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USE OF 4-AMINOPYRIDINE TO PROTECT RIPENING CORN FROM BLACKBIRDS

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Abstract: A toxic, fright-producing chemical, 4-aminopyridine, was tested for alleviating damage by red-winged blackbirds (*Agelaius phoeniceus*) to ripening corn in Brown County, South Dakota. The treatment reduced losses by about 70 percent in 8 contiguous sections containing 1,013 acres of corn. Numbers of blackbirds using the treated area fell sharply during a 5-day period after treatment began and remained at a low level for the remainder of the damage season. The technique was highly specific for blackbirds. Although pheasants (*Phasianus colchicus*) were abundant, there was no evidence that any were affected, and mortality among other species of birds was negligible.

Blackbirds, principally red-winged blackbirds, damage ripening corn in many areas of the United States and create a need for an effective, safe, and economical means of controlling damage. Many techniques have been tried, some providing a degree of relief (Neff 1949, Neff and Meanley 1957, Bird and Smith 1963), but, for the effort expended, most have failed to give the protection desired.

Since 1960, the Denver Wildlife Research Center has investigated methods of controlling blackbird damage to ripening field corn at Sand Lake National Wildlife Refuge, South Dakota (De Grazio 1964). From 1961 to 1963, we determined that redwings destroyed an average of about 3 bushels of corn per acre in a 94-section survey area surrounding the marshes of this refuge. In 1962 and 1963 experiments, we sprayed partially husked ears of standing corn with a chemical frightening agent, 4-aminopyridine.

Some species of birds affected with 4-aminopyridine emit distress cries and perform aerial distress displays, and a few affected individuals often frighten the other birds in the flock and cause them to leave. Although this chemical was first synthesized by Koenigs and Gredner (1931), its unique action on birds was discovered by Goodhue et al. (1964), and its utility for controlling damage by birds in some situations was demonstrated by Goodhue and Baumgartner (1965*a*, *b*). In redwings, we found that a lethal dose of 4-aminopyridine was necessary to produce distress behavior. The acute oral LD_{50}, as well as the dose necessary to produce distress in 50 percent of the birds, was 2.4 mg/kg (95 percent confidence limits, 1.5–3.8 mg/kg). At this level, distress usually began about 15 minutes after dosing and lasted for about 20 to 30 minutes.

Our studies in 1963 indicated the conditions for using 4-aminopyridine sprays effectively, the number of treatments necessary to provide protection during the damage season, and the number of treated ears required per acre. These investigations showed that the feeding habits of blackbirds could be disrupted after they had become established in a field, and that a field could be protected even though only a few birds were affected. Often, a few

[1] Deceased.

birds that had ingested 4-aminopyridine in a treated field moved with a departing flock to untreated fields and provided protection there when the chemical took effect. This paper reports the results of our first attempt to protect a large group of fields with 4-aminopyridine spray for an entire damage season.

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METHODS AND MATERIALS

In 1964, a study area of 8 sections within the 94-section survey area was selected for testing the 4-aminopyridine spray. The test area contained 55 cornfields, totaling 1,013 acres, located from a few hundred feet up to 2 miles from the marshes used by roosting blackbirds. The populations of blackbirds roosting in these marshes between August 25 and September 10, the period of the most vulnerable stages of ripening corn and peak numbers of blackbirds had been estimated in 1962 and 1963 and were estimated again in 1964.

Fields were treated by spraying partially husked ears of corn with a viscous solution containing four percent 4-aminopyridine. The solution was prepared by mixing 1 part Methocel and 3 parts 4-aminopyridine, by weight, in 60 parts acetone and 60 parts water, by volume. (Methocel HG is a product of the Dow Chemical Company. Reference to trade names does not imply endorsement of commerical products by the federal government.) This solution was sprayed in a fan pattern with an 800067 Tee Jet tip from a 1-gallon sprayer under a pressure of about 40 lb per square inch. The upper two-thirds of each ear of corn was stripped of its husk and sprayed for approximately 1 second; this deposited about 5 ml of solution, or 0.2 gram of 4-aminopyridine, per ear. Each treated kernel thus contained approximately 0.5 mg, a lethal dose for a blackbird.

