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Short communication

# Horned lark damage to pre-emerged canola seedlings

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ABSTRACT

Winter canola (*Brassica napus* L.) is considered the most promising domestically-produced oilseed feedstock for biodiesel production and for diversifying wheat (*Triticum aestivum* L.)-based cropping systems in the Inland Pacific Northwest, USA. Winter canola field experiments conducted in east-central Washington were completely destroyed, and commercial fields were damaged or destroyed, over several years by large flocks of horned larks (*Eremophilia alperestis* L.) that ate the cotyledon leaves of pre-emerged and newly-emerged seedlings. Numerous control methods were attempted in field experiments, including laying bird netting over the entire experiment, placement of a life-size predator decoy in a field experiment, loud propane-powered cannon blasts, and mixing garlic with canola seed before planting followed by spraying garlic water on the soil surface. None of the attempted control methods were successful. This is the first report in the literature of horned lark damage to pre-emerged and newly-emerged canola seedlings. We discuss questions relevant to our novel account as well as potential abatement using falcons and non-toxic chemical repellents for the protection of industrial canola crops associated with horned lark depredation.



## 1. Introduction

Canola is planted on approximately 700,000 ha annually in the United States with about 80% of production in North Dakota (USDA-NASS, 2015). An average of 15,000 ha of canola is planted annually in Washington State (USDA-NASS, 2015). Canola is grown on more than 8 million ha per year in Canada, predominantly in Saskatchewan and Alberta (Government of Canada, 2015). Canola is considered an excellent biodiesel feedstock.

The Washington State Legislature passed a law (RCW 19.112.110) in 2006 that requires at least two percent of diesel sold within the state must be biodiesel. This law further mandates that at least five percent must be biodiesel when the state's Department of Agriculture determines that in-state production of oilseed feedstock can satisfy this requirement. Since 2007, the Legislature has provided annual funding averaging US$ 300,000 to Washington State University (WSU) for research on production of oilseed feedstocks.

Biodiesel feedstock production research at WSU has largely centered on winter canola (Fig. 1) due to high seed yields compared to spring canola, camelina (*Camelina sativa* L.), and safflower (*Carthamus tinctorious* L.). Inclusion of canola in wheat-based rotations affords an excellent opportunity for control of grass weeds and soil-borne diseases and enhances nitrogen mineralization that boosts grain yield of the subsequent wheat crop (Kirkegaard et al., 1994; Seymour et al., 2012).

An oilseed crushing plant with a capacity of 1100 mt of canola seed per day was opened in Warden, WA in 2013. This crushing facility provides a local market and reduces transportation costs for canola farmers in eastern Washington. The majority of canola feedstock for the Warden crushing facility is currently imported from Canada and North Dakota.

Horned larks (Fig. 2) are native to North America and they occupy the Arctic south to Mexico. They are also found in central Asia, with outlying populations in Morocco and Columbia. The horned lark is a common bird that prefers short, sparsely vegetated prairies, deserts and agricultural lands (Beason, 1995). Horned larks are permanent residents throughout most of their breeding range (i.e., Canada, U.S. and Mexico), migrating only from northern regions during winter.

In agricultural areas, horned larks inhabit open areas and fallow fields. Horned larks eat mostly seeds during winter. During the breeding season, adults predominantly eat seeds but feed insects to their young. Adults consume more insects during the spring and fall, perhaps to compensate for the energy demands of breeding and molting (i.e., annual feather replacement; Beason, 1995).

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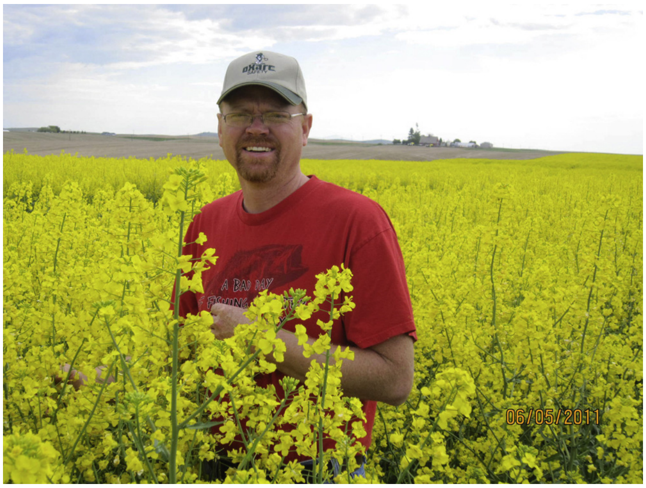


**Fig. 1.** Winter canola in an on-farm field experiment near Davenport, Washington in 2011. Horned larks did not infest this site. Long-term experiments at this site (455 mm annual average precipitation) have documented rainfed winter canola seed yields as high as 4250 kg/ha. Winter canola is considered the most important feedstock for biodiesel production in Washington. Photo by W.F. Schillinger.

