University of Nebraska - Lincoln
DigitalCommons@University of Nebraska - Lincoln

Proceedings of the Eleventh Vertebrate Pest Conference (1984)

Vertebrate Pest Conference Proceedings collection

3-1-1984

CURRENT STATUS OF RESEARCH ON THE BLACKBIRD-SUNFLOWER PROBLEM IN NORTH DAKOTA

Joseph L. Guarino
U.S. Fish and Wildlife Service, Denver Wildlife Research Center, Denver, Colorado

Follow this and additional works at: http://digitalcommons.unl.edu/vpc11

Part of the Environmental Health and Protection Commons

Guarino, Joseph L., "CURRENT STATUS OF RESEARCH ON THE BLACKBIRD-SUNFLOWER PROBLEM IN NORTH DAKOTA" (1984). *Proceedings of the Eleventh Vertebrate Pest Conference (1984)*. Paper 17.
http://digitalcommons.unl.edu/vpc11/17

This Article is brought to you for free and open access by the Vertebrate Pest Conference Proceedings collection at DigitalCommons@University of Nebraska - Lincoln. It has been accepted for inclusion in Proceedings of the Eleventh Vertebrate Pest Conference (1984) by an authorized administrator of DigitalCommons@University of Nebraska - Lincoln.

CURRENT STATUS OF RESEARCH ON THE BLACKBIRD-SUNFLOWER PROBLEM IN NORTH DAKOTA

JOSEPH L. GUARINO, U.S. Fish and Wildlife Service, Denver Wildlife Research Center, Denver, Colorado 80225

ABSTRACT: Since 1979, the Denver Wildlife Research Center, U.S. Fish and Wildlife Service, has conducted an accelerated research program on the blackbird-sunflower problem which occurs annually in the Dakotas and Minnesota. The objective is to develop effective, cost beneficial and environmentally safe methods for reducing blackbird damage to ripening sunflower. A multidisciplinary approach involving interrelated studies of problem definition, ecology, and control methods development is being used. Preliminary results are presented from several studies involving: state- and county-wide estimates of damage; frequency distribution and timing of damage; compensatory growth in early damaged sunflower heads; breeding male blackbird censuses; mass-marking migratory red-winged blackbirds (Agelaius phoeniceus) in spring roosts; food habits of red-wings; the chemical frightening agent, 4-aminopyridine; the avian repellent, methiocarb; decoy crops for blackbirds; frightening devices; and bird-resistant varieties of sunflower. Management strategies suggested from these studies are provided.

INTRODUCTION

The production of sunflower (Helianthus annuus) seed in the Dakotas and Minnesota has accelerated at a rapid pace in the last two decades. In 1959, only 16,634 acres of sunflower were harvested in these states but by 1974 there was about a forty-fold increase to about 668,000 acres (Thomason 1974). Production then surged to 4,679,000 acres in 1982 (Statistical Reporting Service 1983). About 95 percent of the production in 1982 was of the oilseed varieties which are reported to be more heavily damaged by blackbirds (Besser 1978) and more attractive to many species of birds (Geis 1980) than non-oil varieties.

Blackbird damage to ripening sunflower seed also increased in North Dakota by 1978 when sunflower was planted in all counties. In the first statewide objective survey of bird damage in North Dakota in 1972, Stone (1973) estimated that 1.3 percent of the standing crop in 11 eastern counties was lost to birds. In a 1976 questionnaire survey of the attitude of farmers growing sunflower in eastern North Dakota, 27 percent of the respondents reported that birds were a potential problem (Schaffner 1976). In a second statewide objective survey of bird damage to sunflower in North Dakota in 1978, Henne et al. (1979) reported about a $3.5 million loss compared to a $300,000 loss in 1972 which they extrapolated from Stone (1973). The increased loss was attributed to the large increases in acreage and price.

In 1972, in response to the growing blackbird problem in ripening sunflower, the Denver Wildlife Research Center (DWRC), U.S. Fish and Wildlife Service (FWS) initiated research studies at a moderate effort level on the development of control methods. In 1979, following a Congressional appropriation of funds, the blackbird-sunflower problem was given higher priority and a greatly expanded research program was undertaken by the DWRC. This paper presents preliminary research findings from this program. Many studies are still in progress and most of the data collected during various phases of the program are either not yet analyzed, reported on, or published. Therefore, this paper references many unpublished reports.

