Title
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Permalink
https://escholarship.org/uc/item/2fc8g0vn

Journal
Proceedings of the Vertebrate Pest Conference, 9(9)

ISSN
0507-6773

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Publication Date
1980

THE INFLUENCE OF INSECTS IN BIRD DAMAGE CONTROL

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ABSTRACT: Considerable effort has gone into developing and testing the various management methods for keeping blackbirds out of cornfields, but little work has been directed at understanding the relationship of the birds or the damage control methods to the other organisms within cornfields. This report shows that in a number of cases insects may influence bird-damage control programs. It points out the complex interaction among organisms that can occur in agricultural crops and the importance of considering pest control from an integrated view instead of from a single-species basis.

INTRODUCTION

Blackbirds (Icteridae) feeding on maturing corn in parts of North America continue to cause economic losses. For example, estimates of blackbird damage to field corn in Ohio for 1977-79 indicate a $4-6 million loss annually (Dolbeer 1980). Various management methods to reduce bird damage have been developed, such as chemical agents, mechanical noise devices, and bird-resistant hybrids. These methods have been inconsistent in their effectiveness (Woronecki et al. 1979a, Dolbeer 1980).

Although considerable effort has gone into developing and testing the various management methods for keeping birds out of cornfields, almost no work has been directed at understanding the relationship of the birds to the cornfields they feed in. We have little information on factors, besides the corn itself and its proximity to bird roosting areas, responsible for attracting birds to some cornfields and not to others, or causing management techniques to work in some cases and not in others. We contend that information is needed on the interactions among the various factors (e.g., insects, weeds, corn varieties and birds) before we can develop effective management programs to consistently reduce bird damage. We emphasize the importance of approaching bird problems in agriculture from an integrated view instead of from the isolated view of just the birds and the crop.

The objective of this paper is to examine four areas in which insects may have a role or influence in bird-damage control. These areas are (1) the effect of insects on bird damage to a crop, (2) the effect of insects on bird damage control measures, (3) the effect of birds on insect damage to a crop, and (4) the effect of bird damage control methods on insect damage to a crop.

EFFECT OF INSECTS ON BIRD DAMAGE

Evidence has accumulated from recent studies to indicate that insect populations within cornfields can serve as an attractant to blackbirds and thus have an important influence on subsequent bird damage to the crop. In this section we review this evidence and briefly discuss the implications for management of bird depredations to corn and other crops.

Our first indication of a blackbird-insect relationship in corn came during an evaluation of Avitrol®[1/] FC-Corn Chops-99 (AFCC-99) in sweet corn during 1974 in Ohio (Dolbeer et al. 1976). No treatment effect of AFCC-99 was detected; however, blackbird activity in all fields dropped off decidedly about the middle of August (Fig. 1). We did note that the decline in activity coincided to

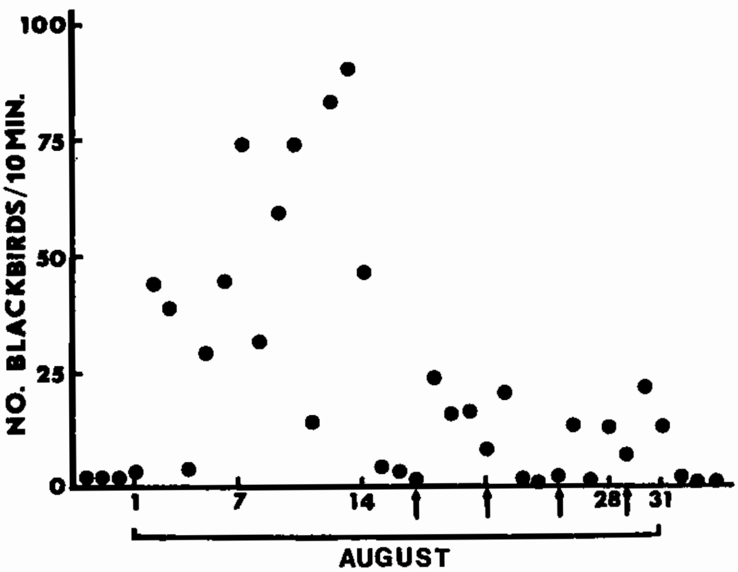

Fig. 1. Mean daily index of blackbird activity per sweet corn field (number of birds observed per 10 min observation) for 31 sweet corn fields in northern Ohio, 1974. Arrows indicate dates Sevin was applied to fields. See Dolbeer et al. (1976) for details of study.

