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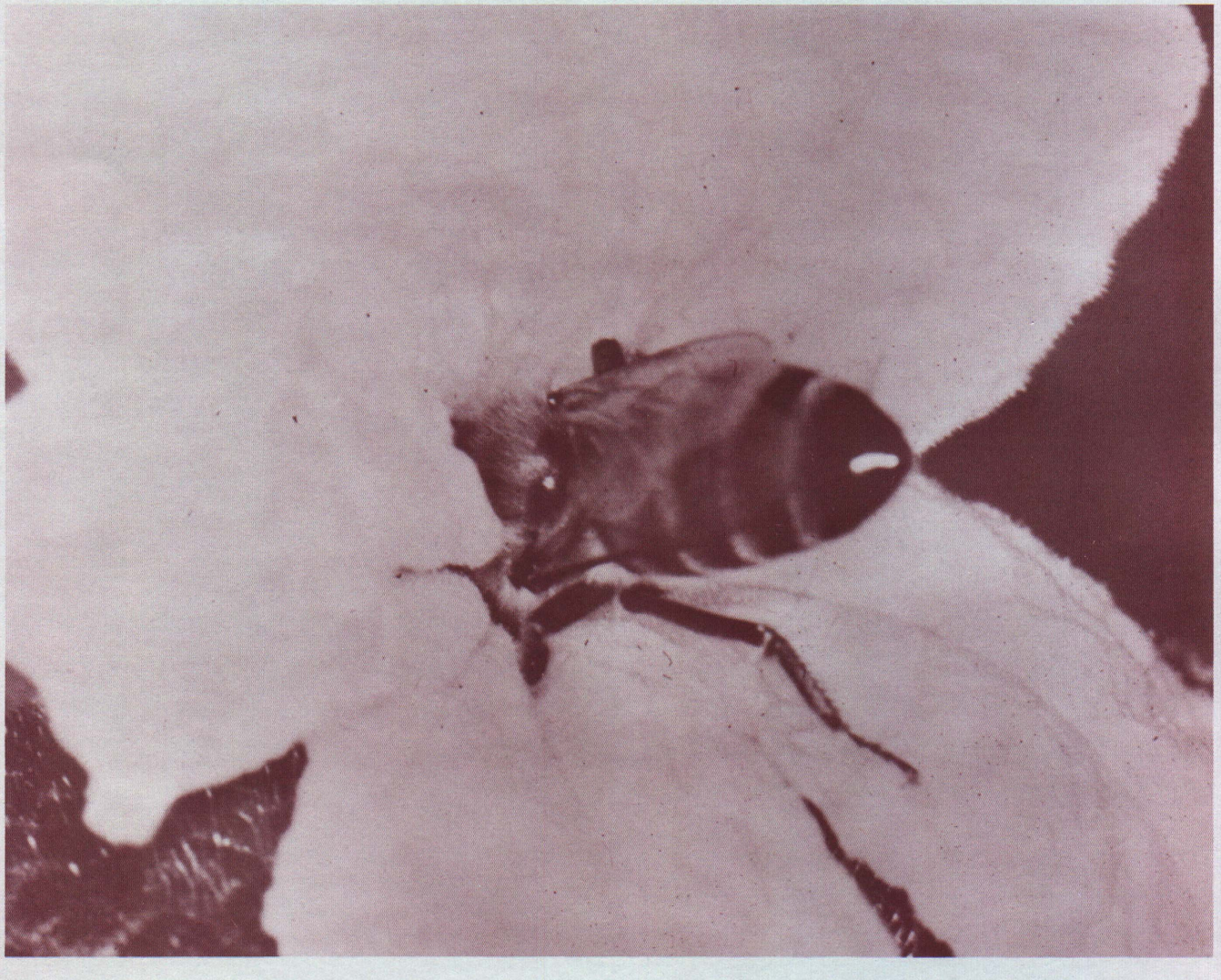
Pesticides and Honey Bees



COOPERATIVE EXTENSION SERVICE • MICHIGAN STATE UNIVERSITY

Pesticides and Honey Bees

By E. C. MARTIN, Department of Entomology

CONTENTS

Michigan's 120,000 colonies of bees produce 8 to 10 million pounds of honey a year, worth about 1½ million dollars. Nevertheless, the main value of bees to the State is not honey production but pollination of crops. The total value of commercial and "backyard" crops pollinated by bees in Michigan is about $100 million.