PROGRAM OBJECTIVE

The overall objective of the program is to develop methods for alleviating losses to sunflower caused by blackbirds. In meeting this objective, we are using a multidisciplinary approach in an integrated research effort involving both short- and long-term studies that fall into three major research areas: a) Problem Definition; b) Ecological Studies; and c) Control Methods Development. Under (a) we have defined the extent, magnitude, and frequency distribution of sunflower losses in the Dakotas and Minnesota, the bird species involved, the timing of these losses, and the inter- and intra-field patterns of damage related to roosts, field location, habitat, and other environmental factors. Under (b) we have censused breeding populations of blackbirds in North Dakota, investigated feeding habits of red-winged blackbirds (Agelaius phoeniceus), and studied the local and migratory movement behavior of problem blackbird populations. This is being done to put the problem in proper perspective and to develop appropriate research and management strategies. And under (c) we are attempting to develop cost effective and environmentally safe chemical, cultural, and mechanical methods to alleviate blackbird damage to sunflower. A summary of the status and preliminary findings from some of these interrelated studies follows.

PROBLEM DEFINITION

Blackbirds are primarily responsible for most of the economically serious damage to ripening sunflower in the United States. The red-winged blackbird probably causes more loss than all other blackbird species. Other blackbird species that contribute importantly to damage are the common grackle (Quiscalus quiscula) and the yellow-headed blackbird (Xanthocephalus xanthocephalus).

Loss Estimates and Damage Patterns

In 1979, we initiated a two-year bird damage survey to objectively evaluate the extent and severity of sunflower losses to blackbirds in North Dakota, South Dakota, and Minnesota. In 1488 randomly selected sunflower fields in about 100 counties in these states we have shown that losses of sunflower to blackbirds from 1979 to 1980 increased from 40.3 million pounds worth $3.6 million to 59.4 million pounds worth $6.5 million in North Dakota, increased from 4.3 million pounds worth $0.4 million to 5.5 million pounds worth $0.6 million in South Dakota, and declined from 12.3 million pounds worth $1.1 million to 6.8 million pounds worth $0.8 million in Minnesota. In the three states, the total dollar loss increased by about 54 percent in 1980—-from $5.1 to $7.9 million, while the loss in pounds of seed increased by only 26 percent—-from 56.9 to 71.4 million pounds (Hothem, pers. comm.). In North Dakota, about 1.9 million acres of sunflower were harvested in 1978 (Lilleboe 1979) compared to about 2.2 million in 1980 (Statistical Reporting Service 1982). This is about a 16 percent increase compared to the 86 percent increase in dollar loss to birds--$3.5 million in 1978 (Henne 1979) and $6.5 million in 1980 (Hothem, pers. comm.). The 1980 increase reflects a particularly large loss of 21 percent of the crop in Stutsman County, a higher value of sunflower seed, and the fact that more acreage occurred in some of the best blackbird habitat in North Dakota.

In 1981, we conducted objective surveys of the distribution of damage in 50 fields each in the most consistently heavily damaged counties in North Dakota (Benson and Bottineau), South Dakota (Brown), and Minnesota (Mahnomen) to determine the percent of fields in which currently available damage control efforts would likely be cost effective. A preliminary analysis of data (Hothem, pers. comm.) showed that only 5 of 100 fields surveyed in North Dakota, 3 of 49 in South Dakota, and none of 50 in Minnesota received greater than 10 percent damage, the level which is generally considered to be the threshold of cost-effective control. In objective surveys in a more localized area surrounding a major blackbird roost at Sheyenne Lake, Sheridan County, North Dakota, however, about 23 percent of 30 and 38 fields in 1980 and 1981, respectively, received greater than 10 percent damage (Sterner and Hothem 1981, 1982). As expected, the high-damage fields were generally closest to the roost. These findings indicate that the use of most available control methods on the majority of sunflower fields in the three-state area will result in minimal or even negative cost-benefits, and that the intensive use of control methods on fields close to major roosts would be most beneficial to growers.

