Evaluation of an Avian Repellent in Reducing Blackbird Damage when Applied to Sunflower Using Drop Nozzle-equipped Ground Rigs

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Introduction

In North Dakota large flocks of blackbirds feed on ripening crops after breeding and prior to migration with annual damage estimates averaging $3.5 million for sunflower (Cummings et al. 1989; Klosterman et al. 2013). Sunflower producers implement various techniques to disperse blackbirds, including firearms, propane cannons, pyrotechnics, and thinning of cattail marshes (Linz et al 2011). As a last resort, sunflower producers have also been known to remove sunflower from their crop rotation due to high levels of blackbird damage (Kleingartner 1992). Chemical repellents applied to sunflower may be a method to protect fields if the product can be effectively applied (Linz et al. 2011). One candidate bird repellent is anthraquinone (AQ). Arkion™ Life Sciences, LLC has been granted a national registration (EPA FIFRA Section 3) to use AQ at the seeding stage and is working on foliar application near harvest. Although AQ has shown repellency in the lab (Werner et al. 2009), field studies in foliar sunflower have been inconclusive (Kandel et al. 2009; Werner et al. 2011, 2014; Niner et al. 2015). Since the repellent needs to be ingested to be effective, one obstacle to using AQ in ripening sunflower is applying sufficient repellent directly on the face of the sunflower. Thus, using a ground rig equipped with drop nozzles to apply repellent directly to the sunflower face may increase field efficacy. We tested efficacy of an anthraquinone-based repellent (AV-5055) when applied via drop-nozzle to sunflower and using enclosed blackbirds in a semi-natural field setting.

Methods

We established 10 replicates with no repellent and 10 replicates where repellent was applied (Fig. 1). Each replicate (11.5 x 12.5 ft) included five rows of oilseed sunflower spaced 30 inches apart (0.0033 acres). On 31 August 2017, we used a ground rig equipped with 360 Yield Center, 360 Undercover® drop nozzle sprayers to apply repellent (AV-5055; 13% AQ by weight) when at least 50% of the sunflowers were at the R6 growth stage (Fig. 1). The drop nozzles were equipped with flat fan nozzles on the side ports (XR11001VS) and a hollow cone nozzle in the center (TX-VK3). We applied 20 gal/ac of solution to sunflower plots with a product application rate of 1.0 gal/ac, achieved with the combination of 60 PSI while driving 2.4 MPH. During application, we applied 35 spray cards (2.25 x 3.5 in) to sunflower heads to assess coverage. We collected disk flowers and achenes for residue analyses after application and prior to harvest.

We installed a bird enclosure (12 x 13 x 6 to 10 ft) over each replicate to stock 10 captive birds for 23 days (7-29 September 2017; Fig. 1). We provided 300 g of alternative diet (i.e., red milo) for the birds in all untreated and treated enclosures and provided water ad libitum. We measured consumption of alternative diet every other day throughout the study. We manually harvested sunflower heads and collected stand count and damage estimates within untreated and treated enclosures on 7 October 2017. We recorded the area of developed by measuring the diameter and undeveloped center of each sunflower head within the enclosure and area damaged for each sunflower head using a 5-cm^2 template grid. The estimate of percent damage was calculated by dividing the area of missing achenes by total area of developed achenes and multiplying by 100. We estimated blackbird consumption of sunflower by dividing the developed area that had sunflower achenes remaining by yield at harvest (corrected for moisture content) to estimate mass of achenes per square inch. We then multiplied mass per square inch by area damaged for an estimate of mass damaged for each enclosure. The mass damaged included the entire achene (i.e., seed and hull).

Results and Discussion

Although yield can be influenced by variation in agronomic factors, we did not see significant differences between untreated and treated enclosures. The stand count ranged from 85–120 plants (mean = 102 ± 3) for untreated and 85-122 plants (mean = 97 ± 4) for treated. The area of developed ranged from 2,329-3,295 in^2 (mean = 2,829 ± 98 in^2) for untreated and 2,143-3,285 in^2 (mean = 2,850 ± 99 in^2) for treated. Thus, the amount of sunflower available to be damaged was similar between treated and untreated. When foraging on sunflower, birds respond to moisture and oil content when selecting which seeds and the amount of seeds to consume in an effort to meet nutritional needs. The percent moisture ranged from 2.2-2.8% (mean = 2.5 ± 0.1%) for untreated and 2.2-2.5% (mean = 2.3 ± 0.04%) for treated. The percent oil ranged from 41.9-45.7% (mean = 44.3 ± 0.4%) for untreated and 42.5-45.9% (mean = 44.4 ± 0.3%) for treated. Sunflower test weight ranged from 28.1-31.4 lbs/bu (mean = 29.8 ± 0.3 lbs/bu) for untreated and 28.7-30.9 lbs/bu (mean = 29.4 ± 0.2 lbs/bu) for treated. Birds were not exposed to different sunflower quality, therefore seed consumption was not likely to vary due to agronomic factors.

