The Role of Insect Control Measures Involving Farm Practices in a Chemical Era

M. Curtis Wilson, Purdue University

Introduction

The writer has selected a subject for review which is of timely interest to all of us who are associated with the science of entomology because entomology as an applied science is evolving at a rapid rate, more rapid since World War II than at any previous time. New methods of control procedures are developing, some of which are remarkable for their effectiveness; others are being developed without thought to overall effects because it may be easiest to follow the path of least resistance.

The prolonged over emphasis of any procedure may be analogous to orthogenesis phenomina of evolution. The effects of orthogenesis both good and bad are clearly understood by biologists and it is the responsibility of entomologists to understand and promote the former and their obligation to mankind to prevent the latter in dealing with their science.

There is little doubt in the minds of most entomologists that the applied science is evolving almost in a straight line in the direction of chemical control of insects. In the years following World War II with the development of tremendous numbers of new organic insecticides the science of applied entomology has entered a new phase, the chemical period. The impetus of industry and the excellent results obtained with many of these new chemicals have caused this phase to evolve with alarming speed.

Entomologists are aware of some of the problems that have arisen since organic insecticides have come into use; problems of contamination, problems such as the development of hardy strains of insects resistant to insecticides as well as the development of serious insect problems because the insecticide kills predators and parasites, but not the host. There are also the problems that develop where there is no evidence that the natural enemies are killed, but the host population build-up occurs, nevertheless. Under such conditions it appears that the insecticide may have an attracting effect or other influence beneficial to the development of an insect population.

A philosophy of general chemical control does not take into consideration the ease with which a simple farm practice can often be employed to prevent a problem before it develops.

This discussion will be confined to the insect problems of field crops. Perhaps at this point a definition should be given of what is meant by a good crop practice to be utilized in insect control.

"A sound farm practice for insect control is a method of *preventing* insect damage to a crop by providing conditions unfavorable to insect development in such a way as to allow economic production of that crop and at the same time be adapted to the best agronomic practices."

Using this definition, a rotation to control insects where it is economically and agronomically feasible, is a sound farm practice. However,

this same practice under other conditions may be unsound. The use of an insecticide in place of a rotation may become a good practice if the use of that insecticide makes it possible for the farmer to grow a crop several years on the same land where that is economically and agronomically the most advantageous thing to do.

The coming of the chemical era with the development of highly effective organic insecticides has replaced many farm practice recommendations that had been in effect for many years. This is not due entirely to the discovery of effective chemicals and equipment for application. It is also due to such new developments as hybrid corn, improved varieties and changes in fertility and rotation programs in crop production. Practices which were considered sound a few years ago are not always considered the best today. It is important to remember that the most sound agronomic practices which enable maximum production with least effort and expense will always be basic in insect control. The entomologist should never lose sight of the crop, for his objective is to successfully produce that crop—*not to control the insect!* If he can produce a sturdy plant able to sustain insect injury by increasing soil fertility or by breeding a hardy hybrid, why use an insecticide or a laborious mechanical method? It may be possible to grow the crop and feed the insects too, when the plants are hardy and in this way limit insecticidal use where possible to unusually heavy outbreaks.

The use of farm practices as a means of insect control has been applied most extensively to field crops, or crops grown in large acreages. Some of the more important of these practices will be discussed with an attempt to evaluate them and show where a revision of some of these recommendations has been, or may be, necessary because of changes in crop production and newer materials and equipment available for insect control.

Delayed Planting to Prevent Insect Outbreaks

Many insect problems have been approached by a study of planting dates in order to find dates when a crop might be planted to avoid insect attack. Since some insects attack a crop only in a certain stage of plant growth, attempts have been made to prevent synchronization of the insect with the crop by delaying planting. There is considerable merit to this principle where it can be applied. Two outstanding examples of the successful use of this practice are the recommendations for corn borer and Hessian fly control which have been practiced for many years.

In the case of the Hessian fly it was found that infestation could be prevented by delaying the planting of wheat until the flight of flies had passed. For years, delayed planting of wheat has been the standard recommendation for control of this insect.

In recent years, two things have occurred which are influencing control of the Hessian fly. First, crop rotations have changed in most of Indiana so that wheat follows either soybeans or corn. This means that wheat of necessity cannot be planted until after the beans or corn have matured which is at least one week to ten days after the fly free date. This agronomic practice has been of considerable significance in reducing

Hessian fly outbreaks. Since wheat is normally planted considerably later than the fly free dates, the threat of this insect in the fall to new seeded wheat has been lessened.