[1/]Use of trade names does not imply endorsement of commercial products by the Federal Government.

some degree with the initial aerial application of Sevin[R] [carbaryl (1-naphthyl methylcarbamate), Union Carbide Corp.] to all fields for the control of earworms (Heliothus zea), and we speculated that the two factors might be related. Because the recorded decline in the bird numbers began 2 days before the initial application of Sevin, the relationship could have been a coincidence. Yet, once Sevin was applied, bird numbers remained very low. On 11 of 19 days before the Sevin applications, the index of blackbird activity in cornfields (birds recorded/10 min observation) averaged over 25 per field. On none of the 18 days after the first application did the activity index exceed 25.

We did not systematically monitor insect populations in the fields, but we did commonly note dead insects (e.g., rootworm beetles [Diabratica spp.], moths) in the fields after the first application of Sevin. Sevin has no known bird repellent properties (Denver Wildlife Research Center, unpubl. data); thus, we speculated the decline in bird activity might be related to a decline in insect populations in the fields.

The next indication of this relationship came in 1975 when Stickley and Ingram (1976) evaluated [R]Mesurol [3-5-dimethyl-4-(methylthio)phenol methylcarbamate = methiocarb, Division of Mobay Chemical Corp.)] to reduce blackbird damage to sweet corn. Mesurol is an insecticide that has been shown in laboratory tests (Schafer and Brunton 1971) and field tests on sprouting corn and fruits (Crase and DeHaven 1976) to have bird-repellent properties. Rogers (1974) showed that Mesurol produces this repellency by causing a post-ingestional illness in the bird.

Stickley and Ingram found that sweet corn fields receiving applications of Mesurol 12 and 6 days before cannery harvest had one-sixth the damage of untreated fields. Although birds were commonly observed in the fields starting 20 days before cannery harvest, no damage to the corn occurred until 5 days before harvest. Since bird numbers dropped significantly in treated fields after the first application, when birds were not feeding on corn, we hypothesized that the chemical (by reducing insect numbers) made the fields less attractive to birds. Thus, fields receiving Mesurol applications had fewer birds frequenting them when the corn became vulnerable to bird damage and damage was reduced. We hypothesized the reduction in damage was not due to repellent properties of the chemical but was due to its insecticidal properties.

In 1978, we designed an experiment to test this hypothesis by comparing Mesurol, the insecticide with proven bird-repellent properties, and Sevin, the broad-spectrum insecticide with no known bird-repellent properties, as chemical treatments to reduce blackbird damage to maturing sweet corn. The hypothesis (that a reduction in insects results in less blackbird damage to sweet corn because the birds are not attracted to the fields) would have been considered upheld if both Sevin and Mesurol treatments reduced damage. If only Mesurol reduced bird damage, then the repellent properties alone would have been considered the most likely mechanism of protection. If neither chemical treatment was effective, then both repellent and insect hypotheses would have been considered unlikely.

We used 12 sweet corn fields at Ottawa National Wildlife Refuge, Ohio, 4 of which received aerial applications of Mesurol 75% W.P. (1.5 lb A.I./acre) at 7 days before fresh market maturity and 6 and 12 days later, 4 of which received the same application rates of Sevin on the same days, and 4 of which served as untreated controls. We monitored blackbird activity in the fields by making systematic counts of birds and bird droppings. We monitored insect populations by using five different capture methods. Blackbird damage was measured on four dates during the fresh market and cannery harvest periods.

The results of this study indicated that applications of either Mesurol or Sevin to sweet corn fields in Ohio reduced blackbird activity, blackbird damage, and insect numbers compared with the control fields. The strong and consistent relationship between reduced insect populations and reduced bird damage under either chemical treatment supported the hypothesis, that a reduction of insects makes the cornfields less attractive to blackbirds and results in less bird damage. The key results of the experiment are summarized in Figures 2 and 3. The full results of the experiment are presented in Woronecki et al. (1980, unpubl. ms.).

