POTENTIAL BIRD REPELLENTS TO REDUCE BIRD DAMAGE TO LETTUCE SEED AND SEEDLINGS

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ABSTRACT: The authors evaluated the effectiveness of ReJeX-iT® AG-145, Mesurol®, activated charcoal, lime, and fipronil to reduce horned lark damage to lettuce seeds and seedlings. In Experiment 1, horned larks consumed significantly more feed mixture (50:50 grains and lettuce seed) than untreated clay-coated lettuce seed in a three-day choice-test. In Experiment 2, where clay-coated lettuce seed was treated with ReJeX-iT® AG-145, Mesurol®, activated charcoal, or lime, there was no significant difference in consumption of untreated clay-coated lettuce seed and treated clay-coated lettuce seed. Horned larks consumed insignificant amounts of all seed treatments including untreated coated lettuce seed. In this experiment horned larks lost an average of 28% of their body weight over the three-day test period. It was concluded that the clay seed coating alone reduced damage significantly. In the aviary test, flats of sprouting lettuce seedlings were sprayed with Mesurol® (4 kg/ha), ReJeX-iT® AG-145 (64 kg/ha), lime (32 kg/ha), activated charcoal (32 kg/ha), and fipronil (4 kg/ha). Mesurol®, ReJeX-iT® AG-145, and lime significantly reduced consumption of lettuce seedlings over a four-day test period. Even though lime significantly reduced consumption, horned larks still consumed over 50% of the available lettuce seedlings. Field evaluations are warranted with Mesurol® and ReJeX-iT® AG-145.

KEY WORDS: activated charcoal, *Eremophila alpestris*, fipronil, horned lark, lime, methyl anthranilate, Mesurol®, methiocarb, ReJeX-iT® AG-145, repellents

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INTRODUCTION

Lettuce (*Lactuca sativa L.*) is an important economic crop in California, with approximately 77,000 ha in production and a value of $735 million in 1996 (California Farm Bureau Federation web page, 1998). Bird damage to recently planted crops is a major problem in several of California's lettuce producing areas, including the San Joaquin Valley, the central coast, and southern California. Annual losses due to bird damage is estimated at $4.6 million; this figure is based only on the amount invested at time of seedling emergence (Mark Arnold, pers. comm.). Actual losses in years of high market value could be several times greater. Forty-five percent of growers responding to a questionnaire survey regarded bird damage as a serious problem (DeHaven 1974).

The major damaging species is the horned lark (*Eremophila alpestris*) which takes the seeds, uproots seedlings and grazes seedling leaves (cotyledons). Damaged seedlings that are not uprooted will usually be stunted or disfigured. In the past, growers have used hazing methods such as shooting and propane exploders to alleviate damage, but few believed these methods to be effective. The current method of choice is hazing by shooting, which costs around $120 per hectare and provides a questionable level of protection against horned larks. Although practically all growers use shooting to haze horned larks, annual losses are estimated at 1,500 ha. The need exists for an effective, economical, and environmentally safe repellent to deter horned lark damage to lettuce seeds and seedlings. One compound that showed promise as a seed treatment or foliar spray on lettuce seedlings was Mesurol®, a product containing methicarb. However, field testing showed inclusive results (DeHaven 1975). At present, Gowan Company, Yuma, Arizona is resuming product registrations for Mesurol®.

Other potential compounds are ReJeX-iT® AG-145, product containing methyl anthranilate, activated charcoal, lime and fipronil. ReJeX-iT® AG-145 is registered with the Environmental Protection Agency (EPA) as an avian repellent for small fruit (PMC Speciality Group, Cincinnati, OH). Evidence indicated that methyl anthranilate at concentrations between 0.5 and 2% is an effective repellent to most bird species (Mason et al. 1989; Cummings et al. 1992). Activated charcoal mixed in with a preferred food of starlings decreased consumption (Mason and Clark 1994). In addition, when applied in a slurry to 0.25 ha winter wheat plots it significantly reduced snow goose use (Mason and Clark 1995). Lime mixed with millet or whole-kernel corn at 25%, 12.5%, and 6.25% reduced brown-headed cowbird and Canada goose feeding in choice cage trials (Belant et al. 1997). Also, application of lime to enclosed 10 x 10 m grass plots in slurry form at an application rate of 544 kg/ha reduced goose feeding on treated plots for two to three days (Belant et al. 1997). Anecdotal observations indicate that fipronil may also show some bird repellency.