The second factor to affect Hessian fly control in recent years is the use of the combine. In combining a wheat field, considerable grain lost in the field is the source of a great deal of volunteer wheat. This volunteer wheat is ideal for the development of a spring brood and under present agronomic practices this brood from volunteer wheat is the real threat to Indiana wheat. A cleanup program that would involve plowing under the stubble in the fall is not possible since clovers and grasses are seeded in most of the wheat to provide pasture, hay, and soil improvement crops the following year.

It appears that the solution of this problem will be in the use of varieties of wheat resistant to Hessian fly. Fortunately, the Bureau of Entomology and Plant Quarantine has made a great deal of progress in this line of research. Varieties suitable for Indiana conditions are now being multiplied for release.

Another problem which, like the Hessian fly, has been successfully controlled through the use of planting dates is the corn borer. Most entomologists are aware of the outstanding research of the late George Fitch in Indiana which showed that corn had to reach a certain height before it was attractive to the corn borer moth for oviposition. This research became fundamental in all future corn borer recommendations since it was found that the ideal planting dates for corn borer control coincided with the dates at which highest yields were obtained.

Aside from delayed planting of corn as a corn borer control measure, hybrid corn was found to be quite tolerant to the insect and the use of adapted hybrids and delayed planting became fundamental in corn borer control.

The emergence of a second brood created a new problem in corn borer control for corn planted after the recommended date was very susceptible to the second brood. Present recommendations attempt to select planting dates that will escape severe infestation of both broods. This is difficult to accomplish since it allows a relatively short period in which to plant and the weather conditions do not always make this possible.

Production of specialized crops, development of hybrid corn, and changing views in crop production make it necessary to allow for exceptions. There are three exceptions to the recommendation of delayed planting for corn borer control. These exceptions are made possible because insecticides are available in which complete control can be obtained if treatments are properly timed. The exceptions are for the farmer who grows early market sweet corn, the hybrid seed producer, and the farmer who has very droughty soils. The early market sweet corn grower of necessity has to use insecticides since his market demands early planting which produces corn in a highly susceptible stage at the time the moths are flying.

The hybrid seed producer deals with a crop of very high value. His corn must be mature enough to dry and shell before danger of freezing. Freezing kills germination and the seed cannot pass certification. Because

of this some growers have had severe losses and the trend is to plant as early in May as possible. If bad weather should prevail at May 20, later planted corn is almost certain to suffer some loss from frost.

Many agronomists now believe that an early corn hybrid should be planted early on droughty soils. Their theory is that usually the corn can be made before drought occurs without loss in yield. This theory has been evident in Indiana during the last two years in early planted corn fields.

Crop Rotations to Prevent Insect Outbreaks

Aside from delayed planting, many other types of farm practices have been developed to prevent or control insect outbreaks. Of these, crop rotation is one of the most important. This method has been employed primarily in controlling insects of the soil. By simple rotation of crops, many pests have been brought under complete control. However, it is in this line that a great deal of research needs to be extended. Farm practices involving the rotation of crops to control insects were excellent for their time, but we now have new and varied needs which call for many exceptions to the rule. Research in the production of field crops has progressed rapidly, and insect control measures must keep pace. A procedure that is a good farm practice from the standpoint of insect control alone may not be a good recommendation.

Agronomic research and practice shows that certain rotations recommended in insect control may not be advantageous for the following reasons:

1. There is no advantage from rotating sod crops on hilly land. Rotation of hilly land causes serious erosion problems. There is a trend to seed hilly land to continuous pasture crops.
2. There is a trend to plant continuous corn on heavy loam soils where the fields are flat. If properly fertilized, the agronomists say there is no disadvantage to this procedure. In some cases, problems of soil structure may arise, but studies indicate that a soil improving legume may be planted with the corn. With this type of farming, erosion is reduced and cropping is confined to the most productive soil.
3. A new type of rotation is to go directly from corn to hay without seeding a small grain. This is accomplished by planting the corn rows wider and seeding legumes and grass between the rows.
4. Pure stands of alfalfa or clover are disappearing. It has been found that mixtures of grass and clover or alfalfa are preferable to either the grass or legume alone. Mixtures control weeds since grasses are easily established. Grasses tend to produce a sod which helps to bring legumes through the winter. For pasture, grass is preferred for cattle and sheep. The legume produces nitrogen for the grass and is feed for livestock during dry weather.
5. Because of high water from floods, rotations cannot be followed in the river bottomlands and this land is largely planted to continuous corn.

