Control of bird pests in sunflower crops: options and limitations

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Abstract

- Bird damage to sunflower (*Helianthus annuus* L.) is recognized as an international economic problem for sunflower producers. Over the past 40 years, scientists in North America have developed and tested numerous methods to reduce bird damage. These include chemical and physical frightening agents, aversive repellents, bird-resistant sunflowers, wildlife conservation sunflower plots (WCSP), habitat management, population management, and cultural modifications in cropping.
- The methods fit into three broad categories: frightening, evading, and population suppression. Evasion techniques such as habitat management, decoy crops, and cultural modifications are applicable in nearly all landscapes where sunflower is grown and should be effective against the majority of bird species that depredate sunflower.
- Usually there is no single management solution to bird damage and multiple methods are needed to reduce damage. Our future research efforts may include development of (1) an aerially applied feeding repellent, (2) a perennial variety of single-headed sunflower for use in WCSP, and (3) a commercially viable, bird-resistant sunflower.

Key words: blackbirds, bird damage, Icteridae, methods development, sunflower

Introduction

Bird damage to sunflower (*Helianthus annuus* L.) occurs in every major sunflower-growing region of the world, including Australia, China, Europe, India, North America, Pakistan, Russia, South America, and Ukraine (Linz et al., 2011). The damage is caused by several families of birds, befitting of commercial sunflower's wide geographic distribution. Among the families of birds, major instigators of damage are Columbidae, Cacatuidae, Psittacidiae, Corvidae, Passeridae, Icteridae, and Emberizidae. Localized damage up to 25% of a field has been reported in South America, Australia, Europe, and Africa (De Grazio, 1989; Bomford, 1992; Rodriguez et al., 1995; van Niekerk, 2009; Khaleghizadeh, 2011; Linz et al., 2011). However, bird damage is quite variable and dependent upon many factors, including cropping patterns and proximity of sunflower to nesting and roosting habitats of depredating bird species (Otis and Kilburn 1988). Ruinous levels of damage, including complete loss, can occur in landscapes having relatively few sunflower fields and locally abundant populations of birds that eat sunflower (Linz and Hanzel, 1997). Defending sunflower fields from birds can be an exasperating and sometimes futile endeavor because there are few efficacious and environmentally safe methods to reduce damage.

An intensive research collaboration to develop methods to reduce bird damage to sunflower was begun in the 1970s in the Prairie Pothole Region (PPR) of central North America. The PPR is renowned for its high density of cattail-dominated (*Typha* spp. L.) wetlands, and concomitantly, its large populations of blackbirds (Icteridae), which use wetlands for reproduction and roosting. The soils and climate in the PPR are ideal for growing sunflower, and the bulk of sunflower production (70%) in North America occurs in this region. Annually, blackbirds in the PPR eat about 19,000 tonnes of sunflower ($US 7.0 million, at $0.37/kg; Peer et al., 2003). This represents a region-wide estimate of 2% damage (Klosterman, 2011). Bird damage of ≤5% is an economically important threshold in the PPR and is considered tolerable by growers (Linz et al., 2011). However, availability of cattail-dominated wetlands in the PPR landscape often dictates blackbird densities, and damage levels locally can be great enough to cause some growers to drop sunflower from crop rotations (Linz and Hanzel, 1997). Damage by blackbirds is a major reason that plantings in the PPR have decreased by 44% from a peak of 1 million ha in the late 1960's (Linz et al., 2011).

Government and university scientists in the United States have invested enormous amounts of effort in researching and developing effective and environmentally safe methods to reduce bird damage to sunflower. Researchers have tested chemical and physical frightening agents, aversive repellents, bird-resistant sunflowers, decoy crops, habitat management, population management, and cultural modifications in cropping. We describe here the methods that have been developed and used in the United States to protect sunflower from birds and report on the progress of ongoing research. Finally, we give guidance for future research to reduce bird damage to sunflower.