The most important bee-pollinated crops of the State are: apples, tart cherries, sweet cherries, pears, plums, peaches, blueberries, raspberries, and strawberries; cucumbers, muskmellon, squash and other vine crops; seed crops of alfalfa, bird's-foot trefoil, sweet clover and other clovers; seeds of many vegetables and garden flowers. For most of these crops, commercial production without bee pollination would be impossible. For example, recent Michigan research showed that highbush blueberries with bees yielded from 11 to 52 lbs. of berries depending on the age and condition of the bush. When bees were excluded, similar bushes yielded 1½ to 2½ lbs. Besides reducing yield, incomplete pollination also results in misshapen, poor-grade fruits.

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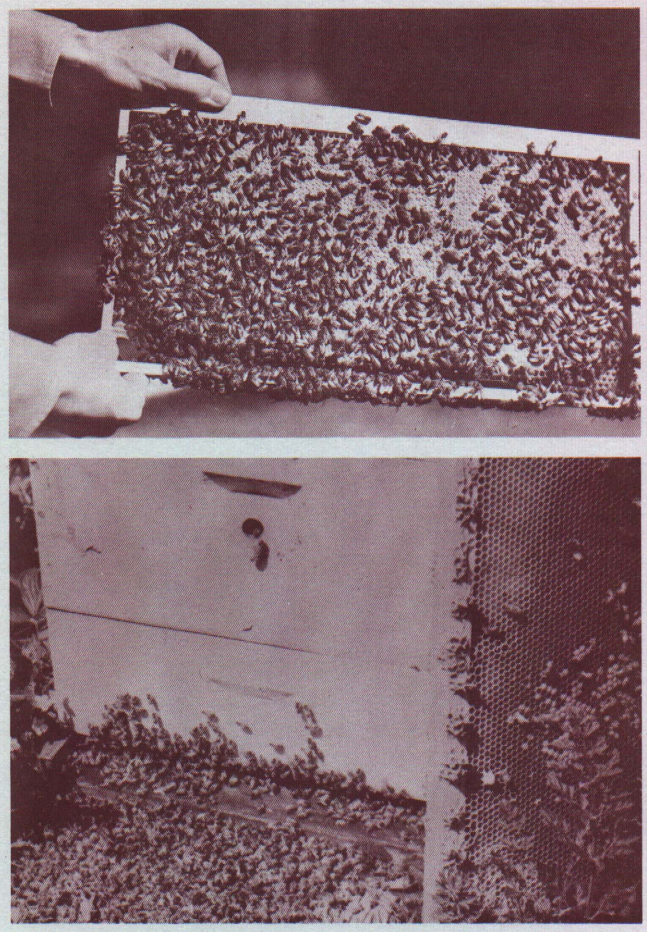
Pesticides Can Kill Bees

Pesticide damage to colonies takes many forms. Colonies may be completely destroyed, but, most commonly, only field bees are killed. This weakens the colony. (Field bees are the older bees which fly to the field to gather nectar and pollen for the hive—pollinating crops in the process.) Loss of field bees can be serious because the factor contributing most to a beekeeper's success in honey production or pollination is his ability to build up colonies that are strong in numbers of bees. If the field force is destroyed by pesticides, the whole colony will be weakened and may remain weak for some time; the queen may reduce egg-laying or be killed by the workers; the colony may fail to survive the winter or obtain a crop of honey or be useful for crop pollination. Financial losses from pesticides vary greatly depending on the date of kill; the date and duration of the main honey flows; the pesticide involved; the strength of the bee colony at the time, and the dates of pollination contracts.