These changes in views on crop rotation are not mere agronomic theories. It is true that some are in the research stage, but farmers can be found in Indiana who are applying each of these new concepts.

How will these new concepts or trends affect insect control? Already they are having tremendous effects in increased outbreaks of white grubs, wireworms, northern corn root worm, grape collaspis, and billbugs. Others could be mentioned. With favorable habitats many of these insects have been increasing gradually until in 1953 when environmental factors were near optimum to the development of insects, more serious economic insect problems of field crops, particularly of corn, occurred than ever experienced in Indiana.

Fortunately, in 1953 there was an abundance of insecticides developed since World War II that could be applied in such an emergency. Otherwise, there would have been crop failures.

These facts corroborate the necessity of research to develop new methods of insect control that will fit in with newer agronomic practices. The entomologist must realize that insects are only one factor in the complex of crop production. Therefore, when agronomic procedures change, if he is thinking in terms of the crop instead of the insect, he will initiate studies for new control methods which are adaptable to the change in cropping practices.

Undesirable Farm Practices Used to Prevent Insect Outbreaks

In the past because other methods were not available for the control of injurious insects, methods involving farm practice were frequently advocated which we now know to be undesirable. These include such practices as the planting of a crop distant from another, elimination of crops during outbreak years, and use of trap crops, cleanup involving the burning of crop residues, fall plowing on certain soils, and delayed harvesting of one crop to prevent infestation of the next.

Few farmers can afford to utilize a recommendation that requires them to plant a crop distant from another, nor can they usually eliminate certain crops in infestation years. Such a procedure interferes with rotations and the general farm program.

Economically, the use of trap crops to control insects may be costly to the farmer. For the control of certain insects it requires a great deal of additional labor to plant a crop twice, a procedure which is seldom feasible. To control wireworms or rootworms by this method it is necessary to plant the entire field to the trap crop prior to planting the primary crop. Purdue economists estimate that this procedure would cost from $3.50 to $4.00 per acre for seed and planting. Since two to three weeks would elapse following the planting of the trap crop before seeding, the risk of a hard seed bed for the primary crop is involved.

To control some insects such as the corn borer with trap crops, it is possible to plant only certain areas to the trap crop, seeding the corn early so that it is highly attractive to the moths. However, this procedure may restrict profitable utilization of all of the field.

Cleanup programs involving the burning of crop residues are a costly waste of soil organic matter and would never be advised today except as a last resort in a severe emergency.

Fall plowing of easily eroded soils is a poor practice from the standpoint of conservation.

Delayed harvesting of one crop to prevent infestation of another may seriously affect the quality of one of the crops. This is evidenced in particular by the old recommendation for control of the potato leafhopper on alfalfa. It was recommended that harvest of the first alfalfa cutting be delayed until the middle of June until the leafhoppers had layed their eggs. In this way the eggs would be removed with the first crop and the second would not be heavily infested. However, there is an optimum time for cutting alfalfa and a delay in harvest means a sacrifice in the nutritive value of the crop.

In this discussion comment has been, in most cases, confined to those farm practices which continue to be dominant in insect control. It has been shown that some recommended practices are out of date and that changes in agronomic practice are causing some insect problems to become more prominent. Simultaneously, insecticides have been synthesized and spray equipment developed which have been, under conditions of high farm prices since World War II, economical to use. It is obvious that we have entered a chemical era and the question arises, "What role will insect control measures involving farm practices have in a chemical control era?"

Outlook for the Utilization of Farm Cultural Practices in Insect Control

The farm practice as applied to insect control is not a thing of the past; on the contrary, it is foreseen that it may arise to new importance following research in experiment stations. We are now in a chemical period largely because of high farm economy, availability of effective chemicals and spray equipment, and the fact that farm practices for insect control adaptable to new agronomic trends are still in a stage of development.

Changes in agronomic trends may make it more difficult to control some insects, but it is foreseen that these same changes may make the control of other insects easier. For example, let us consider the chinch bug. For years farmers have been fighting the chinch bug with barriers, chemicals, etc. in outbreak years. Many of the new organic insecticides have been tried but results have been erratic. Control has ranged from 0 to 100 percent.

