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RESPONSES OF BLACKBIRDS TO MATURE WILD RICE TREATED WITH FLIGHT CONTROL BIRD REPELLENT

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ABSTRACT: Red-winged blackbirds (*Agelaius phoeniceus*) and other granivorous species cause substantial economic damage to wild rice in California. Currently available damage control techniques have only limited effectiveness and there is considerable need for new effective techniques. We conducted a field trial in northern California to determine the effectiveness of the bird repellent, Flight Control™ (50% anthraquinone), applied at rates of 18.6 and 55.8 L/ha, in reducing blackbird depredations to wild rice. We detected no effect of the treatments on blackbird behavior in the field, even though captive red-winged blackbirds were deterred in feeding trials with wild rice seeds collected from our study plot. We suggest several possible reasons for this: 1) blackbirds used wild rice for cover as well as a food source; 2) birds perhaps received insufficient exposure to the repellent owing to either the birds' ability to hull the seeds rapidly, low anthraquinone residues on the seeds, and/or non-uniform coverage of seed heads; 3) although Flight Control™ is a feeding deterrent, an aversive response might require repeated exposure to treated rice; and 4) frequent turnover in the depredating population would result in birds not being present long enough to acquire an avoidance response. Clearly, a better understanding of blackbird movements and behavior in wild rice is needed to develop an effective management strategy.

KEY WORDS: *Agelaius phoeniceus*, anthraquinone, bird repellent, blackbird, crop damage, Flight Control, wild rice

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INTRODUCTION

Red-winged blackbirds (*Agelaius phoeniceus*) and related species cause millions of dollars of damage to newly planted and ripening rice annually in southeastern United States (Wilson et al. 1989; Decker et al. 1990). Blackbirds also damage wild rice, a valuable crop and one that has rapidly increased in acreage in northern California (Gorenzel et al. 1986; Marcum and Gorenzel 1994). Wild rice producers have expressed dissatisfaction with currently available damage control methods and there is considerable need for new, effective techniques.

Blackbirds, due to their numbers and extended presence during the wild rice growing season, are considered by growers to be the primary vertebrate pests of wild rice. Blackbirds consume seed during the milk, dough, and mature stages of wild rice growth. They also use wild rice crops for loafing and escape cover, as nighttime roosts, and for nest sites. Further damage results from bird movements within the crop that causes seed heads in the mature stage to shatter. Estimated losses range from $121 to $309/ha (Marcum and Gorenzel 1994). Control currently relies upon the use of frightening techniques (shotguns, propane cannons, etc.) which have only limited effectiveness (Marcum and Gorenzel 1994).

One candidate compound that holds promise as a blackbird repellent is Flight Control™, a product developed by Environmental Biocontrol International, Wilmington, Delaware. This product contains 50% anthraquinone as the active ingredient. Anthraquinone for many years has been recognized as an avian feeding deterrent. In laboratory studies, birds feeding on anthraquinone-treated rice display signs of illness and learn to avoid the treated rice (Avery et al. 1997). Field trials in newly planted Louisiana rice fields corroborated the repellency of anthraquinone as an effective seed treatment for blackbird control (Avery et al. 1998). Additionally, in field trials conducted in Louisiana during October 1997 and 1998, Flight Control™ discouraged bird use of 4 ha rice plots for several days (M. L. Avery, unpubl. data). In this study, we applied Flight Control™ to mature wild rice in northern California to: 1) document bird responses; 2) determine the potential for reducing yield losses due to blackbirds; and 3) measure residues on wild rice seeds.

METHODS

Study Plots

The study took place at Goose Valley Ranch, in eastern Shasta County, north of Burney, California. The 2630 ha cattle ranch comprises 490 ha of wild rice, irrigated pasture, and 100 ha of peppermint. On the eastern side of the ranch, we established two sites each comprising two plots, within adjoining 36 ha wild rice (variety K2) fields. The treated plot at the south site measured 37 x 90 m (0.33 ha) and the control plot was 37 x 110 m (0.4 ha). The plots at the north site each were 31 x 130 m (0.4 ha). At each site, the two study plots were separated by a 30 m buffer zone. The two pairs of study plots were 0.8 km apart.

