4-AMINOPYRIDINE FOR PROTECTING CROPS FROM BIRDS—A CURRENT REVIEW

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ABSTRACT: 4-aminopyridine, a chemical frightening agent, has proved effective for protecting field corn, sweet corn, sunflowers, peanuts, and pecans from attack by birds, chiefly blackbirds. Problems in more effective use of the product, Avitrol FC Corn Chops 99, by growers include restricted availability; a restricted number of certified applicators, few of whom have the time to attain an adequate knowledge of bird damage problems and to put forth a concerted and maintained baiting effort that is necessary to obtain the best results; a weakness in use directions that causes much of the bait to be squandered or used less effectively; and application and bait costs that have risen faster than the value of crops, primarily because restrictions on product use have resulted in treatment of only a small fraction of the acreage that could be profitably baited. Improvement in use directions for the product, making it available to the grower through more direct channels, and training individuals to lead effective baiting programs are the solutions suggested.

The compound, 4-aminopyridine (4AP), was first synthesized in Germany in 1924 (Koenigs et al., 1924). In 1962, Goodhue et al. (1964) discovered that house sparrows (Passer domesticus) dosed with 4AP became disoriented and emitted distress calls. In ensuing field tests in Oklahoma, Goodhue and Baumgartner (1965) found that sparrows, having ingested baits treated with 4AP, gave these calls while ascending in circular flights often to heights of 500 feet or more, and that this action frightened away other members of the flock. They reported that other gregarious birds including brown-headed cowbirds (Molothrus ater), starlings (Sturnus vulgaris), common crows (Corvus brachyrhynchos), and herring gulls (Larus argentatus) also gave distress display flights after ingesting baits containing distress-producing levels of 4AP (generally 5 to 10 mg/kg of body weight). The compound 4AP was the second that Goodhue and Baumgartner tested that produced distress displays. The first was 4-nitropyridine-N-oxide, trade-named Avitrol 100. 4AP was originally coded Phillips 1861 (DRC-1327) and later trade-named Avitrol 200.

PROTECTION OF CROPS

Field Corn

In 1962, J.W. De Grazio and R.I. Starr discovered that red-winged blackbirds (Agelaius phoeniceus) readily fed on ears of corn with husks removed that were sprayed with a 4% solution of 4AP in 0.5% methyl cellulose (a thickening agent and adhesive), and that 474 redwings were affected after feeding on 200 ears treated in one plot (De Grazio 1963:46). That year they also sprayed one partly husked ear of corn every 50 feet in one row of corn. These ears were preferentially fed upon by blackbirds (primarily redwings) and many birds were affected (De Grazio 1963:44). In 1964, blackbird damage in cornfields in an 8-section area in Brown County, South Dakota, was decreased by about 70% by spraying plots of five consecutive partly husked ears with 4% 4AP in methocel (De Grazio et al. 1971). Plots were located every 2 acres in a grid pattern over the entire 1,013 acres of corn grown in these 8 sections.

In 1964, it was discovered that blackbirds readily took 4AP cracked corn baits broadcast in cornfields (De Grazio 1965:44-50). In 1965, broadcasting baits treated with 3% 4AP that were diluted with 29 parts of untreated corn resulted in an 85% decrease in damage in cornfields in the 8-section area (De Grazio et al. 1972). In that study, baits were broadcast at the rate of 3 lb per acre in swaths covering one-third of the field (1 lb per acre of field) and one to seven treatments were necessary to protect individual fields. In 1966, it was learned that dilution rates could be increased without appreciably lowering the protection afforded (De Grazio et al. 1966:7). A 1:99 dilution rate was substituted for the 1:29 dilution and tests were expanded to a 508-section area in South Dakota, and extended into North Dakota in 1967, and into Ohio and Michigan in 1968. The 1:99 dilution proved successful in frightening blackbirds from cornfields in each of these areas.

