | ... | ... | ... | ... | ... | ... | 2 | 2 |
| malathion | ... | 1 | 3 | 7 | 7 | 7 | 7 | 7 | 3 | 3 | 3 | 1 |
| 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 |
| Perthane | ... | ... | 3 | 3 | 3 | 3 | ... | ... | ... | ... | ... | ... |
| phorate (Thimet)[2] | ... | I | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| rotenone | 1 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 1 | 1 |
| toxaphene | ... | ... | ... | B | 7D | B | C | C | C | ... | 5 | 3 |
| trichlorfon (Dylox) | ... | ... | ... | 21 | 21 | 21 | ... | ... | 28C | ... | ... | 21 |

| Insecticide | Potatoes[1] | Collards | Kale | Lettuce | Spinach | Swiss chard | Sweet corn | Cucumbers[3] | Melons[3] | Pumpkins[3] | Squash[3] Winter | Squash[3] 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) | 7 | 14 | 14 | 14 | 14 | 14 | ... | ... | 7 | ... | ... | ... |
| endosulfan (Thiodan) | 0 | ... | ... | 14H | ... | ... | ... | ... | ... | ... | ... | ... |
| malathion | 0 | 7 | 7 | 14 | 7 | 7 | 5 | 1 | 1 | 3 | 1 | 1 |
| Meta-systox-R[2] | ... | ... | ... | ... | ... | ... | ... | ... | 14A | 14F | 14F | 14F |
| mevinphos (Phosdrin)[2] | ... | 3 | 3 | 2 | 4 | ... | 1 | 1 | 1 | 14 | 14 | 1 |
| naled (Dibrom) | ... | 4 | 4 | 1 | 4 | 4 | ... | ... | ... | ... | ... | ... |
| parathion[2] | 5 | 10 | 10 | 21 | 14 | 21 | 12 | 15 | 7 | 10 | 15 | 15 |
| Perthane | ... | ... | ... | 4 | 7 | ... | ... | ... | ... | ... | ... | ... |
| phorate (Thimet)[2] | I | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| rotenone | ... | 1 | 1 | 1 | 1 | 1 | ... | ... | ... | ... | ... | ... |
| toxaphene | 0 | 28 | 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.

## LIMITATIONS FOR GREENHOUSE VEGETABLES

| Insecticide | Tomatoes | Lettuce |
|---|---|---|
| DDT | 5 days | Do not use after seedling stage |
| 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 CROPS[1]

| 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<br>diazinon | 3 oz. W.P. or 2 oz. E.C. per 50 gal. transplant water<br>4 oz. per 50 gal. transplant water | | 6 fluid oz. transplant water per plant. |
| Aphid (NHE-47) | All season | azinphosmethyl<br>dimethoate<br>malathion<br>mevinphos<br>parathion | ¾<br>0.3<br>1<br>¼<br>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<br>mevinphos<br>naled<br>parathion with<br>toxaphene[3]<br>Perthane with<br>diazinon[3]<br>Parathion with<br>endosulfan[3] | ¾<br>½<br>1<br>½<br>2<br>1<br>½<br>½<br>1 | Foliage | When small worms first appear, and about every 5 to 7 days thereafter. |
| Cutworm | At planting | trichlorfon<br>toxaphene | 1<br>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 and dieldrin 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<br>dimethoate<br>mevinphos<br>naled<br>parathion | ½<br>0.3<br>¼<br>1<br>0.4 | Foliage | As needed. |
| Cutworm | On seedling plants | toxaphene<br>trichlorfon | 1½<br>1 | Base of plant and soil | When first damage appears. |
| Leafhopper | All season | carbaryl<br>dimethoate<br>malathion | 1½<br>0.3<br>1 | Foliage | When first leafhoppers appear and as needed. |
| Caterpillar (NHE-45) | All season | mevinphos<br>naled<br>Perthane<br>with diazinon<br>or malathion[1]<br>parathion with<br>endosulfan[1] | ½<br>1<br>1<br>½<br>1<br>½<br>1 | Foliage | When small worms first appear and every 5 to 7 days thereafter. |
| Leaf miner | All season | diazinon<br>parathion | ½<br>0.4 | Foliage | When first miners are observed. |
| Flea beetle | All season | carbaryl<br>rotenone | 1<br>¼ | 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]<br>lindane[1] | Manufacturer's directions | Seed | At seeding. |
| | | 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<br>malathion | 1<br>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<br>dimethoate<br>malathion | 1<br>0.3<br>1 | Foliage | Before plants become yellow and stunted. Repeat applications at weekly intervals as necessary. |
| | | phorate granules | 1½ | Soilband | As for seed maggot. |
| Mexican bean beetle | Midseason and late season | carbaryl<br>malathion | ½<br>1 | Foliage | When occasional leaves show lacework feeding. |
| | | phorate granules | 1½ | Soilband | As for seed maggot. |
| Aphid (NHE-47) | All season | dimethoate<br>endosulfan<br>malathion | 0.3<br>½<br>1 | Foliage | Usually applied when a few aphids can be found on each plant, but before leaves begin to curl and deform. |
| | | 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 | carbophenothion<br>dicofol<br>dimethoate<br>malathion | ¾<br>0.4<br>0.3<br>1 | Foliage | As needed, but especially during drouthy periods particularly if carbaryl has been used on crops. |
| | | phorate granules | 1½ | Soilband | As for seed maggot. |

[1] No restrictions when used as recommended.

## CUCUMBERS AND OTHER VINE CROPS[1]

| 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<br>parathion | 1<br>½ | Foliage | When beetles first appear; as often as necessary thereafter. |
| Aphid (NHE-47) | All season | diazinon<br>dimethoate<br>malathion<br>Meta-systox-R<br>mevinphos<br>parathion | ½<br>0.3<br>1<br>½<br>¼<br>½ | Foliage | When aphids become noticeable. |
| Squash bug (NHE-51) | All season | parathion<br>trichlorfon[3] | ½<br>1 | Foliage | Do not apply until first eggs are found hatching (about June 15 to July 15). |
| Leafhopper | July-August | malathion<br>dimethoate | 1<br>0.3 | Foliage | As needed. |
| Squash vine borer | June-September | carbaryl | 1 | Base of stem and runners for 3 ft. from stem | 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<br>malathion<br>mevinphos<br>parathion | ½<br>1<br>¼<br>½ | Foliage | As needed. |
| Cutworm (NHE-77) | April-June | carbaryl<br>toxaphene | 2<br>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 AND EGGPLANT

| Insect | Time of attack | Insecticide | Lb. of active ingredient per acre | Placement | Timing of application |
|---|---|---|---|---|---|
| Cutworm (NHE-77) | Early and midseason | carbaryl<br>toxaphene<br>trichlorfon | 2<br>3<br>1 | Base of plants or foliage | As needed. |
| Flea beetle | May-June | carbaryl<br>rotenone | 2<br>0.2-0.4 | Foliage | Apply every week as long as needed. |
| Aphid (NHE-47) | May-July | diazinon<br>dimethoate<br>endosulfan<br>malathion<br>parathion | ¼<br>0.3<br>½<br>1<br>0.4 | Foliage | As needed, but before leaves curl. |
| Corn earworm | July-September; occasionally in June | carbaryl<br>toxaphene | 2<br>2 | Foliage | Add to weekly applications of fungicide sprays beginning at first fruit set. If spraying is infrequent, use 6 lb. of toxaphene. |
| Hornworm | July-September | carbaryl<br>trichlorfon | 2<br>1 | Foliage | When first small worms appear. |
| Mites | July-September | carbophenothion<br>dicofol<br>malathion<br>parathion | 1<br>½<br>1<br>0.4 | Foliage | As needed. |
| Russet mite | July-September | parathion<br>sulfur dust[1]<br>sulfur spray[1] | 0.4<br>10<br>10 | Foliage | As needed. |
| Blister beetle (NHE-72) | June-September | carbaryl<br>parathion<br>toxaphene | 1½<br>¼<br>2 | Foliage | As needed. |
| Fruit fly and picnic beetle | August-October | diazinon spray<br>diazinon granules | ½<br>1 | Foliage | When flies or beetles first appear. |
| | | pyrethrin dust[1] | 1 | Foliage | Apply to hamper immediately after it is filled. |

[1] No limitations on use.

## 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.<br>ethion W.P. | ½-1 for 40-50 lb. of seed<br>1 for 40-50 lb. of seed | Seed | Seed treatment for set onions only. Use lighter dosage of diazinon on sandy, highly mineral soils. |
| | | diazinon granules<br>ethion granules | ½-1<br>½-2 | 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. |
| | | diazinon | 2 | Broadcast | Preplanting; disk into upper 1 to 2 inches of soil. Supplement with foliage spray below. |
| | | diazinon<br>malathion | ⅓<br>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<br>parathion | ½<br>½ | Foliage | When injury first appears and every 10 days as necessary. |

## SWEET CORN

| Insect | Time of attack | Insecticide | Lb. of active ingredient per acre | Placement | Timing of application |
|---|---|---|---|---|---|
| Rootworm (NHE-26) Seed corn maggot (NHE-27) Seed corn beetle (NHE-27) Wireworm (NHE-43) | April-August | diazinon | 1 | Row | Apply on soil surface behind planter shoe and ahead of press wheel. |
| Cutworm (NHE-38) | April-June | carbaryl[1]<br>toxaphene | 2-3<br>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<br>diazinon granules | 2<br>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]<br>diazinon<br>malathion<br>parathion | 2<br>1<br>1<br>½ | Foliage | When adults first appear in field; usually between pollen-shedding and silk-drying. |
| Corn leaf aphid (NHE-29) | July-September | malathion<br>mevinphos | 1<br>¼ | 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.

## 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 | 1½ | Spears and ferns | As needed, not oftener than every 3 days. |
| | | rotenone | 0.2-0.4 | Spears | As needed. |

## POTATOES[1]

| Insect | Time of attack | Insecticide | Lb. of active ingredient per acre | Placement | Timing of application |
|---|---|---|---|---|---|
| Flea beetle | May-July | carbaryl<br>endosulfan spray<br>endosulfan dust | 1<br>½<br>1 | Foliage | When first damage appears on leaves, and repeat as needed. |
| Colorado potato beetle | May-July | carbaryl<br>endosulfan spray<br>endosulfan dust | 1<br>½<br>1 | Foliage | As needed. |
| Potato leafhopper (NHE-22) | May-July | carbaryl<br>dimethoate<br>endosulfan spray<br>endosulfan dust | 1<br>0.3<br>½<br>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<br>endosulfan spray<br>endosulfan dust<br>malathion<br>parathion | 0.3<br>½<br>1<br>1<br>¼ | Foliage | As needed. |
| | | phorate granules | 2 to 3 | Soilband | As for leafhoppers. |
| Blister beetle (NHE-72) | All season | carbaryl<br>toxaphene | 1½<br>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<br>toxaphene | ¾<br>1½ | 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 fleahopper | parathion aerosol | 1 lb. 10% aerosol per 50,000 cu. ft. | In a closed greenhouse above plants. |
| Mealybug<br>Spider mite<br>Whitefly | tepp aerosol | 1 lb. 5% aerosol per 50,000 cu. ft. | In a closed greenhouse above plants. |
| Armyworm<br>Cabbage looper | DDT dust | 3% purified DDT dust, 20 lb. per acre | On soil surface; do not use after seedling stage. |
| Cutworm | malathion aerosol | 1 lb. 10% aerosol per 50,000 cu. ft. | In a closed greenhouse above plants. |
| 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<br>Spider mite<br>Russet mite<br>Thrip | | Use malathion or parathion aerosol as suggested for aphid and whitefly. | |
| Armyworm<br>Cabbage looper | DDT dust | 3% purified DDT dust, 20 lb. per acre | On soil surface for cutworms; dust in air above plants for caterpillars. |
| Cutworm | malathion aerosol | 1 lb. 10% aerosol per 50,000 cu. ft. | In a closed greenhouse above plants. |
| 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 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.
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.*

### Changes in Suggestions During 1968

As of January 1, 1968, use of a pesticide on vegetables will not be approved unless definite tolerances, no matter how minute, have been established for each crop and each chemical. Most manufacturers of pesticides have complied, but the user should be alert for legal changes during 1968. If some changes become necessary they will be announced publicly, but it will be impossible to revise this circular until December, 1968.

# *1968 Suggested Insecticide Guide* | Insect Control for LIVESTOCK AND LIVESTOCK BARNS

As of January 1, 1968, use of an insecticide on livestock will not be approved unless a tolerance (no matter how minute) has been established in the meat, milk, or eggs. A no-residue or zero tolerance will no longer be admissible, but a temporary extension of this deadline may be granted for specific insecticides under certain conditions. It is hoped that all manufacturers of insecticides used on Illinois livestock will have complied and that no labels will be cancelled. You, the user, should be alert for legal changes in 1968. This publication was prepared on the basis of clearances in effect in November, 1967; thus, some changes may become necessary during 1968. We will publicly announce such changes to keep you informed, but this circular will not be revised until December, 1968.

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 greatly reduces meat, egg, and milk 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 pinkeye 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.

Leaflets 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 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.