Cultural Practices

An obvious bird management strategy is simply to not plant near traditional wetland roosting sites (Linz et al., 2011). For several reasons this strategy may be unfeasible. First, sunflower producers may not be aware of all roosts, which can be several kilometers away. Second, because birds are highly mobile animals, roosts may occur in areas not previously occupied. Lastly, many growers recognize that sunflower is a valuable rotational crop and have no inclination to drop it from their systematic crop rotations.

If a field can be defended from birds until it reaches physiological maturity, then growers do have an option for avoiding late-season damage through chemical desiccation, which advances the harvest date. For many years, paraquat and sodium chloride were the only desiccants available (Linz et al., 2011). Both allowed harvest to occur about three weeks earlier than would happen through a natural dry-down process. Unfortunately, both have shortcomings. For example, if precipitation occurs after an application of paraquat, the stems may fail under the weight of moisture-laden heads, which reduces harvesting efficiency. Sodium chloride is expensive to apply because of large volume requirements (187–280 liters per ha) and need for a ground-based sprayer.

In 2007, the U.S. Environmental Protection Agency labeled the herbicide, glyphosate (N-[phosphonomethyl] glycine), for late season use in sunflower, thereby providing not only weed control but the added benefit of collateral killing of standing sunflower. Glyphosate advances the sunflower harvest date by about 10 days and, if sunflower has reached its physiological maturity (achenes at <35% moisture), does not cause reductions in either yield or oil content. Moreover, the plants will not absorb moisture if precipitation occurs (Stahlman et al., 2010). In 2010, Kixor™ (a.i., saflufenacil) became available for desiccating sunflower and controlling broadleaf weeds. Kixor can be tank-mixed with glyphosate. The mix of Kixor and glyphosate acts synergistically, drying sunflower faster than glyphosate alone and drying the stems faster than paraquat (Stahlman et al., 2010). Research on the costs and benefits of desiccation, as it relates solely to reduction in bird damage, will have to be conducted before we determine efficacy of desiccation. However, we believe that desiccation certainly has potential to reduce late-season bird damage.

Wildlife Conservation Plots

The concept of reducing blackbird damage to sunflower crops by offering supplemental feeding plots (i.e., decoy crops) was first tested in the early 1980s with oilseed sunflowers planted near commercial sunflower fields (Cummings et al., 1987). Exploitation of decoy fields by blackbirds indicated that commercial fields had attained a positive cost:benefit ratio of 1:4 (i.e., 1 unit of cost provided 4 units of benefit). Although the results were promising, no government entities were willing to formally implement a decoy crop program.

The use of supplemental feeding plots as a bird-management tool was revisited in 2004 and 2005. The Wildlife Services branch of the U.S. Department of Agriculture (USDA) offered candidate sunflower producers the option of planting financially subsidized, 8-ha Wildlife Conservation Sunflower Plots (WCSP) near cattail-dominated wetlands with histories of blackbird use (Hagy et al., 2008). Blackbird damage to the WCSP was highly variable, ranging from 0% to 100%. During both years of the study, the WCSP produced an average of 1290 kg/ha, and birds removed 34% of this production. In comparison to Cummings et al. (1987), the cost:benefit ratio was 2:1, indicating a negative economic return. However, the cost:benefit ratio did not include the intrinsic values of WCSP, such as value gained from use of the plots by several nontarget bird species for foraging and protective cover. Some of the species using WCSP were grassland bird species of conservation concern (Hagy et al., 2010). Given the current expense of planting decoy plots, WCSP are best used to protect high-value oil and confectionery varieties of sunflower planted either near roosts or under flight lines emanating from roosts. The planting of oilseed WCSP sunflowers near confectionary sunflowers—the latter being much more valuable—could offset WCSP planting costs if bird damage in the WCSP is ≥12%. Hagy et al. (2008) found that 74% of the WCSP had damage levels ≥12%.

