November 1979

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INTRODUCTION

Schafer and Brunton (1971) determined that methiocarb [3,5-dimethyl-4-(methylthio)phenol methylcarbamate] was efficaceous as a bird repellent, reporting low R_{50} and LD_{50} values for several bird species. Guarino (1972) suggested that bird damage to corn, soybeans, rice, sorghum, cherries, and grapes could be reduced by spraying with methiocarb. Crase and DeHaven (1976) concluded that methiocarb could be an effective broad-spectrum bird repellent and crop protectant. Bollengier et al. (1973), Stone et al. (1974), Ali (1978), Teklehaimanot (1978), and Jackson et al. (1978) reported that bird damage to blueberries was significantly lower in methiocarb-treated fields than in the untreated fields. Rogers (1974) describes Mesurol as a conditioning repellent that has post-ingestional effects.

Guarino (1972) reported that house finches *(Carpodacus mexicanus),* and starlings *(Sturnus vulgarus)* constituted 51.5% and 28.8%, respectively, of the birds observed in grape fields in California. In New Hampshire, robins *(Turdus migratorius),* primarily, and starlings, catbirds, *(Dumetella carolinensis),* and scarlet tanagers *(Piranga olivacea)* fed heavily on grapes (Guarino 1972). The birds damaged the upper, exposed clusters more than those on lower, covered branches.

Crase et al. (1976) estimated the amount of bird damage to grapes in the U.S.A. at $4.4 million. Peck damage was reported higher than pluck damage. Larger birds, such as starlings and robins, were observed taking the whole berry, while smaller birds (finches, sparrows, and bluebirds) were pecking holes in the individual berry (Crase et al., 1976). Crase (1975), while reporting a high ratio of pecked to plucked fruit in treated fields, observed a higher proportion of plucked in the untreated area; house sparrows *(Passer-domesticus) were* the most prevalent species. He suggested that birds may be first pecking, and, if no effect is detected, they would take the whole grape.

Previous observations in California had indicated Mesurol treatments to vineyards were efficaceous (Crase 1975, 1976; Crase et al. 1976). Bailey and Smith (1979) obtained twice the yield on vines protected from blackbirds *(Turdus merula)* and silvereyes *(Zosterops lateralis)* in South Australia with this compound. While failures have been reported in protecting cherries (Stickley and Ingram 1973) and blueberries (Dolbeer et al. 1973), their experimental designs may have been deficient.

The objective of the present study was to evaluate methiocarb bird repellency in five selected grape fields in Ohio. The methiocarb formulation used was 75% wettable powder (WP), which is registered as Mesurol. These experiments were conducted under an experimental use permit (#3125-EUP-140). Additional details are found in Kassa and Jackson (1978).

METHODS AND MATERIALS

Experimental areas.

Initially a survey of the major vineyards along the southern shore of Lake Erie in Erie and Ottawa counties was conducted. Several parameters, including past history of bird damage, size of the vineyard, maturity pattern, location, and visual inspections of the vineyard, were considered in selecting the test fields. Five vineyards, devoted to wine grapes were chosen from four areas (Table 1).

Experimental design.

Each vineyard was divided into treatment and reference units that were adjacent but not necessarily of equal size. The plot divisions were made by considering

environmental factors (e.g., woods, fences), so that both units would be equally affected by birds. Four rows between the experimental and control units served as a buffer zone.

In each unit, 50 vines were selected, such that the vines were randomly distributed over the whole area of the unit. No vines were selected from the buffer zone. Five grape clusters on each vine were randomly chosen by following the procedures described by DeHaven and Hothem (1979). Numbered spring-clothespins were attached carefully to the base of the peduncle of each selected grape cluster. A total of 500 numbered clothespins, 250 for each unit, was used at each site.

Spray applications.

One application level of methiocarb (75% wettable powder) was used (2.5 lbs. ai/100 gal water/acre). A second application was made in two units in Sandusky. All treatments were made by the grower, using an air-blast, tractor-pulled sprayer (Table 1).

The first treatments were made when depredating birds were observed entering and leaving the vineyard. The second spray was made 15 days after the first application and following the first damage sampling.

Bird damage evaluation.

The first damage evaluations were made about two weeks after the initial application of methiocarb. In Sandusky, the second damage samplings were conducted a day or two before harvest. The total number of grapes damaged (pecked and/or lost) from each cluster was determined by actual count. Statistical comparisons used the t-test and ANOVA.

In one variety of grape (Delaware) yellow jacket damage was evaluated by following the same procedure. In this vineyard wasp damage was extensive and quite distinct from the bird depredations (all pluck berries) seen elsewhere in the same vineyard but on another variety.

Bird Census.