Observed bee kill from poisoning varies with conditions and pesticides. Some pesticides kill bees so quickly that the bees die in the field before they can return to the hive. In such cases, the beekeeper may be unaware of losses other than his lack of success in building up strong colonies. Other pesticides kill more slowly—the bees may return to the hive and die in large numbers at the hive entrance. The beekeeper should immediately try to track down the source of the bee kill and proceed as indicated in section, "What the Beekeeper Can Do," page 6.

It should be noted that under some circumstances, pesticides control pests of honey plants, and thereby help beekeeping. In Michigan, the *Sweet Clover Weevil* greatly discouraged Sweet Clover plantings. The *Vetch Bruchid* eliminated Hairy Vetch as a Michigan farm crop. Alfalfa bloom and nectar secretion can be reduced by *Lygus Bugs*, *Potato Leafhoppers* and *Alfalfa Weevils*.

The present challenge is to determine how and when to use pesticides, and which pesticides and supplementary control measures to use, so that pests may be most adequately controlled without killing bees. This challenge can be met surprisingly often. Usually, a thorough appraisal of the situation, by interested parties, and advisory and regulatory agencies will result in satisfactory spray programs which keep bee losses to a minimum. In the past, beekeepers have had a small voice and difficulty in gaining recognition of their problem. In recent years, the great value of bees has become widely recognized. In Michigan, fruit growers and other farm groups, and extension and regulatory personnel, have shown readiness to support beekeeping and conserve pollinator populations. Development of the Pesticide Laboratory at Michigan State University is also proving to be a major step forward in coordinating research so that some complicated pest control problems can be more readily solved or nipped in the bud before they become too serious.



Top: comb of healthy brood and bees. Pesticide damage will reduce both brood and bee population. Bottom: dead bees in front of a hive—killed by malathion sprayed in the area.

Pests must be controlled and pollinating bees must be maintained. *Both* can be accomplished through research, adequate and accurate communication, goodwill, and a conviction that problems must be solved. Bees must be protected, even if it means more trouble and expense to growers.

Factors Which Influence Losses

Spraying on bloom. Since bees collect nectar and pollen from flowers, the flower is normally the only part of a plant they visit. The first rule in avoiding bee kill is: **do not spray plants in bloom**. Fruit growers are usually careful in this respect. The advent of the alfalfa weevil makes it important that growers and aerial applicators complete all alfalfa sprays be-

fore bloom starts. If bloom has started, the alfalfa should be cut, before it is sprayed. Never apply insecticides to plants in bloom.

Drift of spray to bloom. Michigan bee poisoning would be minor if poison application could be restricted entirely to the target crop. Unfortunately, drift occurs from nearly all applications, sometimes unavoidably and sometimes through carelessness—from a short distance to miles downwind. Bees kept near orchards are often killed when they visit clovers or other bloom in or near the orchard. Sprays or dusts often drift to surrounding bloom when grain or bean fields are treated.

Custom sprayers. Fruit growers who do their own spraying try to reduce drift by spraying in the evening or early morning when the air is calm and drift minimal. The inevitable trend toward custom and aerial spraying has aggravated the drift problem because the custom sprayer wants to keep his crew busy all day, every day, if possible. Since bee losses from drift can be serious, continuing research, communication and coordination are needed. Spraying directly over an apiary can be very harmful, particularly in warm weather when bees may be clustered in front of the hives.

Variable toxicity of insecticides. Nearly all agricultural pesticides have been laboratory tested and rated for their toxicity to bees. Research and practical experience is building up our knowledge of the relative toxicity of pesticides to bees in the field. However, laboratory and field results do not always coincide due to peculiarities of bee behavior, length of residual life of the pesticide, effect of different formulations, etc.

A list of insecticides, rated according to their toxicity, is included at the end of this publication. Where there is a choice of pesticides, growers are advised to use those least toxic to bees. In general, granular applications are not harmful to bees.

Timing the application of insecticides. Ideally, pesticides should be applied when there is no wind and bees are not "working" plants in the area. For instance, bees gather pollen from sweet corn but they discontinue their visits in the late afternoon. Little damage will result if the crop is sprayed late in the afternoon with a spray that breaks down in a few hours. In general, evening applications are least harmful to bees. Since bees usually fly from the hive when temperatures are above 55°F., applying sprays when the temperature stays below 55°F. will do little harm to bees.