An initial release of a perennial sunflower variety that makes WCSP more cost effective is anticipated in 2013 (Kantar et al., 2010). Perennial sunflowers would add more to WCSP economic contributions by substantially reducing planting costs, stabilizing highly erodible lands near wetlands, and providing year-round habitat for wildlife. Sunflower growers often argue that (in addition to planting costs) WCSP take valuable agricultural land out of production, but WCSP need not be planted on agricultural lands provided that public lands, such as federal wildlife refuges, waterfowl production areas, and Conservation Reserve Program lands, are available (Cummings et al., 1987). If WCSP were to become a viable tool in an integrated pest-management strategy for sunflowers, it would provide synergy with other management tools being developed, especially the repellents. When an alternative food source is available, repellents can become more effective because if starvation is the only alternative, birds will withstand greater levels of discomfort from repellents (Avery, 2002).

Propane Exploders and Pyrotechnics

Propane exploders are the most popular of the mechanical scare devices used by growers and wildlife professionals in the PPR (Bomford and O'Brien, 1990; Conover, 2002). The effective range of propane cannons has been shown to be confined to relatively small areas of 2-3 ha (Cummings et al., 1986). In the PPR, field sizes are often 65 ha or larger, and for propane cannons to be cost-beneficial the expected field damage should exceed 18%, which is an uncommonly high level of damage for the region (Linz and Hanzel, 1997). Blackbirds can quickly habituate to propane cannons; we suggest that they be moved frequently, vary in direction and timing of explosions, and be augmented with pyrotechnics or live ammunition. Timers and infrared motion sensors are used to vary the timing between explosions. Propane cannons have inherited a perception of effectiveness that may not be entirely justified unless the above recommendations are followed.

Trapping

Decoy traps allow wildlife managers and growers to reduce the numbers of a depredating target species while greatly reducing the risks of taking nontarget species. Cage traps stocked with live decoy birds have been used successfully to remove European starlings (*Sturnus vulgaris* L.) from fruit orchards, house sparrows (*Passer domesticus*) from small plots of experimental sunflower, and blackbirds in rice-growing areas (Conover, 2002; Linz et al., 2011). Nevertheless, trapping has been ineffective when used for defending large fields. Scientists from USDA-Wildlife Services' National Wildlife Research Center (NWRC) evaluated two large-sized, mobile decoy traps for capturing blackbirds actively feeding on ripening sunflowers during late summer and early fall (Linz et al., 2011). They captured only a few dozen birds from among the thousands of blackbirds using the fields. Moreover, the captures occurred after the crop had reached physiological maturity and after the achenes had become less palatable, so the risk for substantial damage had subsided. Thus, trapping was deemed economically inefficient for protecting sunflower crops because of labor costs, travel costs to maintain decoy birds, and poor trapping success. Similarly, Weatherhead et al. (1980) concluded that decoy traps removed less than 2% of the trappable number of blackbirds foraging in ripening cornfields.

Bird-resistant sunflowers

In the 1980s, plant geneticists developed sunflower lines with traits presumed to thwart foraging blackbirds. Bird-resistant features included a concave head shape, thick fibrous hulls, hulls with high levels of anthocynanins, long chaff, long bracts, a head-to-stem distance >15 cm, and ground-facing heads (Gross and Hanzel, 1991). Field tests and cage experiments showed that blackbirds preferred feeding on standard oilseed hybrids compared to bird-resistant varieties; however, the bird-resistant varieties had low oil content and agronomic yield, which unfortunately are characteristics avoided both by blackbirds and by sunflower producers. In the early 1990s, the sunflower-breeding program was abandoned because of prohibitive technical challenges involved in developing a commercially competitive hybrid that would have a combination of bird-resistant traits and high oil content and yield. Research on bird- resistant sunflower may have received new life in August 2010. North Dakota State University and the USDA Agricultural Research Service announced a collaborative research project for developing and evaluating new cultivars from completely homozygous inbred sunflower lines using double-haploid technology (Jan et al., 2011). This technology could allow rapid development of new bird-resistant varieties in the future.