A bird census at each site was made within three hours of sunrise once a week before treatment and at least twice a week after treatment until the day of harvest. Counts of birds feeding, entering, and leaving, were made from two stations, one on each side of the buffer zone at 10-minute intervals (5 minutes for each unit) for a total of 20 minutes. Since no attempts were made to flush birds from the vineyards, the counts do not represent the entire bird population that might have been in the fields at the time.

RESULT AND DISCUSSION

Seventeen bird species were observed entering and/or leaving vineyards. During the pre-treatment census fewer birds were noted. Random sampling of the fields during this pre-treatment census period (first two weeks of August) showed no bird damage. At this time the berries are green in color, taste very sour, and are hard. Stevenson and Virgo (1971) and Boudreau (1972) suggested that the sugar content was very important in influencing bird damage, but no data were collected on this relationship.

Birds flying over the plots were not considered an index to Mesurol efficacy. While some of these birds may have been approaching the site to feed, many were merely transgressors of the air space. Many of the depredating birds, especially if local residents, approached from peripheral woods, orchards, or fence rows.

Robins were the major depredating species at Sandusky, Catawba, and Vermillion, while starlings and red-winged blackbirds *(Agelaius phoeniceus)* were the species most encountered on North Bass Island. House finches, robins, house sparrows, and starlings were assumed to be the major grape-depredating species by Crase et al. (1976). House finches are not present in Ohio. Occasionally house sparrows were seen entering or leaving grape fields, but usually they perched on closeby trees, electric wires, tops of buildings, and on the grounds. On South Bass Island, they were said to damage grapes adjacent to farm sheds. Flocks of blackbirds, mostly grackles *(Quiscalus quiscula)* and redwings, were observed in Vermillion entering nearby corn fields by the thousands.

Mesurol-treated fields received less damage than reference plots ($P<05$) (Table 1). The numbers of birds observed in the reference plots also were higher than in the treated plots (Figure 1; Table 2).

Small berries (Baco #1, Seibel 10878, Delaware, Beta) had a higher ratio of pluck to peck damage than larger berries (Catawba) that were more frequently pecked (Table 3).

The upper exposed branches also had higher damage than the lower protected branches (Table 4). This suggests that the type of damage depends on the berry size, degree of exposure, and depredating species. DeHaven (1974) suggested that large birds, such as robins and starlings, take the whole berry, while small birds (house finches and house sparrows) puncture the berries. On occasions we observed a starling flying away with a whole berry in its beak. However, we were not able to make extensive observations of the feeding behavior of the different species involved, due to the difficulty in watching feeding birds from a distance. However, it was evident from watching the many robins leaving the vineyard and noting the bare stems afterwards that the birds were plucking the fruit, filling their crops, and leaving.

SUMMARY

Mesurol applied to grapes (2.5 lbs/100 gal water/A) provided significant protection from depredating song birds, particularly robins, starlings, and red-winged blackbirds. Even in an early-ripening, and thus highly-vulnerable variety, losses were more than halved. In other varieties, percentage losses in untreated units were more than eight times those in corresponding treated units.

Most of the observed depredations resulted from removal of the whole grape, especially by robins. In a later-maturing variety with larger berries, puncture damage by blackbirds and starlings was greater than loss by removal. Protection was afforded by the Mesurol treatment regardless of the feeding mode.

No adverse effects were observed either to target or non-target species. Lack of avian mortality also was observed by Bailey and Smith (1979).

ACKNOWLEDGEMENTS

We appreciated the field assistance of Ramona P. Hayne, Technical Service Representative, and the financial support from Mobay Chemical Corporation. Vineyard managers, Don Mantey, Dale Burris, Jim Stevens, and Mr. Novoteny, were most helpful in accommodating our needs.

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DISCUSSION

Q: Did you know what bird species caused the pluck versus the peck?

A: We did not observe the birds that did the damage, but most is done by the starlings, robins, and blackbirds.

Q: On Catawba, where you had the large percentage of damage, did your bird activity counts indicate the species that were active there?

A: In Catawba, also, we observed starlings, but robins were the primary species causing damage.

Q: When were the applications made?

A: The first application was made in August by the farmers. The initial application was made when the grapes started to color and birds were seen in the field. They made the second treatment after we assessed the damage. The last damage assessment was made three days before harvesting.

Q: Two applications?

A: Yes, in most cases.

Table 1. Plots of wine variety grapes utilized in Mesurol (2.5 lbs/A) treatments and resulting losses to birds.

Location	Variety	Acreage	Bird Damage Suscep-tibility[1]	Reference Plots[2] No. Grapes	Reference Plots[2] % Loss	Treated Plots[2] No. Grapes	Treated Plots[2] % Loss
Sandusky	Baco #1	1.3	High	19617	2.8	22719	1.0
Sandusky	Seibel 10878	1.8	High	14026	7.2	14550	0.4
Vermillion	Beta	1.0	Medium	9677	5.5	10423	5.6
Catawba	Delaware	1.0	Medium	10776	2.7(2.5)[3]	15344	0.3(0.2)[3]
N. Bass Island	Catawba[4]	5.0	Medium	8530	14.5	9420	1.7

[1]rating based on experience of vineyard operators
[2]all differences between treated and control fields were statistically significant ($P<0.05$)
[3]additional damage from yellow jackets
[4]late season maturation

Table 2. Summary of birds seen entering or leaving vineyard plots during 20-minute morning observation.

