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Frederick T. Crase
U.S. Fish and Wildlife Service

Richard W. Dehaven
U.S. Fish and Wildlife Service

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FREDERICK T. CRASE[1] and RICHARD W. DEHAVEN, Wildlife Biologists, U.S. Fish and Wildlife Service,
Denver Wildlife Research Center and Field Station, Davis, California 95616

ABSTRACT: Studies by the U.S. Fish and Wildlife Service of the efficacy of methiocarb for reducing bird damage to sprouting corn, rice, soybeans, lettuce, and sugar beets, and to ripening rice, grain sorghum, wheat, cherries, grapes, and blueberries have shown it to be an effective, broad-spectrum bird repellent and crop protectant. The short-term plans of the Service for the further development and testing of methiocarb are reviewed. Also discussed is some of the rationale behind the use of chemical repellents to prevent agricultural damage by birds.

INTRODUCTION

Many agricultural damage problems caused by birds involve several species that react differently to currently available damage control methods, thereby reducing, or in many cases, practically eliminating the effectiveness of these methods. In 1960, the U.S. Fish and Wildlife Service began a program of screening chemical compounds hoping to find an avian repellent that was an effective crop protectant against many species of birds. Methiocarb [3,5-dimethyl 4-(methylthio) phenol methylcarbamate] emerged as one of the most promising of the chemicals tested (Schafer and Brunton 1971) and after further evaluation was chosen for field testing on several crops.

Results of early field tests with methiocarb through 1971 were summarized at the 1972 session of this conference (Guarino 1972). At that time, methiocarb had shown promise for preventing damage by several bird species to sprouting corn and soybeans, and to ripening rice, grain sorghum, cherries, and grapes. However, the positive results obtained were from only a few trials for each kind of crop, and more testing with improved experimental designs was needed. Additional field tests through 1975 have confirmed the broad-spectrum effectiveness of methiocarb as a bird repellent on crops and have added substantially to the body of knowledge required for eventual registration. This paper looks at the current status of methiocarb as a bird repellent for various crops, describes the short-term plans of the Service for its further development, and examines some of the rationale behind the use of chemical repellents to control agricultural damage by birds.

SPROUTING SEEDS

Corn

A large amount of data exists on the effectiveness of methiocarb as a corn seed protectant. In four studies using a 75% wettable powder (W.P.) formulation and 0.5% active ingredient (AI) in a water slurry treatment on the seed before planting, 3-50 times more sprouts were damaged in untreated (control) fields than in treated fields (West and Dunks 1969; West *et_* al_. 1969; Guarino and Forbes 1970; Stickley and Guarino 1972). A variety of birds were involved in these studies including pheasants (Phasianus colchicus), boat-tailed grackles (Cassidix mexicanus), common grackles (Quiscalus quiscula), crows (Corvus brachyrhynchos), and several species of blackbirds. The water slurry was not wel1-accepted as an application technique, however, and in two more recent studies (Ingram et_ al_. 1973; Lewis and Besser 1974 using a 0.5% graphite-powder hopper-box treatment, damage by black-birds was reduced 96% and damage by pheasants 74%.

Federal registration of methiocarb (Mesurol^{R} 50% Hopper-Box Treater) for use as a dust treatment for seed protection against blackbirds has been obtained for all states east of the Mississippi River (EPA Registration Number 3125-309).

Rice

Two studies have shown the potential of reducing blackbird damage to rice seeds and sprouts with methiocarb seed treatment. In Texas, Besser (1973) found that 8 times more seedlings were produced on plots where the seed was treated with 0.5% (Al) methiocarb

[1]Present Address: U.S. Bureau of Reclamation, P.O. Box 2553, Billings, Montana 59103

(75% W.P.) than on plots with untreated seed. In Louisiana, Mott et_ al. (1976) found 1.7 times more seedlings in treated plots using a 0.25% treatment. Our future studies of methiocarb rice seed treatment depend upon the attainment of an experimental permit by the manufacturer.

