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Effectiveness of Flight Control™ to Reduce Damage to Lettuce Seedlings from Horned Larks

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ABSTRACT: Lettuce is an important economic crop in California, with approximately 101,000 ha in production and a value of \$1.3 billion in 2002. Bird damage to lettuce in the San Joaquin Valley, the central coast, and southern California is believed to amount to millions of dollars annually. We evaluated the effectiveness of Flight Control™ (50% anthraquinone applied at 10 L/ha) as a foliar spray for protecting emerging lettuce seedlings from depredation by horned larks. In field enclosure trials conducted near Huron, in the San Joaquin Valley of California, damage to treated lettuce seedlings was 8.5%, compared to 68% damage to untreated seedlings. In a field test, anthraquinone residues on the day of treatment averaged 570 ppm and at Day 50 after treatment were lower than the method of detection (0.063 ppm). However, horned lark numbers using test sites were too low to detect any differences in damage among treated and untreated sites. Anthraquinone offers promise for reducing bird depredations to sprouting lettuce, but additional testing should be conducted to evaluate this repellent in a large-scale field setting.

KEY WORDS: anthraquinone, bird repellent, birds, California, *Eremophila alpestris*, horned lark, lettuce, seedling damage

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INTRODUCTION

Lettuce is an important economic crop in California, with approximately 101,000 ha in production and a value of \$1.3 billion in 2002 (California Farm Bureau Federation web page, 2006). Bird damage to lettuce is a severe problem in several of California's lettuce producing areas, including the San Joaquin Valley, the central coast, and southern California (Hueth *et al.* 1998), with losses believed to be millions of dollars annually (Cummings 1997, York *et al.* 2000). In 1974, about 45% of respondents to a survey of California lettuce growers considered bird damage a serious problem (DeHaven 1974). Some growers reported that their entire crop was destroyed by horned larks (*Eremophila alpestris*).

The major damaging species is the horned lark, which uproot seedlings, graze seedling leaves (cotyledons), and eat seeds. Damage usually continues until seedlings are about 8 cm in height. Seedlings that are nipped off below the crown will eventually die. Persistent pruning by birds can permanently dwarf plants resulting in reduced production and disrupted harvest schedules. Although the most severe damage occurs to seedlings, horned larks also damage the outer leaves of head lettuce. Most damage to lettuce from horned larks occurs from November to January in the Central Valley of California. Severe damage of lettuce by horned larks usually occurs first near the center of the field. If the number of birds is high, damage spreads rapidly until there is only a narrow fringe of undamaged plants remaining near the field border.

Growers have employed scaring methods such as shooting and propane exploders to alleviate damage, but few believed these methods to be effective. The current method of choice is scaring by shooting, which costs approximately \$145/ha and provides a questionable level of protection against an elusive species like horned larks.

An effective, economical and environmentally safe repellent to deter horned lark damage to lettuce seedlings

would be a valuable tool to integrate into damage reduction efforts (Cummings *et al.* 1998). Flight Control™ (SePRO Corporation, Carmel, IN) contains anthraquinone (50% a.i.). It is currently registered with the U.S. Environmental Protection Agency only as a general-use turf treatment for geese, but it has also shown promise for protecting newly planted rice from blackbirds (Cummings *et al.* 2002). This study was designed to evaluate the effectiveness of Flight Control™ to reduce horned lark damage to lettuce seedlings. We conducted two tests: a controlled field enclosure trial, and a small-plot field test with natural bird pressure. We also determined anthraquinone crop residues up to 50 days post application.

METHODS

Field Enclosure Trial

We conducted the study in a lettuce field near Huron, CA when lettuce seedlings were at the cotyledon stage, which according to lettuce growers is when plants are most susceptible to bird damage. We placed 6 portable enclosures (1.8 × 3 × 2.1 m) over 4 rows of lettuce seedlings, with enclosures separated by at least 2 m. In addition, one screen enclosure (0.3 × 0.3 × 0.1 m) was randomly placed over lettuce seedlings in each enclosure to provide an estimate of undamaged seedling density. The number of seedlings in each enclosure and under each enclosure was recorded prior to treatment and the release of horned larks into each enclosure.

We used a Solo® (Solo Corp., Newport News, VA) gasoline-powered backpack sprayer to apply Flight Control™ at a rate of 10 L/ha to emerging lettuce seedling in 3 randomly selected enclosures. Following the application, we released 3 wild-caught horned larks in each enclosure. Horned larks were provided commercial wild bird seed and water *ad libitum*. On each of the 5 days following application, we recorded the number of lettuce seedlings in treated and untreated enclosures and

under each screen enclosure.

A single-factor repeated measures ANOVA using SAS PROC GLM (SAS 2004) was used to compare enclosure and enclosure lettuce seedling counts over days.

Field Test

We selected six 1.2-ha test sites that were planted near Huron, CA to evaluate the efficacy of Flight Control™ under field conditions. Test sites were at least 300 m apart and subject to the same irrigation regime as a typical commercial lettuce field. Flight Control™ was applied by helicopter at a rate of 10 L/ha in 3 randomly selected fields at seedling emergence. The remaining 3 fields were treated with water only.