In 1972, the 1:99 product was registered in the United States as Avitrol FC Corn Chops 99 (AFCC 99) (EPA Registration No. 11649-12). Use of the product to protect cornfields has increased each year, but the acreage treated in 1975 was far less than half of the 600,000 acres in 1971 and the 1,000,000 acres in 1970 in the U.S. that Stone and Mott (1973) calculated

suffered blackbird losses of 3 or more bushels per acre. It appears that many corn growers have yet to learn about the effectiveness of 4AP baiting, or have not learned to use it in an effective manner.

Field corn in other countries has also been effectively protected with 4AP. Woronecki (1972:21) reported that a field in Colombia being raided by shiny cowbirds (Molothrus bonariensis) was protected by a 2% 4AP broadcast corn bait. In initial tests in Uruguay, monk parakeets (Myopsitta monachus) were frightened from cornfields after feeding on ears sprayed with a solution of 8% 4AP in methocel (De Grazio and Besser 1975); one plot of 10 consecutive ears on each hectare of a 20-hectare field was treated. Additional tests are taking place in Uruguay in 1976. The obvious disadvantage of spraying ears compared with broadcasting baits is that each treated ear must be removed before the field can be harvested.

Sweet Corn

A logical extension of the use of AFCC 99 in field corn was its use in sweet corn. An experimental permit was granted in 1974 to test 4AP in this crop. In Wisconsin, blackbirds consumed 10 times as much sweet corn in untreated fields as in fields treated aerially with AFCC 99 at 1 lb per acre of field (Knittle et al. 1974). In Idaho, blackbirds consumed 4 times as much corn in untreated irrigated sweet corn fields as those treated with AFCC 99 (Mott and Royall 1975). In New York, blackbirds consumed 2.5 times as much sweet corn in untreated fields as those treated with AFCC 99 (Stickley and Ingram 1975). Conclusive data were not obtained in similar tests in Ohio and Maryland, probably because of low bird pressure. In 1975, sweet corn was added to the AFCC 99 field corn label in most of the United States. The northeastern and southeastern regions of the United States were excepted in this registration because of a lack of conclusive data on effectiveness. In New York in 1975, blackbirds damaged 10 times as many ears in untreated sweet corn fields treated with AFCC 99 (Swindle 1975); the product may be registered for the northeastern region in 1976.

Sunflowers

Testing of AFCC 99 for protection of sunflower fields was begun in North Dakota in 1967. R.V. Hansen and W.K. Pfeifer obtained satisfactory to excellent results by spreading AFCC 99 in disked strips between standing sunflowers in Rolette County in 1967, in Ransom County in 1968 to 1970, in Cass and Ransom Counties in 1971, and in Cass County in 1972 (unpublished reports of Division of Wildlife Services, North Dakota). In 1973, when AFCC 99 was broadcasted at 1 lb per acre in sunflower fields in 28 sections of Steele County, North Dakota, under an experimental permit, only 18% as much damage occurred in this area as in 1972, despite the presence of 7 times as many birds in 1973 (Guarino 1974). It was calculated that about $9 worth of sunflower seed was saved for each $1 spent for bait. In 1974, blackbirds consumed about 2.5 times as much sunflower seed in 12 untreated fields in Traill and Grand Forks Counties, North Dakota, as in 12 fields treated with AFCC 99, and results were generally satisfactory over the 18,000 acres of sunflowers in Minnesota and the Dakotas that were treated under an EPA permit granted that year (Besser and Cummings 1975). AFCC 99 was used on about double that number of acres in these states in 1975 under State registrations. Federal registration is expected in 1976.

Smaller scale tests of AFCC 99 have been conducted in sunflower plantings in California, Ohio, and Tennessee, but the sizes of test areas were not sufficient to support registration for these areas.

Hazards to protected species of migratory birds have been noted, mostly in tests which extended beyond the normal harvest period of sunflowers (Dolbeer et al. 1974; Besser and Cummings 1975); greater caution should be taken if baiting in October or November in northern latitudes of the United States when "waves" of migrant fringillids appear in sunflower fields. A cautionary statement to this effect appears on a proposed label for AFCC 99S.