On 9 September, we marked the corners of the plots, and then the rice around the plots was harvested following normal harvesting procedures. This ensured that the study plots would receive bird pressure and that the repellent application spray did not contaminate other rice and render it unmarketable.

Repellent Application

Flight Control™ was aerially applied to one plot at each site between 0800 h and 0830 h on 11 September. The application rate was 18.6 L/ha. We mixed 15 L of Flight Control™ with 355 ml of sticker (Bond, Loveland Industries, Greeley, CO) and diluted with water to a total volume of 303 L including rinsate from the mixing barrel. The applicator delivered 151 L to each plot. There was minimal drift as the wind blew slightly from the north. On 16 September, we applied an additional 15 L of Flight Control™ to the treated plot of the north site. The total application volume was 151 L. There was no wind and negligible drift. The application occurred at 1115 h.

Flight Control™ was applied under Research Authorization #803048 issued by the California Department of Pesticide Regulation. The treated crop was destroyed at the end of the study.

Residues

To determine the amount of anthraquinone delivered to the seed heads, we collected five panicles from each of eight randomly located points within each of the treated plots, 2 h after application of Flight Control™. We clipped the seed heads directly into paper bags that we then labeled and refrigerated (40°F). To examine changes in anthraquinone residue over time, we collected samples prior to treatment, and 1, 3, and 5 days after treatment. This schedule of sampling was repeated at the treated plot of the north site, following the second application there. On 22 September, all seed heads collected were shipped overnight to EBI for residue analyses. In addition, samples of seeds from each study plot were sent to the Fall River Wild Rice processing plant (Fall River Mills, CA) to be parched according to standard industry practices. Hulling was done with a McGill huller. The parched and hulled samples were then sent to EBI for determination of anthraquinone residues on the processed wild rice grain.

Bird Observations

We made observations daily from 0700 to 1000 h and 1600 to 1800 h. Because bird activity was consistently greater in the morning, analyses and discussion will be based on data collected during the morning period. Observations concluded on 19 September at the south site and 21 September at the north site. We recorded the number of birds seen entering and leaving the plots during each 10 minute interval to obtain a measure of plot use over time and between treatments. Bird activity for each 10 minute interval was measured as the sum of the number of birds arriving and leaving. We also recorded feeding rates for birds that remained visible for at least 1 minute on wild rice plants. To estimate what proportion of the birds' time was actually spent feeding, we recorded seeds eaten per minute for each bird observed.

Bird activity between plots at each study site was analyzed in paired t-tests against a null hypothesis of no difference in plot use. Feeding rates between treatments were compared in a one-way analysis of variance (ANOVA).

Yield Determination

On 21 September, after the final observation, each study plot was harvested to determine yield. Using an International 1680 axial flow combine with a 5.3 m head, we harvested four 15 m measured strips within each plot. Each individual sample was bagged and weighed to determine combine yield. Plot yields were analyzed in a one-way ANOVA. The remaining rice within each plot was harvested and weighed. Samples of harvested material from each study plot were sent to Monarch Laboratory, Inc. (Chico, CA) to determine recovery (finished rice as a percentage of harvest yield).

Food Habits

To determine the range of food items eaten by blackbirds using the rice fields, on 18 September we shot nine red-winged blackbirds as they left the south site. Later the same day, we shot three brown-headed cowbirds (*Molothrus ater*) as they entered the plot, presumably to roost. The birds were later dissected to determine crop and gizzard contents. Food items were identified (wild rice, other seed, unidentified matter) and the relative proportion of each determined. The number of seeds in the crop was estimated at 1 to 5, 6 to 10, or >10 seeds.