In studies from 1979 through 1981 on the timing of blackbird damage in 20 selected fields in northern North Dakota, it was shown that bird damage peaked an average of nine days after sunflower seed first became vulnerable to damage (when the yellow ray flowers started to wilt and drop on about 10 percent of the heads in a field) and that 66 percent of the damage occurred between 3 and 15 days after first vulnerability (Cummings, pers. comm.). At this stage of maturity the bowls of heads are still green and the developing seeds are soft. Damage declined thereafter until harvest. Thus, most growers, especially those with limited operating funds or time, need to apply their control efforts during this short period of the 7 to 10-week-long damage season to reap the greatest cost-benefit.

Factors Affecting Loss Estimates

In a two-year study designed to increase the accuracy of sunflower damage estimates conducted near Harvey, North Dakota, during 1981 and 1982, we discovered that measurements of blackbird damage to sunflower which are made just before harvest time probably underestimate actual losses. Sedgwick et al. (1983a) reported an average of about 28 percent greater shrinkage of bird damaged areas than undamaged areas on sunflower heads between the time damage occurred and the time when it is usually measured in near harvest surveys. On the other hand, data gathered on compensatory growth in these same test fields indicated that bird damage assessments made before harvest overestimate total damage because small-to-moderate amounts of bird damage are compensated for through increased weight of the remaining seed due to plant vigor. Sedgwick et al. (1983b) showed that when damage occurred during the first two weeks after the seeds first become vulnerable to birds, seed yields per unit of sunflower head area (analogous to yield/acre and of most interest to the grower) are similar between undamaged heads and heads that have received up to 15 percent damage. Thus, the data from studies on shrinkage of damaged areas and compensating growth complicate the final damage estimates and are now being analyzed in hopes of developing correction factors for use in future surveys.

The tentative findings from the problem definition phase of our research suggest that damage control efforts should generally be applied to a small percentage of sunflower fields and that the most intensive effort is needed for only a short period. By frightening blackbirds from fields during the first two weeks after they are vulnerable to bird damage could be spread among fields and if damage is kept at low levels, growth compensation should allow yields at harvest to be largely unaffected.

ECOLOGICAL STUDIES

Monitoring Breeding Blackbird Populations

We are continually collecting information needed for the proper management of problem breeding and migrating blackbird populations. The birds causing sunflower damage are migratory and begin arriving in North Dakota in late March for breeding and begin departing in late August to over-winter in more southerly states. In a survey of 130 randomly selected 160-acre blocks in North Dakota, Besser (1982) found that the number of breeding male red-wings in North Dakota in 1981-1982 had decreased an estimated 29 percent from numbers found by Stewart and Kantrud (1972) in 1967. While red-wings declined, breeding grackle and yellow head numbers increased by about 71 and 371 percent, respectively, making these increasingly important species in the sunflower problem. The number of breeding male red-wings in North Dakota was estimated to be about 1.5 million birds in 1981-1982.

Monitoring Red-wing Spring Migratory Roosts

We are also trying to identify major spring migratory blackbird roosts that may have an impact on the sunflower problem in North Dakota. DeGrazio et al. (1969) have shown that blackbird control at winter roosts for resolving corn damage problems in South Dakota is probably not feasible. Little is known, however, about spring migratory roosts in this context. Therefore, we sought to determine the feasibility of managing huge blackbird populations that funnel through and coalesce in major spring migratory roosts from a myriad of winter roosts scattered throughout the blackbirds' more southerly wintering area.

To evaluate this concept, in March 1982 we marked about 9 million adult male red-wings at two major spring roosts in northwestern Missouri which contained about 15 million total blackbirds. Marking was accomplished by mixing extremely small fluorescent resin particles (a talcum powder-like substance) in diesel fuel and boiled linseed oil and applying this formulation aerially to the roosting birds just before dark. Birds marked in this manner can be identified by examining their feathers under long-wave ultra-violet black light.

After birds dispersed from the roosts, about 6500 male red-wings were than collected from mid-May through mid-July throughout 19 states and 3 Canadian provinces by numerous cooperators. Collectively about 9 percent were marked--28 percent from Manitoba, 16 percent from North Dakota, and about 9 percent from South Dakota, Minnesota and Alberta. Less than 5 percent of the birds collected front 5 other states were marked and none were marked in 11 other states sampled (Knittle 1984). These data indicated that red-wing population management at these spring roosts would impact the breeding red-wing populations in at least 8 states and 3 Canadian provinces over an area encompassing 688,000 square miles.