**CIRCULAR 898 UNIVERSITY OF ILLINOIS COLLEGE OF AGRICULTURE COOPERATIVE EXTENSION SERVICE**
**In cooperation with ILLINOIS NATURAL HISTORY SURVEY Urbana, Illinois, December, 1967**

## 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 (NHE-18) | Ciodrin E.C., 4 lb. per gal.<br>3.2 lb. per gal.<br>2 lb. per gal.<br>rotenone 5% W.P. | 1½ pt.<br>2 pt.<br>3 pt.<br>2 lb. | 1–2 gal. per animal. Spray to saturation. Make 2 treatments 14 days apart. |
| *Pastured cattle only* | Horn flies (NHE-59)<br>Stable flies (NHE-61) | Ciodrin 2.0% O. | | 1–2 oz. per animal; 2–6 times per week.[1] |
| | | dichlorvos 1.0% O.<br>pyrethrin 0.1% + synergist O. | | 1–2 oz. per animal daily.[1] |
| | Horse flies (NHE-60) | pyrethrin 0.5% + synergist O. | | 1–2 oz. per animal daily.[1] |
| | | 1% pyrethrin + synergist E.C. | 10 gal. | 1–2 qt. per animal every 3 days.[1] |
| | Face flies (NHE-106) | Ciodrin 2.0% O. | | 1–2 oz. per animal, 2–6 times per week.[1] |
| | Grubs | rotenone 5% W.P. | 7½ lb. + 1–2 lb. of detergent | 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.<br>lindane 12.4% E.C.<br>malathion 50–57% E.C. | 1½ pt.<br>1 qt.<br>3 qt. | 1–2 gal. per animal. Spray to saturation. Make 2 applications 14 days apart. |
| *Pastured cattle only* | Horn flies (NHE-59)<br>Stable flies (NHE-61) | toxaphene 60% E.C. | 5 pt. | 1–2 qt. per animal every 3 weeks. Only partially controls stable flies.[1] |
| | | Ciodrin 2.0% O. | | 1–2 oz. per animal; 2–6 times per week from automatic sprayer.[1] |
| | Horse flies (NHE-60) | Use as directed for dairy cattle above. | | |
| | Face flies (NHE-106) | Ciodrin 2.0% O. | | As for stable flies. |
| | | 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.<br>rotenone 1½% dust | As for dairy cattle | |
| | | The following systemic insecticides, coumaphos, Ruelene, and trichlorfon, as sprays provide excellent control of grubs and good control of lice. Use only on *native beef cattle;* apply during September or October. Grub control in Illinois is seldom profitable for the farmer. | | |
| **Swine** | Mange and lice | lindane 20% E.C.<br>lindane 12.4% E.C.<br>malathion 50–57% E.C. | 1 qt.<br>3 pt.<br>3 qt. | 1–2 qt. per animal. Make two applications 14 days apart. |
| **Sheep** | Ticks, lice, and scab (NHE-53) | lindane 20% E.C.<br>lindane 12.4% E.C. | 1 qt.<br>3 pt. | Spray to saturation. With dips use ½ strength. |
| | | toxaphene 60% E.C. | 5 qt. | Spray to saturation. With dips use ½ strength except for scab. |

Note: E.C. = emulsion concentrate, O. = oil solution, W.P. = wettable powder.

[1] Spray head, back, sides, belly, and legs carefully. Start treatments in June.

Cooperative Extension Work in Agriculture and Home Economics: University of Illinois, College of Agriculture, and the United States Department of Agriculture cooperating. JOHN B. CLAAR, *Director*. Acts approved by Congress May 8 and June 30, 1914. O-1352

## CHICKENS, 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** | Lice (NHE-54) | coumaphos 25% W.P.<br>malathion 50–57% E.C. | 6 oz. per 5 gal. water<br>10 oz. per 5 gal. water | Apply to roosting areas. |
| | | carbaryl 5% dust | | Apply to litter only, 1 lb. per 40 sq. ft. |
| | | coumaphos 0.5% dust | | Apply to litter and nests, 1 lb. per 20 sq. ft. |
| | | malathion 4% dust | | Apply to litter and nests, 1 lb. per 50 sq. ft. |
| | Common red mites 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.<br>malathion 50–57% E.C. | 6 oz. per 5 gal. water<br>10 oz. per 5 gal. water | Spray roosts, back walls, side walls, and nests. |
| | 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. |
| | | coumaphos 0.5% dust | | Apply to litter and nests, 1 lb. per 20 sq. ft.; 1 lb. per 100 male birds. |
| | | malathion 4% dust | | Apply to litter and nests, 1 lb. per 50 sq. ft.; 1 lb. per 100 male birds. |
| | | 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.<br>malathion 50–57% E.C. | 3 oz. per 5 gal. water<br>5 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. |
| **Residual Sprays for Barns and Sheds** | Houseflies (NHE-16, 88)<br>Stable flies (NHE-61) | fenthion 46% E.C. (beef barns only)<br>fenthion 25% W.P. (beef barns only) | 3 gal.<br>48 lb. | 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. |
| | | diazinon 48% E.C.<br>diazinon 50% W.P. | 2 gal.<br>16 lb. | Treat every 2–4 weeks during fly season.[1] Otherwise apply as for fenthion. |
| | | dimethoate 25% E.C. | 4 gal. | Treat every 4–6 weeks during fly season.[1] Otherwise apply as for fenthion. |
| | | ronnel 24% E.C.<br>ronnel 25% W.P. | 4 gal.<br>32 lb. | Treat every 1–3 weeks during fly season.[1] Otherwise apply as for fenthion. |
| **Baits as Supplements for Barn and Shed Sprays** | | diazinon E.C.<br>trichlorfon E.C. | Dilute to 0.1% mixture in 2 parts corn sirup and 1 part water | Apply to favorite fly-roosting areas from tank sprayer as needed to supplement residual spray treatment. |
| | | dichlorvos E.C.<br>naled E.C. | Dilute to 0.1%–0.5% in 2 parts corn sirup and 1 part water | Apply as for diazinon and trichlorfon. |
| | | ronnel E.C. | Dilute to 2% in 2 parts corn sirup and 1 part water | Apply as for diazinon and trichlorfon. |
| | | Dimetilan 4% bands | | Hang 1 band per 75 sq. ft. of area from the ceiling or support posts. A supplement to residual sprays. |

Note: E.C. = emulsion concentrate, O. = oil solution, W.P. = wettable powder.

[1] Lasting effects are shortened during periods of hot, dry weather.

## LIMITATIONS FOR SUGGESTED INSECTICIDES APPLIED TO LIVESTOCK OR IN LIVESTOCK BARNS

**(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) | ... | ... | D | ... | ... | ... | ... | ... | I, J | I, J |
| diazinon | ... | H, C | ... | H, C | ... | H, C | ... | H, C | ... | H, C |
| dichlorvos (DDVP) (Vapona) | B | C | ... | C | ... | C | ... | C | ... | C |
| dimethoate (Cygon) | ... | H | ... | H | ... | H | ... | H | ... | H |
| Dimetilan | ... | C, M | ... | C, M | ... | C, M | ... | C, M | ... | C, M |
| fenthion (Baytex) | ... | ... | ... | H | ... | ... | ... | ... | ... | ... |
| lindane | ... | ... | G, K | ... | G, K | ... | G | ... | ... | ... |
| malathion | ... | ... | B | ... | B | ... | ... | ... | I | I |
| naled (Dibrom) | ... | C | ... | C | ... | C | ... | C | ... | C |
| pyrethrin | B | ... | B | ... | ... | ... | ... | ... | ... | ... |
| rotenone | B | ... | B | ... | ... | ... | ... | ... | ... | ... |
| ronnel (Korlan) | ... | H, C | ... | H, C | ... | H, C | ... | H, C | ... | I |
| Ruelene | ... | ... | A | ... | ... | ... | ... | ... | ... | ... |
| toxaphene | ... | ... | F, K | ... | ... | ... | F | ... | ... | ... |
| trichlorfon (Dipterex) (Neguvon) | ... | C | D, L | C | ... | C | ... | C | ... | C |

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.

## FOR YOUR PROTECTION

Always handle insecticides with respect. 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.

# *1968 Suggested Insecticide Guides*

# Insect Control for FIELD CROPS

Insects and related pests play a major role in field crop production in Illinois. Although normal agronomic practices developed during the past century have reduced the importance of many insect pests, chinch bugs, grasshoppers, armyworms, aphids, white grubs, wireworms, cutworms, and many other native insects have continued to be threats to grain and forage production. These native insects have been joined by such aliens as the European corn borer, Japanese beetle, alfalfa weevil, spotted alfalfa aphid, southwestern corn borer, sweet clover weevil, and others. Without the use of the modern insecticides, these insects would seriously hamper economical production by Illinois farmers and harvests would be much less bountiful. Weather variations from year to year greatly affect insect populations, but annually Illinois farmers reap more than 30 million dollars profit from the use of insecticides to control field crop insects.

Financial gain from use of insecticides has not been the only compensation. Use of modern insecticides reduces stalk breakage and lodging from insect damage. This possibly has reduced the incidence of clogged pickers and accidents. Proper use of insecticides has also greatly reduced the need for replanting. Thus proper use of insecticides is an integral part of our farming business.

However, those using insecticides should 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.

Some of the insecticides suggested in this publication can be poisonous to the applicator. The farmer is expected to protect himself, his workers, and his family from undue or needless exposure.

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.

Descriptions of specific insects, their life history, biology, and cultural control methods are available. These are designated in the tables with NHE numbers, and can be obtained from the county extension adviser or by writing to Office of Agricultural Publications, University of Illinois, Urbana, Illinois 61801.

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 900 — Insect Control by the Homeowner;

Circular 936 — Pest Control in Commercial Fruit Plantings.

These suggestions are revised annually by entomologists of the College of Agriculture and the Illinois Natural History Survey.

Suggestions sometimes change during the growing season and thus are subject to change without notification.

**CIRCULAR 899 UNIVERSITY OF ILLINOIS COLLEGE OF AGRICULTURE COOPERATIVE EXTENSION SERVICE**
**In cooperation with ILLINOIS NATURAL HISTORY SURVEY Urbana, Illinois, December, 1967**

# SPECIAL SUGGESTIONS AND MAJOR CHANGES FOR 1968

## Changes in Suggestions During 1968

As of January 1, 1968, use of a pesticide on food or feed will not be approved unless definite tolerances, no matter how minute, have been established for each crop and each chemical. Most manufacturers of pesticides have complied, but the user should be alert for legal changes during 1968. If some changes become necessary they will be announced publicly, but it will not be practical to revise this circular until December, 1968.

## Dairy Farms

Although there is label approval we caution dairy farmers against the use of the chlorinated hydrocarbons, *aldrin, chlordane, dieldrin, DDT, endrin, heptachlor,* or *lindane* either as foliar treatments or soil treatments, even though they have been used for many years. The tolerance in milk for most of these insecticides is still zero. Even slight drift onto dairy pastures, hay crops, or other dairy forage crops will result in minute but traceable amounts in milk and body fat which will then be excreted in the milk presenting a legal problem, not a public health problem. Because of possible drift, do not apply sprays or dusts of these insecticides to fields adjacent to dairy hay, pasture, or ensilage crops.

Do not apply these chlorinated hydrocarbons to dairy buildings or barns or on dairy cattle.

The greatest possibility of milk contamination from use of aldrin or heptachlor as corn soil insecticides exists in use of harvested cornfields as a grazing or resting area for dairy cattle. As the animals contact the treated soil and pick up corn from the ground, they pick up soil containing sufficient insecticide to be detectable in the milk. Use of aldrin or heptachlor as corn soil insecticides does not present a residue problem in the grain. Cut corn for ensilage or stover about 18 inches above the ground if soil treatments of aldrin or heptachlor have been used. Hay produced even two years after the last soil application may have slight residues from contaminated soil particles.

When buying corn ensilage or other forage, be sure it does not have an objectionable residue. Question the supplier and, if in doubt, have a chemical analysis made. These statements apply to heifers and dry cows, as well as to producing cows.

*Toxaphene* is a chlorinated hydrocarbon not included in the list above. It will appear in the milk when dairy animals eat toxaphene-treated forage; however, it is not stored in the animals' bodies, and they will produce clean milk in about one week after exposure. You may wish to use toxaphene on your farm to control insect pests of soybeans, corn (for grain), or small grain, providing you do not use these products for pasture, hay, ensilage, or stover. In using toxaphene, take all precautions to avoid drift onto dairy pasture, hay, or other forage crops.

## Soybean Farms

Recent research shows that aldrin and heptachlor, and their breakdown products, dieldrin and heptachlor epoxide, are translocated to the beans grown in the field the year of application. This research also shows that soybeans following corn to which the soil insecticides aldrin and heptachlor have been applied absorb small but still detectable amounts of these insecticides.

On the basis of preliminary research and guided by the results of random surveys of Illinois soybeans, we suggest to Illinois soybean producers the following uses of insecticides in 1968:

1. *Do not use* the soil insecticides aldrin, chlordane, dieldrin, endrin, heptachlor, or lindane as a soil or foliar treatment for soybeans. Aldrin, dieldrin, and heptachlor are not cleared for use on soybeans as a foliar treatment. DDT was granted a tolerance in soybeans but we do not recommend that it be used by Illinois farmers.

2. At present, allow two years to elapse after the last application before planting soybeans in a field where either aldrin or heptachlor have been applied annually for five or more years. Thus, if aldrin or heptachlor were applied to a field from 1963 through 1967, skip 1968, and do not grow soybeans in this field until 1969.

3. For the common Illinois rotations that include soybeans, corn, and grains, continue to plant soybeans as you have in the past. The future of this suggestion depends upon research and survey data.

## Farms With Continuous Corn

*Northern* and *western* corn rootworm populations increase rapidly in fields where corn is grown for three or more years in succession. The beetles emerge in late July and August, feed on silks and pollen, and deposit eggs in the soil. The eggs hatch into larvae the following June. The larvae feed on the corn roots and by early August the corn begins to lodge.

In 1962 northern corn rootworms highly resistant to aldrin and heptachlor appeared. By 1965 there were individual problem fields in almost every county in the northern half of Illinois. This trend continued in 1966 and the extent of the resistance problem increased. By 1967 failures to control rootworms were common in the northern half of Illinois and corn lodged in many fields where corn had been grown for three or more years continuously. If you have used aldrin or heptachlor regularly and if there were lots of green beetles in the fresh silks during August, you probably have resistant northern corn rootworms.

In 1967 western corn rootworm attacks caused severe lodging and yield losses in many fields in Mercer County and neighboring counties. This rootworm species is now present in all counties north and west of a line from Quincy to Peoria to Belvidere, and an occasional specimen could be present in every county in the north half of Illinois. Furthermore, all western corn rootworms in Illinois are highly resistant to aldrin and heptachlor. In 1968 commercial damage from this rootworm may occur in Hancock, Henderson, Mercer, Rock Island, Whiteside, Lee, Bureau, Henry, Knox, McDonough, Peoria, Stark, Fulton, and Warren counties.