Studies in Uruguay were begun in 1975 to protect sunflowers from attack by monk parakeets. Treating the tallest heads of sunflowers in the favored feeding spots of parakeets with a solution of 8% 4AP in methocel showed promise for protecting fields (De Grazio and Besser 1975).

Peanuts

Tests of AFCC 99 in Oklahoma peanut fields in 1969 and 1970 showed that the numbers of feeding blackbirds were greatly reduced by 4AP baiting (West et al. 1969; Mott 1970). These data were used to obtain a state registration of AFCC 99 for Oklahoma in 1974. Federal registration has not been obtained.

Pecans

Tests in Louisiana have shown that 4AP can be used effectively and safely to reduce losses of pecans to common crows (Wilson 1974). The method involves prebaiting crows in pecan orchards with untreated whole corn, then substituting a small amount of whole corn treated with 1% 4AP. This use was registered in Louisiana in 1974.

Grain Sorghum

Studies to determine the efficacy and safety of AFCC 99 were begun in 1974. The corn bait was readily accepted by blackbirds in Oklahoma and Kansas and large numbers of blackbirds were affected (Cummings et al. 1975; Guarino et al. 1975); however, fields were not of sufficient size or number to support registration. An experimental permit to test the compound in commercial fields in Texas, Oklahoma, and Kansas was sought in 1975, however, the permit is still pending in early 1976.

USE PROBLEMS

Despite the effectiveness demonstrated in tests that secured registration of AFCC 99 in field corn, sweet corn, and sunflowers in the United States, a number of problems confront growers in making the most effective use of this product. A discussion of these problems and some possible solutions follows:

Professional Applicators

Because of the toxicity of 4AP to nontarget species of migratory birds, AFCC 99 is registered for use only by professional applicators trained in bird control. Qualified applicators are widely scattered in agricultural areas and few possess as much knowledge of the activities of the problem birds in agricultural crops as do the growers. The grower knows far more than anyone about the pattern of bird damage in his fields, and has the great advantage of regularly observing fields for birds causing damage. Although the grower's call to a professional applicator may result in the field being treated the same day, 1 to 3 days often elapse before a treatment is received because of the applicator's distance from the field and his previous commitments (usually insecticidal and herbicidal applications). Damage is alleviated most successfully, if fields receiving heavy damage are treated within hours, as a large flock of birds can cause substantial damage in a single day. Pearson et al. (1964) reported that blackbirds in South Dakota consumed more than 0.7 bushel of field corn per acre per day on a 10-acre test field over a 35-day period. It is also the regrettable practice of many applicators to schedule treatments on a weekly basis. Under the weekly schedule, a treatment applied one day followed by a substantial rain the next day results in the field being left unprotected for 6 critical days. Fields of corn and sunflowers have also been treated before the crop was vulnerable to birds, and sometimes cornfields were treated after the crop had matured beyond the stage of major vulnerability.

In addition, professional application costs have increased from the original $0.40 per acre in 1965 to a commonly quoted current price of $5.10 for three treatments, or $1.70 per acre. At these prices, growers await a prolonged period of clear weather so that heavy rains do not deactivate the bait. Frequently, heavy damage takes place during the delay.

Clearly, the product needs to be available to growers through more direct channels. Perhaps growers can be certified under the new pesticide regulations now being formulated by individual states. In 1966, 54 farmers in Brown County, South Dakota, who were allowed to purchase 4AP baits applied them effectively and safely (without the aid of aircraft) and protected cornfields in a 508-square mile area (De Grazio et al. 1966).

Concerted Baiting Efforts

The best results from AFCC baitings have been obtained when an individual (usually a biologist) familiar with the feeding patterns of birds led a baiting program supported by

several or many growers. These programs often covered several townships. It is understandable that a single grower has more difficulty in protecting his fields than a block of growers, when birds ingesting baits sometimes travel as far as 2 miles from a treated field before displaying distress (Besser and Cummings 1975). Furthermore, treated fields are more likely to be reinvaded by blackbirds when a large flock feeds for several days in nearby crop fields without being molested.