Puddles of spray and spray in the water supply. Bees gather water to drink and regulate temperature and humidity within the hive. If they gather poison spray, they may be killed in large numbers. Care should be taken not to let spray drip and form puddles, accumulate in wheel tracks or be exposed in any way. Bees will drink water containing poisonous materials as readily as pure water. This problem is most serious when bees are moved to a new location for crop pollination. Soon after colonies are set down, bees search for water and may readily collect poison spray. Beekeepers can lessen chances of loss at the time of a move by supplying clean water near hives.

Top: puddles in the soil are a favorite source of water for bees. Do not allow puddles of spray material to become a source of drinking water for bees. Bottom: aerial spraying increases the possibility of spray drift to plants in bloom. Cooperation between aerial applicators and beekeepers is necessary to avoid excessive bee kill.

Air vs. ground application. Air application of insecticides is more dangerous to bees than ground application, chiefly because the material drifts greater distances and is applied much more rapidly. Application of insecticides to large areas, as in grasshopper, mosquito or cereal leaf beetle control programs, may be harmful because bees cannot avoid contact with the spray on flowers or in water. Total wild bee and honey bee loss over the large area may be sizable.

Formulation of the material. Sprays are usually less harmful than dusts because they do not drift as much. Granular materials seem to present very little hazard. Ultra-low volume applications of some materials have been more toxic than regular sprays. No effective repellent has yet been developed that may be added to the spray to keep bees from treated areas.

Examples of Michigan Problems

Following are examples of specific types of bee poisoning problems that have occurred in Michigan:

• Spray applied to fruit trees in bloom. Established Michigan fruit growers have long understood the need for pollination by bees and have omitted insecticide sprays during the bloom period. Custom sprayers have not always been as concerned or as well informed. Bees work most fruit bloom profusely so that if sprays are applied through accident or ignorance, bee losses may be very heavy. Fruit growers, without rented bees in their own orchards, sometimes think that they can safely apply spray before the bloom period is over—and kill bees from colonies located in a neighboring orchard. Loss also results when petal-fall spray applied to one variety drifts to an adjoining, late-blooming variety.

• Spray drift from orchards. Sprays applied in orchards before or after bloom period may drift to such flowers as dandelion, yellow rocket, clovers or alfalfa directly below the trees, or sometimes a considerable distance. Beekeepers near Michigan cherry orchards have suffered heavier July bee losses from drifting spray than formerly. Heavier losses near some orchards suggest that some growers are controlling drift better than others by spraying in the evening or at other times when there is little wind.

• Spraying for alfalfa weevil. The alfalfa weevil is a fairly new arrival in Michigan and will undoubtedly spread to all alfalfa growing parts of the state. Control recommendations emphasize spraying before alfalfa blooms. If alfalfa requires spray after it comes into bloom, cut it for hay and then spray. Do not spray alfalfa in bloom. The grower or aerial applicator may be liable for damages if fields are sprayed at a time or in a manner contrary to official recommendations.

• Spraying sweet corn with Sevin. Corn is not commonly thought of as a bee plant, but bees frequently gather corn pollen. When Sevin sprays are applied to sweet corn, large numbers of dead bees may be found in front of nearby colonies. Apparently excessive loss may be partly explained by the fact that Sevin remains toxic in bee-gathered pollen long enough to kill young adult hive bees, which consume large amounts of pollen, prior to secreting royal jelly.

• Spray drift to wild flowers near Christmas trees. Some beekeepers who moved apiaries away from orchards to avoid spray drift have run into similar problems near Christmas tree plantations. Spotted knapweed (starthistle), sumac, sweet clover, goldenrod and other wildflowers frequently grow among or near Christmas trees. Prolonged spraying in Christmas tree areas can weaken bee colonies and keep them in a non-productive state. Investigation of this problem indicates that absentee owners of Christmas tree plantations often spray later than recommended, with less effective insect control and more bee kill. Bee losses would be minimized if official spray recommendations for both materials and timing were followed in detail.