Soybeans

In recent tests on sprouting soybeans in Uruguay, Calvi et_ al. (1975) found that 0.6% of the sprouting plants on a one hectar plot in which the seed was treated with 0.25% methiocarb were damaged by pigeons and doves, compared to 51% on the control plot. Three species of birds were responsible for the damage--the spotted pigeon (Columba moculosa), the Picazuro pigeon (C. picazuro), and the eared dove (Zenaida auriculata). These results confirmed the earlier findings of Thompson and Agudelo (1969)in Columbia that methiocarb at a higher level (0.5%) was highly effective in reducing eared dove damage to emerging soybeans. The Service plans to continue testing methiocarb on soybeans to determine the most effective and economical treatment rate.

Lettuce and Sugar Beets

DeHaven et_ al. (1976) conducted several field trials of methiocarb for protecting sprouting lettuce and sugar beets from damage by horned larks (Eremophila alpestris). A 2.0 lbs (AI) methiocarb (75% W.P.)/ acre foliar spray was applied after sprout emergence. Treated plots of both crops had about 18-44% more undamaged seedlings than untreated plots. Because substantial bird damage occurred before spraying, the Service plans to continue field tests using alternate application methods such as seed treatments before planting or earlier spray applications.

RIPENING GRAINS

Rice

Crase (1975a) summarized data from four trials in California with methiocarb for reducing blackbird damage to field plots of ripening rice. Treatment rates of 2.0-10.0 lbs/ acre resulted in about a 50% reduction in damage to eight treated plots compared to damage in adjacent untreated plots. In a study in Tanzania with a weaverbird, quelea (Quelea quelea) about 10 times more heads were damaged in untreated plots than in plots treated at a rate of 3.0 lbs/acre (De Grazio 1974). Similar results were obtained in Columbia where various blackbirds and purple gallinules (Porphyrula martinica) damaged 9 times more heads in untreated plots than in plots treated at 1.0 1b/acre (Woronecki 1974). In a recent residue study with rice (Crase 1976a), no mortality of mosquitofish (Gambusia affinis) resulted from a 5.0 lbs/acre aerial treatment, indicating that possible hazards of methiocarb to fish may not be as great as laboratory data might suggest. Future plans call for attempting to locate suitable commercial fields this year in California, Louisiana, and Texas for large-scale testing in 1977.

Grain Sorghum

Mott et al_. (1974) and Mott and Lewis (1975) showed that treatment rates of 2.0 and 3.0 lbs/acre, respectively, resulted in 11 times more damage by blackbirds in untreated Oklahoma and South Dakota grain sorghum fields than in treated fields. In Uruguay, a 5.0 lbs/acre aerial spray resulted in 43% less damage from eared doves in a treated field than in an untreated field (Mott 1973). Tests in commercial plantings of grain sorghum in the United States will be scheduled when an experimental permit is obtained or when the use of methiocarb as an insecticide is registered for this crop. Tests in fields of seed sorghum in Uruguay, designed to find a more economical level of protection, are scheduled for 1976.

Wheat

De Grazio (1974) treated ripening wheat in Tanzania for protection against quelea and observed that a 3.0 lbs/acre spray resulted in 8 times more damage to an untreated plot than to an adjacent treated plot. Another study in Kenya using a 1.5 lbs/acre rate gave inconclusive results due to insufficient bird pressure (DeHaven and De Grazio 1974). Two studies of methiocarb on swathed wheat in North Dakota to prevent damage by waterfowl (Cunningham 1974; Cunningham and Knittle 1975) were inconclusive because of low treatment levels and lack of bird pressure, respectively. A study of methiocarb on ripening wheat to prevent blackbird damage was also inconclusive because of insufficient bird pressure (Knittle et_al. 1975). Plans are to continue testing methiocarb on wheat with greater emphasis on selecting suitable sites.

