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Ripening blueberries are subject to serious damage by a variety of bird species. Through a questionnaire survey, Pearson (1958) calculated that losses of highbush blueberries to birds in Massachusetts averaged about $38,000 a year in 1955-57. From a 1972 questionnaire on bird damage to highbush blueberries directed to individuals in 14 states, Mott and Stone (1973) estimated that birds damaged at least 5% of the crop, representing a minimum nationwide loss of about $1.6 million.

Most species of birds that feed on blueberries are not only desirable but also protected under the Migratory Bird Treaties Act. Any means of reducing this damage must therefore be nonlethal. Since the experimental insecticide, methiocarb [4-methylthio)-3,5-xylyl N-methylcarbamate], has recently proved to be an effective, nonlethal repellent for protecting cherries and grapes from damage by birds (Guarino, 1972; Guarino, *et al.,* 1974), initial trials were conducted to determine if methiocarb would protect wild, lowbush blueberries (*vaccinium angustifolium*) from bird damage.

## *Procedures*

*Test sites.* Tests were conducted on 2-year-old wild, lowbush blueberries from July 17 to August 16, 1972, at three sites near Laconia, New Hampshire, which were made available by local growers. Site 1 consisted of about 8 treated and 8 untreated acres on Mt. Rowe, near Gilford; Site 2 consisted of 3 treated and 3 untreated acres on Belknap Mt., near Gilford; and Site 3 consisted of 0.5 treated and 0.5 untreated acre on Teneriffe Mt., near Milton. The treated and untreated plots at each site were separated by 150 to 250 yards of mixed hardwood and conifer woodland.

*Treatment.* The blueberries in the three treatment plots were aerially sprayed on July 18 with a water formulation containing 4.8% of a methiocarb preparation (Mesurol[1] 75% wettable powder) and 0.8% of an adhesive (Dow Latex 512R). This formulation was applied in 60-foot swaths, at a rate of 3 1b. active methiocarb in 10 gal. of water per acre, with a Bell G-5 (bubble-type) helicopter flying about 40 mph at a height of 60 feet. The spray system used was a Bell-Ag-master with 60 nozzles. Site 1 was treated at 8:45 AM and required six passes for complete coverage. Sit 2 was treated at 8:15 AM with five passes, and Site 3 at 9:30 AM with two passes. The weather was clear and the wind speed less than 2 mph during application.

Filter paper indicator discs (7-inch diameter) and cellulose thin-layer chromatographic sheets (8 inches square) were used to detect the amount and distribution of methiocarb. Nine discs and nine sheets were randomly placed side-by-side at plant height in the plots chosen for treatment in Sites 1 and 2 before spraying, collected immediately after spraying, and analyzed later at the Denver Wildlife Research Center. The discs were analyzed by a thin-layer chromatographic method developed by Cunningham and Starr (1973) to determine the amount of methiocarb deposited. To determine the size and distribution of the spray droplets, the sheets were examined under ultraviolet (UV) light.

*Damage Evaluation.* The effectiveness of the treatment was determined by calculating differences in bird damage in treated and untreated plots. Sample plants were marked along a line transect in each plot. The transects at Sites 1, 2, and 3 were 400, 300, and 200 feet long, respectively. On July 17, 40 plants were randomly selected in the treated and untreated plots at Site 1, 50 plants each at Site 2, and 25 plants each at Site 3. Each plant was marked and thinned to a total of 10 berries. About 2 weeks after spraying and again about 1 month later, the number of berries remaining on each plant was counted, the number of green berries (which were assumed not susceptible to bird damage) was subtracted from the initial total of 10, and the resulting difference (number of susceptible berries) was compared with the number of ripe, undamaged berries remaining.

*Bird Population.* The number and species of birds that visited all plots were recorded during a total of 26 1-hr. observation periods from July 17 to August 16. Observations were made throughout the morning and afternoon, although slightly more were made in the morning. Two 1-hr. counts were made in each plot during the first week of the test (July 17-26), with the exception of the treated plot in Site 1 in which four counts were made; one count was made in each plot during the third week (August 1-8); and one the end of the fourth week (August 15-16). Counts were conducted in each plot along a permanent line transect containing fixed points that provided cover for an observer. While the observer was at these points, he identified and counted birds as they left the plot. He also made flush counts when he moved between the points, to more readily detect birds of secretive species; we felt that these flush counts did not affect the fixed-point counts. Both types of counts were included in the total tally of birds for each 1-hr. observation period, and special effort was made to identify any species seen eating berries.

## *Results and Discussion*

Differences in damage between treated and untreated plots at the three sites were evident in both evaluations. Untreated plots were consistently damaged at least 1.5 times more than treated plots (Table 1). In the first evaluation, about 2 weeks after treatment, loss of blueberries to birds averaged 33.4% in the untreated plots and 16.8% in the treated, a 49.7% reduction in damage. In the second evaluation, about 1 month after treatment, damage was 54.5% on untreated plots and 34.8% on treated, a 36.2% reduction in damage.

Destruction of some of the sample plants by deer, raccoons, and man resulted in unequal numbers of samples between treated and untreated plots. Therefore, treatment, block, and interaction effects were analyzed by Bancroft's (1968:35) method of unweighted means. For the first evaluation, the difference in damage was significant (P < 0.025) between treated and untreated plots and highly significant (P < 0.005) among sites. For the second evaluation, the difference in damage was highly significant (P < 0.005), both between treated and untreated plots and among sites. Interaction effects were insignificant in both evaluations.