Viewing the extent of the population and resistance to aldrin and heptachlor of both the northern and western corn rootworms, we can assume that all fields, but particularly those in the northern half of Illinois, planted to corn for three or more consecutive years could have moderate to severe lodging from rootworm attack in 1968. Although use of aldrin or heptachlor may provide satisfactory control in some fields, attempts to control corn rootworms with these two previously effective soil insecticides will meet with failure in the majority of cases. *Therefore farmers, particularly those in the northern half of Illinois, who have fields that are to be planted to corn for the third consecutive year or longer should consider some program other than the conventional use of aldrin or heptachlor to control northern and western corn rootworms.*

Unfortunately there is no insecticide presently available that can be applied at planting time that will control rootworms on all dates of planting. Therefore a crop rotation may be the easiest method of corn rootworm control; grow some other crop in the field for two years. When rotating crops to control resistant corn rootworms, use a crop other than soybeans in 1968 if you have used aldrin or heptachlor annually for five or more years including 1967. If you have applied aldrin or heptachlor annually for several years, but not in 1967, you can plant soybeans in 1968.

Natural History Survey entomologists have shown that dyfonate, phorate, BUX ten, and diazinon granules in a 7-inch band ahead of the press wheel to *late-planted* corn will control the rootworms hatching in late June and early July. Dyfonate, phorate, and BUX ten applied to *mid-season* plantings usually provide get-by root protection during rootworm attack, but *no insecticide* used at planting on *early planted* corn gave practical rootworm control.

To control rootworms on early or mid-season plantings, make a *basal application* of insecticide during cultivation. A special applicator on the cultivator directs organic phosphate insecticide granules at the base of the plant. This kills rootworms for about six inches on each side of the plant allowing roots to establish themselves and secure the plant. The three most effective insecticides for basal applications appear to be phorate, diazinon, and disulfoton granules.

There are several organic phosphates and carbamates labelled for rootworm control. Of the ones tested in Illinois, only those above gave consistent and satisfactory results. Others failed to provide root protection to the corn when conditions were slightly adverse. Fertilizer-insecticide mixtures are discouraged at this time; band fertilizers are generally applied to only one side of the row and results from such treatments have been no better than from untreated plots.

## Pollination Injury by Rootworm Beetle Feeding

*Silk damage by corn rootworm beetle feeding:* Corn rootworm beetles feed on silks. When these beetles are numerous during pollination, kernel set can be affected, particularly in late-planted fields when silking has just begun. If beetle emergence occurs during dry silk, then pollination is not seriously hurt. Control will be profitable when five to ten or more beetles per ear are present and not more than 50 percent of the plants have silked.

## Condensed Soil Insecticide Suggestions

*General non-dairy farms:* In a normal rotation continue to use aldrin or heptachlor broadcast and disked in before planting or in the row at planting time to control white grubs, wireworms, grape colaspis, and seed-infesting insects. Broadcast applications generally control cutworms, but if a row treatment is used, plan to apply a post-planting or emergency application for cutworms if necessary as listed on page 5.

*Dairy farms:* Use an organic phosphate or carbamate insecticide as described for rootworm control. For early-planted corn use a planter box seed treatment to supplement early June basal applications, but take precautions not to interfere with the seeding rate. In some instances you may have to apply a post-planting or emergency application of one of the insecticides listed in the table for cutworm control.

*Soybeans:* Do not apply aldrin, chlordane, dieldrin, endrin, or heptachlor as a soil or foliar treatment for soybean insects. If you have applied aldrin or heptachlor annually for five or more years for corn-soil insect control, skip one year before planting soybeans.

*Continuous corn and control of resistant corn rootworms:* When planting *early,* plan to use a basal insecticide application in the first part of June. With *mid-season plantings* you may wish to try a planting-time treatment of dyfonate, phorate, or BUX ten in a 7-inch band ahead of the press wheel. For *late-planted* corn use dyfonate, phorate, BUX ten, or diazinon granules ahead of the press wheel.

For early planted corn, you may want to use an aldrin or heptachlor preplanting- or planting-time treatment, or at least a planter box seed treatment.

## ALFALFA WEEVIL

Insecticide suggestions are listed on page 7.

Use of flamers or burners during the dormant winter period to burn alfalfa stems and debris has met with varying success. Special burners are available for this purpose. Their success in alfalfa weevil control will depend on the extent of fall and winter egg laying by the adults, because they deposit eggs in alfalfa stems. When these are burned during the winter months or in early spring before plant growth begins, the attack by weevil is delayed. Thus burning replaces the first insecticide application. Because the value of this method depends on fall and winter egg laying, it may be limited in use to the southern one-third of Illinois. Few eggs will be laid before spring in the north half of Illinois.

## 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 |
| aldrin | A | ... | ... | ... | ... | ... | ... | ... |
| azinphosmethyl (Guthion)[1] | ... | ... | ... | ... | 16,E | 16,E | ... | 16,E |
| carbaryl (Sevin) | ... | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| demeton (Systox)[1] | ... | ... | ... | ... | 21,E | 21,E | 21,E | 21,E |
| diazinon | A | 0 | 10 | 10 | 7 | 7 | K,L | 7 |
| dieldrin | A | ... | ... | ... | ... | ... | ... | ... |
| disulfoton (Di-Syston)[1] | 100,J | 100,J | 100,J | 100,J | ... | ... | ... | ... |
| dyfonate (N2790)[1] | A | I | I | I | ... | ... | ... | ... |
| Gardona | ... | A | ... | ... | ... | ... | ... | ... |
| heptachlor | A | ... | ... | ... | ... | ... | ... | ... |
| malathion | ... | 5 | 5 | 5 | 0 | 0 | 0 | 0 |
| methoxychlor | ... | ... | ... | ... | 7 | 7 | 7 | 7 |
| naled (Dibrom) | ... | ... | ... | ... | 4 | 4 | 4 | 4 |
| BUX ten (0-5353)[1] | A | I | I | I | ... | ... | ... | ... |
| 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,N | 40,N | 40,N | ... | ... | ... | ... |

| | Barley | | Oats | | Rye | | Wheat | | Soybeans | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Grain | Straw | Grain | Straw | Grain | Straw | Grain | Straw | Grain | Forage |
| azinphosmethyl (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,M | D |
| trichlorfon (Dylox) | 21 | D | 21 | D | ... | ... | 21 | D | ... | ... |

1. Except as granules, to be applied only by experienced operators wearing proper protective clothing.
A. No specific restriction when used as recommended.
B. Do not apply if soil application was used. Otherwise apply before tassel stage.
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. Do not make more than 2 applications after pods begin to form.
N. Once only per season when plants are 3-12 inches tall.

## FIELD CORN

| Insects | Time of attack | Insecticide | Lb. active ingredient per acre | Placement | Timing of application (See table of limitations) |
|---|---|---|---|---|---|
| Seed corn maggot<br>Seed corn beetle (NHE-27)<br>Wireworm (NHE-43) | At germination | dieldrin<br>heptachlor | Follow manufacturer's directions | On seed | Protects seed only. Use with resistant rootworm soil treatment. |

Note: See footnotes at bottom of page 5.

## FIELD CORN (continued)

| Insects | Time of attack | Insecticide | Lb. active ingredient per acre | Placement | Timing of application (See table of limitations) |
|---|---|---|---|---|---|
| Corn rootworms[5] (also for soil insect control on dairy farms) (NHE-26) | June-August | phorate[2]<br>BUX ten[2]<br>diazinon[2]<br>dyfonate | 1<br>1<br>1<br>1 | Soil surface | Apply as 7-inch band on soil immediately ahead of press wheel for late-planted corn. Cultivation or basal treatment cultivated into the soil in June may be used for corn rootworm control. For early plantings see page 3. |
| Wireworm (NHE-43) | May-July | aldrin[1] | 1 in row<br>1½ broadcast | In soil | If broadcast, work into soil immediately. 1½ lb. kills only small or medium size worms. |
| White grub (NHE-23) | May-October | heptachlor[1] | Same as aldrin | In soil | |
| Grape colaspis (NHE-25) | May-July | As for wireworm; broadcast preferred. | | | |
| Sod webworm (NHE-42) | May-June | carbaryl | 1 | At base of plant | At time of initial attack. |
| Cutworm (NHE-38) | May-June | **Broadcast treatment:** apply 1½ lb. of aldrin or heptachlor. For late-planted corn you may use 4 lb. of diazinon as preventive (planting must occur soon after diazinon treatment). | | | |
| | **Emergency treatment:**[4] | carbaryl<br>diazinon<br>toxaphene<br>trichlorfon | 2-3<br>2<br>3<br>1 | At base of plant | When damage is first seen; use 20 gal. of finished spray per acre. Cultivation immediately after application will be helpful. |
| Grasshopper (NHE-74) | June-September | carbaryl<br>toxaphene | ¾<br>1½ | Over row as spray | As needed. For ensilage corn use carbaryl, diazinon, or malathion. |
| Flea beetle (NHE-36) | May-June | carbaryl<br>toxaphene | ¾<br>1½ | Over row as spray | When damage becomes apparent on small corn. |
| Armyworm (NHE-21) | May-June | carbaryl<br>toxaphene<br>trichlorfon | 1½<br>1½<br>1 | Over row as spray | At first migration or when damage first becomes apparent. |
| Fall armyworm (NHE-34) | June; August-September | carbaryl granules<br>toxaphene granules | 1½<br>1½ | In whorls | Granules preferred for whorl. When silking (see earworm). |
| 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<br>phorate granules | 1<br>1 | In whorl | Just before tasseling when aphids are appearing on individual plants. Preventive treatment. |
| | | malathion<br>diazinon<br>methyl parathion[3] | 1<br>1<br>¼ | As a foliage spray | To clean up severe infestation. |
| Corn rootworm adults | Late July, early August | carbaryl<br>malathion<br>diazinon<br>methyl parathion[3] | 1<br>1<br>1<br>¼ | Overall spray or directed towards silk | When silking is not over 50% and there are more than an average of 5 beetles per ear. |
| Corn borer, first generation | June-July | carbaryl 5% granules<br>diazinon granules<br>parathion granules<br>bacillus thuringiensis | 1½<br>1<br>½ | On upper ⅛ of plant and into whorl | When tassel ratio is 30 to 50, and 75% or more plants show recent borer feeding in whorl. |
| Corn borer, second generation | Mid-August | carbaryl<br>diazinon<br>parathion[3] | As for first generation<br>½ | From ear upward | At first hatch when there are 1 or more egg masses per plant. |
| Corn earworm Seed corn only (NHE-33) | July-August | carbaryl<br>Gardona | 1½<br>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. |

[1] Not for use on dairy farms. Do not apply as foliage sprays or dusts to fields adjacent to dairy pasture, hay, or forage crops.
[2] Dairy farmers should use these materials for soil insect control although they are not as effective as aldrin or heptachlor.
[3] By experienced applicators only.
[4] Dyfonate will be recommended for cutworm control upon label approval.
[5] Dasanit, Landrin, Mocap, Mobam, and Furadan also will be recommended for rootworm control upon label approval.

## SOYBEANS

| Insect | Time of attack | Insecticide[3] | Lb. active ingredient per acre | Placement | Timing of application (See table of limitations) |
|---|---|---|---|---|---|
| Bean leaf beetle (NHE-67) | May-June, August | carbaryl<br>toxaphene[1] | 1<br>1½ | On foliage | When leaf feeding becomes severe, but before plants killed and pods eaten. |
| Clover root curculio adult (NHE-71) | May-June | carbaryl<br>toxaphene[1] | 1<br>1½ | On marginal rows | When clover is plowed, beetles migrate to adjacent beans. |
| Grasshopper (NHE-74) | June-September | carbaryl<br>toxaphene[1] | ¾<br>1½ | On foliage | When migration from adjacent crops begins. |
| Flea beetle | May-June | carbaryl<br>toxaphene[1] | 1<br>1½ | On foliage | Seedlings usually attacked. Treat when needed. |
| Green clover worm (NHE-75) and webworm (NHE-42) | August | carbaryl<br>toxaphene | 1<br>1½ | On foliage | When damage appears and small worms are numerous between blossom and pod fill. |
| Mites | June-August | carbophenothion[2]<br>azinphosmethyl[2] | ¾<br>½ | On foliage | As needed on field margins and entire field. |
| Stink bugs | July and August | carbaryl<br>malathion | 1<br>1 | To foliage | As needed but when stink bugs are numerous. |
| Thrips<br>Leafhoppers | June-August | malathion | 1 | To foliage | As needed. |

[1] 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.
[2] To be applied only by experienced operators or those wearing protective clothing.
[3] See page 2 for insecticide use restrictions on soybeans.

## 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 ⅓ 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<br>malathion 57% E.C., 3 oz. per gal. water | 30 lb. per 1,000 sq. ft.<br>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**<br>Internal and external feeders (NHE-64, 65)<br>Rice and granary weevils | April-October | malathion 1.0% dust<br>malathion 57% E.C., 1 pt. per 3-5 gal. water | 40-60 lb. per 1,000 bu.<br>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<br>Saw-toothed grain beetle<br>Rusty grain beetle<br>Foreign grain beetle<br>Cadelle beetle<br>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 | Lb. active ingredient per acre | Placement | Timing of application (See table of limitations) |
|---|---|---|---|---|---|
| Grasshopper (NHE-74) | June-August | carbaryl<br>toxaphene[1] | ¾<br>1½ | 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 to protect corn from migrating bugs. |
| Armyworm (NHE-21) | May-June | carbaryl<br>toxaphene[1]<br>trichlorfon | 1<br>1½<br>¾ | On foliage | When worms are still small and before damage is done. |
| Greenbug<br>English grain aphid | May-June | demeton[2]<br>parathion[2] | ¼<br>¼ | On foliage | When needed. |
| Hessian fly | Sept.-October; April-May | disulfoton<br>phorate | ½<br>½ | In drill row | Use granules in a grass-seeder for susceptible varieties planted early. |

[1] 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.
[2] To be applied only by experienced operators or those wearing protective clothing.