**Fig. 2.** The horned lark is a ground-dwelling bird commonly found in open areas and in fallow fields throughout North America. Photos by Terry Sohl (with permission) and S.J. Werner.

North American flocks of migrating horned larks often intermix with resident horned larks (Beason, 1995) to form flocks of great density.

With regard to agricultural depredation, horned larks uniquely damage lettuce (*Lactuca sativa* L.) seeds and seedlings. Horned lark damage to lettuce crops has motivated the use of several bird damage management techniques, including chemical repellents. Although methiocarb effectively reduced horned lark damage to lettuce seedlings in aviary tests (Cummings et al., 1998) and a field enclosure study (York et al., 2000), methiocarb is no longer registered in the U.S. as a bird repellent. Werner et al. (2015) observed 38–100% feeding repellency among horned larks offered wheat seeds treated with 168–3010 ppm anthraquinone.

Horned larks were first observed as a problem in newly-planted winter canola at the WSU Dryland Research Station at Lind, WA in 2006 where they completely destroyed a 0.13-ha field experiment before any seedlings could emerge. Birds ate only the cotyledons, not the hypocotyl or seed. This same phenomenon occurred with all rainfed and irrigated winter canola plantings in four subsequent years at Lind. Winter canola was planted in late August. In all cases, horned larks infested plots about three days after planting and exhibited a frantic feeding behavior. Hundreds of horned larks fed in research plots and continued to eat cotyledon leaves until about 24 h following emergence, after which they showed no further interest in the canola and departed the area. During these same years, many thousands of horned larks were present in at least five individual 52-ha commercial circle-pivot irrigated winter canola fields located as distant as 65 km from the WSU Dryland Research Station. Damage to canola stands in commercial fields by horned larks ranged from minor to complete destruction. One farmer related that at least 10,000 horned larks destroyed a stand of newly-planted winter canola on 25 ha which necessitated replanting (Jeff Schibel, personnel communication, 2016). In late April 2016, horned larks destroyed two irrigation circles (105 ha) of newly-planted spring canola and the farmer replanted both fields (J.R. Swinger, personnel communication, 2016).

## 2. Materials and methods

Both rainfed and irrigated winter canola field experiments have been conducted at the WSU Dryland Research Station since 2000. These experiments included long-term irrigated cropping systems, direct seeding winter canola into thick, standing irrigated winter wheat stubble, and rainfed winter canola planting date studies. No observed horned lark damage to winter canola occurred from 2000 through 2005. Beginning in 2006, horned larks completely destroyed all winter canola experiments. The land area planted to winter canola in the experiments ranged from 0.1 to 1.3 ha.

Since 2006, several measures were attempted to control horned lark damage in newly-planted winter canola experiments at Lind. These were:

(i) A loud propane-powered boom cannon (such as that used in fruit orchards) was placed inside the plot area three days after planting and set to explode at both random and fixed one-to five-minute intervals.

(ii) Bird netting with 2-cm mesh such as used to protect cherry trees was purchased from a supply store and spread on the surface a 0.2-ha irrigated winter canola experiment the day after planting. Standing stubble from the previous wheat crop helped to keep much of the netting above the soil surface. Segments of netting were connected with plastic ties.

(iii) Concurrent with placing bird netting on the soil surface, a life-size great horned owl (*Bubo virginianus* Gmelin) replica was mounted on a 1-m-tall perch in the plot area two days after planting.

(iv) A large quantity of garlic powder was mixed with canola seed (a 0.5-L container full of garlic mixed with 1.5 kg of seed) in the air drill before planting. Immediately after planting, additional garlic was then mixed with water and applied uniformly on the soil surface with a plot sprayer. A light water irrigation of 3 mm was then applied to incorporate garlic into the surface soil.

## 3. Results

The results from the treatments described above were as follows:

(i) Propane-powered boom cannon. Explosions initially caused the birds to take flight, but they soon returned to feeding. Horned larks soon became accustomed to the cannon blasts, after which they fluttered briefly about a meter off the ground before resuming feeding.