Unfortunately, we could not collect blackbirds feeding in the cornfields; thus, we do not know what insects were of key importance. General studies (Bird and Smith 1964, Hintz and Dyer 1970, Mott et al. 1972) have shown that in late summer red-winged blackbirds (Agelaius phoeniceus) shift from a predominately insectivorous diet to a predominance of vegetable material. Still, insects, many of which occur in cornfields, are important food items at this time of year. The only feeding-habits study of redwings done specifically in corn (W.T. Bridgeland, unpubl. data) revealed that insects were commonly consumed in cornfields in August in New York State. All 46 redwings he collected feeding in cornfields contained insects. Beetles were the most common order identified; 28 percent of the birds contained rootworm beetles. However, Bridgeland could not detect any relationship between rootworm density and blackbird activity or blackbird damage in these same fields.

Excepting studies on the direct toxic effects of pesticides on birds (e.g. Graber et al. 1965), no other quantitative data are available on the relationship of insect control to bird activity in agricultural environments. However, several studies have examined the impact of insecticides used in forests on nesting populations of birds therein. These studies, reviewed by Bart and Hunter (1978), Bart (1979), and DeWeese et al. (1979), generally have not detected significant changes in bird activity (i.e., singing males heard, numbers seen, nesting success) related to applications of various insecticides including Sevin. One notable exception was a study by Moulding (1976) in which he measured a 55 percent decline in bird numbers over an 8-week period following the application of Sevin to blocks of forests in New Jersey. Moulding hypothesized that the decline was due, at least in part, to a reduction in food supply causing the birds to forage outside the sprayed areas.

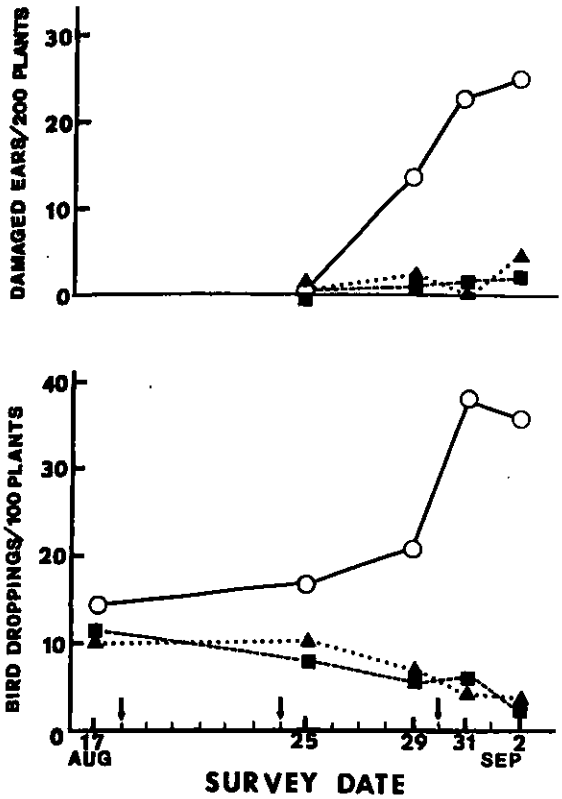

Fig. 2. Mean number of bird droppings per 100 sweet corn plants and mean number of blackbird-damaged sweet corn ears per 200 ears recorded by date, Ottawa National Wildlife Refuge, Ohio, 1978. The circles, triangles, and squares represent the control, Sevin, and Mesurol treatment groups of fields, respectively. Arrows indicate day of insecticidal application. Fresh market, early cannery, late cannery, and post-cannery maturity dates were on 25, 29, and 31 August and 2 September, respectively (from Woronecki et al. 1980, unpubl. ms.).