Roost habitat management

In 1989, scientists in the United States initiated a multifaceted series of studies to assess the efficacy, cost–benefits, and environmental effects of using an aquatic herbicide to eliminate blackbird roosting habitat through fragmentation of cattail-dominated wetlands (Linz and Homan, 2010). These studies led to the creation in 1991of an operational cattail management program in North Dakota and South Dakota. The program was conducted by USDA-Wildlife Services. Helicopters were used to spray wetlands with 28 L ha^{-1} of an aqueous solution containing 2.2 kg ha^{-1} glyphosate and 1% v/v surfactant. The treatments effectively controlled cattails for more than four years when water depths remained stable at >30 cm (Linz et al., 2010). Presumably, dispersing dense concentrations of blackbirds from their roost sites spreads bird damage over a larger area, which leads to reduced severity of localized damage (Otis and Kilburn, 1988). Statistical evidence to support this hypothesis, however, remains indirect (Linz et al., 2010). We recommend a systematic monitoring program to assess the regrowth of cattails and track temporal changes in blackbird damage patterns near glyphosate-treated wetlands.

Chemical repellents

Wildlife managers recognize that an integrated pest management program to reduce and disperse blackbird damage would benefit greatly from the discovery of a chemical bird repellent. Currently two products are registered for foliar use as bird repellents on ripening crops, Bird Shield™ (a.i., methyl anthranilate, Bird Shield Repellent Corporation, Pullman, Washington) and FlockBuster (a.i., lemon grass oil, garlic oil, clove oil, peppermint oil, rosemary oil, thyme oil and white pepper; [FlockBuster, 1018 Center Street, West Fargo, North Dakota, 58078, USA]). Both products have produced inconsistent results in the laboratory and field (Linz et al., 2011). A small number of sunflower growers have reported to the senior author during extension meetings that they still use these products in North Dakota, albeit with inconsistent results.

Chemists at NWRC have screened thousands of candidate compounds for bird repellency, with only a few showing promise (Avery, 2002). Recent investigations have focused mainly on naturally occurring compounds called biopesticides. Among the numerous biopesticides tested, 9,10-anthraquinone (Arkion Life Sciences, New Castle, Delaware) might be an effective blackbird repellent (Avery, 2002). Cage trials and field trials have demonstrated that anthraquinone-based (AQ) repellents protected ripening corn and sunflower. Werner et al. (2011) reported that AQ repelled blackbirds confined within enclosures in fields of standing sunflowers. In the United States and Uruguay, initial studies to determine the AQ concentration needed to repel free-ranging blackbirds from ripening sunflower began in 2011. The latter country already has AQ-based repellents registered for several crops, including sunflowers (Rodriguez et al., 2004).

At least two major obstacles will have to be overcome to have a successful and effective bird repellent for sunflower. First, bird damage in sunflowers can occur up to the harvesting date; therefore, the repellent must be effective for up to six weeks, yet chemical residues must be gone by harvest in October. Second, the downward-facing heads of sunflower plants prevent a repellent from reaching the achenes using aerial methods of application, the most efficacious method for crop treatment.

Our future research on repellents includes studies on the use of high-clearance ground sprayers that can apply large volumes of liquids with nozzles pointed upward toward the face of the heads (Mullally, 2010). This equipment should enable pesticide applicators to achieve better coverage of the achenes than is possible with low-volume aerial applications. In addition, we will test whether a persistent compound, such as AQ, sprayed on the back of sunflower heads might provide sufficient repellency to move birds to an alternate food source. Both of these studies will provide strong indications of the potential efficacy for use of repellents on sunflowers. Finally, if AQ fulfills its potential as a cost-effective feeding deterrent for ripening sunflowers, the ecological and environmental effects on nontarget bird species will need to be investigated.

Population Management

Attempts to manage blackbird populations to reduce sunflower damage have largely failed because of societal concerns and inherent inefficacy in trying to control pest populations with a high growth rate. In the 1960s, in response to producer concerns about large populations of pest-bird species using dairies and feedlots, the U.S. Fish and Wildlife Service developed the avicide DRC-1339 (3-chloro-p-toluidine hydrochloride, also known as 3-chloro-4-methylbenzenamine hydrochloride). It has broad utility for population management because it is highly toxic to several bird species that are agricultural pests, including European starlings, blackbirds, and corvids. DRC-1339 is considered environmentally safe when it is applied according to the label instructions, which include applying the avicide away from all nontarget birds.