Responses of Captive Blackbirds to Wild Rice Seeds

At the National Wildlife Research Center's Florida Field Station, Gainesville, FL, we conducted two feeding trials to assess under controlled conditions blackbird responses to repellent-treated wild rice collected from the plot of the north site that had received a total of 56 L/ha Flight Control. In the first trial, we placed five adult male red-winged blackbirds in separate test cages (45 x 45 x 45 cm) and allowed them to acclimate for three days. On the next four mornings, maintenance food was removed at 0800 h and feeding trials commenced 30 min later. On day 1, we offered each bird 5 g of untreated wild rice for 1 h. This was followed by 1 h of food deprivation after which each bird was given 5 g of treated wild rice for 1 h. On days 2 to 4 the order of presentation was reversed. Aluminum pans suspended beneath each cage caught spillage. We videotaped one bird each day to examine behavioral responses to treated rice, and to detect possible indications of illness. Rice consumption data were analyzed in a two-way repeated measures ANOVA.

The second trial was conducted similarly, with six different birds, except that each bird received two cups, one containing 10 g of untreated wild rice and the other containing 10 g of treated wild rice. For each bird, position of the treated rice was randomly determined on day 1 and kept constant thereafter. Test food was presented for 2 h on each of three consecutive mornings. Only two birds were tested on day 3 because a predator killed the others.

RESULTS

Anthraquinone Residues

Low (0.1 to 0.3 ppm) anthraquinone residues were found unexpectedly but consistently on the pretreatment wild rice samples. Anthraquinone residues on post-treatment wild rice seed samples were highly variable (Figure 1). The initial concentrations were similar between treated plots (400 ppm) and tended to decline during the next five days. After the second application, residues in the north treated plot increased and remained high.

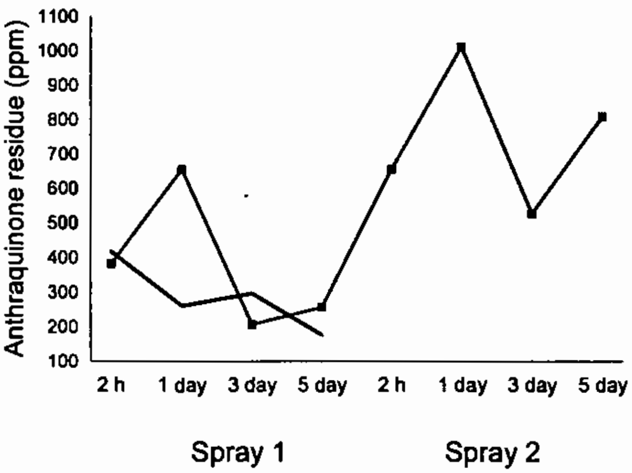

Figure 1. Mean anthraquinone residues on wild rice seeds from study plots sprayed with Flight Control bird repellent. Both plots received an initial 18.3 L/ha treatment. The north plot (dotted line) was sprayed a second time with an additional 36.6 L/ha.

Anthraquinone was found on the samples of parched wild rice from the north (0.22 ppm) and south (0.43 ppm) control plots. From the treated plots, residues on parched rice were 4.48 ppm (south site) and 9.61 ppm (north site).

Blackbird Activity

Throughout the study, there was no difference in blackbird activity between the treated and control plots at the north site (Figure 2). At the south site, bird activity in the treated plot (68 birds/period, SE=8) exceeded (t=4.58, P=0.0013, n=10) activity in the unsprayed control plot (29 birds/period, SE=13). Overall, bird activity at the two sites was similar. Bird activity at the north site declined sharply after 17 September (Figure 3). There was also reduced activity at the south site beginning 17 September but observations there ended two days later.

Red-winged blackbirds dominated the daytime observations at both sites. We estimated that 80% to 90% were females. Brewer's blackbirds were very abundant on other parts of the ranch, especially along fence lines and utility wires adjoining pastures. They did not appear to favor standing wild rice.