RIPENING FRUITS

Cherries

In a 1971 study in Michigan, in which 1.0 1b (A1) methiocarb (75% W.P.)/100 gallons water was sprayed until it dripped, untreated sweet cherries showed 5 times as much damage and untreated tart cherries twice as much damage as did the treated ones (Guarino et al. 1974). In 1972, 1.7 times more damage occurred to untreated cherries than to treated ones when a 1/3 lb/100 gallons water treatment rate was used, but it was concluded that this rate was near the lower level of effectiveness of methiocarb (Guarino 1973). In both tests, as many as 16 species of birds were observed in the orchards, but robins (Turdus migratorius), rose-breasted grosbeaks (Pheucticus ludovicianus), cedar waxwings (Bombycilla cedrorum), starlings (Sturnus vulgaris), and common grackles were responsible for most of the damage. Plans have been made to undertake large-scale testing this spring of a 1.0 lb/100 gallons water formulation applied at 200 gallons/acre in two applications (14 and 7 days pre-harvest). Tests are scheduled for California, Washington, and Michigan. We hope to obtain data sufficient for a bird repellent registration; a Federal registration for use of methiocarb as an insecticide on cherries has already been granted (EPA Registration Number 3125-288).

Grapes

In the Fall of 1976, the Service will conclude a 3-year study at Almaden Vineyards, Paicines, California (with Gordon Boudreau) to determine the potential of methiocarb for protecting wine-grapes from damage by starlings, house finches (Carpodacus mexicanus), western bluebirds (Sialia mexicana), and other species. For the past 2 years, 1 acre of a 2 acre portion of Almaden's wine-grape nursery was sprayed until drip with the 1.0 lb/100 gallons water formulation and resprayed 4 weeks after the first treatment (Crase 1975b; Crase 1976b). Damage on the treated half was about one-fourth that on the untreated half during the first year of testing and about one-half that on the untreated half during the second year. Total damage was much less during the second year of the test. After this study is concluded, plans are to locate test sites in 1977 for the large-scale testing required to register methiocarb for use on this crop.

Blueberries

In studies in New Hampshire and Michigan, where blueberries were treated with 1.0 lb (AI) methiocarb/100 gallons water, 2 to 3 times as many berries were eaten by birds on untreated plantings as on treated ones (Bollengier et_ al. 1973; Stone et_ al. 1974). Again, a large variety of birds visited the test plots (12 species in the New Hampshire test). Large-scale testing in blueberries will depend on the progress made on methiocarb registration for cherries and grapes.

RATIONALE BEHIND THE USE OF CHEMICAL REPELLENTS

Guarino (1972) believed that the mechanism of methiocarb's repellency to birds was an initial post-ingestion disturbance, quickly followed by taste aversion. Rogers (1974) provided evidence that methiocarb's primary mode of action was similar to that for compounds that produce illness-induced aversion. After consuming methiocarb, birds learn to avoid treated foods and find alternative food sources. Our observations indicate that sufficient natural foods are available in most crop-damage situations, but that birds feed on cultivated crops largely because these crops are more available and abundant at some seasons. Also, on a per-unit-of-effort basis, cultivated crops may provide more nourishment than wild-growing foods. The hope is that birds repelled from fields of cultivated crops will return to eating natural foods rather than simply moving over onto untreated fields.

Most studies with methiocarb in the United States have been limited to relatively small acreages because of the necessity to purchase treated crops. These small treated acreages have often received serious damage, even though it was usually substantially less than that on untreated acreages. Some investigators believe, however, that when large commercial fields are treated, the repellent effect will be enhanced and damage to the treated areas will be less than that recorded in small-lot tests. Recently in Nicaragua, J. Sequeira treated 110 acres of rice being damaged by 300,000 dickcissels (Spiza americana) roosting adjacent to one of the fields (J.F. Besser, personal communication). A 1.25 lbs/acre methiocarb treatment completely stopped the damage, and the dickcissel roost moved to a new area several miles away. Investigators involved in field-testing methiocarb have often observed extensive changes in the flight patterns and feeding habits of birds after a methiocarb treatment, indicating that the chemical is indeed a very effective bird repellent and crop protectant.

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