## CLOVER AND ALFALFA

| Insect | Time of attack | Insecticide | Lb. active ingredient per acre | Placement | Timing of application[3] (See table of limitations) |
|---|---|---|---|---|---|
| Alfalfa weevil (NHE-89) | March-June | azinphosmethyl[2,4]<br>methyl parathion[2]<br>malathion[6]<br>malathion[5] with<br>methoxychlor<br>diazinon[5] with<br>methoxychlor[5] | ½<br>½<br>1¼<br>¾<br>¾<br>½<br>1 | 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 and spray new growth if necessary. For flaming see page 3. |
| 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 | 1 | 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[2]<br>diazinon<br>malathion | ¼<br>½<br>1 | On foliage | When aphids are becoming abundant. |
| Leafhopper (NHE-22) | Early July | carbaryl<br>methoxychlor | 1<br>1 | On foliage | When second-growth alfalfa is 1 to 6 inches high, or as needed. |
| Garden webworm (NHE-42) | July-August | carbaryl<br>toxaphene[1] | 1<br>1½ | On foliage | When first damage appears. Use toxaphene only on new fall seedlings. |
| Cutworm (NHE-77) | April-June | carbaryl | 1½ | On foliage | Cut, remove hay, and spray immediately. |
| Armyworm (NHE-21) | May-June, September | carbaryl<br>malathion | 1½<br>1 | On foliage | Only when grasses are abundant. |
| Seed crop insects | July-August | toxaphene[1] | 1½ | On foliage | No later than 10% bloom. |
| Grasshopper (NHE-74) | June-September | carbaryl<br>diazinon<br>malathion<br>naled | ¾<br>½<br>1<br>¾ | On foliage | When grasshoppers are small and before damage is severe. |
| Sweet clover weevil (NHE-15) | April-May | toxaphene[1] | 1½ | On foliage | When 50% of foliage has been eaten. New seedlings only. |

[1] Not for use on dairy farms. Do not apply as foliage sprays or dusts to fields adjacent to dairy pasture, hay, or forage crops.
[2] To be applied only by experienced operators or those wearing protective clothing.
[3] Before applying insecticides, be certain to clean all herbicides out of equipment.
[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.

## TOXICITY AND PERSISTENCY RATINGS FOR INSECTICIDES[1]

| Insecticide | Toxicity to Warm-blooded animals | Toxicity to Fish | Persistency as a residue |
|---|---|---|---|
| aldrin | 2 | 1 | 1 |
| azinphosmethyl | 1 | ... | 3 |
| carbaryl | 4 | 6 | 3 |
| carbophenothion | 1 | ... | 2 |
| demeton | 1 | 3 | 3 |
| diazinon | 3 | 2 | 3 |
| disulfoton | 1 | ... | 3 |
| heptachlor | 2 | 1 | 1 |
| malathion | 5 | 3 | 6 |
| methoxychlor | 6 | 1 | 4 |
| naled | 3 | 2 | 6 |
| parathion | 1 | 2 | 3 |
| phorate | 1 | ... | 3 |
| toxaphene | 3 | 1 | 1 |
| trichlorfon | 4 | 6 | 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.

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 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.*

**Cooperative Extension Work, University of Illinois, College of Agriculture, and the U.S. Department of Agriculture cooperating.
JOHN B. CLAAR, *Director*. Act approved by Congress May 8 and June 30, 1914.**

*1968 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 *DDVP* is *dichlorvos,* 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 936 — 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 growing season, 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.

**CIRCULAR 900 UNIVERSITY OF ILLINOIS COLLEGE OF AGRICULTURE COOPERATIVE EXTENSION SERVICE**
**In cooperation with ILLINOIS NATURAL HISTORY SURVEY Urbana, Illinois, December, 1967**

Cooperative Extension Work in Agriculture and Home Economics: University of Illinois, College of Agriculture, and the United States Department of Agriculture cooperating. JOHN B. CLAAR, *Director.* Acts approved by Congress May 8 and June 30, 1914.

## VEGETABLE INSECTS

| Insects | Crop | Insecticide | Suggestions |
|---|---|---|---|
| Aphids (NHE-47)<br>Leafhoppers (NHE-22)<br>Mites (NHE-58)<br>Thrips | Most garden crops | malathion | Apply on foliage to control the insects. Aphids and leafhoppers transmit plant diseases; early control is important. Mites web underside of leaves; apply insecticide to underside of leaves early before extensive webbing occurs. |
| Blister beetles (NHE-72)<br>Cutworms (NHE-77)<br>Flea beetles (NHE-36)<br>Grasshoppers (NHE-74)<br>Leafhoppers (NHE-22)<br>Picnic beetles (NHE-40) | Most garden crops | carbaryl | For cutworms, collars of paper, aluminum foil, or metal at planting for small numbers of plants are recommended, 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. | ¾ 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)<br>Codling moth (NHE-98)<br>Green fruit worm<br>Leaf rollers | Apple | malathion<br>methoxychlor<br>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. Carbaryl can be added or substituted after 21 days past bloom. |
| Aphids | Most fruits | 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<br>carbaryl | Use methoxychlor just before bloom and repeat every 10 to 14 days for 3 applications. Do not spray during bloom. Do not use carbaryl on apples until 21 days after bloom or thinning of fruit will occur. |
| 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 | carbaryl | 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<br>Stink bug | Peach and apricot | carbaryl | Make first application at petal fall, plus 2 more applications 10 to 14 days apart. |
| Mites | Most fruits | malathion<br>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<br>Raspberry cane borers | Raspberry | carbaryl<br>methoxychlor<br>malathion | Apply just before buds open and repeat in 2 weeks. |
| Grape berry moth | Grape | carbaryl<br>malathion<br>methoxychlor<br>diazinon | Apply to first generation larvae immediately after bloom and apply sprays again 35 to 45 days later for second brood. |
| Strawberry leafroller<br>Strawberry weevil<br>Strawberry crown borers | Strawberry | carbaryl<br>diazinon<br>malathion<br>methoxychlor | Apply once before bloom and again after bloom. If leafroller remains a problem after harvest, make an additional application. |

[1] There are general-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 can be substituted for methoxychlor for all fruit crops except apples. 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% E.C. | 2 tsp. | 4 tbl. | 1 qt. |
| dicofol 18.5% E.C. | 2 tsp. | 4 tbl. | 1 qt. |
| malathion 50-57% E.C. | 2 tsp. | 4 tbl. | 1 qt. |
| methoxychlor 50% W.P. | 2 tsp. | 4 tbl. | 1 qt. |

Note: E.C. = emulsion concentrate; W.P. = wettable powder.

# TREE AND SHRUB INSECTS

| Insects | Insecticide | Suggestions[1] |
|---|---|---|
| Aphids (NHE-7) | diazinon<br>malathion | Spray foliage thoroughly with force. Repeat as needed. |
| Bagworms (NHE-6) | carbaryl<br>diazinon<br>malathion | Spray foliage throughly. Apply June 15. Later sprays are less effective. |
| Borers (NHE-8) | DDT | Spray trunk monthly in summer, beginning about May 15. Do not spray foliage. Wrap trunks of newly set trees with heavy paper for first two years or until trees are growing vigorously. |
| Catalpa sphinx | carbaryl | 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) | Same as for catalpa sphinx | Spray as soon as damage is noticed. |
| European pine shoot moths and Nantucket pine moth (NHE-83) | DDT | Spray ends of branches thoroughly in mid-April and late June. |
| Fall webworms | carbaryl | Spray when first webs appear; clip off and destroy infested branches or burn out webs. |
| Galls (NHE-80, 81)<br>Elm cockscomb<br>Hickory | lindane | Spray foliage thoroughly when buds unfold. |
| Hackberry blister | diazinon<br>malathion | Spray foliage thoroughly in late May. Kills psyllids in galls. |
| Cooley spruce<br>Eastern spruce | Either spray above | Apply in late September or October or early spring just before buds swell. |
| Green-striped mapleworms | Same as for catalpa sphinx | Spray as soon as damage is noticed. |
| Leaf miners<br>Boxwood<br>Hawthorn<br>Oak | diazinon<br>malathion | Spray foliage thoroughly when mines first appear. Repeat treatment in 10 to 12 days. |
| Mealybugs | malathion | Spray foliage thoroughly and with force. Repeat in two weeks. |
| Mimosa webworms (NHE-109) | carbaryl<br>malathion | Spray foliage thoroughly when first nests appear (June, July). A repeat treatment may be needed. |
| Mites (NHE-58) | Aramite<br>chlorobenzilate | Pay particlar attention to underside of leaves. One treatment is effective for several weeks. |
| | 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) | Same as for fall webworms | 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. |
| Scales (NHE-114)<br>Cottony maple<br>European elm<br>Oystershell<br>Pine needle<br>Scurfy<br>Spruce bud<br>Sweet gum | malathion | Spray foliage thoroughly in late May for pine needle and sweet gum scale; in early June for scurfy, oystershell, euonymous, Fletcher, and European elm scales; and again in early August for oystershell scale; in early July for cottony maple, Juniper, and dogwood scales; and between July 10 and 15 for spruce bud scale. |
| Putnam<br>San Jose<br>Tuliptree | dormant oil diluted according to label | Apply when plants are still dormant in late winter. Do not use on evergreens. For tuliptree scale, a malathion spray in late September is also effective. |

[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<br>malathion | Spray when nymphs appear, usually in late May. |
| Thrips | Same as for aphids | Mainly on privet. Spray foliage thoroughly. Do not use DDT on privet. |
| Yellow-necked caterpillars | Same as for catalpa sphinx | Spray foliage when worms are small. |
| Zimmerman pine moths | DDT | Spray foliage thoroughly in early August. |

[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. | Aramite 15% W.P. | 1 tsp. | 2 tbl. | 2 lb. |
| diazinon 25% E.C.[2] | 2 tsp. | 4 tbl. | 1 qt. | chlorobenzilate 25% W.P. | 1 tsp. | 2 tbl. | 2 lb. |
| lindane 20% E.C. | 1 tsp. | 2 tbl. | 1 pt. | dicofol 18.5% E.C. | 2 tsp. | 4 tbl. | 1 qt. |
| malathion 50-57% E.C.[3] | 2 tsp. | 4 tbl. | 1 qt. | DDT 25% E.C.[4] | 3 tbl. | 1 cup | 2 gal. |

[1] Do not use on Boston ivy. [2] Do not use on ferns or hibiscus. [3] Do not use on canaert red cedar. [4] Do not use on privet. Note: E.C. = emulsion concentrate; W.P. = wettable powder.

## LAWN INSECTS

| Insects | Insecticide | Dosage per 10,000 sq. ft.[1] | Suggestions |
|---|---|---|---|
| True white grubs (NHE-23)<br>Annual white grubs (NHE-23)<br>Japanese beetle larvae (NHE-32)<br>Green June beetle larvae<br>Ants (NHE-111, Cir. 887) | chlordane 45% E.C.<br>40% W.P.<br>10% G.<br>5% G. | 5 cups<br>3 lb.<br>12½ lb.<br>25 lb. | 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. |
| Ants (NHE-111, Cir. 887)<br>Cicada killer (NHE-79)<br>and other soil-nesting wasps (NHE-17) | diazinon 25% E.C.<br>2% G. | 2 qt.<br>50 lb. | Apply as spray or granules and water in thoroughly. For individual nests pour 1% diazinon in nest. Seal in with dirt. |
| Lawn webworms (NHE-115) | carbaryl 50% W.P.<br>5% G.<br>diazinon 25% E.C.<br>2% G.<br>trichlorfon 50% W.P.<br>5% G. | 4 lb.<br>40 lb.<br>2 qt.<br>50 lb.<br>2 lb. 8 oz.<br>25 lb. | As sprays use at least 25 gal. of water per 10,000 sq. ft. Do not water for 72 hours after treatment. As granules, apply from fertilizer spreader. |
| Armyworms (NHE-21)<br>Cutworms (NHE-77)<br>Chinch bugs (NHE-35) | carbaryl 50% W.P.<br>5% G. | 1 lb.<br>10 lb. | As sprays or granules. Use 5 to 10 gal. of water per 1,000 sq. ft. |
| Leafhoppers (NHE-22) | carbaryl 50% W.P.<br>methoxychlor 25% E.C. | 1 lb.<br>1 lb. | As a spray. |
| Millipedes and sowbugs | As for webworms | | |
| Mites (NHE-58) | dicofol 18.5% E.C.<br>malathion 50-57% E.C. | ¾ pt.<br>¾ pt. | Spray grass thoroughly, 20 to 25 gal. of water per 10,000 sq. ft. |
| Slugs (NHE-84) | Slug baits | Scatter in grass | Where slugs are numerous. |

[1] 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 spray has dried.

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.

# FLOWER INSECTS

| Insect | Insecticide[1] | Dosage | Suggestions |
|---|---|---|---|
| Ants, white grubs, and soil-nesting wasps (NHE-17, 79, 111) | chlordane 45% E.C. | 4 oz. per gal. water | Spray over 1,000 square feet of soil and water in thoroughly. Do not spray on plant foliage. Do not plant vegetable root crops on treated soil for 5 years. |
| 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.<br>diazinon 2% granules | 6 oz. per 2-3 gal. water<br>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.<br>malathion 50-57% E.C. | 2 tbl. per gal. water<br>2 tsp. per gal. water | Spray foliage and also adjacent grassy or weedy areas. |
| Iris borer | DDT 25% E.C.<br>dimethoate 2% E.C. | 1 oz. per gal. water<br>4 tsp. per gal. water | Spray DDT as soon as new leaflets appear. Repeat 4-6 times at weekly intervals. Apply dimethoate when iris are in bloom, but not on blooms. |
| Leaf-feeding beetles | carbaryl 50% W.P.<br>DDT 25% E.C. | 2 tbl. per gal. water<br>4 tsp. 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. |
| Sowbugs | DDT 25% E.C.<br>DDT 5% dust | 1 oz. per gal. water | Spray or dust soil around plants. Remove boards and trash under which bugs hide. |
| Spider mites (NHE-58) | Aramite 15% W.P.<br>chlorobenzilate 25% W.P. | 1 tsp. per gal. water | Pay particular attention to underside of leaves when spraying. One treatment is effective for several weeks. |
| | dicofol 18.5% E.C.<br>malathion 50-57% E.C. | 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.<br>malathion 4% dust | 2 tsp. per gal. water | Spray foliage and soil.<br>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 DDT and 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.