In March 1983, we also marked about 2.4 million red-wings at a large roost at Lake Thompson, South Dakota. Male red-wings were collected from many of the same areas as in 1982 and are presently being examined for markers. Although this spring roost is much closer to the sunflower problem areas than the Missouri roosts, preliminary information indicates that a lower percentage of birds involved in the sunflower problem were marked.

The percentage of marked red-wings in the sample collections each year was relatively low for North Dakota. Control at these roosts applied in the same manner as the marker would probably have a minimal effect on sunflower damage in late fall in North Dakota. However, due to population turnover, we may have marked only a small portion of the total numbers of birds moving through these roosts. Therefore, in our effort to determine the feasibility of this strategy, we will continue studies on the population dynamics of not only these roosts but also of any newly found roosts.

Red-wing Feeding Habits

Beginning in 1979, the DWRC contracted with North Dakota State University (NDSU) to research several aspects of the blackbird-sunflower problem that would interrelate with and complement our studies. One study was to determine the feeding behavior of red-wings in Cass County, North Dakota. Studies conducted in 1979 and 1980 showed that the red-wing diet progressively changed from insects to weed seeds to crops from spring through fall; that red-wing use of sunflower seed was highest from 26 August to 6 October (a period which includes their fall migratory season and which coincides with peak damage); that sunflower seed made up 71 percent of the male and 57 percent of the female diets; and that foxtail or pigeon grass (*Setaria* spp.) was a significant item in their diet (Linz et al. 1982). Insects also made up a significant percentage of the diet of red-wings collected in sunflower fields through at least mid-August, illustrating some of the beneficial aspects of red-wings.

The food habits results suggest several potential management strategies for reducing red-wing damage to sunflower: diversification of crops to include those less attractive to red-wings, retention of stubble fields until area-wide harvest is completed, encouragement of pigeon grass stands where they do not interfere with crop production, and controlling insects and weeds in sunflower fields to reduce their attractiveness to birds.

CONTROL METHODS DEVELOPMENT

Avitrol®

Results from early studies conducted with Avitrol® FC Corn Chops-99S (AFCC-99S; Avitrol Corp., Tulsa, Oklahoma; use of trade names does not constitute a U.S. Government endorsement), which contains 4-aminopyridine(4AP) as the active ingredient, provided efficacy information which resulted in its Federal registration in August 1976 for use in reducing blackbird damage to ripening sunflower (Besser and Guarino 1976). Increased conflicts between sunflower growers and blackbirds, changing agricultural practices, use problems associated with baiting methods (Besser and Pfiefer 1977), reported grower dissatisfaction with AFCC-99S, and conflicting results from other trials with the registered product prompted us to re-examine our research effort with this bird management tool. Results from our studies with AFCC-99S conducted from 1979 through 1982 near Upham and Devil's Lake, North Dakota, were also conflicting and showed either no significant reductions in damage due to treatments or reductions that averaged around 45 percent.

In 1981 and 1982, we identified and corrected what was considered a serious problem with AFCC-99S baits--4AP was being lost from corn baits through abrasion during treatment, shipping, dilution, and application processes. However, in 1983, 4AP was also found to readily vaporize at temperatures of

70°F to 95°F and up to 83 percent of the 4AP was lost at 95°F in 168 hours (Cunningham 1983). In cooperation with the manufacturer, these problems have been corrected by stabilizing 4AP with hydrochloric acid (HCl).

During 1983 a block treatment with the reformulated 4AP-HCl bait was undertaken near Harvey, North Dakota. Twenty-three of 204 sunflower fields were treated in a 144-section block centered on a large blackbird roost. In randomly sampled fields overall bird damage was lower but not significantly different from damage in 1981 in a similar overlapping block when no treatment was used. There was a clear, statistical difference in the ranking of field damage between 1981 and 1983 supporting a treatment effect which dispersed damage. However, there was also a real possibility that this difference was due to a large increase in the number of fields and total area of sunflower in 1983 rather than to the 4AP-HCl baiting (Jaeger et al. 1983). Conclusions at this time are tentative as there is only a single year for both the treatment and the control for comparison. A third year without control and a fourth year with control are planned.