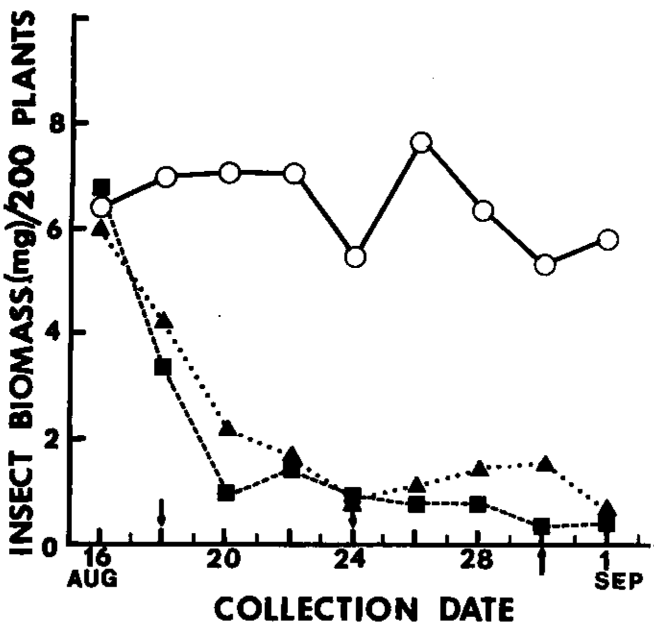

Fig. 3. Biomass of insects collected on 20 corn plants with a vacuum insect net in sweet corn fields at Ottawa National Wildlife Refuge, Ohio, 1978. The circles, triangles, and squares represent the control, Sevin, and Mesurol treatment groups of fields, respectively. Arrows indicate day of insecticidal application. Fresh market, early cannery, late cannery, and post-cannery maturity dates were on 25, 29, and 31 August and 2 September, respectively (from Woronecki et al. 1980, unpubl. ms.).

Obviously, additional research is needed in agricultural and natural habitats to clarify the relationships of bird activities and bird feeding responses to insect populations and insecticidal applications. We do not have enough information at present to make specific recommendations for managing insect populations in corn to reduce blackbird damage; however, we do feel the study (Woronecki et al. 1980, unpubl. ms.) reveals excellent possibilities for developing new or enhancing old bird-damage control techniques for corn and other agricultural crops.

EFFECT OF INSECTS ON BIRD-DAMAGE CONTROL METHODS

As suggested in the above section, insects may indirectly affect the performance of bird-damage control methods because of their influence on bird feeding behavior in cornfields. However, insects also may have a direct influence on the performance of bird-damage control methods.

When AFCC was first evaluated in field corn fields in 1965 to reduce blackbird damage, De Grazio et al. (1972) noted that in several fields, having little bird pressure, bait disappeared rapidly. Closer examination revealed high insect populations in these fields; beetles (Hadpalus sp.) and crickets (Gryllus sp.) appeared to be chiefly responsible for the missing bait. However, De Grazio et al. (1972) did not consider it a major problem.

In 1969, Mitchell et al. (1976, unpubl. rep.) and Stickley et al. (1976) quantified the rate of disappearance of AFCC-99 baits in 19 field corn fields in Sandusky and Seneca counties, Ohio. Daily bait loss was estimated to average 10 percent and an average of 41 percent of the bait remained on the plots 6 days after treatment. These data indicated that bait usually was present in fields throughout the periods when protection from birds was needed and that bait removal by insects was not a problem. Insects were not conspicuous in any fields (A.R. Stickley, Jr., pers. comm.).

Woronecki et al. (1979a) while evaluating different treatment forms of AFCC in 1976 observed rapid disappearance of aerially applied baits in field corn in Sandusky, Ottawa, and Lucas counties, Ohio. Bait particles were evident in only 4 of the 28 fields searched 3 to 5 days after the first and last AFCC application. We believed something other than birds was responsible for most bait loss since blackbird activity in most fields was low.

We measured bait disappearnce (from factors other than birds), in 1976 and 1977 in 24 cornfields in Ottawa County, Ohio that were receiving applications of AFCC. Daily counts of the bait placed under randomly located bird-proof exclosures in 1976 and 1977 revealed only 5 and 16 percent of the bait particles remained after 1 day, 2 and 8 percent after 2 days, and 1 and 3 percent after 3 days, respectively. In both years, 100 percent of the bait was lost after 5 days. In one field, 16 of 20 corn particles were missing from an exclosure within 3 h. Bait placed closer to a field edge disappeared more rapidly than bait placed a distance greater than 15 m from the edge of a field (Fig. 4).