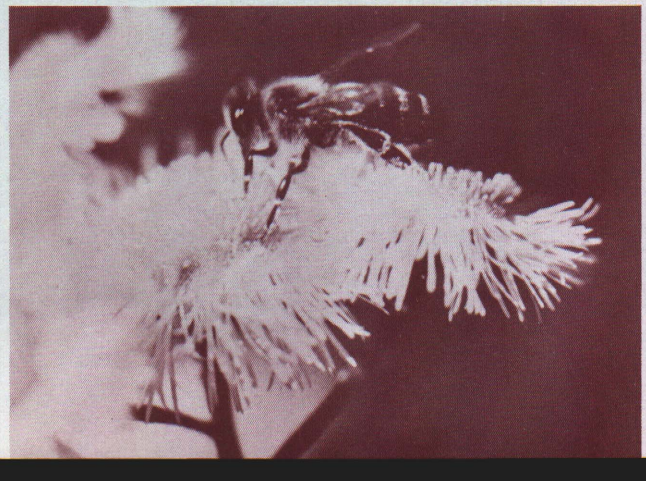
• Drift from cereal leaf beetle sprays. The grain pest, cereal leaf beetle, has become wide-spread in Michigan. Bee kill can be minimized if farmers make sure that (a) spraying is necessary, (b) spraying is done in the evening or when the wind is slight and danger of drift minimized, (c) local beekeepers are *warned of the spray* and (d) recommendations, especially timings, are followed precisely. In a case investigated in 1968, a beekeeper experienced heavy losses at an apiary located one-quarter mile from an oat field sprayed for cereal leaf beetle. The spray had drifted to a sweet clover field near the apiary and the beekeeper had not been notified. Furthermore, the spray application was made later than officially recommended, so that the damaging stage of the beetle was past, the oats were in good shape, and the farmer actually wasted his money on the spray.

• Sweet clover planted in strips alternating with potatoes. This provides a deadly situation for honey bees and all types of bees whenever the potatoes are sprayed. Spray inevitably drifts to the sweet clover. This practice should certainly be discouraged since sweet clover is one of the most attractive plants to bees.

• Sprays to control pests which periodically reach outbreak proportions. Armyworm on grains, Mexican bean beetle and green clover worm on beans sometimes reach outbreak proportions in Michigan. Increased use of aerial spray applications has caused bee losses largely from drift to adjoining clover or alfalfa fields.

• Mosquito control programs. Mosquito control programs involving the widespread application of insecticides when dandelion, fruit or other plants are in bloom, have caused severe losses of honey bees, bumble bees and other wild bees. When DDT was used for this purpose, bee losses were light, but DDT is no longer recommended and present replacement materials are more toxic to bees.

Bees thrive on many wild flowers which grow in Christmas tree plantations. Correct use and timing of spray materials is necessary, since spray applied to trees will also cover the wild flowers.



What The Spray Applicator Can Do

Follow Spray Recommendations

Extension specialists, using the latest information from research and regulatory authorities, publish control recommendations for all major pests of Michigan crops. Before using a poisonous chemical to control any pest, study the Extension literature on control of the pest involved, read the label carefully on the insecticide, and observe all precautions in application. Often, bee losses occur because official recommendations are not followed. Growers or spray applicators who do not comply with spraying recommendations, increase their liability for losses.

Inform the Beekeeper

If informed of an intended spray that may harm bees, the beekeeper can protect his colonies to some extent. All beekeepers register with the Plant Industry Division of the Michigan Department of Agriculture, and the names of beekeepers in an area may be obtained from the County Extension Agent, who is eligible to receive a list of beekeepers in his county.

What the Beekeeper Can Do

Locate Source of Kill

If excessive numbers of dead bees are found in front of the hives, and it is fairly certain that bees have been poisoned, the beekeeper should note the date on which poisoning occurred and try to determine what sprays were applied within about two miles of the apiary. Get as many facts as possible, such as: crop sprayed, insecticide used, date and time of day applied—as a spray or dust, by aerial or ground equipment, by the land owner or a custom sprayer.