## ANIMAL AND NUISANCE INSECTS

| Insects | Insecticide[1] | Method of application | Suggestions |
|---|---|---|---|
| Flies, mosquitoes, gnats (NHE-16) | Outdoors: 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. |
| | Indoors: 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 Dimetilan 4% plastic bands in attached garages (1 per 100 sq. ft.). Use screening and keep repaired. In severe cases brush 5% DDT in oil on screens. |
| Fleas (NHE-107)<br>Brown dog tick | carbaryl 5% dust<br>malathion 4% 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. |
| 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, 116) | dichlorvos 1% O.[2]<br>malathion 1% O. or 4% dust | Treat nests of bees, wasps or hornets after dark. For soil nests treat as for ants (p. 7 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)<br>Boxelder bugs (NHE-9) | dichlorvos 0.5%[2]<br>pyrethrin 0.1% | Brush or spray inside surfaces of window casements | Spray on sides and foundation of house and 3 ft. of adjacent soil with 2% chlordane for elm leaf beetle or 0.5% dieldrin for boxelder bugs. Removal of seed-bearing boxelder trees will help. |
| Clover mites (NHE-2) | Aramite 0.15%<br>chlorobenzilate 0.25%<br>dicofol 0.05%<br>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 | diazinon<br>carbaryl<br>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.<br>malathion 4% dust | 2 tsp. per gal. water. | Spray foliage and soil next to house. |
| Drainflies (NHE-91) | *Outdoors:* malathion 0.5% | Spray shrubbery, tall grass, and refuse container. | 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. |
| | *Indoors:* pyrethrin 0.1% space spray or 20% dichlorvos resin strip | 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] 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.

Note: E.C. = emulsion concentrate; W.P. = wettable powder; O. = oil solution (usually available in pressurized spray cans).

## FOOD, FABRIC, AND STRUCTURAL INSECTS

| Insects | Insecticide[1] | Method of application | Suggestions |
|---|---|---|---|
| Ants (NHE-111, Cir. 887) Spiders (NHE-116) | diazinon 0.5% | Spray runways. | 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. |
| Cereal insects (NHE-11) Drugstore beetle Cigarette beetle | pyrethrin 0.1% dichlorvos 0.5% diazinon 0.5% | Spray or dust inside food cabinets and shelves. | Discard infested packages. Brush out or vacuum food cabinets and shelves. Do not use dichlorvos in pet shops or if tropical fish are present. |
| Roaches (NHE-3,4,5) | diazinon 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% | Spray runways. | Baits using 1 part sodium fluoride plus 9 parts pancake flour are also effective. |
| Crickets | Same as for ants | | |
| 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. DDT 5% 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 1965 there were 16 deaths in Illinois caused by accidental ingestion of pesticides: 10 from insecticides, 4 from rodenticides, and 2 due to a herbicide. Of these 16, eight 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 showed that 50 percent of the children obtained the pesticide while it was in use and 13 percent obtained it from storage (the source was not known in the rest). Fifty-three 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 1968
## 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 are 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. 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 1968 some herbicides may not be available for use because of the loss of a no-tolerance residue basis. Watch for notices of these herbicides (as they are identified by FDA) in the Illinois Vegetable Farmer's Letter.

NOTE: In the suggestions table on the following pages, the trade names of the herbicides are usually used. The list immediately below shows both trade names and their corresponding common names.

| Common name | Trade name |
|---|---|
| amiben | Amiben, Vegiben |
| atrazine | Atrazine |
| CDAA | Randox |
| CDEC | Vegadex |
| CIPC | Chloro IPC |
| dalapon | Dowpon |
| diuron | Karmex |
| DCPA | Dacthal |
| diphenamid | Dymid, Enide |
| DNBP (dinitro) | Sinox PE, Premerge |
| endothall | Endothal |
| EPTC | Eptam |
| linuron | Lorox |
| monuron | Telvar |
| MCPA | Numerous |
| MCPB | Numerous |
| NPA | Alanap |
| PEBC | Tillam |
| propachlor | Ramrod |
| pyrazon | Pyramin |
| simazine | Simazine |
| trifluralin | Treflan |
| Petroleum solvent | Stoddard Solvent |
| 2,4-D (amine) | Numerous |
| not named | TOK |

UNIVERSITY OF ILLINOIS · COLLEGE OF AGRICULTURE · COOPERATIVE EXTENSION SERVICE — CIRCULAR 907

Prepared by H. J. Hopen and J. S. Vandemark, Department of Horticulture

## USE THESE SUGGESTIONS IN 1968 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 planting)** | **Dowpon** | **5-10 lb.** | Perennial grass | End of harvest season following disking | Apply when grass weeds are 3 to 4 inches tall. |
| | **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. |
| | **Simazine** | **3-4 lb.** | Annuals | In spring and after harvest | Apply after disking. Apply only once a year after first year. Do not treat during last year in asparagus because of residue. |
| **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[3] | Preplant soil application Incorporate with soil immediately | Plant crop immediately or within 3 weeks after application. Do not feed foliage to livestock. Can be used up to 1 lb. on dry beans. |
| **Beans, snap** | **Sinox PE or Premerge** | **4-5 lb.** | Annuals[2] | Preemergence | |
| | **Eptam** | **3-4 lb.** | Annual grasses and nutgrass[5] | Preplant soil application Incorporate with soil immediately | Use 3-pound rate on light sandy soil. Do not feed foliage to livestock. |
| | **Treflan** | **0.75 lb.** | Annuals[3] | Preplant soil application Incorporate with soil immediately | Plant crop immediately or within 3 weeks after application. Do not feed forage to livestock. |
| **Beets, garden and sugar** | **Endothal** | **4-6 lb.** | Annuals | Preemergence | Rainfall or irrigation after treatment and before weeds emerge gives maximum control. |
| | **TCA** | **8 lb.** | Annual grasses | Preemergence | Do not use treated tops for food. |
| | **(Endothal-TCA is available as a commercially prepared mixture of 2% endothal and 4% TCA for a mixture of weed populations. Use at same rate as individual chemicals alone.)** | | | | |
| | **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. |
| **Broccoli Brussels sprouts Cabbage Cauliflower** | **Treflan** | **1 lb.** | Annuals[3] | Preplant soil application Incorporate with soil immediately | Transplant after application to 3 weeks later. Do not graze or feed foliage from treated fields. |
| **Broccoli Cabbage Cauliflower** | **TOK** | **4-5 lb.** | Annuals | One to 2 weeks after crop emergence or transplanting, while weeds are in seedling stage. | May not control ragweed or chickweed. Grass control is sometimes marginal. |
| **Carrots Celery Dill Parsnips Parsley** | **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. |
| **Carrots Parsnips** | **Lorox** | **2 lb. 1½ lb.** | Annuals | Preemergence | Do not feed treated foliage to livestock or replant treated area for 4 months. Do not use on parsnips on sandy soil. Use ⅔ rate on carrots on sandy soil. |
| **Cucumbers Muskmelons** | **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. |
| | | **3-3.5 lb.** | | After transplanting or vining | Use granular form. Keep away from foliage. |
| **Onions** | **Dacthal** | **8-10 lb.** | Annuals[4] | Immediately after seeding or transplanting | May not kill smartweed or common ragweed. Can be used on seeds, sets, or seedlings. CIPC can be used for smartweed or common ragweed. |
| | **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. |
| | **Randox** | **4-6 lb.** | Annuals[6] | After 3 or more true leaves | Heavy rainfall may reduce stand. Very effective on purslane and pigweed. Use no later than 45 days before harvest. Direct application to base of plant in later treatment. |

**[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 smartweed and annual grasses. [3] May not control ragweed. [4] May not control ragweed, smartweed, and velvetleaf. [5] May not control smartweed. [6] May not control smartweed and velvetleaf. [7] May not control crabgrass.**

| *Crop* | *Herbicide* | *Rate of active ingredient per acre actually covered*[1] | *Weeds controlled* | *Best time of application (based on crop stage)* | *Remarks, cautions, limitations* |
|---|---|---|---|---|---|
| **Peas** | **Sinox PE or Premerge** | 1-1¼ lb. | Annuals[2] | Postemergence: Before peas are 6 inches tall | Apply in at least 20 gal. of water per acre. Use lower rate when temperature is 80°. Do not graze or use for stock for 60 days. |
| | 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. | | | |
| **Peppers** | Dymid, Enide | 4-5 lb. | Annuals | Preemergence or after transplanting | Do not plant another food crop on treated areas for 6 months. Use 4 lb. on light soil. |
| | Vegiben | 3-4 lb. | Annuals | Within 2 to 3 days after transplanting or immediately after lay-by | Apply only once during growing season. Apply when foliage is dry. Rainfall or irrigation after application will give best results. Use granular formulation only. Do not feed foliage to livestock. |
| | Treflan | 1 lb. | Annuals[3] | Preplant soil application Incorporate with soil immediately | Use on transplants only. Do not feed foliage to livestock. |
| **Potatoes, Irish** | Eptam | 3-5 lb. | Annual grasses and nutgrass[5] | Preplant soil application Incorporate with soil immediately | Use lower rate on sandy soil. |
| | Lorox | 1-2 lb. | Annuals | Preemergence or 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. |
| | Dowpon | 4 lb. | Annual grasses and quackgrass | Just before emergence | Do not use on red-skinned varieties. Do not use if a preplant treatment was used. |
| | | 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[4] | 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°. |
| | Vegadex | 3-4 lb. | Annuals | Immediately after seeding | Do not apply if temperature is above 80°. Irrigation or rainfall after treatment gives best results. |
| **Squash Pumpkins** | Alanap | 3-3.5 lb. | Annuals[5] | 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. |
| **Sweet corn** | Atrazine | 2-3 lb. | Annuals, annual and perennial grasses[7] | Preemergence; apply no later than 3 weeks after seeding Shallow cultivation may improve weed control during dry weather | Grow corn a second year without 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 Atrazine only where quackgrass is a problem. Residue hazard decreased when banded or in combination with Ramrod. |
| | Ramrod | 4 lb. | Annuals | Preemergence | |
| | Atrazine plus Ramrod | 1.5 lb. +2.5 lb. | Annuals and perennial grasses | Preemergence | Use to reduce Atrazine 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, transplanted** | Dymid, Enide | 4-6 lb. | Annuals | After transplanting | Do not plant other food crops on treated areas for 6 months. Use 4 lb. on light soils. |
| | Vegiben | 3-4 lb. | Annuals | Within 2 to 3 days after transplanting or | Use granular formulation only. Do not use on sandy soils. |
| | | | | Immediately after lay-by | Granular formulation can be used on all soils. Apply only once during growing season. |
| | Treflan | 1 lb. | Annuals[3] | Preplant soil application Incorporate with soil immediately | Do not feed foliage to livestock. |
| **Watermelon** | Alanap | 3-5 lb. | Annuals[6] | Immediately after seeding | Do not use on cold soil. Use low rates on sandy soil. Rainfall or irrigation after treatment gives maximum control. |
| | | 3-3.5 lb. | | After transplanting or vining | Granular form preferred. Keep material away from foliage. |

**(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 in the range of 20 to 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 would be a good range for liquid application. The amount of herbicide per acre, however, must be controlled closely by careful calibration, and while there are many ways to calibrating a sprayer, the following one has been found to be satisfactory:

1. Before beginning calibration, be sure the boom and nozzles are adjusted to give the overall or band coverage that is desired.
2. Fill the spray tank with water.
3. Spray a measured area at a set speed. If band applications are being used, be sure to calibrate only for the actual area covered with the herbicide.
4. Measure the amount of water required to refill the tank. This amount divided by the portion of an acre covered will give the gallons of spray per acre being used. For example, if 20 gallons were used to cover one-half acre in the test run, then 40 gallons per acre can be expected in the actual spraying operation.
5. Then add the suggested amount of herbicide per acre to this much water. If 4 pounds per acre are needed, this amount should be added to every 40 gallons in the above example. Note that suggestions are for active ingredient. Thus, if the material used is shown on the label to contain 50 percent active ingredient, then 8 pounds of herbicide should be added to the 40 gallons of water to obtain 4 pounds of active ingredient.

The above method is condensed from the University of Illinois Circular 837, "Calibrating and Maintaining Spray Equipment."

### Granular Equipment

One way to accurately calibrate granular units is as follows: Detach the delivery tubes and place or tie cans under the spouts. Drive a measured distance, which equals some fraction of an acre, at a set speed. Make three runs at a low setting and three at a high setting. The amount of material used divided by the fraction of an acre covered will give the amount of material applied per acre at any one setting. Further settings to obtain additional rates per acre must be tried on a measured area before actual field application.

Check application rate when changing materials and with changes of weather. University of Illinois Circular 839, "Calibrating and Adjusting Granular Row Applicators," supplies additional details on calibration.

## 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 insure circulation of the cleaning solution throughout the sprayer. Water will rinse out many preemergence materials, but persistant 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 when not in use.

Urbana, Illinois December, 1967

Cooperative Extension Work in Agriculture and Home Economics: University of Illinois, College of Agriculture, and the United States Department of Agriculture cooperating. JOHN B. CLAAR, *Director*. Acts approved by Congress May 8 and June 30, 1914.

# 1968 WEED CONTROL GUIDE

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 their effectiveness. Under certain conditions some herbicides may damage the 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. 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 of a herbicide may damage crops, may be unsafe if the 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.

- Guard against possible injury to nearby susceptible plants. With 2,4-D, 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 is safer to use than the volatile ester form. But even with the amine form, spray may drift to susceptible crops. To reduce chance of damage, operate sprayers at low pressure with tips that deliver large droplets and high gallonage output. Some farm liability insurance policies do not cover crop damage caused by the ester form of 2,4-D. Droplets of 2,4-D, MCPA, 2,4,5-T, and dicamba sprays often drift for several hundred yards. Spray only on a calm day or make sure air is not moving toward susceptible crop plants and ornamentals.

- 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, in a safe place 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 for specific information.

This guide is provided 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.

After December 31, 1967, some pesticides previously registered federally on a "no residue" or a "zero tolerance" basis may have registration cancelled unless finite tolerances or exemptions are established by the FDA or unless progress reports have been submitted indicating that studies are being conducted to obtain data to support finite tolerances.

This publication has been prepared on the basis of previous clearance and use and on the assumption that manufacturers of most herbicides for the major crops in Illinois will take necessary steps to allow continued use. However, herbicide users should be alert for any action or lack of action after December 31, 1967, which would change the registration and use status of a herbicide.