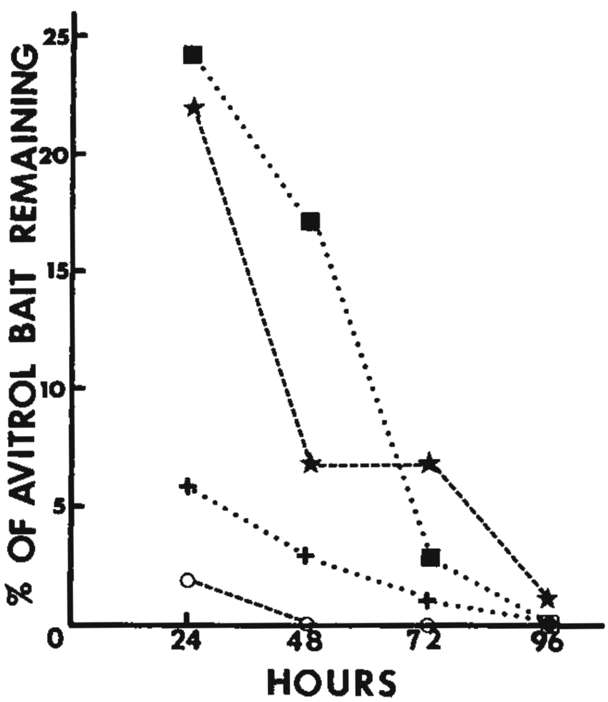

Fig. 4. Rate of Avitrol bait disappearance from bird-proof exclosures at four distances from edge of cornfields, northern Ohio, 1977. Exclosures were placed 1.5 (circles), 19.0 (crosses), 38.0 (stars), and 76.0 (squares) m from the field edges. Each data point represents the mean value from 12 fields having one exclosure at each distance.

Crickets were conspicuous in most fields, and we believe they were responsible for most bait loss. On several occasions, crickets were observed carrying corn particles into cracks in the ground.

To determine if crickets and other insects could distinguish between AFCC-treated and untreated bait particles, treated and untreated particles were separated and placed under exclosures in four fields. The number of baits remaining were counted at 2, 4, 6, 24, 48, and 168 h intervals following the initial placement. Within 6 h there were twice as many AFCC-treated particles still under the exclosures and after 24 h more than 5 times as many treated baits remained (Fig. 5). Although about 70 percent of the treated particles were removed after 48 h, most of them were found uneaten within a short distance of the exclosure. It was obvious that the crickets could distinguish between treated and untreated bait particles and preferred the untreated ones.

Thus, AFCC-99 bait depletion by crickets or other insects in cornfields apparently can be a problem in certain years or certain locations. This depletion can influence the performance of AFCC-99 in several ways. First, it probably reduces the effectiveness of the product by rapidly removing the untreated bait and leaving only a very sparse (less than 800 particles/acre) scattering of treated particles. This may partially explain the inconsistent performance of AFCC in numerous experiments (Woronecki et al. 1979a). Secondly, it may enhance hazards to non-target bird species by decreasing the ratio of untreated to treated bait particles, especially near field edges.

