February 1982

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ABSTRACT: Red-winged blackbirds (Agelaius phoeniceus) were offered a choice between cultivated wild rice (Zizania aquatica) treated with methiocarb and untreated wild rice. Unhulled wild rice soaked in methiocarb solution was highly effective in repelling blackbirds at residue levels <132 ppm. The responses of blackbirds to methiocarb residues <132 ppm on soaked rice were variable. Most of the blackbirds conditioned to avoid treated rice at 132 ppm of methiocarb were subsequently repelled by treated rice with residues as low as 30 ppm.

INTRODUCTION

Granivorous blackbird populations have a serious economic impact upon grain crops in many regions of the United States (DeHaven 1971, Dyer 1975, Meanley 1971, Stone and Mott 1973, Stone et al. 1972), and have been steadily increasing in numbers and extending their wintering ranges during this century (Graber and Graber 1963:490). Consequently, blackbird damage to crops has resulted in intensive control efforts in many areas of the United States (Crase and DeHaven 1976, Guarino 1972, Weins and Dyer 1975).

Recent research has emphasized the development of chemical repellents for controlling bird damage (Schafer and Brunton 1971). One promising candidate repellent, methiocarb [3, 5-dimethyl-4-(methylthio) phenol methylcarbamate] (Mesurol, a product of Mobay Chemical Corp.), causes illness-induced, conditioned aversion in blackbirds (Rogers 1974, 1978).

The purpose of this study is to evaluate the effectiveness of methiocarb-soaked wild rice in repelling caged Red-winged blackbirds. The methiocarb residue levels used in this study simulated the levels attained by aerial spraying during field trials that attempted to evaluate the efficacy of methiocarb in repelling blackbirds from cultivated wild rice paddies in Minnesota (Moulton 1979).

METHODS AND MATERIALS

Wild, second-year, male Red-winged blackbirds were individually caged indoors and randomly assigned to treatment conditions based on the methiocarb-soaked rice that was presented to the birds. The birds were acclimated to the experimental conditions and diet for 2 to 3 days before they were tested. Each bird was presented with a dual-choice feeding test of dried, unhulled wild rice that had been soaked for 1 min in either 0.1, 0.05, 0.025, or 0.0125 percent solutions by weight of methiocarb, along with untreated rice. In addition to the treated and untreated rice, each bird was presented water ad lib. One experiment tested birds that had not previously been exposed to methiocarb. The test involved 5 birds at each of 3 treatment levels of methiocarb, 0.1, 0.05, and 0.025 percent, and was run for 4 days. A second experiment tested birds that had previously been conditioned to avoid methiocarb-treated (0.1 percent) rice. That test involved 5 birds at each of 2 treatment levels, 0.025 and 0.0125 percent, and was run for 3 days. The locations of the treated and untreated rice dishes were exchanged in each cage at the start of each 24-h period to counteract the tendency of some birds to feed primarily in one corner of their cages.

Birds that showed no aversion to treated wild rice would be expected to consume 50 percent treated and 50 percent untreated rice (Moulton 1979:749-750). In this study, the term repelled is defined as a statistically significant deviation from the expected 50 percent consumption of treated rice. The results (proportions) were transformed, using the arcsine transformation (Snedecor and Cochran 1967:327) to help meet the assumption of homogeneous variances, and tested by contrasting the mean daily proportion $(\sum \hat{p})/n$, of untreated rice eaten by all 5 birds at each treatment level with the expected 50 percent consumption [$H_0 : (\sum \hat{p})/n = 0.5$]. Some result-guided contrasts of individuals or groups within treatment levels were made when reasonable. Samples of treated and untreated rice were analyzed for methiocarb residue (in parts per million) by thin-layer chromatography at the Denver Wildlife Research Center.