A solution to this problem is to employ a person familiar with the movement patterns of bird flocks over many square miles. There are currently many unemployed biologists who could profitably be employed by growers or industry to lead these concerted efforts.

Maintenance of Effort

It is noteworthy that the greatest benefit-cost ratios have been attained in those studies where the most treatments were applied. Knittle et al. (1974) applied as many as four treatments in sweet corn fields during a 10-day vulnerability period; De Grazio et al. (1972) applied as many as seven treatments in field corn during the 3 weeks of vulnerability for that crop; Guarino (1974) applied as many as 14 treatments in sunflower fields during a 6-week vulnerability period. Benefit-cost ratios for these three studies were 4-fold, 10-fold, and 9-fold, respectively. All of these studies were led by a biologist who was knowledgeable about bird movements over many square miles, and who knew how to use the product effectively. The solution to the problem of maintenance of baiting effort again appears to be the training of a group of individuals to lead effective programs.

Improvement of Use Directions

On the basis of early studies, growers were regularly advised to apply AFCC 99 to entire fields, although this advice was not expressly stated on the label. In recent studies, however, it has been demonstrated that blackbird forays in crop fields nearly always originate from suitable loafing cover (most frequently a group of trees) or from roosting cover (most frequently marshes). Knittle (1976) showed that large sunflower fields that were treated with 4AP had about 4 times as much damage within 50 rows of the edges and within 100 yards of the ends of the fields as in interior areas. Frequent baiting of the more vulnerable portions of fields should result in more effective and more economical protection of the field than less frequent baiting of the entire field. This method of treatment should also be safer to nontarget species of birds that also feed in crop fields. Obviously, if the portions of a field in which blackbirds seldom or never feed are baited, one will kill a greater proportion of (or only) nontarget individuals. This use direction, recommending strip or spot baiting, should be added to present labels for AFCC 99. This change, if made, will further the need both for more precise knowledge about individual fields and for the grower to have the capability to treat his own fields.

Density of Bait Particles

Besser and Cummings (1975) presented evidence that AFCC 99 at 1 lb per acre of field provides better protection when broadcast more densely in fewer areas (strips or spots). They observed that the broadcasting of baits by hand resulted in more birds being affected in shorter periods, and that fields were cleared of birds more rapidly than when baits were broadcast aerially. They believed that blackbirds attacking the crop more readily joined birds that were feeding on the ground when the birds on the ground were feeding on a denser concentration of bait particles, rather than on more thinly distributed particles; and that the birds were more likely to ingest a second treated particle, resulting in a quicker reaction. More dense distribution of baits may slightly increase hazards to nontarget species also, but hazards were minimal in the initial large-scale tests in cornfields in 1965 in which all baits were broadcast by hand at more than three times the application rate of 4AP currently registered (De Grazio et al. 1972).

The solution to this problem lies in the greater use of means to broadcast baits more densely in fewer areas. Hand baiting and baiting from high-clearance tractors should be favored over aerial baiting. However, it is not now possible to bait densely planted fields of sunflowers and corn by means other than the use of aircraft. To use nonaerial means to broadcast baits in such fields, growers should leave an unplanted row at intervals to accommodate passage of a man or a vehicle. Such wide rows at 25 and 75 yards from loafing cover would probably be sufficient for most fields. The loss of yield from leaving wide rows would not be as great as many growers might suspect, for in a North Dakota survey, I found that an edge row of sunflowers adjacent to a fallow field yielded 1.5 times as much seed as the 10th row in the field.

A suggestion by a co-worker, J.L. Guarino, to narrow the aperture from which baits are aerially broadcast (thereby increasing bait density) probably has merit. This should be especially suitable for densely planted fields with low amounts of damage where the slight loss of yield or the nuisance of leaving wide rows would be considerations, and where the grower has ready access to a competent and cooperative aerial applicator.

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