(ii) Bird netting. Horned larks were able to peck the soil surface through the netting mesh where the netting was in contact with the soil. The birds were not able to peck the soil surface where netting was suspended on top of standing wheat stubble. Many horned larks wedged themselves underneath the netting in small gaps where netting segments were attached with plastic ties and travelled under the netting to eat pre-emerged cotyledon leaves. A few dozen horned larks died after becoming trapped in the netting. The sight of dead horned larks did nothing to deter their companions. Essentially all canola seedlings in the experiment were destroyed.

(iii) The placement of a life-size great horned owl in the plot area appeared to have little to no effect on deterring horned larks from feeding on pre-emerged canola seedlings.

(iv) Garlic treatments. A very strong odor of garlic was emitted from the plot area following these treatments. Mason and Linz (1997) reported that many bird species avoid sulfurous odors such as that emitted from feed treated with garlic oil (0.01–1.0%, vol./mass). However, garlic had little to no effect in our experiment as horned larks completely destroyed the plot before seedlings emerged from the ground.

## 4. Discussion

This is the first report in the literature of horned lark damage to pre-emerged and newly-emerged canola seedlings. We documented damage to, and destruction of, canola seedlings in commercial-size fields and destruction of canola in smaller-sized field experiments. Several attempted control strategies were unsuccessful.

A new potential control method was tried in April 2016 by the farmer discussed earlier who had just lost his 105-ha irrigated spring canola seedlings to horned larks. After replanting spring canola, this farmer placed five propane-powered boom cannons around the two fields and hired a commercial falconer. The falconer brought six Aplomado falcons (*Falco femoralis* Temminck) to the site. These falcons were trained to follow a ground-controlled airplane that was modified to resemble the size and appearance of an Aplomado falcon. Operating with three falcons at a time, the falconer systematically flew the airplane, followed by three falcons, over the canola fields at a height of 75 m or less. Horned larks would take flight when they saw the falcons but would return to feeding in the canola field when the falcons passed over. Nonetheless, the density of horned larks soon declined as evidenced by diminished flock size. After the first day using the falcons, horned larks in the two canola fields were generally feeding in groups of four or less (Andres Sandoval, Falconry Bird Abatement, Burbank, WA, personal communication). Although some bird damage occurred, the farmer was able to achieve a satisfactory spring canola stand from his second planting.

The cost for replanting canola is substantial. At the standard seeding rate of 5.5 kg/ha, the current canola seed cost is $43/ha. Custom planting of crops in the region (with tractor, drill, fuel, and operator provided) costs about $45/ha (Jeff Schibel, personal communication, 2016). In addition, reduced seed yield with delayed planting of spring canola is common. In a 9-year study in Pullman, WA, Huggins and Painter (2011) showed an average 50% seed yield decline when planting was delayed from April 11 to May 11. Chen et al. (2005) reported that delaying planting from mid-April to mid-May in a 3-year study in central Montana resulted in a 43–63% seed yield reduction. Seed yield reductions with late planted spring canola were associated with flowering and seed development occurring under more heat stress compared to earlier-planted spring canola.

These experiences raise several questions: (i) Why did horned larks become a problem at the WSU Dryland Research Station beginning in 2006 when winter canola had been successfully established many times at this site (with no known horned lark damage) in several preceding years? (ii) Horned larks are native over a wide geographic area, yet damage to canola seedlings by this bird was documented in only a relatively small (i.e., 15,000 $km^2$) area. What are the implications of horned lark depredation to canola throughout the U.S. and Canada? (iii) Why are new cotyledon leaves of canola so appetizing to horned larks? (iv) Why do horned larks infest some canola fields but not others? (v) How can horned larks detect pre-emerged canola seedlings through a strong odor of garlic? (vi) What are the movement, roosting, nesting and foraging patterns of horned larks associated with canola depredation?

Repellent seed treatments can be used to protect newly-planted crops from bird depredation. In January 2016, an anthraquinone-based seed treatment was registered in the U.S. for the protection of newly-planted corn (*Zea mays* L.) and rice (*Oryza sativa* L.) from blackbird (*Agelaius phoeniceus* L.) depredation (AV-1011®, Arkion Life Sciences, New Castle, DE, USA). We plan to test the field efficacy of pre-plant seed treatments (e.g., ≥3000 ppm anthraquinone) for the protection of pre-emerged and newly-emerged canola seedlings from horned lark depredation.

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## Further reading

Washington Oilseed Cropping System Project. http://css.wsu.edu/biofuels/.