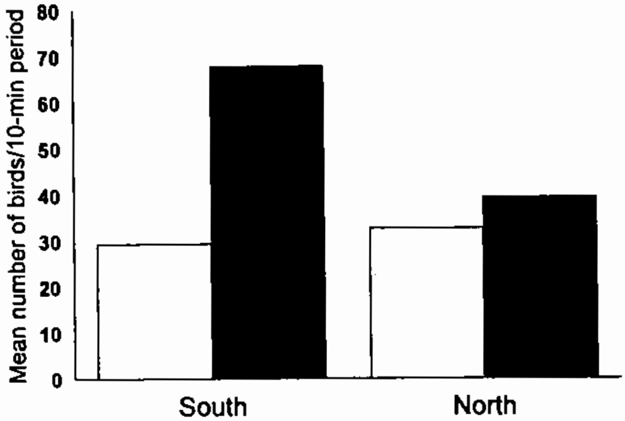

Figure 2. Blackbird activity during 10 to 21 September 1998 at four 0.4 ha plots of wild rice, Goose Valley Ranch, Burney, California. Both treated plots (solid bars) were sprayed with Flight Control repellent (18.3 L/ha) on 11 September. The north treated plot received a second application (36.6 L/ha) on 18 September. Control plots (open bars) were unsprayed.

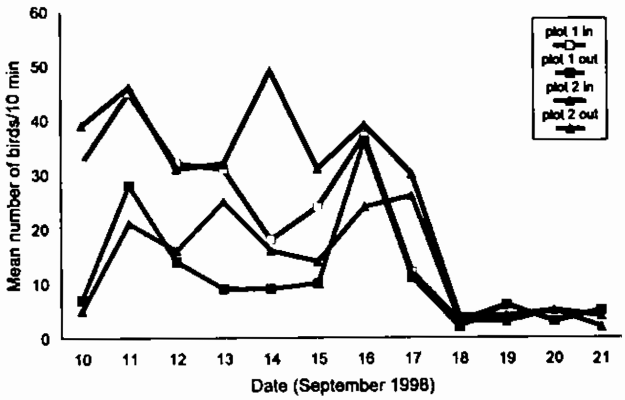

Figure 3. Mean arrivals and departures of blackbirds during 10 minute intervals at two 0.4 ha wild rice plots. Flight Control bird repellent was sprayed on plot 2 on 11 September (18.3 L/ha) and 16 September (36.6 L/ha). Plot 1 was untreated.

Feeding Activity

Among birds that were actively feeding, rates of wild rice seed consumption did not differ ($F_{2,54}$=0.40, P=0.674) among treatments and averaged 5.1 seeds/min (n=57, SE=0.4). Of the 181 birds that we watched for 1 min each, 135 preened, looked around, and did not eat a seed. The 46 birds that did eat consumed 1 to 13 seeds/min.

Plot Yield

There was no difference ($F_{3,12}$=0.25; P=0.858) among the four study plots in estimated green yield ($\bar{x}$=681 kg/ha; SE=24; n=16). Average yield for the fields surrounding our study plots was approximately 1680 kg/ha. Recovery was 43.03% and 47.01% at the north site and 47.7% and 43.76% at the south site, for the treated and untreated plots, respectively.

Food Habits

The crops of three red-winged blackbirds were empty. In the other six blackbirds, wild rice was the only food item: two crops contained >10 seeds, two contained 6 to 10 seeds, and two contained 1 to 5 seeds. Approximately 10% of the wild rice seeds were green. All red-winged blackbirds had substantial fat deposits. The crops of two cowbirds each contained >10 wild rice seeds. The other bird's crop contained approximately 95% grass seed and 5% wild rice (4 seeds).

Responses of Captive Blackbirds to Wild Rice Seeds

In the one cup sequential presentation trial, mean consumption of untreated wild rice (1.67 g/bird, SE=0.17) exceeded ($F_{1,8}$=18.79, P=0.002) mean consumption of treated rice (0.91 g/bird, SE=0.07). Consumption did not vary (P=0.814) across days (Figure 4). Examination of videotapes revealed no evidence of illness or discomfort in birds that fed on treated wild rice.