## Names of Some Herbicides

| Common | Trade |
|---|---|
| amiben | Amiben |
| amitrole | Amino triazole, Weedazol |
| amitrole-T | Cytrol, Amitrol-T |
| ammonium sulfamate | Ammate-X |
| atrazine | Atrazine |
| bromoxynil | Brominil, Buctril |
| CDAA | Randox |
| CDAA-T | Randox-T |
| CIPC | Chloro IPC |
| chloroxuron | Tenoran |
| cypromid | Clobber |
| dalapon | Dowpon |
| DCPA | Dacthal |
| dicamba | Banvel-D |
| dinitro (DNBP) | (Several) |
| diphenamid | Dymid, Enide |
| EPTC | Eptam |

EPTC plus 2,4-D........................Knoxweed
fenuron..................................Dybar
fenuron TCA..............................Urab
linuron..................................Lorox
MCPA.....................................(Several)
monuron..................................Telvar
monuron TCA..............................Urox
norea....................................Herban
NPA......................................Alanap
picloram.................................Tordon
propachlor (formerly called CP31393)........Ramrod
propazine................................Propazine
R1910....................................Sutan
nitralin.................................Planavin
simazine.................................Simazine
sodium chlorate..........................(Several)
sodium chlorate plus calcium chloride.........Atlacide
trifluralin..............................Treflan
vernolate................................Vernam
2,4-D....................................(Several)
2,4,5-T..................................(Several)
2,4-DB................Butoxone, Butyrac, and Others

For clarity, trade names have been used frequently. This is not intended to discriminate against similar products not mentioned by trade names.

## Corn

For most effective weed control in corn, plan a program well in advance of planting that includes both cultural practices and herbicide applications. If weeds are not a serious problem, cultural practices alone are sometimes adequate. Prepare seedbeds well enough 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 well enough during final seedbed preparation. Working the seedbed excessively may intensify the weed problem and may contribute to crusting. A relatively high plant population and perhaps narrow rows provide effective shading to discourage weed growth.

Early cultivations are most effective for killing weeds. The rotary hoe or harrow works best if used 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. However, enough soil should be thrown into the row to smother weeds. 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, are broadcasting herbicides and are sometimes eliminating cultivation if control is adequate. Research indicates that if weed control is adequate and the soil is not crusted because of excessive seedbed preparation or other factors, there usually is little or no benefit from cultivation on most Illinois soils. Weigh the added expense of broadcasting herbicides against other factors, such as time saved at a critical season.

The use of preemergence herbicides has increased rapidly from 5 percent of the corn acreage treated in 1960 to over half treated in 1967. Their popularity 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.

Most preemergence herbicides are applied as the crop is planted. However, you may apply some preplant (before planting) and some after planting. You can mix some 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.

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.

## Preemergence Herbicides Applied at Planting

*Preferred*

**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 preemergence applications of Atrazine. 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 the rate is increased. Don't exceed the rates specified on the label, however.

Atrazine will often persist long enough to give weed control for most of the season. But unless you take proper precautions, enough Atrazine may remain in the soil to damage some crops the following season. Where Atrazine is applied in the spring, do not follow that fall or the next spring with small grains, small seeded legumes, or vegetables.

Soybeans planted where Atrazine was used the previous year may show some effect, especially if more than the recommended amount was used or on ends of fields where some areas received excessive amounts. However, where the recommended rates of Atrazine are closely followed and accurately applied, soybeans have usually not been damaged enough to affect yields significantly in Illinois research trials.

You can use Atrazine on most types of corn, including field corn, silage corn, seed-production fields, sweet corn, and popcorn. For use on corn, Atrazine 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, often giving better initial control and usually a little longer than Randox. It has also controlled pigweed and given fair control of lambsquarter. Ramrod performs best on the darker soils of the state, but does well on lighter soils also.

Corn has good tolerance to Ramrod. It is cleared for field corn, hybrid seed-production fields, and sweet corn. Clearance for 1968 is anticipated for corn for silage and corn to be grazed. (Refer to most recent label.)

Ramrod is available as a 65-percent wettable powder and as 20-percent granules. Ramrod is not as irritating to handle as Randox, but take precautions to avoid irritation to skin and eyes. Some individuals are more sensitive than others.

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, controls both annual broad-leaved and grass weeds. This combination has given good weed control in research and field trials. For the combination, 4½ pounds of Ramrod 65-percent wettable powder is suggested, regardless of soil type. The amount of Atrazine to add will vary with soil type — 1¼ pounds of Atrazine 80-percent wettable powder for the light-colored soils that are low in organic matter and 2 pounds for the darker soils. The reduced rate of Atrazine will control many broad-leaved weeds, such as smartweed, but may be marginal for control of some like velvetleaf. The reduced rate of Ramrod 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 Atrazine alone. It reduces the Atrazine residue problem, and gives more consistent control on the darker soils or with limited rainfall than Atrazine alone. As with Ramrod alone, do not use the corn for silage and do not graze or feed the forage to livestock unless cleared.

If for some reason such a combination does not give adequate control, because you have used a reduced rate of Atrazine preemergence, then you can still use an early postemergence application of Atrazine at a reduced rate with oil. Do not let the combined rate of both Atrazine applications exceed the full rate normally recommended for the soil type.

**Randox** (CDAA) is approved for field corn, hybrid seed corn, sweet corn, and popcorn. It is adapted primarily to the darker soils with moderate to high organic matter. Do not use Randox on sandy soils. It controls annual grass weeds and pigweed for about four weeks. Preemergence application of Randox can be followed with early postemergence application of 2,4-D to improve broad-leaved weed control. Most Randox is used in granular form to reduce irritation. But even with granules, be careful to avoid irritation to skin and eyes.

*Less Preferred*

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.

A combination of **Atrazine plus Lorox (linuron)** 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. Control of crabgrass and panicum may be better than with Atrazine alone. Using a lower rate of Atrazine in the combination lessens the chance of residue problems with Atrazine on later crops. However, this has not been a serious problem in Illinois. 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.

A combination of **Lorox and Ramrod,** referred to as Londax, has recently received federal clearance for use on corn for grain. It contains Lorox and Ramrod in a ratio of 1 to 2 parts respectively of active ingredient. This combination has given relatively good weed control in research trials. Control of broad-leaved weeds is better than with Ramrod alone. However, the addition of Lorox increases the chance of crop injury.

**Randox-T (CDAA-T)** is cleared for field corn, silage corn, sweet corn, and popcorn. It occasionally causes injury to corn and the "T" part may carry over in the soil occasionally to cause injury to soybeans the following season. Like Randox it is irritating to handle, so most of it is used in granular form. Take appropriate precautions when handling.

Randox-T controls broad-leaved weeds a little better than Randox. However, a preferred alternative would be to use Ramrod or Randox for control of annual grass weeds and follow with an early postemergence application of 2,4-D for broad-leaved weed control.

**Roundup** is a combination of Ramrod and 2,4-D. It is available as a wettable powder or in granular form. It has given reasonably good early weed control. Although there is some chance of injury to corn from the 2,4-D, this has not presented a serious problem.

**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. Although the possibility of corn injury exists, this has not been a serious problem. Knoxweed presents no hazard to crops the next season. It is available in both liquid and granular forms. Do not use on peats, mucks, or sands. 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.

**2,4-D ester** preemergence for corn controls broad-leaved weeds and gives some control of grass weeds. Weed control is rather erratic and 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.

**Banvel-D (dicamba), 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.

## Preplant Herbicides for Corn

Recent research and field experience indicate the feasibility of applying some herbicides prior to planting where you wish to commit yourself to broadcast application.

**Atrazine** is the major preemergence corn herbicide currently available for preplant application. Although early spring and even fall applications have been tried, research indicates that for corn, the closer to planting time Atrazine is applied, the more successful the application is likely to be. Make applications no earlier than two weeks before planting.

Apply Atrazine 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. The 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 at time of incorporation.

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 dilute 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 ⅓ to ½ the depth at which the implement is operated.

The major reason for incorporating some herbicides is to reduce loss of the herbicide from the soil surface. Since loss of Atrazine is not very rapid, incorporation is by no means essential. Another advantage for incorporating some herbicides may be moving the herbicide into soil where there is sufficient moisture for weeds to absorb the herbicide.

Atrazine 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 Atrazine to improve grass control.

**Atrazine plus Sutan (R1910)** was one of the more promising combinations tested in research during 1967. If sufficient label clearance is obtained and if further test results are favorable, this combination could be incorporated prior to planting. Research suggests that other herbicides for possible combination with Atrazine, such as Ramrod and Lorox, often do not maintain their effectiveness sufficiently when incorporated.

In the future, combinations such as Atrazine and Ramrod or Atrazine and Lorox might be applied after final seedbed preparation just prior to planting. But research suggests they should not be incorporated. Present labels do not suggest preplant application for Ramrod or Lorox alone or in combination with Atrazine.

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.

Preplant applications offer an opportunity to make some herbicide applications 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. However, 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.

## 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 broadcast 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 leafing," a condition in which the upper leaves remain tightly rolled and may delay tassel emergence.

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. Double-cross 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 recommended rates per acre for broadcasting are: ⅙ pound of low-volatile ester; ¼ pound of high-volatile ester; or ½ pound of amine.

Here's 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. Thus, 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.

Esters of 2,4-D are more effective than amines of 2,4-D; therefore, use lower rates of esters than of amines to reduce crop injury. After you adjust rates to allow for this difference in effectiveness on weeds and crops, the results with either amines or esters are usually similar.

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** is an amine form of 2,4-D that is formulated in oil and is called an oil-soluble amine. Since it is formulated in oil like the esters it is said to have the effectiveness of the esters, but it retains the low-volatile safety features of the amines.

**Emulsamine** is a trade name for another oil-soluble amine. 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-D (dicamba)** is not usually recommended, but you can use it as a postemergence spray over the top of field corn until the corn is 3 feet high. Corn has relatively good tolerance to Banvel-D at the recommended rate of ⅛ to ¼ pound (¼ to ½ pint) per acre on a broadcast basis. Use proportionately less if directed only into the row.

You can mix Banvel-D with ¼ to ½ pound of 2,4-D amine (most 2,4-D esters do not mix well with Banvel-D). Drop nozzles are not necessary with Banvel-D alone, but use them if you mix Banvel-D with 2,4-D and apply it after corn is 8 inches high.

Banvel-D is similar to 2,4-D in some respects, but controls smartweed better than does 2,4-D. *Banvel-D has often affected soybeans in the vicinity of treated corn fields 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-D can also affect other susceptible broad-leaved plants, such as vegetables and ornamentals.

Do not make more than one postemergence application of Banvel-D per season. You can use Banvel-D 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-D 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-D over 2,4-D and the greater risk of injury to other crops in the vicinity, Banvel-D is suggested only for very serious smartweed problems in corn.

**Atrazine** can be applied as an early postemergence spray to corn up to 3 weeks after planting, but before weed seedlings are more than 1½ inches high. Most annual broad-leaved weeds are more susceptible than grass weeds. The addition of 1 to 2 gallons of oil formulated especially for this purpose has generally increased the effectiveness of early postemergence applications of Atrazine. On the relatively light-colored soils of Illinois, a regular preemergence application of Atrazine will likely remain one of the most successful treatments. On the relatively dark soils of the state there is increased interest in the "Atrazine-oil" treatment. Research and field experience suggest that for those relatively dark soils, 2½ pounds of Atrazine 80W plus 1 to 2 gallons of oil may be just as effective initially, and sometimes more effective than a preemergence application of 3¾ pounds of Atrazine 80W.

As with many herbicide applications, the results with Atrazine and oil will be influenced by many factors, and results are not always consistent. Especially for control of annual grasses, it is important to apply early when grasses are small. If the rate of Atrazine is reduced below the rate normally recommended for preemergence application, the length of control during the season may be reduced. However, a reduced rate applied *early* postemergence may reduce the possibility of residual activity on other crops the next season.

Where a reduced rate of Atrazine has been used in combination with another herbicide for preplant or preemergence application, an early postemergence application of Atrazine at a reduced rate with oil might offer "another chance" in case control with the earlier treatment is not satisfactory. However, where Atrazine is applied twice, do not let the total rate used exceed the amount normally recommended for preemergence application for the particular soil.

The early postemergence application with Atrazine 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 Atrazine alone, corn has sometimes shown a general stunting where oil was added, and there were a few cases of fairly severe injury to corn where Atrazine and oil were used in 1967. 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. Aerial applications of Atrazine, with or without oil, are not recommended for Illinois.

Certain other additives might be used instead of oil to enhance the postemergence activity of Atrazine. The one most widely tested in 1967 was Tronic. Although results with Tronic were not 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. Based on limited observations in 1967, the possibility of injury to corn might be less with Tronic than with oil.

## Directed Postemergence Applications for Corn

Directed sprays are sometimes considered for emergency situations when grass weeds have become too tall for control with cultivation. By the time help is sought, the weeds are often too large for the directed sprays to be very practical or successful. Since the 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 are 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.

**Dowpon (dalapon).** Apply as a directed spray when corn is 8 to 20 inches tall from ground to whorl. Direct Dowpon over the row using the equivalent of 2 pounds of product on a broadcast basis (⅔ 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 broadleaved weeds. If this treatment is used, 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).** Apply 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 as much as possible, 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 and if you want to use it refer to the label for further information on rates, addition of a surfactant (wetting agent), and other precautions.

**Clobber (cypromid).** This is another herbicide for directed-spray application for broad-leaved and grass weeds in corn. The degree of weed control has been erratic and corn can be injured. As with the other directed-postemergence applications, this herbicide has not gained much acceptance in Illinois.

**Flame cultivation** has been tried as a means of controlling weeds in corn. To obtain satisfactory control, flaming must be started early when weeds are very small and must be repeated whenever new growth appears. Three or four flamings are usually required. To be effective, use flame cultivation as a planned program, not as an emergency measure when weeds are already too tall for control by other means. Flame cultivation does not give good control of tall weeds either.

With other alternatives, such as preemergence herbicides, now available there has been very little acceptance of flame cultivation by Illinois farmers. Flaming requires special equipment and some new skills for proper operation and timing. LP gas for flaming costs approximately the same as banded preemergence herbicides per acre. But flaming requires several more trips over the field.

## 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 3 to 5 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, and is used on about three-fourths of the soybean acreage in Illinois. It not only helps control early weeds, but if the soil is crusted, it aids emergence. 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. But 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. Therefore, a good weed-control program is just as important, or more so, for narrow-row beans.

There is considerable 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. So for most situations it is preferable to keep the rows wide enough so you can use cultivation as required. Recent research results do look encouraging and future developments may offer a better answer for weed control in "solid-drilled" soybeans.

Use of preemergence herbicides for soybeans has increased rapidly from about 5 percent of the Illinois acreage treated in 1960 to about half of the acreage treated in 1967. 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. Row cultivation should be used 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.