Usually, there is little value in shipping a package of dead bees for chemical analysis. Chemical tests for a specific insecticide can be very accurate, but it is impractical to analyze a sample of bees to find which of hundreds of possible poisons were responsible for death.

If the above information is obtained, the beekeeper can help prevent future losses by contacting the county agent to determine if the spray was necessary and applied according to official recommendations, if loss was caused by drift or could have been prevented by using a different material or applying in the evening. If the grower, the beekeeper, and the county agent can then visit together, the problem may be solved or at least improved. If the county agent feels the situation warrants more detailed investigation or specialist recommendations, he can call on the Entomology Department at Michigan State University. The problem is generally worsened if the beekeeper tries to rely on aggressive argument and condemnation of the grower and the use of insecticides in general. All statements should be as accurate and factual as possible. Inaccurate statements weaken the opportunity for maximum cooperation between growers and beekeepers. A reasoned approach is the best way to find solutions to spray problems. If it is obvious that the grower was guilty of gross carelessness in the use of poisonous chemicals, such as extensive application of an insecticide to a crop in bloom, compensation to the beekeeper may certainly be warranted. This is generally obtained only through legal action, however.

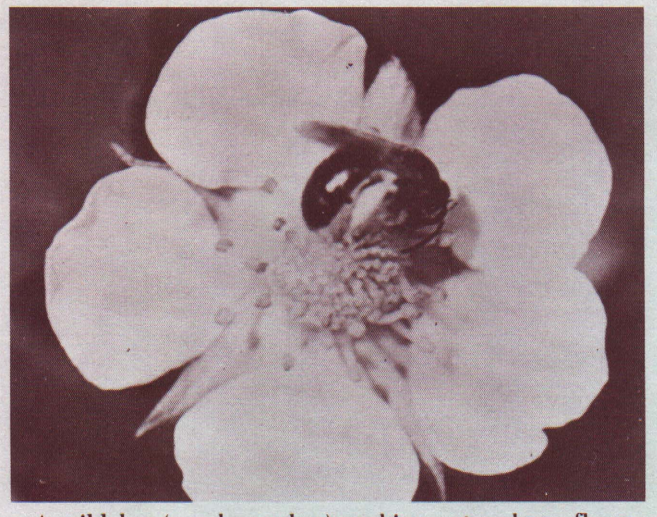
The beekeeper located near orchards or where sprays are applied regularly to a crop throughout the season may experience repeated bee kill. In such cases, he should learn all he can about the grower's spray schedule, possible distance of drift, etc. If change in the spray schedule or improvement in the situation is impossible, the best solution is to locate the apiaries at a safer distance from the sprayed area.

Protect Colonies from Spray Damage

(a) Provide water after moving bees for pollination. Bees must have water throughout their active season. When bees are moved to orchards, their only source of water may be puddles which are poisoned from many spray applications in the area. Chances of spray damage may be reduced by placing containers of water near the colonies when the hives are located in the orchard.

(b) Cover hives. Tests have shown that colonies can survive quite well under wet burlap for at least two days. The hives should be covered the night before the spray is applied and the burlap soaked with water every hour. Plastic sheeting has also been used to

Colonies can be covered with burlap to reduce danger from pesticides. But, they must be sprinkled with water regularly to avoid bee suffocation.



A wild bee (non-honey bee) working a strawberry flower. Wild bees should be conserved, since they pollinate agricultural crops, and numerous wild plants essential to a stable environment.

cover colonies. However, plastic should be left on for only a few hours in the morning or the colonies may suffocate. The effectiveness of confining bees to their hives varies with the nature of the spray. If the pesticide has a short residual life, the method can protect colonies quite well.