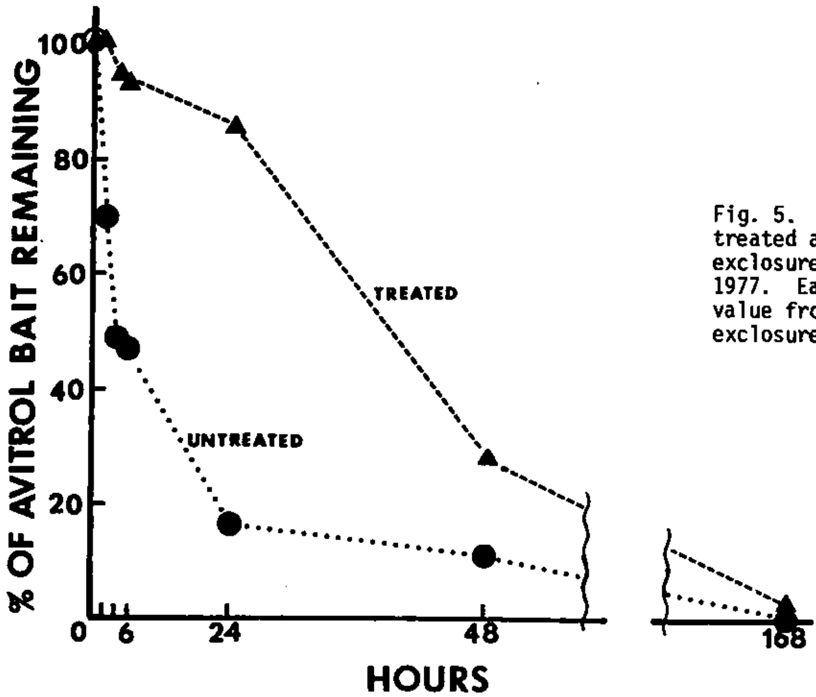

Fig. 5. Rate of disappearance of Avitrol-treated and untreated bait from bird-proof exclosures in cornfields, northern Ohio, 1977. Each data point represents the mean value from four fields, each having eight exclosures.

Crickets appear to be very difficult to control in cornfields. For example, three applications of the insecticides, Sevin or Mesurol, to cornfields in Ohio had no effect on cricket populations although populations of most other insects declined significantly (Woronecki et al. 1980, unpubl. ms.). Thus, bait monitoring should be an important part of any bird-damage control program using AFCC and AFCC probably should not be used as a bird-control device in cornfields where crickets are conspicuous.

EFFECTS OF BIRDS ON INSECT DAMAGE TO CROPS

Increased insect damage following blackbird damage. -- Cardinell and Hayne (1945) reported that under certain weather conditions bird-damaged corn ears are more subject to molding and sprouting (i.e., secondary damage) than are undamaged ears. Our studies of simulated bird damage to maturing corn (Woronecki et al. 1976, 1979b) substantiated this earlier observation and showed that insect damage also can be an important secondary factor. These studies revealed that the incidence of secondary damage varied between years and was dependent on the amount of bird damage and the maturity of corn at the time of damage. In both studies, the frequency of insect damage increased following simulated bird damage (Table 1).

Because it is difficult to quantify, secondary damage is often ignored in estimates of total loss to corn yields from blackbirds (e.g., Wiens and Dyer 1975). During 1968-76, U.S. Fish and Wildlife personnel did attempt to separate secondary damage from primary bird damage in surveys of 7,237 cornfields in 19 counties in Ohio. The estimated total loss averaged 0.58 percent of the crop of which 0.39 percent was primary bird damage and 0.19 percent was secondary damage (Dolbeer 1980). We do not know how much of this secondary loss was caused by insects but the studies done to date indicate it could be important in some cases.

Possible reduction in insect damage caused by bird feeding activities. -- Although considerable information has been gathered on the agricultural damage caused by blackbirds, few studies have been undertaken to examine beneficial feeding habits. During the nesting season, the estimated 8 million redwings and their nestlings in Ohio probably consume over 12 million lb (5.4 million kg) of insects--an average of almost 300 lb/sq mile (53 kg/sq km) (Dolbeer 1980). Many of these insects, such as weevils (*Hypera* spp.), come from alfalfa fields, pastures, oat fields, and other crop fields (Stone 1973). In maturing cornfields, blackbirds often feed on insects such as earworms (Mott and Stone 1973), and rootworm beetles (W.T. Bridgeland, unpubl. data). In early spring, redwings consume European corn borers (*Pyrausta nubilalis*) while foraging in fields of corn stubble (Fankhauser 1962). Starlings (*Sturnus vulgaris*) also often feed on earworms and other insects in cornfields (Stewart 1973).