Soybean herbicides currently being used have not usually had any serious effect on wheat seeded after soybean harvest or on other subsequent field crops commonly grown in Illinois.

## Preemergence Applications for Soybeans

### *Preferred Herbicides*

**Amiben** has been one of the most popular herbicides for soybeans. It controls the majority of annual grass and broad-leaved weeds in soybeans for most of the season. The major exception is annual morningglory. Control of velvetleaf, jimsonweed, and cocklebur is somewhat erratic. Amiben occasionally injures soybeans, but the damage is usually not very severe. When it occurs, the 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 1½ 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. The higher rate is suggested primarily for heavy clay or high-organic soils. University trials have shown best weed control with 1½ 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, 1¼, and 1½ 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.

**Treflan (trifluralin)** is one of the most effective herbicides available for controlling annual grasses such as foxtail. It is also the major soybean herbicide suggested for controlling wild cane and Johnsongrass seedlings. Treflan will also control pigweed and give fair control of 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 and occasionally may be fairly severe. It may cause tops to be stunted and may cause a reduction in the number of lateral roots in the treated zone. Compared to 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 are very important in reducing the possibility of injury.

You can apply Treflan just before planting or anytime during 6 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. Crossdisk 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 the possibility of soybean injury. You can delay the second disking until anytime before planting, and you can use it for final seedbed preparation just before planting.

The disk probably will incorporate the chemical to only ⅓ to ½ the depth of operation. Disking 4 to 6 inches deep to mix the chemical about 2 inches deep is usually considered appropriate. You can use implements other than the disk if they adequately mix the chemical to a depth of about 2 inches. Results with the field cultivator have sometimes been acceptable, but not always as good as with the disk. The degree of incorporation may very considerably depending on type of implement, adjustment, speed, soil moisture, soil texture, and other soil physical conditions.

The rate of Treflan is between ½ and 1 quart (½ 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. For most of the light-colored silt loams of Illinois use ½ to ¾ quart per acre; for the dark-colored silt loams, silty clay loams, and clays use ¾ to 1 quart per acre.

Treflan is also available in granular form. The granules have not been as thoroughly tested as the liquid, but appear to be comparable in performance.

**Randox (CDAA)** is primarily for control of annual grass weeds on the relatively dark soils. It also controls pigweed. Soybeans have good tolerance to Randox. Since Randox is irritating to handle, most of it is used in granular form. With either liquid or granules be very cautious to avoid irritation to skin and eyes. The suggested rate is 1 gallon of liquid or 20 pounds of granules (4 pounds of active ingredient) per acre on a broadcast basis, or proportionately less for band application. Randox is relatively soluble, so do not use it on sandy soils. Randox may be expected to control weeds for about 4 weeks.

**Ramrod (propachlor,** formerly referred to as CP-31393) is more effective for controlling weeds than Randox, performs better on the lighter soils, and is less irritating. Ramrod can provide weed control for about 6 weeks. It is irritating, especially to certain sensitive individuals, so take appropriate precautions in handling. Ramrod is cleared for use on soybeans to be grown and used for seed, but do not use it for soybeans that will be harvested and processed for food, feed, or edible oil purposes unless additional federal clearance is obtained. Ramrod is available as 20-percent granules or as a 65-percent wettable powder. Twenty pounds of the granules or 6 pounds of the wettable powder is equivalent to 4 pounds of active ingredient, which is the recommended rate per acre on a broadcast basis. Proportionately less is suggested for band applications.

*Less Preferred Herbicides*

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 (NPA plus CIPC).** This combination has replaced most of the straight Alanap formerly used in Illinois. Although sometimes satisfactory, weed control from Alanap alone or combined with CIPC has been rather erratic. Crop injury can occur with either one of these herbicides alone or in combination. The same is true for Dyanap, which is a combination of Alanap plus dinitro. 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 NPA and 2 pounds of CIPC active ingredients broadcast per acre.

**CIPC** has not commonly been used in Illinois, except in combination with other herbicides. When tested alone, rates of CIPC sufficient to give adequate control of most weeds have sometimes caused soybean injury. However, smartweed is particularly sensitive to CIPC. And where smartweed presents a severe problem in soybeans you might try rates of 2 to 4 pounds per acre of active ingredient on a broadcast basis. Since this is below the normally recommended rate of 6 to 8 pounds, the risk of soybean injury is reduced. Use this reduced rate of CIPC alone or possibly in combination with some other herbicides that are weak on smartweed. Since such combinations have not been thoroughly tested, use caution and conduct trials on limited acreage.

**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. It is difficult to select a satisfactory rate for fields with major variations in soil type. The rate suggested for light-colored silt loams is 2 pounds of the 50-percent wettable powder (1 pound of active ingredient) on a broadcast basis, or proportionately less on a band. (Rates for other soils are given on the label.) Lorox granules will be available in 1968 for trial use. Lorox injury is characterized by a reduced stand with stunted plants showing brown, dead leaf tissue. Do not use Lorox on sandy soils because of the risk of crop injury.

**Vernam (vernolate)** has given good control of annual grass weeds in Illinois trials, but injury to soybeans sometimes occurs. Vernam might be considered for control of serious infestations of wild cane and for control of Johnsongrass seedlings where some soybean injury from the herbicide might be tolerated. Vernam may be applied after planting. But when sprayed, it requires shallow incorporation with a rotary hoe or similar implement to a depth of about 1½ inches. Incorporation of granules is not essential but usually improves control, especially if rainfall is delayed. In addition to annual grasses, Vernam can control pigweed, lambsquarter, and may give some control of annual morningglory. Rates of active ingredient suggested vary from 2 to 3 pounds per acre depending on soil type, formulation, and method of application.

**Planavin** is similar to Treflan in the kinds of weeds controlled. However, research indicates that in Illinois higher rates of Planavin are needed to provide about the same control obtained with Treflan. Although results are reportedly more favorable in the cotton-growing areas of the South, the rates presently cleared for soybeans may not be sufficient for satisfactory control under most Illinois conditions. Planavin is formulated as a 75-percent wettable powder that is cleared for application up to 1½ pounds per acre on heavy soils. This is equivalent to 1⅛ pounds of active ingredient per acre on a broadcast basis. Planavin can be applied from 4 weeks before planting to immediately after planting. Incorporate within a few hours to a depth of 1 to 1½ inches with a rotary hoe, a disk operated shallow, or similar equipment.

**Dacthal (DCPA), Dymid (diphenamid)** and **Enide (diphenamid)** are herbicides that are used primarily for vegetable crops, but also have clearance for soybeans. Because these materials have cost more and give no apparent advantage over other soybean herbicides, it is doubtful that they will gain much acceptance for use on soybeans in Illinois.

**Sodium PCP (Weedbeads)** has been used in Missouri and, to some extent, on the light-colored soils of Illinois. It is primarily for control of broad-leaved weeds. Injury to soybeans may occur, particularly if rain splashes the chemical from the soil surface onto the leaves. Apply the beaded material dry or dissolve it in water for spray application. The beads go into solution slowly. Sodium PCP is irritating to handle and dust or fine spray particles cause sneezing. Use considerable precaution in handling. Rates are 20 to 30 pounds per acre of Weedbeads containing 79 percent sodium pentachlorophenate.

**DNBP (dinitro)** is sold under such trade names as Premerge and Sinox PE. Used as a preemergence, dinitro is rather erratic for weed control and may cause some injury and stand reduction. Rates are 2 to 2½ gallons per acre (6 to 7½ pounds per acre active ingredient) on a broacast basis.

Dinitro also may be used as an early postemergence treatment at the rate of 3 to 4 quarts (2¼ to 3 pounds of active ingredient) per acre broadcast when soybeans are in the cotyledon to the first-true-leaf stage and weeds are up. This treatment is for control of emerged broad-leaved and grass weed seedlings. Soybean leaves may be burned. Do not make this treatment if temperature exceeds 85° F.

Since dinitro is a relatively toxic herbicide, take extreme precautions when handling it. The development of more effective and less toxic herbicides has discouraged the use of dinitro.

## Postemergence Applications for Soybeans

**Tenoran (chloroxuron).** Apply Tenoran at the rate of 2 to 3 pounds of the 50-percent wettable powder 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 spray solution for banding. Apply when broad-leaved weeds are less than 1 to 2 inches high and grass weeds no more than ½ inch high. 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 very small.

The major interest in Tenoran would be as a possible control for some of the broad-leaved weeds where a preemergence herbicide such as Treflan had been used preemergence. Control with Tenoran has been somewhat erratic and soybeans are usually injured at rates required for weed control. Injury to soybeans from Tenoran may not necessarily be reflected in final yields. Some difference in the degree of soybean injury has been noted for some varieties.

**2,4-DB** is sold under several trade names including Butoxone SB and Butyrac 175. Apply it from 10 days before soybeans begin to bloom until midbloom. Consider this herbicide for emergency situations where cocklebur is quite serious (as in some bottomland areas). The chemical 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, four feet wide is equivalent to 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 the fencerow vegetation consists chiefly of woody plants, use a mixture of 2,4-D and 2,4,5-T.

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.

Readers who want additional information on weed control may obtain single copies of the following publications from the University of Illinois, College of Agriculture, Urbana 61801 or from a county extension adviser.

Weeds of the North Central States. Circular 718. ($1.00)

Band Spraying Preemergence Herbicides. Circular 791.

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 Cranular Row Applicators. Circular 839.

Controlling Poison Ivy. Circular 850.

Using Preemergence Herbicides. Circular 932.

## Herbicide Application Rates

Table 14 lists the amount of commercial herbicides to apply per acre for liquids or granules, either broadcast or banded.

How to calculate 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 one 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 one acre measure the amount of water needed to refill the tank. Multiply the percentage figure from the table 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.

The amount of active chemical per row doesn't change with row spacings, but the amount of chemical applied per acre does change. Table 15 below shows the liquid and granular band rates for 13-inch bands on various row widths.

**Table 14. — 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** | | |
| Atrazine | 5/6 to 1¼ lb. | ...... | 2½-3¾ lb. | .... |
| Randox | 1⅓ qt. | 7 lb. (20%) | 1 gal. | 20 lb. |
| Ramrod | 2 lb. | 7 lb. (20%) | 6 lb. | 20 lb. |
| Randox-T | 1½ qt. | 10 lb. (35%) | 4½ qt. | 30 lb. |
| Roundup | 2 lb. | 7 lb. (20%) | 6 lb. | 20 lb. |
| Knoxweed | 1⅓ pt. | 7 lb. (14%) | 2 qt. | 20 lb. |
| 2,4-D ester | 1 pt.[c] | 3⅓ lb. (20%) | 1½ qt.[c] | 10 lb. |
| Eptam | 1⅓ pt. | 20 lb. (5%) | 2 qt. | 60 lb. |
| | | **SOYBEANS** | | |
| Amiben | 2 qt. | 10 lb. (10%) | 1½ gal. | 30 lb. |
| Treflan | ⅙-⅓ qt. | 3⅓-7 lb. (5%) | ½-1 qt. | 10-20 lb. |
| Randox | 1⅓ qt. | 7 lb. (20%) | 4 qt. | 20 lb. |
| Ramrod[d] | 2 lb. | 7 lb. (20%) | 6 lb. | 20 lb. |
| Alanap Plus | 2 qt. | 14 lb. (12.5%) | 1½ gal. | 40 lb. |
| Lorox[e] | ⅔ lb. | ...... | 2 lb. | .... |

[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] For use only on soybeans raised for seed.

[e] Amount for light-colored silt loam. See label for rates on other soils.

**Table 15. — 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 |
|---|---|---|---|---|---|
| | | *Liquid (gallons per acre)* | | | |
| 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 |
| | | *Granular (pounds per acre)* | | | |
| | 1 | 1.1 | 1.1 | 1.3 | 2.0 |
| | 2 | 2.1 | 2.2 | 2.7 | 4.0 |
| | 3 | 3.2 | 3.3 | 4.0 | 6.0 |
| | 4 | 4.2 | 4.4 | 5.3 | 8.0 |
| | 5 | 5.3 | 5.5 | 6.7 | 10.0 |
| | 6 | 6.3 | 6.7 | 8.0 | 12.0 |
| | 7 | 7.4 | 7.8 | 9.3 | 14.0 |
| | 8 | 8.4 | 8.9 | 10.7 | 16.0 |
| | 9 | 9.5 | 10.0 | 12.0 | 18.0 |
| | 10 | 10.5 | 11.1 | 13.3 | 20.0 |
| | 11 | 11.6 | 12.2 | 14.7 | 22.0 |
| | 12 | 12.6 | 13.3 | 16.0 | 24.0 |
| | 13 | 13.7 | 14.4 | 17.3 | 26.0 |
| | 14 | 14.8 | 15.5 | 18.7 | 28.0 |
| | 15 | 15.8 | 16.7 | 20.0 | 30.0 |
| | 16 | 16.9 | 17.8 | 21.3 | 32.0 |

NHE-90
Miscellaneous
1/1/68

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 or 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 <u>not</u> 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.

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 root insects and termites.

ALLETHRIN Synthetic pyrethrin, Pynamin FMC, Benzol Products

Acute oral--680-1,000
Acute dermal--11,200
Chronic oral--5,000

Bee toxicity--Low

Botanical--Used in household aerosols and fly sprays as a quick knockdown. No residual action.

APHOLATE Olin Mathieson

Acute oral--90
Acute dermal--50-200

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

ARAMITE* U.S. Rubber

Acute oral--3,900
Chronic oral--500

Fish toxicity--Moderate
Bee toxicity--Low

Sulfonate--Miticide limited to ornamentals and household. No clearance on fruit or vegetables, has carcinogenic properties.

AZINPHOSMETHYL Guthion Chemagro

Acute oral--11-13
Acute dermal--220
Chronic oral--5

Bee toxicity--High

Organic phosphate--Used on cotton, forage crops, and on tree fruit to control both insects and mites.

* Trade name.

AZODRIN* SD 9129 Shell

Acute oral--21
Acute dermal--354
Chronic oral--1

Bee toxicity--High

Organic phosphate: Systemic insecticide for use on cotton and fruit crops upon label approval.

BACILLUS POPILLIAE

Bacterial--Nontoxic microbial insecticide. Applied to soil to infect Japanese beetle grubs with milky disease.

BACILLUS THURINGIENSIS Thuricide, Agritrol, Larvatrol

Bee toxicity--Low

Bacterial--A nontoxic microbial insecticide used to control caterpillars on vegetable crops and forest trees.