(c) Move colonies. Sometimes a temporary move will prevent a serious bee kill. Moving is best done at night when no bees are flying. Chemical breakdown of most sprays and the development of new flowers will generally make it safe to move them back after four or five days. The period may have to be extended in cool weather or for such chemicals as Sevin or arsenic. Moving colonies is difficult, expensive and often harmful to the colonies. A spray applicator should be very certain that a dangerous spray to bees is unavoidable, before he forces a beekeeper to move an apiary. Sharing expenses of the move may be justified, particularly if the danger comes from spray drift to non-target plants.

If an apiary is frequently subjected to spray damage, it may be best to move it permanently to a new site. Commercial beekeepers choose apiary sites with great care and consideration for high nectar and pollen yield, easy access, successful wintering, agreeable landlord and acceptable distance from other apiaries. The possibility of spray damage only makes locating the apiary still more complicated. To stay in business, a commercial beekeeper must have locations that will yield at least 80 to 100 lbs. of honey per colony.

(d) Post name, address and phone number at the apiary. A sign at the apiary might state: "Please contact if poisonous sprays are to be applied in this area." Early contact can help the beekeeper influence the applicator to spray at night, use a different material, omit the spray altogether, or, in some other way, avoid damage to the bees. Such communication between the beekeeper and spray applicator also makes it possible for the beekeeper to move the colonies or cover them with wet burlap, if necessary.

(e) Protect honey comb in storage. Honey combs can absorb some chemicals in sufficient quantities to kill bees when hive bodies are placed on the hives. Examples are chlordane for ant control and *Vapona No Pest Strips* for flies in the honey house. P.D.B. should be placed in stored hive bodies in the fall so that all fumes are dissipated from the combs by late spring. Otherwise, the odor can repel bees and damage the flavor of honey.

Wild Bees

Wild bees include all species of bees other than the common honey bee. There are over 3,000 species of wild bees in North America, north of Mexico. Collectively, these bees perform a very useful service by pollinating many crops and wild plants. Their service is free to growers and they should be conserved. Fence rows, wood lots and unused land provide nesting sites for wild bees. These bees should be considered in any spray program, especially those repeated frequently or covering a large area. Their conservation is of great economic importance to the state of Michigan.

Legal Aspects

Some landowners feel that bees are trespassing on land not owned by the beekeeper. Some believe that they have no real responsibility to alter their practices to conserve bees, and anything they might do would be purely a goodwill gesture. Bees are vital to Michigan Agriculture and ownership of land does not give the right to do things that are detrimental to the public good.

Legislation to protect bees has been developed in various parts of the world. In Sweden, legislation prohibits using many pesticides known to be hazardous to honey bees and bumble bees on flowering plants. In New York State, it is illegal to spray fruit trees or alfalfa in bloom with any insecticide harmful to honey bees.

In Michigan, we have relied on education and cooperation, which has likely been more effective than legislation. The usefulness of bees for crop pollination is becoming widely recognized. Most growers, especially fruit growers, avoid spraying plants in bloom knowing that their own business would fail without bees. In general, laws cannot be designed to deal with the various situations under which bees may be killed. Reliance on laws in this matter tends to emphasize enforcement of the law rather than the

development of rational procedures to solve specific problems. Pollination has a value to agriculture and wild plants that can challenge that of pesticides. There is need to continually seek formulae that will allow bees to prosper in spite of extensive pesticide use.

All too often, sprayers, especially aerial applicators, allow sprays to drift and kill bees some distance from the target crop. Their legal right to allow poisons to drift from the target crop is highly questionable. In these situations, the beekeeper would often be justified to sue for damages. Other times, he might legitimately expect the sprayer to pay all, or part of, the cost of moving colonies to a new location before the spray is applied. Consideration for the effect of pesticides on bees should be an important aspect of all recommendations for pesticide use. Where bees suffer excessive damage, recommendations should be changed. Growers or applicators who do not follow recommendations should be held responsible for damage to bees or other aspects of the environment.