It has been known for a long time that the chinch bug is a sun loving insect and that shade is unfavorable to its development. A study of the history of the chinch bug will show that wheat fields are infested much less today by chinch bugs than they were twenty years ago. A study of wheat production in recent years shows that the tendency has been to grow legumes such as sweetclover in the wheat. Likewise, modern improved varieties of wheat and high applications of fertilizer have been used. These factors have produced dense stands which are heavily shaded and unfavorable to chinch bugs. Thus, the chinch bug is less of a problem than it used to be. With this thought in mind, it is foreseen that the

chinch bug problem may be lessened if the agronomists turn to a practice of growing legumes with corn which will shade the base of the corn plants.

In the future, farmers will have increasingly more varieties which are tolerant and perhaps resistant to insects. The use of resistant or tolerant varieties is the most desirable method of insect control because of its simplicity and low cost. However, the breeding of resistant or tolerant varieties is a slow process as it involves many years of selection and testing of plants by plant breeders and entomologists. However, it has been shown that hybrid corn has been developed which is more tolerant to the corn borer and that wheat resistant to the Hessian fly is becoming available. The Departments of Entomology and Agronomy at the Purdue Agricultural Experiment Station are working cooperatively to develop varieties of alfalfa which will be tolerant to the meadow spittlebug and the potato leafhopper. Considerable progress has been made in these studies and it is hoped that tolerant varieties will be available within a few years.

Aside from the development of varieties tolerant to insects, studies are underway to produce greater tolerance in a crop plant by applying principles of growing a vigorous and healthy plant. It is easily understood that a healthy plant will withstand more insect damage without loss than an undernourished spindly plant.

To prevent loss in stands from infestation by the sweetclover weevil, principles that would promote accelerated growth of the plants, once the seed had germinated, were applied. It was found that by increasing soil fertility by top-dressing the soil in the spring, increased vigor could be obtained and many plants which otherwise would have been killed by the weevil could withstand the damage. Where infestations had been heavy, DDT could be applied in the same operation by combining it with the fertilizer. This protected the plants until establishment. Recent studies show that DDT can be applied in combination with liquid nitrogen. This treatment is very simple to apply and only the cost of the insecticide is involved, since the nitrogen application to small grains is a regular spring procedure in Indiana.

Plant vigor can also be increased through irrigation. Studies on Purdue experimental farms on droughty soils indicate that under irrigation, damage to alfalfa by the potato leafhopper is much less. Thus, under conditions that produce vigorous plants there is less need for chemical treatment to control insects, and when applied, dosages often can be smaller and the number of applications may be less.

Developments such as have been mentioned do not indicate the eventual elimination of insecticides. On the contrary, insecticides will continue to be used in large quantities, but the trend in general should be toward the control of outbreaks that get out of hand. In some cases, because of economics in which very small quantities of insecticide can be used at low cost without hazard, the use of insecticides should be considered good insurance and will be employed because it is a good practice. For example, when planting corn in a soil that has had any indication of wireworms, a farmer could not afford not to apply a seed treatment

which would cost only 16 to 20 cents per acre. Likewise, when grasshoppers can be killed for only 56 cents per acre, there is no incentive to mix bait, nor would there be any reason to use the frequently undesirable practice of plowing in the fall to destroy the eggs.

Conclusion

In conclusion, farm practices to control or prevent insect outbreaks are not a thing of the past, but a thing of the future in a chemical era. However, entomologists must recognize the specialization of crops and agronomic procedures which is becoming more and more pronounced. Such specialization requires control measures to fit the case. This means that the entomologist is challenged with the task of providing a variety of control measures, one of which can be utilized for each circumstance. Insects are important, let us not minimize them; but they are only a single factor in the complex production of a crop. Therefore, they should not be the limiting factor in the utilization of a soil or the production of a crop.

Research in entomology if it is to keep pace with agronomic research will produce improved methods which will incorporate the use of insecticides in sound programs where it is economically and agronomically most feasible to use them. To do this, the research entomologist cannot be a lone wolf. He must work cooperatively with the plant breeder, the soil specialist, the irrigation specialist, the plant pathologist, the soil microbiologist, and other specialists who are concerned with the production of the crop. Finding the best method of producing a crop requires cooperative team work of all specialists working on that crop. Think first, in terms of producing the crop, and as an entomologist, think secondly, in terms of controlling the insect!