RESULTS

The mean weight of the dried wild rice consumed per bird per day for all the trials was 10.5 g (SE = 2.87 g). The blackbirds did not ingest the wild rice hulls (treated or untreated). The birds ate the dried wild rice by taking the unhulled grain in the bill and cracking it into small pieces, simultaneously breaking open the hull. The pieces of grain dropped out of the hull into the bird's bill, and the entire hull was discarded.

The results of the tests with birds previously unexposed to methiocarb are given in Fig. 1. The amount of untreated rice eaten by the 5 birds at the 0.1 percent level (~ 132 ppm of methiocarb on treated rice) was 89.3 percent [$\sum \hat{p}/20 = 0.893$] of their total consumption, a highly significant

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departure from the expected 50 percent (t = 11.8, 12df , P < 0.001). All 5 birds were strongly repelled. The amount of untreated rice eaten by the 5 birds at the 0.05 percent level (~113 ppm) was 72.8 percent [$(\sum \hat{p})/20 = 0.728$] of their total consumption, also a highly significant departure from 50 percent (t = 5.95, 12df, P < 0.001). Three of the birds were strongly repelled, but 2 were not significantly repelled t = 0.9, 12df, P > 0.2). The amount of untreated rice eaten by the 5 birds at the 0.025 percent level (~ 108 ppm) was 64.8 percent [$(\sum \hat{p})/20 = 0.648$] of their total consumption. This was also a significant departure from 50 percent (t = 2.64, 12df , P < 0.025); however, only 2 of the birds were actually significantly repelled (t = 4.5, 12df. P < 0.001). The other 3 birds were not significantly repelled (t = 0.3, 12df, P > 0.5). The data for the 3 unrepelled birds indicated that they had all eaten primarily in 1 corner of their cages, whether they were eating treated or untreated rice. This resulted in the pronounced up and down effect of the graph for the group at the 0.025 percent level (Fig. 1, C).

All 10 of the birds from the 0.05 and 0.025 percent treatment levels subsequently were exposed to the 0.1 percent level for 2 days before being randomly assigned to a treatment in the second experiment. All but 1 of these birds were strongly repelled by the treated rice. The unrepelled bird apparently suffered adverse physiological consequences from ingesting treated rice, as evidenced by the decline in this bird's total daily rice consumption from Day 1 (11.22 g) to Day 2 (3.94 g).

The results of the tests with birds previously conditioned to avoid methiocarb-treated (0.1 percent) rice are given in Fig. 2. The 5 birds at the 0.025 percent level consumed 93.7 percent [$(\sum \hat{p})/15=0.937$]

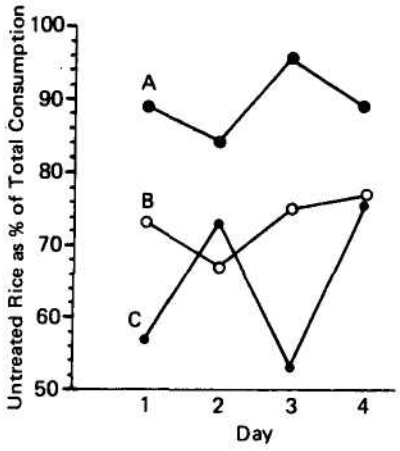

Fig. 1. Results of feeding trials with caged Red-winged blackbirds (5 birds per level) previously unexposed to methiocarb. The values depicted represent the percentage of the total daily wild rice consumption (treated and untreated) that was untreated. A = 0.1 percent (132 ppm) level; B = 0.05 percent (113 ppm) level; C = 0.025 percent (108 ppm) level.