Three studies have tried to measure beneficial effects of blackbirds feeding on insects in cornfields. Mott and Stone (1973), although clearly documenting that redwings often fed on earworms in sweet corn fields in Idaho, could not show significant reductions in earworm damage related to the blackbird feeding. Dolbeer and Woronecki (unpubl. Bird Damage Report 122, Denver Wildlife Research Center) also could not detect any significant impact of blackbirds feeding on earworms in sweet corn. W.T. Bridgeland (unpubl. data) in a recent study in New York State concluded that, although redwings commonly fed on rootworm beetles in cornfields, there was little likelihood of this feeding having a depressing effect on the rootworm populations. Thus, no studies, to our knowledge, have demonstrated economically beneficial effects of blackbirds feeding on insects in corn. However, considering the proclivity of the blackbirds to feed on insects and the tendency of blackbirds to concentrate in large numbers, there may be situations where such benefits occur. These possible impacts blackbirds may have feeding on insect pests should be kept in mind in bird-damage control work.

Table 1. Percent of ears with three types of secondary damage following artificial bird damage. Asterisk (*) indicates a significant difference in frequency from undamaged ears (χ^2, $P < 0.05$) (from Woronecki et al. 1979b).

			% of ears with secondary damage				
			Maturity level when ears were artificially damaged				Undamaged ears
Year	No. of kernels artificially damaged	Type of secondary damage	Milk	Dough	Late dough	Total	
1975	0-12	insect	13*	9*	9	9*	4
	18-72		11*	7	6		
1977	0-12		15*	10		13	11
	24-72		15*	10			
1975	0-12	mold	9	6*	6*	7*	11
	18-72		14	4*	1*		
1977	0-12		17*	7*		14*	3
	24-72		25*	7*			
1975	0-12	sprouting	<1	0	0	2*	<1
	18-72		6*	3*	3*		
1977	0-12		5	6		10*	4
	24-72		23*	11*			

EFFECT OF CONTROL METHODS ON INSECT DAMAGE

Mesurol has known insecticidal properties but little information has been gathered on its effect on insects in fields where it is used to control bird damage. There is some evidence (Hermann and Kolbe 1971) that when it is used as a bird repellent to reduce sprout pulling, it may also control certain insects that can reduce seedling survival. In Ohio, growers have reported that Mesurol applications to grapes for reducing bird damage also reduce yellow-jackets (Vespinae) which cause nuisance and possible damage problems in vineyards (W.B. Jackson and Ramona Hayne, pers. comm.). If real, these additional benefits can offset the cost of Mesurol applications for bird control when incorporated into an integrated pest control program.

In 1978, we (Woronecki et al. 1980, unpubl. ms.) found that Mesurol was as effective as Sevin in reducing blackbird damage and in reducing most insect populations in maturing cornfields. However, in sampling earworm populations we found the Mesurol-treated fields had significantly higher percent of ears with earworms and numbers of earworms per ear than did control fields or Sevin-treated fields. We hypothesize that this unexpected response resulted from the reduction of some natural arthropod enemy of earworms, but we have no idea of the actual mechanism. The use of Mesurol on sweet cherries and applies has resulted in increases of certain pest arthropods because of the decline of certain predatory species of mites (S.C. Hoyt, pers. comm.) and perhaps a similar mechanism was operating in the sweet corn fields. We did note that the two groups of predatory arthropods monitored, ladybird beetles (Coccinellidae) and spiders (Arachnida), were adversely affected by both insecticides. Regardless of the causative factor, if Mesurol actually enhances earworm populations or any other pest species, this could negate its usefulness as a bird-damage control chemical in maturing corn or on other crops.

CONCLUSIONS

This report shows that in a number of cases insects may significantly influence bird-damage control programs. Undoubtedly, there are many other situations where similar influences may occur. Obviously, there are many complex relationships and we cannot investigate all ramifications of bird-damage control programs. However, we believe the influence of insects is important enough in certain situations that they must be taken into account. For example, the control of insects at critical times in maturing corn may greatly enhance bird-damage control devices. Alternatively, the indiscriminate use of certain bird-damage control products may enhance populations of other pests. In summary, this report points out the complex interaction among organisms that can occur in agricultural crops and the importance of considering pest control from an integrated view instead of from a single-species basis.

ACKNOWLEDGEMENTS

We wish to thank R.A. Stehn and M.E. Laderach for all their assistance and K.M. Cote, B.F. Dotson, P.C. Kleinhenz, W.G. Maddox, K.L. Marquess, T.G. O'Brien, and D.M. Woods for helping collect and tabulate data.

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