In the mid-1990s, a multiyear assessment was conducted on feasibility of an operational DRC-1339 program for managing populations of spring-migrating blackbirds in eastern South Dakota (Linz et al., 2003). This area is a major stopover site used by millions of blackbirds migrating toward their breeding territories in sunflower production areas (Homan et al., 2004). Although scientist demonstrated that thousands of blackbirds could be attracted to rice-baited plots in cornfields, a baiting program was not implemented because program costs would likely have outweighed the benefits (Blackwell et al., 2003).

Sunflower producers in the PPR remained supportive of DRC-1339 as a management tool, reasoning that using DRC-1339 directly in ripening sunflower fields might be the solution. In the 1990s, scientists placed DRC-1339 baits on the ground in ripening sunflower fields near blackbird roosting sites. They did not detect a statistical difference in the amount of bird damage between baited and unbaited fields (Linz et al., 2011). In 2007 and 2008, Winter (2010) made what was presumably a final attempt at baiting blackbirds feeding in ripening sunflower. He placed DRC-1339 baits in elevated feeding trays attached to cages of live decoy blackbirds adjacent to ripening sunflower fields. Field observations indicated that although the risks to nontarget species were minimal, the decoys could not attract sufficient numbers of free-ranging blackbirds to make this baiting strategy cost effective. Enticing blackbirds away from foraging on the heads of ripening sunflower is a major challenge that must be met for the effective use of DRC-1339 plots in sunflower.

Suggested best practices

Most of the nonlethal methods we discussed either have been used or can be used in nearly all agricultural ecosystems facing problems with flocking granivorous birds. Currently, we suggest a tiered suite of methods to reduce blackbird damage in the PPR. The first tier includes 1) managing dense cattail stands to disperse large roosting concentrations of blackbirds and 2) using a plant desiccant to accelerate fall harvest. The second tier includes 1) using propane cannons that are moved regularly and timed to fire at irregular intervals and 2) planting decoy crops in strategic locations. The third tier includes 1) not planting crops susceptible to bird damage near traditional roosts, 2) synchronizing the planting time of sunflowers with those in neighboring fields to eliminate the availability of early-maturing and late-maturing crops in the same locality, 3) planting large fields to spread the damage over greater areas, 4) delaying the plowing of harvested grain fields to provide an alternate food source, 5) controlling weeds and insects that may habituate birds to feeding in sunflower fields prior to achene development, and 6) leaving unplanted pathways within fields so that the grower has access to interior portions to chase birds (Linz et al., 2011). A damage-management strategy combining these three tiers is most likely to meet the test of predictable efficacy, economic viability, and practicality. Population management works only in scenarios where the depredating population is localized and stable without immigration. Because this scenario is uncommon in most bird-agriculture conflicts, it has the least chance for long-term success at controlling damage.

Future research

We will continue to pursue an effective, safe and cost-beneficial bird repellent for use in sunflower and other grains crops. Further, we remain optimistic that scientists at the USDA Agricultural Research Service in Fargo, North Dakota, and the University of Minnesota, St. Paul, will develop a perennial sunflower variety with a single head that can be planted and used by blackbirds as an alternative food source on otherwise unproductive private and government owned lands. Alternative sources of foods, in combination with a repellent, would be a powerful bird management tool. The advent of double-haploid technology might allow rapid development and evaluation of new bird-resistant cultivars. We believe that a dwarf variety with extreme head concavity might be a reasonable approach, provided that the line’s yield and oil content can be maintained. A dwarf variety would provide less cover for the birds and a concave head might increase the time needed to remove achenes, thus increasing the energetic costs of feeding. The sunflower industry is looking for new methodologies to confront this very difficult production problem. Do you have an idea?

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