If the repellent was effective in decreasing avian consumption of sunflower, the consumption of alternative feed would increase to maintain daily energy demands of the red-winged blackbird. The consumption of alternative diet ranged from 0.035–1.268 lbs (mean = 0.582 ± 0.096 lbs) for untreated and 0.159–0.833 lbs (mean = 0.433 ± 0.076 lbs) for treated replicates. Thus, the avian repellent did not cause the birds to consume more alternative diet. The red-winged blackbirds in this study were using sunflower to maintain their daily energy needs as evidenced from the estimated mass of sunflower damaged. Sunflower damage ranged from 891–1,572 lbs/ac (mean = 1,238 ± 60 lbs/ac) for untreated and 874–1,554 lbs/ac (mean = 1,243 ± 76 lbs/ac) for treated replicates. For individual blackbirds average mass of achenes consumed per day ranged from 0.0128-0.0225 lbs (mean = 0.0178 ± 0.001 lbs) for untreated and 0.0125-0.0223 lbs (mean = 0.0178 ± 0.001 lbs) for treated replicates, which is in line with bioenergetic models as discussed by Peer et al. (2003), where male red-winged blackbirds were estimated to consume 0.0110-0.0198 lbs of achenes per day. Thus, sunflower yield did not differ between treated and untreated enclosures as a result of blackbird damage. Sunflower yield corrected for moisture ranged from 846–2,167 lbs/ac (mean = 1,397 ± 136 lbs/ac) for untreated and 959–1,668 lbs/ac (mean = 1355 ± 84 lbs/ac) for treated replicates. As applied, the avian repellent was not effective at reducing blackbird damage in sunflower.

Spray cards indicate presence of repellent on the sunflower face after application, but the amount of residue needed on disk flowers to effectively decrease blackbird consumption is unknown. Repellent residues appeared to be insufficient to decrease blackbird consumption of sunflower treated with AV-5055. Our results indicate that field application of repellent to achenes within downward facing sunflower heads is problematic. Repellent coverage on the spray cards ranged from 0–61% (mean = 14 ± 3%). The variation in the amount of repellent reaching the face of the sunflower is a limitation when applying a repellent to reduce bird damage in sunflower. This could be overcome by increasing the application rate. Sprayer technology and economic limitations related to repellent costs currently make increasing application rate impractical for broad-scale agriculture. Thus, future repellent studies should be aimed at optimizing the repellent formulation (e.g., %AQ) for specific pests and crops. For example, studies aimed at optimizing the efficacy of repellents in sunflower should take into consideration growth form and application abilities in the field in combination with blackbird feeding physiology and behavior.

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Literature Cited

Cummings, J. L., J. L. Guarino, and C. E. Knittle. 1989. Chronology of blackbird damage to sunflowers. *Wildlife Society Bulletin* 17:50–52.

Kandel, H., B. Johnson, C. Deplazes, G. Linz, and M. Santer. 2009. Sunflower Treated with Avipel (Anthraquinone) Bird Repellent. *Proceedings of the 31st National Sunflower Association Research Forum*, Fargo, ND.

Kleingartner, L. 1992. Sunflower losses to blackbirds: an economic burden. Page 13-14 In: Linz, G. M., ed. *Management of North American Blackbirds*. Washington, D.C., United States Department of Agriculture.

Klosterman, M. E., G. M. Linz, A. A Slowik, and H. J. Homan. 2013. Comparisons between blackbird damage to corn and sunflower in North Dakota. *Crop Protection* 53:1-5.

Linz, G. M., H. J. Homan, S. J. Werner, H. M. Hagy, and W. J. Bleier. 2011. Assessment of bird-management strategies to protect sunflowers. *Bioscience* 61:960-970.

Niner, M. D., G. M. Linz, and M. E. Clark. 2015. Evaluation of 9,10 anthraquinone application to pre-seed set sunflowers for repelling blackbirds. *Human-Wildlife Interactions* 9:4-13.

Peer, B. D., H. J. Homan, G. M. Linz, and W. J. Bleier. 2003. Impact of blackbird damage to sunflower: bioenergetic and economic models. *Ecological Applications* 13:248-256.

Werner, S. J., J. C. Carlson, S. K. Tupper, and M. M. Santer, and G. M. Linz. 2009. Threshold concentrations of an anthraquinone-based repellent for Canada geese, red-winged blackbirds, and ring-necked pheasants. *Applied Animal Behaviour Science* 121:190-196.

Werner, S. J., G. M. Linz, J. C. Carlson, S. E. Pettit, S. K. Tupper, and M. M. Santer. 2011. Anthraquinone-based bird repellent for sunflower crops. *Applied Animal Behaviour Science* 129:162-169.

Werner, S. J., S. K. Tupper, S. E. Pettit, J. W. Ellis, J. C. Carlson, D. A. Goldade, N. M. Hofmann, H. J. Homan, and G. M. Linz. 2014. Application strategies for an anthraquinone-based repellent to protect oilseed sunflower crops from pest blackbirds. *Crop Protection* 59:63-70.

Fig. 1: A) Sunflower plots at NDSU Carrington REC with installation of 20 bird enclosures (U = untreated replicates; T = treated replicates; * = spray cards). B) The 12 x 13 x 6-10 ft bird enclosure stocked with 10 male red-winged blackbirds (*Agelaius phoeniceus*). C) Small plot, ground rig equipped with 360 Yield Center, 360 Undercover® drop nozzles.