Fields were observed closely for the onset of damage. As soon as damage was noted, the field was immediately treated. Plots selected for treatment were gridded and located at least 50–100 yards from the edge of the field; this was a precautionary measure against species that frequented nearby shelterbelts and other cover. In 1963, studies testing the number of plots needed per acre showed that maximum effectiveness could be obtained by treating at the rate of one plot (five consecutive ears) per 2 acres. Fields were retreated at weekly intervals as long as ears on the treated plots were being damaged by birds, or until the corn dented. One man was able to treat about 15 plots or 30 acres per hour. The first treatment was made on August 7 and the last on September 11. At the end of the study, all treated ears and husks were collected and buried.

To determine the effect of the treatment on the numbers of birds, three types of censuses were made. Populations on and off the 8-section area were censused three mornings weekly by slowly driving a route that bordered most of the treated fields, and many of the untreated ones, within 3 miles of the treated area. Numbers of birds, their location, and their activities were recorded. A complete census of birds in the treated area was made weekly by walking strips through each of the 8 sections. Birds that crossed the treated area on flight lines from the roost were counted in September when populations peaked; these counts

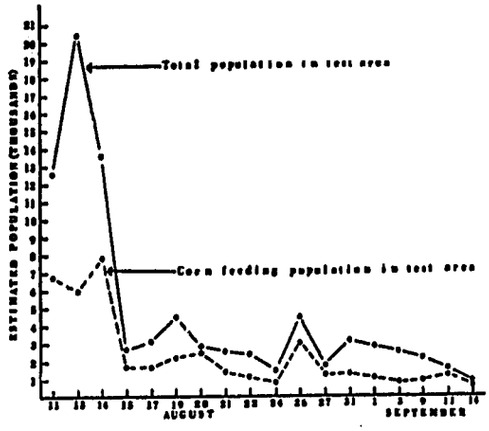

Fig. 1. Blackbird population trends in the test area that was treated with 4-aminopyridine, August 11–September 14, 1964—only the dates that censuses were made are shown.

were compared with similar counts made in 1962 and 1963.

Damage to corn by blackbirds in the treated area was estimated in late September by the method developed by De Grazio et al. (1969). Expected damage for the 55 fields in the treated area in 1964 was calculated by projecting data on loss of corn, obtained in 27 of these fields during 1961, 1962, and 1963.

The numbers of birds killed were estimated by searching alongside treated rows in 48 fields. To estimate the distance birds dispersed from treated rows before dying, carcasses were counted in all rows in half of one field with a heavy redwing kill. Of the 107 dead redwings collected, 18 percent were found 3.3 feet on either side of the treated row, 66 percent within 33 feet, and 85 percent within 66 feet. However, an investigator walking through a field could thoroughly cover only the 3.3-foot area on either side of a corn row, and thus only this area alongside the treated rows was searched in 48 treated fields. Since an estimated 18 percent of the birds should have been found within this area, the number of dead birds found was multiplied by 5.6 to estimate the total minimum kill.

Table 1. Peak blackbird populations in survey and test areas during pretreatment and treatment years, Sand Lake National Wildlife Refuge, Brown County, South Dakota—treatments were from August 7 through September 11, 1964.

Year	Estimated Number of Blackbirds: Survey Area (94 sections)	Estimated Number of Blackbirds: Test Area (8 sections)	Percent Population in Test Area
Pretreatment			
1962	1,354,000	92,000	6.8
1963	1,434,000	106,700	7.4
Average	1,394,000	99,000	7.1
Treatment			
1964	1,797,000	55,000 127,000[a]	3.0

[a] Expected population based on the 1964 population in the 94-section area and the average proportion of birds in the test area in 1962 and 1963.