Relative Toxicity of Pesticides to Honey Bees

Pesticides differ greatly in their effect on honey bees. Many organophosphorous materials, such as TEPP, kill bees very quickly when first applied but have such a short residual life that bees may safely visit the area a few hours later. Arsenicals can kill bees for a long time after application and will survive in pollen to kill bees and brood for many months. Sevin (carbaryl) also remains toxic in pollen for a long time killing young bees which consume large quantities of pollen. Some insecticides, which are very toxic to other insects, are almost harmless to honey bees. The following lists have been adapted from research reports published largely by Atkins and Anderson, University of California, Riverside and Carl Johansen, Washington State University, Pullman.

Group I: Highly Toxic Insecticides

aldrin
[1]arsenicals
azinphosethyl (Ethyl Guthion)
azinphosmethyl (Guthion)
[2]Azodrin
[3]Banol
[2]Baygon
[1]BHC
[2]Bomyl
[2]carbaryl (Sevin)
[1]chlordane
Ciodrin
[3]Dasanit
[2]diazinon
dicapthon
[2]dichlorvos (Vapona) (DDVP)
[1]dieldrin
[2]dimethoate (Cygon)
[2]dinitrobutylphenol (DNOSBP)
[2]Dursban
[2]EPN
[2]fenthion (Baytex)
[2]Furadan
[3]Gardona
heptachlor
[1]Imidan
[2]Lannate
[1]lindane
[2]malathion
[1]malathion ULV
[1]Matacil
Metacide
[2]methyl parathion
[2]mevinphos (Phosdrin)
[3]naled (Dibrom)
[2]parathion
phosphamidon (Dimecron)
Pyramat
[3]Telodrin
[3]Temik
[3]TEPP
[2]Zectran

Group II: Moderately Toxic Insecticides

[3]Abate
[2]carbophenothion (Trithion)
[3]Carzol
coumaphos (Co-Ral)
[1]DDT
[3]demeton (Systox)
[3]Dimetilan
[3]disulfoton (Di-Syston)
[3]endosulfan (Thiodan)
endothion
[2]endrin
[3]methyl demeton (Meta Systox)
[2]Perthane
[3]phorate (Thimet)
[3]phosalone (Zolone)
Pyramat
[3]ronnel

Group III: Relatively Non-Toxic Insecticides

[3]Acarol
allethrin
Aramite
Bacillus thuringiensis
[3]chlorbenside (Mitox)
chlorobenzilate
dicofol (Kelthane)
[3]Dilan
[3]dioxathion (Delnav)
[3]ethion (Nialate)
fenson (Murvesco)
[2]Kepone
[3]Lethane
Lovozal
[2]methoxychlor
[3]Morestan
nicotine
[3]Omite
oil sprays (superior type)
[3]Plictran
[3]Pyrethrum
[2]rotenone
Strobane
Sulphenone
TDE (Rhothane)
[3]tetradifon (Tedion)
[2]toxaphene
[3]trichlorfon (Dylox, Dipterex)

[1]Residual effect likely to persist for several days.

[2]Residual effect of spray persistent for three days or less.

[3]Residual effect of spray likely dissipated overnight—spray when bees are not in flight.

Relatively Non-Toxic Fungicides*

bordeaux mixture
captan
copper oxychloride sulfate
copper 8-quinolinolate
copper sulfate
copper oxide
Dexon
dichlone (Phygon)
dinocap (Karathane)
dodine (Cyprex)
Dyrene
ferbam (Fermate)
folcid (Difolatan)
folpet (Phaltan)
glyodin (Glyoxide)
maneb (Manzate)
Mylone
nabam (Parzate)
Polyram
sulfur
thiram (Arasan)
zineb (Parzate)
ziram (Zerlate)

Relatively Non-Toxic Herbicides*

amitrole
CDAA (Randox)
CDEC (Vegedex)
dalapon
dicamba (Banvel-D)
diquat
diuron (Karamex)
EPTC (Eptam)
EXD (Herbisan)
IPC
MCPA
monuron
NPA
paraquat
Planavin
sesone
simazine
2,3,6-TBA (Trysben)
2,4-D
2,4,5-T

Relatively Non-Toxic Defoliants*

DEF
merphos (Folex)
PREP

*Most fungicides, herbicides, and defoliants are relatively non-toxic.