As blueberries ripen, some drop off the plant naturally, and the assumption that all missing berries were taken by birds could have caused inaccurate estimates of damage, particularly in the 1-month evaluation. We attempted to determine natural berry drop by randomly placing small cheesecloth bags with drawstrings over 10 plants in both plots in Sites 1 and 2. However, this proved unreliable because the handler knocked off some berries when bagging and particularly when collecting the samples. If natural drop represented an appreciable portion of the missing berries, we have underestimated the protection (percentage damage reduction) afforded by the treatment.

Altogether, 27 species of birds visited the test plots during scheduled observation periods; 12 were observed eating berries (Table 2). Robins (*Turdus migratorius*) and Starlings (*Sturnus vularis*) were the most frequently observed species, accounting for over one-half of all visits, and 87% and 100% of their visits were recorded in the untreated plots. There were 31 times more visits per hour in untreated than in treated plots by Cedar Waxwings (*Bombycilla cedrorum*), 11 times more by Blue Jays (*Cyanocitta cristata*), 8 times more by Catbirds (*Dumetella carolinensis*), 6 times more by Brown Thrashers (*Toxostoma rufum*), 5 times more by Song Sparrows (*Melospiza melodia*), 3 times more by Scarlet Tanagers (*Piranga olivaces*), and about 2 times more by Field Sparrows (S*pizella pusilla*) and Eastern Bluebirds (*Sialia sialis*). Rufous-sided Townees (P*ipilo erythrophthalmus*) and Black-capped Chickadees (*Parus atricapillus*) were the only two species recorded more frequently in treated than in untreated plots, but the difference was slight. During a nonobservation period, a flock of about 50 Bobolinks (*Dolichonyx oxyzivorus*) was seen feeding on blueberries in the untreated plot at Site 2.

Inspection of the thin-layer chromatographic sheets under UV light showed the aerial spraying had resulted in a fairly even distribution of methiocarb throughout the two plots monitored. However, an analysis of the filter paper discs showed that only about 1.4 lb. of the 3 lb. methiocarb per acre disseminated by the helicopter reached the level of the plants. Furthermore, a total of 4.7 inches of rain fell on the sites during the test, 3-4 inches within the first 2 weeks after treatment. Because of these factors, the considerable reduction in damage achieved and the low numbers of birds recorded in treated plots suggest that methiocarb, even at low levels, is a promising means of protecting lowbush blueberries from birds.

In any further tests requiring helicopter application of methiocarb to crops, the loss of spray, apparently by dissipation in the air, should be considered. For spray equipment and weather conditions like those in these tests, it appears that the application rate should be approximately double the desired on the plants.

*Table 1.* Loss of lowbush blueberries to birds at three New Hampshire test sites; treated plots sprayed with methiocarb on July 18, 1972. (U = Untreated plots, T = Treated plots)

| Sites | Damage evaluation | Total number of ripe berries evaluated[a] U | T | Percent loss U | T | Percent reduction in damage |
|---|---|---|---|---|---|---|
| 1 | 1st (August 4) | 302 | 290 | 33.1 | 12.8 | 61.3 |
| | 2nd (August 16) | 355 | 314 | 43.1 | 20.1 | 53.7 |
| 2 | 1st (August 2) | 410 | 374 | 29.8 | 13.6 | 54.4 |
| | 2nd (August 15) | 401 | 417 | 42.4 | 28.5 | 32.8 |
| 3 | 1st (August 1) | 242 | 226 | 37.2 | 23.9 | 35.8 |
| | 2nd (August 16) | 249 | 210 | 77.9 | 55.7 | 28.5 |
| Mean | 1st | | | 33.4 | 16.8 | 49.7 |
| | 2nd | | | 54.5 | 34.8 | 36.2 |

[a] Green berries excluded because they were not susceptible to bird damage.

*Table 2.* Birds visiting lowbush blueberries at three New Hampshire test sites; average hourly counts of species seen eating berries, July 17 to August 16, 1972. (U = Untreated plots, T = Treated plots)

| Species | Sites 1 U | 1 T | 2 U | 2 T | 3 U | 3 T | Total U | Total T |
|---|---|---|---|---|---|---|---|---|
| Robin | 5.5 | 2.7 | 2.3 | 1.0 | 30.0 | 2.0 | 12.6 | 1.9 |
| Starling | 37.5 | 0.0 | 0.5 | 0.0 | 0.0 | 0.0 | 12.7 | 0.0 |
| Rufous-sided towhee | 3.0 | 0.0 | 2.0 | 1.8 | 1.0 | 1.3 | 2.0 | 2.3 |
| Blue jay | 0.3 | 0.8 | 4.3 | 0.0 | 6.0 | 0.0 | 3.5 | 0.3 |
| Cedar waxwing | 1.0 | 0.0 | 0.0 | 0.3 | 8.3 | 0.0 | 3.1 | 0.1 |
| Field sparrow | 1.0 | 2.8 | 4.0 | 0.0 | 0.3 | 0.5 | 1.8 | 1.0 |
| Song sparrow | 0.5 | 0.0 | 5.3 | 1.3 | 0.8 | 0.0 | 2.2 | 0.4 |
| Eastern bluebird | 1.0 | 0.0 | 0.0 | 0.0 | 4.3 | 0.0 | 1.8 | 0.0 |
| Catbird | 0.0 | 0.2 | 0.3 | 0.0 | 2.0 | 0.0 | 0.8 | 0.1 |
| Brown thrasher | 1.8 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 | 0.1 |
| Scarlet tanager | 0.0 | 0.0 | 0.0 | 0.0 | 0.8 | 0.3 | 0.3 | 0.1 |
| Black-capped chickadee | 0.3 | 0.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 |
| Total | 51.9 | 10.9 | 18.7 | 4.4 | 53.5 | 4.1 | 41.5 | 6.5 |

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[1] Chemagro Division of Baychem Corporation. Reference to trade names does not imply endorsement of commercial products by the U.S. Government.

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