Mesurol®

Mesurol® (Mobay Chemical Corp., Kansas City, Missouri), containing the active ingredient methiocarb, is a broad-spectrum avian repellent which is effective in reducing damage to several agricultural crops against a variety of species of birds (Guarino 1972, Crase and DeHaven 1976). It is federally registered for use on planted corn seed to prevent sprout-pulling by blackbirds and pheasants (*Phasianus colchicus*), and on ripening cherries and blueberries to prevent damage by many bird species; registrations for use on planted rice seed and ripening grapes are pending.

A contract study conducted by NDSU suggested that Mesurol treatment of sunflower seed both in the laboratory and field had promise in reducing blackbird damage to sunflower (Gustavson et al. 1982). Although our laboratory studies have also shown that Mesurol will reduce feeding by caged red-wings on sunflower seed, we have not been able to achieve efficacy in South Dakota sunflower field trials from 1979-1982. Spraying sunflower heads with methiocarb has proven ineffective except when using treatment rates greater than 7.5 lbs methiocarb/acre. Such high levels are impractical due to their high cost and resulting high residue levels. Results from small plot studies in 1982 in South Dakota by Jaeger et al. (1983) clearly indicated the ineffectiveness of methiocarb-treated ground baits in repelling birds from sunflower heads. Combining these baits with either visual (colored flags), or behavioral (4AP induced stress) cues also had no apparent beneficial effects. Simultaneous treatment with methiocarb sprays and methiocarb-treated baits also failed to provide significant differences in damage between treated and control plots.

Decoy Crops

Decoy crops have proved to be effective for reducing waterfowl damage to swathed cereal grain fields (U.S. Fish and Wildlife Service 1979). From 1979 through 1983 we conducted tests of this concept as a means for reducing blackbird damage to ripening sunflower in several areas of North Dakota. Results have been highly encouraging.

In 1981, 70 acres (four fields) of sunflower decoy plantings for blackbirds received an average of 54 percent bird damage. In 1982, an interplanted field (17 acres corn, 17 acres sunflower) received 100 percent damage on the sunflower and 23 percent damage on the corn. About 37,000 pounds of seed were removed from the lure crop fields each year. In 1983, all the seed was eaten in about 135 acres of sunflower plantings (Cummings, unpubl. data). Theoretically, overall bird damage in surrounding commercial fields should have been reduced by about the same amounts as consumed in the decoy fields each year.

It costs an average of about $30 per acre to plant the decoy crops, but an acre consumed by birds in commercial fields is worth from $100 to $150 depending on yield and price. Therefore, about $4 to $5 should be saved for every dollar spent. If decoy crops are strategically placed in high-damage locations and planting is timed properly, they should prove to be a valuable management tool. The key to their successful utilization, however, depends on the availability of idle or otherwise nonproductive land (private, state, or federal) near large blackbird roosts.

Frightening Devices

It has been reported that birds become accustomed to frightening devices rather quickly--especially those which produce a single stimulus such as sound, and that combined devices which produce both sound and sight stimuli are more effective. Under the premise that it takes longer for birds to condition to a combination of devices (because the response might be additive), and if this period could be lengthened to about 15 days (when 66 percent of the total damage occurs based on chronology data reported earlier), these devices would be most useful for reducing bird damage to sunflower. Therefore, we conducted studies with a combined audio-visual frightening device in North Dakota in 1981 and 1982. The device consisted of a CO_2-operated, full-bodied, man-sized, pop-up scarecrow operated in synchrony with a Purivox® Double-John carousel propane exploder.

Results from 1982 data showed about an 84 percent reduction in bird damage when one device was used for every 4-6 acres of field (Cummings et al. 1983). Effectiveness was not demonstrated, however, in 1981 when one device was used for every 8-10 acres (Knittle et al. 1982). Although the 1982 results are encouraging, the combined device was relatively expensive at about $14 per acre per year (based on a 10-year life expectancy). Thus, at current average yields and prices, expected damage to sunflower

field must be at least 18 percent before the device could potentially be cost-effective. Based on statewide data, only about 3.5 percent of the sunflower fields in North Dakota receive damage this high so it would be cost-effective for only a few growers.