BAYGON propoxur Chemagro

Acute oral--95-104
Acute dermal--1,000+
Chronic oral--800

Carbamate--For use by pest control operators only against mosquitoes, household insects, and certain lawn insects.

BAYTEX*--see fenthion

BENZENE HEXACHLORIDE BHC, gammexane Diamond Alkali, Hooker, Olin Mathieson, Stauffer

Acute oral--1,250
Chronic oral--10

Bee toxicity--High

Chlorinated hydrocarbon--Limited use; replaced by lindane.

BENZYL BENZOATE Monsanto

Acute oral--500-5,000

Repellent--A repellent for chiggers, mosquitoes, and ticks on man.

BIDRIN* Shell

Acute oral--22
Acute dermal--225
Chronic oral--1

Bee toxicity--High

Organic phosphate--Highly toxic systemic insecticide used for mimosa webworm control on honey locust. Recommended in many states as an injected systemic for elm bark beetle control but to be applied only by people especially trained to do the work.

* Trade name.

BINAPACRYL | Morocide, Acricid | FMC

Acute oral--161
Acute dermal--1,350
Bee toxicity--Low

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
Acute dermal--4,000+
Chronic oral--200
Fish toxicity--Very low
Bee toxicity--High

Carbamate--A general insecticide registered for control of many pests of field crops, vegetables, fruit, homeowner, and livestock.

CARBON DISULFIDE | Stauffer

Chronic vapor--20 ppm. (40 hr.)
Acute vapor--200 ppm. (1 hr.)

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
Acute dermal--27-54
Chronic oral--5
Bee toxicity--Moderate

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
Chronic oral--20

Bee toxicity--Low

Organic sulfide--A miticide used on many fruit crops.

CHLORDANE | Octachlor, Octa-Klor | Velsicol

Acute oral--335-430
Acute dermal--690-840
Chronic oral--25+

Fish toxicity--Very high
Bee toxicity--High

Chlorinated hydrocarbon--A residual insecticide for control of ants and roaches and a soil insecticide for termites, lawn, and corn soil insects. Has some uses on fruits and vegetables.

CHLOROBENZILATE | Geigy

Acute oral--1,040-1,220
Acute dermal--5,000+

Bee toxicity--Moderate

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
Acute dermal--10,200

Bee toxicity--Low

Chlorinated hydrocarbon--Miticide for fruit crops.

CIODRIN* | SD 4294 | Shell

Acute oral--125
Acute dermal--385
Chronic oral--7

Bee toxicity--High

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
Acute dermal--860
Chronic oral--5

Bee toxicity--Moderate

Organic phosphate--A systemic insecticide for beef cattle and poultry to control grubs, lice, and mites.

CYGON*--see dimethoate

DASANIT* Bayer 25141 Chemagro

Acute oral--2-11
Acute dermal--3-30

Organic phosphate--Experimental insecticide and nematocide for possible use for soil insect control in corn.

DDD*--see TDE

DDT Allied, Diamond Alkali, Geigy, Lebanon, Montrose, Olin Mathieson, Stauffer

Acute oral--113-118
Acute dermal--2,510
Chronic oral--5

Fish toxicity--Very high
Bee toxicity--Moderate

Chlorinated hydrocarbon--A general insecticide registered for use on some field, vegetable, and fruit crops. Also for control for certain livestock insects.

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
Acute dermal--8-14
Chronic oral--1

Fish toxicity--Moderate
Bee toxicity--Low

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 Geigy

Acute oral--76-108
Acute dermal--455-900
Chronic oral--1

Fish toxicity--High
Bee toxicity--High

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 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
Acute dermal--75-107

Fish toxicity--Moderate
Bee toxicity--High

Organic phosphate--Short-lived residual insecticide for livestock, fly bait, greenhouses, and warehouses.

DICOFOL Kelthane Rohm and Haas

Acute oral--1,000-1,100
Acute dermal--1,000-1,230
Chronic oral--20

Fish toxicity--High
Bee toxicity--Low

Chlorinated hydrocarbon--Miticide used on vegetables, fruit, and ornamentals.

DIELDRIN Octalox Shell

Acute oral--46
Acute dermal--60-90
Chronic oral--0.5

Fish toxicity--Very high
Bee toxicity--High

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
Acute dermal--400-610
Chronic oral--5

Fish toxicity--Very low
Bee toxicity--High

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 dermal--4,000+

Repellent--General purpose mosquito repellent.

DIMETILAN* | SNIP | Geigy

Acute oral--25-64 | Bee toxicity--Moderate
Acute dermal--600+

Carbamate--Insecticide impregnated on plastic foam bands for fly control in livestock buildings.

DINITRO COMPOUNDS | (Elgetol, DN, DNBP, DNOC) | Dow, FMC, Chem. Ins. Corp.

Acute oral--5-60 | Bee toxicity DN-111--Low
Acute dermal--150-600 | DNOSBP--High

Nitrophenol--Used primarily for controlling aphids 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 | Bee toxicity--Low
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 | Bee toxicity--Moderate
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.

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
Acute dermal--74-130
Chronic oral--30

Bee toxicity--Moderate

Chlorinated hydrocarbon--Used on some vegetable crops to control aphids, cabbage worms, and other caterpillars. Also used for borer control on peach trees.

ENDRIN Shell, Velsicol

Acute oral--8-18
Acute dermal--15-18
Chronic oral--1

Fish toxicity--Very high
Bee toxicity--Moderate

Chlorinated hydrocarbon--Highly toxic residual insecticide used on some field crops and ornamentals.

ENTEX*--see fenthion

EPN DuPont

Acute oral--8-36
Acute dermal--25-230

Bee toxicity--High

Organic phosphate--Used mostly on fruit insects as an insecticide and miticide.

ETHION Nialate FMC

Acute oral--27-65
Acute dermal--62-245
Chronic oral--3

Bee toxicity--Low

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.

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* — NIA 10242 — Niagara, FMC

Acute oral--5
Acute dermal--885

Carbamate--Experimental insecticide for possible use on corn soil insects and alfalfa weevil.

GARDONA* — SD 8447 — Shell

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

Organic phosphate--Used for earworm control on seed corn only.

GERANIOL — Fritzche

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

GUTHION*--see azinphosmethyl

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* Trade name.

GYPLURE USDA

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
Acute dermal--195-250
Chronic oral--0.5-5

Fish toxicity--Very high
Bee toxicity--High

Chlorinated hydrocarbon--Used as corn seed treatment, soil insecticide for corn insects 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 and for rodent control and building fumigation.

IMIDAN* R-1504, Prolate Stauffer

Acute oral--147-216
Acute dermal--3,160

Organic phosphate--Experimental insecticide for possible use for soil insect control in corn, for fruit insect control, and against certain foliar 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.

LANDRIN* SD 8530 Shell

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

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

LANNATE* 1179 DuPont

Acute oral--17-24
Acute dermal-->1,500

Carbamate--Experimental insecticide for possible use against a wide variety of foliar feeding insects and for soil insect control in corn.

LEAD ARSENATE

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

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* Rohm and Haas

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 Fish toxicity--Very high
Acute dermal--900-1,000 Bee toxicity--High
Chronic oral--50

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

MALATHION American Cyanamid

Acute oral--1,000-1,375 Fish toxicity--High
Acute dermal--4,444+ Bee toxicity--High
Chronic oral--100-1,000

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.

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* Trade name.

METALDEHYDE

Acute oral--1,000

Attractant--Used in combination with stomach poisons for snail and slug baits.

META-SYSTOX R*--see oxydemetonmethyl

METEPA — Metaphoxide, Methyl Aphoxide — American Cyanamid

Acute oral--93-277
Acute dermal--156-214

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

METHOXYCHLOR — Marlate — DuPont, Geigy

Acute oral--5,000
Acute dermal--6,000+
Chronic oral--100

Fish toxicity--Very high
Bee toxicity--Low

Chlorinated hydrocarbon--Used in many homeowner fruit and vegetable spray or dust mixtures and for certain field crop insects.

METHYL BROMIDE — bromomethane — American Potash, Dow, Frontier, Great Lakes, Michigan Chemical

Chronic vapor--20 ppm. (40 hr.)
Acute vapor--200 ppm. (1 hr.)

Fumigant--Used on stored products.

METHYL PARATHION — Metacide, Nitrox, Metron — American Potash, Monsanto, Shell, Stauffer, Velsicol

Acute oral--14-24
Acute dermal--67

Fish toxicity--Very low
Bee toxicity--High

Organic phosphate--It is closely related to parathion and is used primarily for insect control on cotton.

METHYL TRITHION* — Stauffer

Acute oral--98-120
Acute dermal--190-215

Bee toxicity--High

Organic phosphate--It is closely related to trithion or carbophenothion. It is a residual insecticide used in both insect and mite control on certain fruits and vegetables.

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* Trade name.

MEVINPHOS | Phosdrin | Shell

Acute oral--4-6 | Bee toxicity--High
Acute dermal--4-5
Chronic oral--0.8

Organic phosphate--Very toxic, 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 and certain insects of vegetable crops.

MOBAM* | MCA600 | Mobil

Aucte 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
Acute dermal--2,000+
Chronic oral--50

Bee toxicity--Low

Organic carbonate--Miticide to be used on apples prior to bloom.

MOROCIDE*--see binapacryl

NALED Dibrom Chevron

Acute oral--250
Acute dermal--800

Fish toxicity--High
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
Acute dermal--285

Bee toxicity--Low

Heterocyclic botanical compound--Contact insecticide that is used to control aphids.

OVEX Ovotran, Chlorofenson, Ovochlor Dow, Murphy

Acute oral--2,050
Chronic oral--25

Fish toxicity--Low
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
Acute dermal--250
Chronic oral--10

Bee toxicity--Moderate

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 dermal--7-21
Chronic oral--1

Fish toxicity--High
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
Acute dermal--3,160+

Bee toxicity--Low

Chlorinated hydrocarbon--Miticide used on greenhouse floral crops and nursery stock.

PERTHANE* — Rohm and Haas

Acute oral--4,000+
Chronic oral--500

Fish toxicity--Very high
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
Acute dermal--3-6

Bee toxicity--Moderate

Organic phosphate--A highly toxic 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
Acute dermal--107-143

Fish toxicity--Very low
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.

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* Trade name.

PYRETHRUM | pyrethrin I and II | FMC, Penick

Acute oral--820-1,870
Acute dermal--1,880+
Chronic oral--1,000

Fish toxicity--High
Bee toxicity--Low

Botanical--Used as a fly control insecticide in household and livestock sprays.

RONNEL | Korlan, Trolene, Viozene | Dow

Acute oral--1,250-2,630
Acute dermal--5,000+
Chronic oral--10

Bee toxicity--Moderate

Organic phosphate--Used in baits and sprays for fly control in livestock barns.

ROTENONE | derris, cube | FMC, Penick

Acute oral--50-75
Acute dermal--940+
Chronic oral--25

Fish toxicity--Very high
Bee toxicity--Low

Botanical--A contact poison used to control certain home garden insects and cattle grubs.

RUELENE* | Dowcoe 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

STROBANE | 3961 | Heyden

Acute oral--200
Acute dermal--5,000+

Fish toxicity--Very high
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 dermal--9,000+
Chronic oral--2,000

Synergist--Commonly used with pyrethrum.

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* Trade name.

SYSTOX*--see demeton

TDE | DDD, Rhothane | Allied, Rohm and Haas

Acute oral--4,000+
Acute dermal--4,000+
Chronic oral--100

Fish toxicity--Very high
Bee toxicity--Moderate

Chlorinated hydrocarbon--A DDT related compound used to control leaf rollers, tobacco hornworm, and tomato fruitworm.

TEDION*--see tetradifon

TEMIK* | UC 21149 | Union Carbide

Acute oral--5-10
Acute dermal--1,400

Carbamate--Experimental residual, systemic insecticide and miticide for possible use against mites and certain insects of fruits, vegetables, and ornamentals.

TEPA | Aphoxide | Dow

Acute oral--126-252

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

TEPP | Vapatone, Tetron | American Potash

Acute oral--1
Acute dermal--2

Bee toxicity--High

Organic phosphate--A highly toxic, short-lived insecticide for the control of aphids and mites on fruit, vegetable, and forage crops.

TETRADIFON | Tedion | Niagara, Phillips

Acute oral--14,700+
Acute dermal--10,000+

Bee toxicity--Low

Sulfonate--A miticide for fruit crops.

THANITE* | | Hercules

Acute oral--1,600
Acute dermal--6,000

Thiocyanate--It is added to household and livestock sprays to increase knockdown of flying insects.

THIMET*--see phorate

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* Trade name.

THIODAN*--see endosulfan

THUROCIDE*--see bacillus thuringiensis

TOXAPHENE chlorinated camphene Hercules

Acute oral--80-90
Acute dermal--780-1,075
Chronic oral--10

Fish toxicity--Very high
Bee toxicity--Low

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
Acute dermal--2,000+

Fish toxicity--Very low
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
Acute dermal--1,500-2,500

Fish toxicity--Very low
Bee toxicity--High

Carbamate--Used for ornamentals and turf insect control, also for control of slugs.

* Trade name.

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*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, 1968
Cooperative Extension Work, University of Illinois
College of Agriculture and the U. S. Department of
Agriculture Cooperating. John B. Claar, Director.
Acts Approved by Congress May 8 and June 30, 1914.

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* Also, members of the planning committee.

# 100 YEARS AGO
## IN ENTOMOLOGY

1. "I hope cider drinkers will make note of the fact that maggoty apples can be coverted 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." *Benjamin D. Walsh*--First Annual Report of State Entomologist, 1868, on Noxious Insects

2. Three insecticides were used--hellebore for imported cabbage worms, Paris green for Colorado potato beetle, and sulfur tobacco for sheep scab.

3. Benjamin D. Walsh was completing his first year as the first State Entomologist of Illinois.

4. Walsh's first report included discussions on the grape curculio, grape-leaf gall-louse, rose-bug, grape-root borer, codling moth, apple-maggot fly, rascal leaf-crumpler, oystershell bark-louse, Harris's bark-louse, apple-root plant louse, plum curculio, plum gouger, plum moth, and the hateful grasshopper.

UNIVERSITY OF ILLINOIS CENTENNIAL YEAR