We assessed damage immediately before treatment and on Days 6 and 12 post-treatment. After 12 days post-emergence, lettuce seedlings were no longer susceptible to bird damage. We used a stratified random sampling design to assess bird damage. We divided each test site into 20 equal strata along the long axis of the field. An assessor walked from a randomly determined starting point the length of the strata and assessed bird damage at 10 evenly spaced points. At each assessment point, a 60 × 60 cm grid was placed on the ground and the number of lettuce seedlings was recorded. One screened enclosure (0.6 × 0.6 m) was randomly placed in every assessment transect at the start of the experiment to allow us to estimate normal seedling density. We used a 3-factor repeated measures structure design and a mixed linear model using SAS PROC MIXED (SAS 2004) to detect differences in damage among treated and untreated fields.

We conducted bird observations daily between 0600-1100 during the 12-day test period at each site. The number of birds observed entering and departing each test site during a 1-hour period was recorded. Observations were conducted from the same location each day at each site to reduce observation bias and minimize any influence on birds.

Residues

We collected lettuce from test sites prior to treatment, immediately after treatment, and 3, 6, 12, and 50 days after treatment to determine Flight Control™ (anthraquinone) residues. Lettuce samples were placed in labeled plastic bags, sealed and refrigerated in a cooler at 4°C for approximately 4 hours until they were transferred to a freezer at -10°C. At the conclusion of the study, all samples were shipped overnight in coolers with ice packs to the National Wildlife Research Center in Fort Collins, CO for analysis. The validated analytical method (Mauldin *et al.* 2002) was used to determine the residue concentration of anthraquinone. Untreated lettuce samples fortified at approximately 0.50 and 500 ppm were assayed for each of the 5 analysis days to assess the efficacy of the analytical methodology.

RESULTS

Field Enclosure Trial

Horned larks consumed fewer lettuce seedlings treated with Flight Control™ than untreated seedlings ($F = 5.09$, $d.f. = 5$, one-sided $P = 0.04$). Birds consumed an average

of 44 of 522 seedlings (8.5%) in the treated enclosures, versus 370 of 540 seedlings (68.5%) in untreated enclosures (Table 1). Most consumption (34 seedlings) of lettuce seedlings in treated enclosures occurred on Day 1 post-treatment, whereas lettuce seedling consumption in untreated enclosures occurred each day with highs on Days 1 and 3 (147 and 218 seedling consumed, respectively).

Table 1. Horned lark damage to lettuce seedlings treated with a foliar application of Flight Control™ at a 10 L/ha rate, Huron, California. Values indicate total number of undamaged lettuce seedling remaining.

Enclosure	Days Post-treatment					
	0	1	2	3	4	5
Treated-1	171	168	165	164	158	161
Treated-2	186	177	179	173	171	175
Treated-3	165	143	146	141	143	142
Total	522	488	490	478	472	478
Untreated-1	189	166	162	158	161	159
Untreated-2	182	114	117	86	38	11
Untreated-3	169	113	111	28	0	0
Total	540	393	390	272	199	170

Field Test

We observed only 77 horned larks foraging in all test fields during the entire 12-day test. Bird pressure on test fields was too low to detect differences in the consumption of lettuce seedlings. Screened enclosures indicated normal seedling emergence for treated and untreated test fields.

Residues

The recovery of anthraquinone residues from untreated lettuce seedling and cover leaves from mature lettuce head samples fortified at 0.50 and 500 ppm averaged 94.8% and 89.3%, respectively. The anthraquinone residues from treated fields averaged 570 ppm on the day of treatment, 314 ppm on Day 3 post-treatment, 103 ppm on Day 6 post-treatment, 32 ppm on Day 12 post-treatment, and 1.2 ppm on Day 50 post-treatment (Table 2). The average method limit of detection for this analysis was 0.063 ppm.

Table 2. Flight Control™ (anthraquinone) residues (ppm) in lettuce collected from test sites prior to treatment, immediately after treatment, and 3, 6, 12, and 50 days post-treatment, Huron, California. The method limit of detection (MLOD) for this analysis was 0.063 ppm.

Test Field	Pre-treatment	Treatment	Days Post-treatment			
			3	6	12	50
Field 1	MLOD	665	279	92	32	1.0
Field 2	MLOD	558	357	79	19	1.4
Field 3	MLOD	486	305	137	46	1.4

DISCUSSION

Small field test sites commonly used to meet the Environmental Protection Agency's acreage limitation of 4 ha, together with the necessity of destroying the crop after the test, often make it difficult to evaluate bird repellents under ordinary conditions. Bird pressure often

is unpredictable and often too low to successfully evaluate a compound in such small plots. The enclosures ensured that there would be bird pressure throughout the test. This allowed us to evaluate the repellent under what can be considered severe conditions. The bird pressure in the enclosure during the 5-day trial was equivalent to about 5,000 horned larks per ha per day. Under these conditions, bird damage was reduced by 92%. The effectiveness of Flight Control™ would probably be greater under normal conditions encountered in lettuce fields, where birds have alternative food and can fly to other feeding sites. We attempted to evaluate Flight Control™ in an open-field test, but bird pressure was not sufficient to assess repellency. Additional research should be conducted to allow testing on larger field sites.

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