RESULTS AND DISCUSSION

The effects on blackbird populations in the area were apparent almost immediately after the treatment was begun. The number of birds counted on census routes within the treated area dropped rapidly within 5 days after treatment and remained low during the remainder of the study (Fig. 1). The weekly strip census of the treated area showed that only a small percentage of the birds lingered there; only 14,000 birds were counted on August 19 (12 days after the first treatment), 37,000 birds on August 26, 24,000 on September 2, and 16,000 on September 9. There were 55,000 birds in flight lines crossing the treated area on September 1 (Table 1). This represented only 43 percent of the birds counted there at comparable times in 1962 and 1963, even though the roosting population in the Sand Lake marshes was estimated to be slightly larger in 1964 than in 1962 and 1963.

Before treatment, field observations showed the typical feeding pattern of the blackbirds. In early morning, flocks dropped

Table 2. Bushels of corn lost per acre to blackbirds in the 8-section test area during pretreatment and treatment years, Sand Lake National Wildlife Refuge, Brown County, South Dakota.

Year	Number of Fields Surveyed	Loss (bushels/acre)
1961	4	10.0
1962	9	5.4
1963	14	10.9
Average	9	8.8
1964[a]	27	2.7

[a] Year of treatment.

from flight lines into fields near the marsh and often spent several hours in these fields. After feeding, the birds moved into more distant fields. This slow outward dispersal pattern continued until about midday when the birds were 5 to 15 miles from the marsh. In late afternoon, the flocks moved back toward the marsh, visiting fields close to the roost before dusk. After treatment began, outward movement was greatly accelerated; the birds lingered in treated fields for less than 30 minutes and often reached their usual midday locations within 2 hours after sunrise. Field observations indicated that they also spent relatively short periods in cornfields near the roost, shifting their feeding to stubble and pastures, and that they entered the roost earlier, and over a shorter period of time, than before treatment.

Estimated losses of corn to blackbirds in 1964 averaged 2.7 bushels per acre in the 27 treated fields for which loss data from previous years were available (Table 2). This was approximately 70 percent less than the loss of 8.8 bushels per acre recorded in these fields in pretreatment years. The treatment also afforded a slight degree of protection to adjoining untreated fields; 10 of these that were surveyed suffered about 30 percent less damage in 1964 than in pretreatment years.

Of the treated fields, the ones near marshes and shelterbelts received the heaviest damage. Birds used these fields regularly and within 2 or 3 days often ate all the kernels from treated ears on the more vulnerable plots. This left the fields unprotected for 4 or 5 days until they were treated again. Fields somewhat farther from the roost and without nearby cover were used for only short periods, and weekly treatments were adequate to protect them. Of the treated fields, the ones farthest from the roost received the least damage. One treatment protected these fields for 2 to 4 weeks, and only one or two applications were necessary for the entire season. An average of four treatments per field was used on the entire treated area.

Altogether, 564 redwings, 11 yellow-headed blackbirds (*Xanthocephalus xanthocephalus*), and 6 common grackles (*Quiscalus quiscula*) were found dead in the 48 treated fields that were sampled. By using the multiplier of 5.6, explained previously, the total number of redwings killed in treated fields was estimated at 3,158. This was a minimum figure because many affected birds were observed drifting with the wind from treated fields. Other species found dead in the searches were one Baltimore oriole (*Icterus galbula*), one red-headed woodpecker (*Melanerpes erythrocephalus*), one brown thrasher (*Toxostoma rufum*), and one black-headed grosbeak (*Pheucticus melanocephalus*); all were found within 10 feet of treated plots. Pheasants and mourning doves (*Zenaidura macroura*) were abundant in the treated fields, but none was observed to be affected.

If corn is assumed to be $1.20 per bushel, the 6,100 bushels saved on the treated area amounted to a savings of about $7,300. The cost of the treatments was about $1,100.

250 man-hours of labor at $3.00 per hour	$ 750
5 pounds of 4-aminopyridine at $60.00 per pound	300
Methocel and acetone for 16 gallons of spray	15
Sprayer parts plus one-fourth the cost of sprayer	35
	$1,100

Although spraying 4-aminopyridine on partially husked ears of standing corn appears to be an effective and economical method of control, highly restrictive precautions must be taken to ensure that all treated plots are adequately marked and that all treated ears are retrieved as soon as they become unpalatable to blackbirds.

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