Variety	Principal Species	Pre-treatment[1] Reference	Pre-treatment[1] Treated	Post-treatment[2] Reference	Post-treatment[2] Treated
Baco #1	Robin, Starling	9	6	31	69
Seibel 10878	Robin, Starling	4	2	80	120
Catawba	Red-winged Blackbird, Starling, Robin	232	270	4565	240
Delaware	Robin	23	13	42	35

[1]involved 1-3 days
[2]involved 6-10 days

Table 3. Proportion of bird damage from pecking and plucking (total removal) of grapes.

Variety	No. Damaged Berries	Pecked (%)	Plucked (%)
Baco #1	567	4.6	95.4
Seibel	1010	6.4	93.6
Delaware	281	6.0	94.0
Beta	537	16.0	84.0
Catawba*	1249	56.0	44.0

* Large size

Table 4. Bird damage to grapes in non-treated plots relative to position.

Variety	Branch Position: Upper			Lower		
	No. Clusters	No. Berries	% Damaged	No. Clusters	No. Berries	% Damaged
Baco #1	155	12542	3.6	95	7075	1.6
Seibel 10878	156	8491	9.9	95	5335	5.0

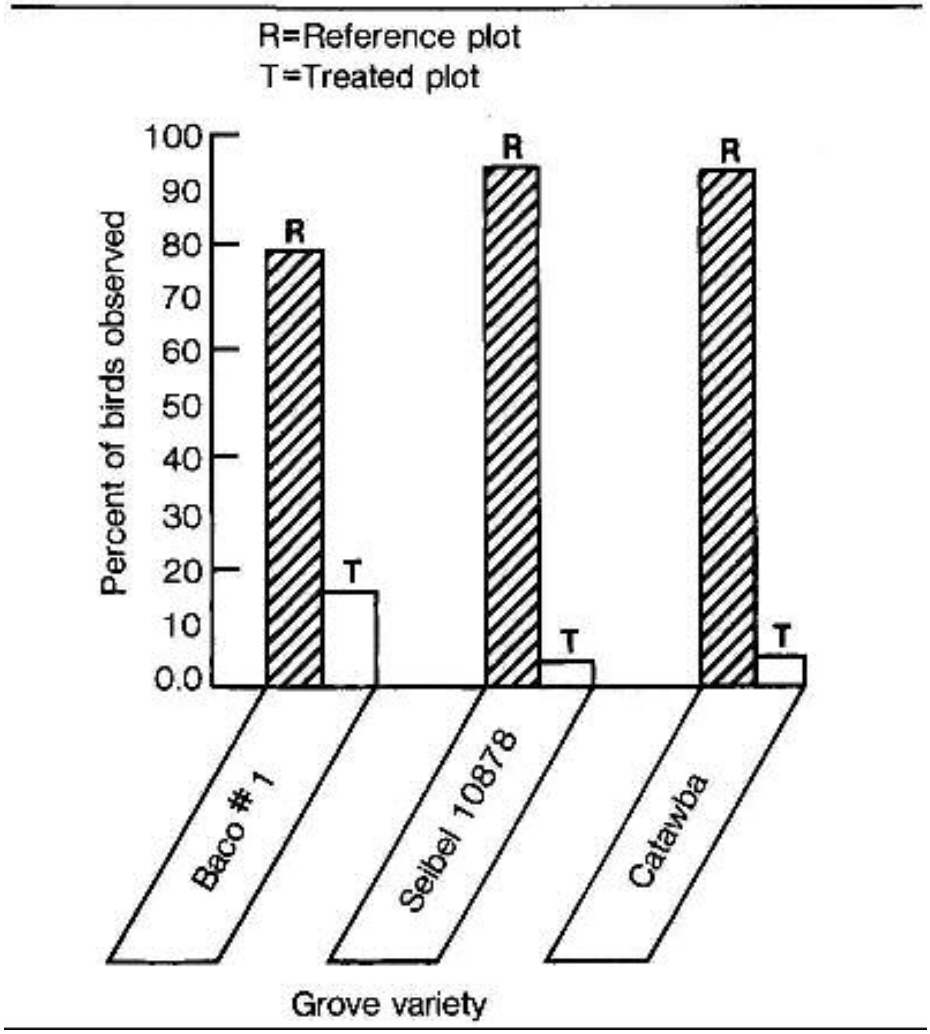

Fig 1. Relative number of birds seen entering and leaving the reference and test vineyard plots following treatment with mesurol.