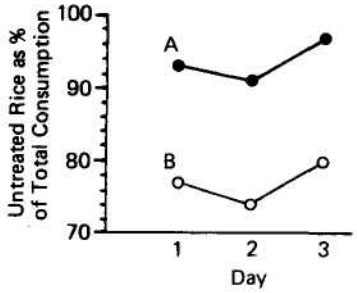

Fig. 2. Results of feeding trials with caged Red-winged blackbirds (5 birds per level) previously conditioned to avoid methiocarb-treated (0.1 percent) wild rice. The values depicted represent the percentage of the total daily wild rice consumption (treated and untreated) "that was untreated. A = 0.025 percent (108 ppm) level; B = 0.0125 percent (30 ppm) level.

untreated rice, a highly significant departure from 50 percent (t = 11.7, 8 df, P < 0.001). All 5 birds were strongly repelled. The 5 birds at the 0.0125 percent level (~30 ppm) consumed 76.9 percent [$(\sum \hat{p})/15 = 0.769$] untreated rice, also a highly significant departure from 50 percent (t = 3.6, 8df, p < 0.01). Only 1 bird was not significantly repelled (t = 0.27, 8df, P > 0.5).

DISCUSSION

Red-winged blackbirds do not ingest the hull that completely encloses the wild rice grain. Methiocarb residues on ripening wild rice are primarily on the hulls, since the chemical does not appear to penetrate to the grain (Moulton 1979). In methiocarb-feeding studies where hulled grain was treated (Schafer and Brunton 1971), or where methiocarb was mixed into the diets (Rogers 1974, 1978), blackbirds necessarily ingested large doses of methiocarb when they consumed the treated diets. The present study represents a more realistic model for ripening wild rice and possibly for some other small grains, many of which are completely (e.g., oats and barley) or almost completely (e.g., white rice, wheat, rye) covered by hulls.

This study showed that blackbirds that did not have prior experience with methiocarb were strongly repelled by unhulled wild rice that had gross methiocarb residues >132 ppm. At the lower treatment levels (<113 ppm), some of the birds were strongly repelled and others were not repelled at all. Those birds that were not repelled did not seem to be intoxicated and consumed normal amounts of wild rice. Therefore, it is possible that the repellent effect at the lower treatment levels was due to simple

taste aversions in some birds, as suggested by Rogers (1974). Red-winged blackbirds appear to vary in their susceptibility to the toxic effects of, and perhaps their ability to detect, methiocarb.

The experiments with blackbirds previously conditioned to avoid methiocarb showed that at least some blackbirds can detect methiocarb on wild rice at levels of 30 ppm or less. Blackbirds that have developed conditioned aversions to methiocarb subsequently avoid the chemical, even at very low levels. This is important because methiocarb breaks down rapidly and would have to be applied to ripening wild rice (and other grains) at least twice before harvest (Moulton 1979). If the initial application effectively repelled blackbirds, a lower level of methiocarb might be adequate for subsequent applications, thereby reducing costs and possible environmental contamination. However, field trials with methiocarb on wild rice (Moulton 1979) showed that aerial application did not provide effective protection.

SUMMARY

Methiocarb was effective in repelling caged Red-winged blackbirds from wild rice that had been soaked in solutions that resulted in residue levels of 132 ppm or more on the unhulled grain. The effectiveness of residue levels of less than 132 ppm varied from bird to bird. Most of the blackbirds that developed conditioned aversions to treated rice with residues of 132 ppm or more were also effectively repelled by treated rice with residues as low as 30 ppm. In the field, methiocarb on wild rice was not effective in repelling blackbirds because aerial application did not provide adequate coverage of the grain (Moulton 1979).

ACKNOWLEDGMENTS

Financial support was provided by the C.K. Blandin Foundation and Wild Rice Growers' Association, Inc. The author thanks J.F. Besser and D.J. Cunningham (Denver Wildlife Research Center) for methiocarb residue analyses; R.S. Wetzel (U.S. Fish and Wildlife Service) for providing blackbirds; R.E. Stucker (University of Minnesota) for statistical consultation; and M.W. Weller (University of Minnesota) for reviewing the paper. This is Paper No. 10, 343, Scientific Journal Series, University of Minnesota Agricultural Experiment Station, St. Paul, MN 55108.

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