Bird Resistant Sunflower

A third contract study by NDSU was to investigate the potential of developing a sunflower variety resistant to bird damage. Fox and Parfitt (1982) found (a) significant differences among inbred genotypes for bird resistance, (b) no apparent relationship between chlorogenic acid content of seeds and hulls and bird damage, (c) a high heritability of bird resistance, and (d) a relationship between morphological traits of sunflower and bird damage. Protective morphological features include flat or concave horizontally oriented heads, long wrap-around bracts, tightly held seeds, and a head-to-stem distance greater than 15 cm (6 in) (Fox and Linz 1983). Their evaluations demonstrated that bird-resistant genotypes were significantly more resistant to bird depredation within all tested environments than 11 commercial hybrids. In addition, they conducted about 20 small plot (1-5 acres) field trials with bird-resistant varieties in North Dakota, Ohio, Florida and Manitoba, Canada, from August through October 1983. These data are presently being analyzed.

MANAGEMENT IMPLICATIONS

There is no panacea for the sunflower problem. However, based on the preliminary findings from our research effort to date, we believe that sunflower growers can often minimize their losses to blackbirds by the judicious use of several management measures as follows: Whenever possible, diversify crops and plant crops less susceptible to blackbirds in fields adjacent to known blackbird roosts or trees that harbor birds during the day, synchronize planting time of sunflower with neighbors to eliminate early or late maturing crops which are more vulnerable to damage; control weeds and insects in fields to minimize a field's attractiveness to blackbirds; leave stubble, especially sunflower, unplowed for as long as possible to provide alternative feeding sites for blackbirds; consider using desiccants for earlier harvest of fields if serious bird problems persist; cooperatively, with neighbors, plant decoy crops in a strategic location on idle or noncrop land; use AFCC-99S baits and various mechanical frightening devices, especially in various combinations; apply the most intensive damage control operations primarily during the first 15 days after ray flowers start to wilt and drop on at least 10 percent of the heads in a field; and, finally, weigh the cost of crop protection against expected damage to achieve a positive cost-benefit.

LITERATURE CITED

BESSER, J. F. 1978. Birds and sunflower, pp. 263-278 In: Sunflower Science and Technology, Jack F. Carter, Ed. Am. Soc. of Agron., Madison, Wisconsin.

_____. 1982. Breeding blackbird populations in North Dakota, 1967 versus 1981-1982. Unpubl. Bird Damage Research Report No. 253, Denver Wildlife Research Center. 16pp.

_____, and J. L. GUARINO. 1976. Protection of ripening sunflowers from blackbird damage by baiting with Avitrol® FC Corn Chops-99S. Proc. Bird Control Semin., Bowling Green State University, Bowling Green, Ohio. 7:200-203.

_____, and W. K. PFEIFER. 1977. Improvement of baiting methods for protecting ripening sunflowers from blackbirds. Proc. Sunflower Forum 2:11-12.

CRASE, F. T., and R. W. DEHAVEN. 1976. Methiocarb: its current status as a bird repellent. Proc. Vertebr. Pest Conf. 7:46-50.

CUMMINGS, J. L., C. E. KNITTLE, and J. L. GUARINO. 1983. An evaluation of a mechanical, audio-visual, scare-device for reducing blackbird damage to ripening sunflower. Part II. Unpubl. Bird Damage Research Report No. 284, Denver Wildlife Research Center. 12pp.

CUNNINGHAM, D. J. 1983. Avitrol bait formulation improved. Research Information Bulletin No. 83-39. U.S. Fish and Wildlife Service, Washington, D.C. 2pp.

DEGRAZIO, J. W., J. F. BESSER, and J. L. GUARINO. 1969. Winter distribution of blackbirds as related to corn damage control in Brown County, South Dakota. Trans. North Amer. Wildl. and Nat. Resour. Conf. 34:131-136.

FOX, G. J., and D. E. PARFITT. 1982. Genetic sources of resistance/tolerance to bird predation of sunflower. Agron. Abstr. p.66.

_____, and G. M. LINZ. 1983. Bird resistant sunflower. Proc. Bird Control Semin., Bowling Green State University, Bowling Green, Ohio. (in press)

GEIS, A. D. 1980. Relative attractiveness of different foods at wild bird feeders. U.S.D.I. Spec. Sci. Rep., Wildl. No. 233. 11 pp.