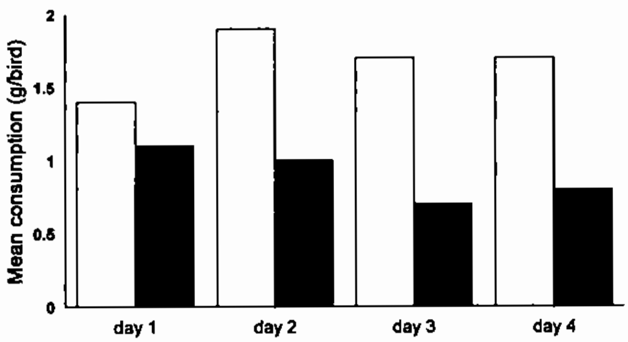

Figure 4. Consumption of wild rice by five individually caged male red-winged blackbirds. Open bars represent untreated rice and solid bars represent rice treated with 55.8 L/ha Flight Control bird repellent. Each bird was offered 5 g of each type of rice separately for 1 hour on four successive mornings.

When treated and untreated wild rice were presented simultaneously, red-winged blackbirds consistently selected untreated rice ($F_{1,22}$=42.71, P<0.001) after day 1 (Figure 5). Across all three test days, consumption of untreated rice averaged 2.87 g (SE=0.37) compared to mean consumption of 0.30 g (SE=0.13) of treated rice. Videotaped birds displayed no evidence of illness or discomfort, but on day 1, we found two clumps of partially digested, regurgitated wild rice seeds in the spillage pan of one bird.

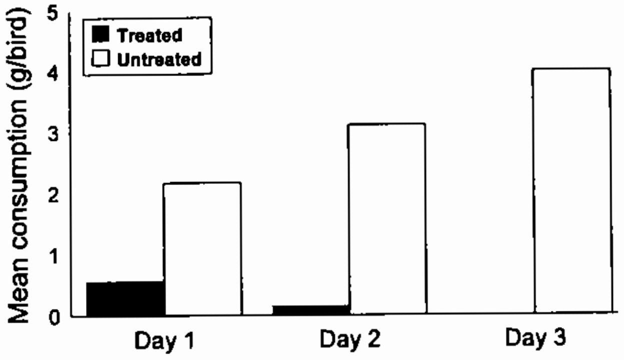

Figure 5. Wild rice consumption by singly-caged male red-winged blackbirds given untreated rice in one cup and rice treated with 55.8 L/ha Flight Control in a second cup for 2 hours on successive days.

Wild rice seeds that were offered to blackbirds during captive feeding trials contained an average anthraquinone residue of 430 ppm (SE=36). Control seeds contained residues that averaged 0.8 ppm (SE=0.1). The hulls from treated seeds eaten by captive blackbirds retained an average of 262 ppm (SE=31), or 60.9% of the anthraquinone.

DISCUSSION

Flight Control™ did not deter blackbirds from wild rice. There was no statistical difference in bird activity or final yields between treated and untreated plots. Most birds that arrived at the study plots immediately disappeared into the standing rice. This was particularly noticeable during the afternoon. Thus, the birds we observed arriving and leaving are only a small sample of the total population present in the plots. We, therefore, do not know how our index of activity relates to the number of birds present in the plots, or if observations of individual birds are representative of the total population. Many red-winged blackbirds appeared to spend all day in the rice, and many roosted there at night as well. The tall, dense vegetation provides good protection from heat and from numerous avian predators in the area. Also, we noticed many brown-headed cowbirds and Brewer's blackbirds flying into our study plots at dusk. This suggests that birds that do not feed in the standing wild rice do roost in it.

Anthraquinone residues on parched wild rice samples were surprising. We suggest that these findings were the result of contamination during the collection and processing of the samples. At the end of the study, the first plot harvested was the north treated plot that received the heaviest dose of Flight Control™. Then the two control plots were harvested. The combine was not cleaned between harvesting plots. It is, therefore, possible that anthraquinone left in the combine from the north treated plot contaminated the other samples. Also, the parcher and huller were not cleaned between processing batches. Thus, there was considerable potential for contamination among samples prior to residue determination.

Why Didn't Flight Control Reduce Blackbird Use of Treated Plots?

We suggest a number of reasons as to why Flight Control™ did not reduce bird use of treated plots. Blackbirds appeared to use the standing rice for cover and roosting as well as feeding. By applying a feeding deterrent (i.e., anthraquinone), we did not address the other reasons for the birds being there. This may have been especially significant at the time of our study when there was relatively little wild rice still standing and thus a limited number of suitable sites for blackbirds to use. The additional pressure our plots received as loafing and roosting locations may have masked any effect of the feeding deterrent.

Low exposure of birds to the repellent also may have been a factor. The hull of wild rice is very thin and papery, much less substantial than that of white rice, and is hulled quickly by blackbirds. By rapidly eating these seeds, birds may not be sufficiently exposed to the compound. Residue data also suggest poor coverage of the repellent on the seed heads. Feeding trials with captive blackbirds corroborate this view. The captive birds preferred to eat untreated wild rice, but they did not avoid treated wild rice. This suggests that the application rate was not sufficient.

Additionally, in the field flocks could have varied daily in composition. New birds entering the treated plots would not have learned to avoid eating the treated wild rice. Repeated exposure to the repellent-treated rice might be necessary for avoidance behavior to occur. Thus, Flight Control™ might have affected the feeding behavior of individual birds, but sufficient numbers of new birds entering the plots daily could easily obscure evidence of a repellency effect. Results from the two cup test in which positions of treated and untreated rice remained constant from day to day suggest a learned avoidance response from the test birds.

Given the highly variable anthraquinone residues on samples from the field, it is possible that blackbirds selected seeds that were only lightly treated and avoided the heavily treated seeds. On close inspection, Flight Control™ was visible to us on the treated seeds, and it is highly likely that blackbirds could detect it visually also. Whether the birds could also associate variable amounts chemical visible on the seed with differing post-ingestional consequences is interesting but as yet untested.

Future Research Directions

From this initial field trial it is clear that a better understanding of blackbird behavior in a wild rice growing area is needed for development of an effective management strategy. Such additional research should include efforts to determine residency status and home range of blackbirds in wild rice by using radio telemetry. Information on behavior and movements throughout the season would help determine optimal timing for the application any blackbird management method (lethal control, noncrop habitat modification, feeding repellent).

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LITERATURE CITED

AVERY, M. L., J. S. HUMPHREY, and D. G. DECKER. 1997. Feeding deterrence of anthraquinone, anthracene, and anthrone to rice-eating birds. J. Wildl. Manage. 61:1359-1365.

AVERY, M. L., J. S. HUMPHREY, T. M. PRIMUS, D. G. DECKER, and A. P. McGRANE. 1998. Anthraquinone protects rice seed from birds. Crop Protect. 17:225-230.

DECKER, D. G., M. L. AVERY, and M. O. WAY. 1990. Reducing blackbird damage to newly planted rice with a nontoxic clay-based seed coating. Vertebr. Pest Conf. 14:327-331.

GORENZEL, W. P., D. B. MARCUM, and T. P. SALMON. 1986. Application of a benefit:cost model to blackbird damage control in wild rice. Proc. Vertebr. Pest Conf. 12:269-274.

HOLLER, N. R., H. P. NAQUIN, P. W. LEFEBVRE, D. L. OTIS, and D. J. CUNNINGHAM. 1982. Mesurol for protecting sprouting rice from blackbird damage in Louisiana. Wildl. Soc. Bull. 10:165-170.

MARCUM, D. B., and W. P. GORENZEL. 1994. Grower practices for blackbird control in wild rice in California. Proc. Vertebrate Pest Conf. 16:243-249.

WILSON, E. A., E. A. LEBOEUF, K. M. WEAVER, and D. J. LEBLANC, D. J. 1989. Delayed seeding for reducing blackbird damage to sprouting rice in southwestern Louisiana. Wildl. Soc. Bull. 17: 165-171.