GUARINO, J. L. 1972. Methiocarb, a chemical bird repellent: A review of its effectiveness on crops. Proc. Vertebr. Pest Conf. 5:108-111.

GUSTAVSON, C. R., G. A. HOLZER, J. C. GUSTAVSON, and D. L. VAKOCH. 1982. An evaluation of phenol methylcarbamates as taste aversion producing agents in caged blackbirds. Appl. Anim. Ethol. 8(6):551-559.

HENNE, D. R., W. K. PFEIFER, and J. F. BESSER. 1979. Bird damage to sunflower in North Dakota in 1978. Proc. Sunflower Forum, Fargo, North Dakota. 3:16-17.

JAEGER, M. M., J. L. CUMMINGS, D. L. OTIS, J. L. GUARINO, and C. E. KNITTLE. 1983. Block treatment of Avitrol to protect ripening sunflower from blackbirds near Harvey, North Dakota. Proc. Sunflower Workshop. Bismarck, North Dakota. (in press)

_____, D. J. CUNNINGHAM, R. L. BRUGGERS, and E. C. SCOTT. 1983. Assessment of methiocarb-impregnated sunflower seeds as a ground-bait to repel blackbirds from ripening sunflower at Sand Lake, NWR, South Dakota. Proc. Bird Control Semin., Bowling Green State University, Bowling Green, Ohio. (in press)

KNITTLE, C. E. 1984. Red-winged blackbird dispersal traced from Missouri roosts via mass-marking techniques. Research Information Bulletin. U.S. Fish and Wildlife Service. Washington, D.C. (in press)

_____, J. L. CUMMINGS, and J. L. GUARINO. 1982. An evaluation of a mechanical, audio-visual, scare-device for reducing blackbird damage to ripening sunflower. Unpubl. Bird Damage Research Report No. 254, Denver Wildlife Research Center. 16 pp.

LILLEBOE, D. 1979. Crop Reporting Service, "Our goal is to provide facts for decision making." The Sunflower. May/June. pp. 12, 26.

LINZ, G. M., J. F. CASSEL, and R. B. CARLSON. 1982. Molt, food habits, and brown-headed cowbird parasitism of red-winged blackbirds in Cass County, North Dakota. North Dakota Res. Rep. 93, Nov., Agric. Exp. Sta., North Dakota State University. 7 pp.

SCHAFFNER, L. W. 1976. Survey details farmers' attitudes about sunflower. The Sunflower. February. pp. 20-21.

SEDGWICK, J. A., J. L. OLDEMEYER, and E. L. SMITH. 1983a. Shrinkage of sunflower related to head size, percent damage and time of damage. Unpubl. Bird Damage Research Report No. 282, Denver wildlife Research Center. 31 pp.

_____. 1983b. Growth compensation in sunflowers. Unpubl. Bird Damage Research Report No. 283, Denver Wildlife Research Center. 10 pp.

STATISTICAL REPORTING SERVICE. 1982. Crop production: 1981 annual summary. U.S.D.A., Washington, D.C. 42 pp.

_____. 1983. Crop production: 1982 annual summary. U.S.D.A., Washington, D.C. 42 pp.

STERNER, R. T., and R. L. HOTHEM. 1981. Analysis of blackbird damage to sunflower fields surrounding Sheyenne Lake, North Dakota--1980. Unpubl. Bird Damage Research Report No. 199, Denver Wildlife Research Center. 23 pp.

_____. 1982. Analysis of blackbird damage to sunflower fields surrounding Sheyenne Lake, North Dakota--1981. Unpubl. Bird Damage Research Report No. 251, Denver Wildlife Research Center. 16 pp.

STEWART, R. E., and H. A. KANTRUD. 1972. Population estimates of breeding birds in North Dakota. Auk 89(4):766-788.

STONE, C. P. 1973. Bird damage to agricultural crops in the United States - a current summary. Proc. Bird Control Semin., Bowling Green State University, Bowling Green, Ohio. 6:264-267.

THOMASOM, F. G. 1974. The U.S. sunflower seed situation. The National Sunflower Grower 1(11):7-14.

U.S. FISH AND WILDLIFE SERVICE. 1979. Waterfowl lure crop program. Annual Report, Animal Damage Control, Bismarck Area Office, Bismarck, North Dakota. 21 pp.