The purpose of this evaluation was to test the bird repellency of five candidate compounds: ReJeX-iT® AG-145, Mesurol®, activated charcoal, lime, and fipronil to horned larks when applied to lettuce seed and seedlings in an aviary setting. Concurrently, the phytotoxicity of each compound was evaluated.

METHODS

Over 150 horned larks were captured during April and May 1995 in eastern Colorado for use in this study.

Equal numbers of birds were housed in each of four outdoor pens with access to mixed grains, meal worms and water. Horned larks were quarantined for 30 days before study initiation.

Cage Test

Experiment 1: Thirty experimentally naive horned larks were randomly selected, weighed, banded, and each assigned one per cage (27 cm x 27 cm x 40 cm). During the three-day preconditioning period, the birds were offered two cups with 10 g each of feed mix. The feed mix was 4 parts millet, 1 part wheat, and 1 part cracked corn mixed 1:1 with untreated lettuce seed. Immediately following the preconditioning period, on each of three test days between 0700 and 1300 h, horned larks were offered two cups, one with 20 g of the feed mix and one with 20 g of clay-coated lettuce seed. The position of the cups was switched each day to reduce location bias. A pan was placed under each cage to catch spillage. At the end of each 6 h test period, consumption was measured. Throughout the preconditioning period and test period, horned larks were offered water *ad libitum*. Each horned lark was weighed at the end of the test. An analysis of variance (ANOVA) was used to determine if there were differences between treatments. Linear contrasts were used to test whether mean consumption of feed mix during the preconditioning period and the test period was different, and whether mean consumption of feed mix and clay-coated lettuce seed during the test period was different.

Experiment 2: Thirty experimentally naive horned larks were randomly selected, weighed, banded, and assigned one per cage (27 cm x 27 cm x 40 cm). After a three-day acclimation period to cages, groups of six birds were randomly assigned one of the following treatment groups: control, ReJeX-iT® AG-145, Mesurol®, lime, and activated charcoal. The control was untreated clay-coated lettuce seed and the other treatments were lettuce seeds treated at 1% (wt/wt) of the respective chemical and then clay-coated. On each of three test days, horned larks were offered a cup containing a respective treatment between 0700 and 1300 h. A pan was placed under each cage to catch spillage. At the end of each 6 h test period, consumption was measured. Throughout the preconditioning period and test period, horned larks were offered water *ad libitum*. At the completion of the test, horned larks were weighed. An ANOVA was used to test if there were differences between treatments.

Aviary Test

Flats of lettuce seedlings were grown in a greenhouse and used in the test when they were 0.4 cm tall. Flats of untreated lettuce seedlings were offered to birds for a two-day preconditioning period. Each flat of lettuce seedlings were sprayed just prior to inclusion into the test with a hand-held sprayer calibrated to the respective chemical application rate. Thirty experimentally naive horned larks were randomly selected, weighed, banded, and assigned one per cage (2 m x 2 m x 2 m) with six birds per treatment. Each group of six birds was randomly assigned one of the following treatments: activated charcoal (32 kg/ha), fipronil (4 kg/ha), lime (32 kg/ha), ReJeX-iT® AG-145 (64 kg/ha), and Mesurol® (4 kg/ha). The test was conducted for four days from 0700 to 1300 h. During the test period, maintenance food was removed and only a flat of lettuce was available to each bird. Flats contained an average of 76 seedlings (range 40 to 128). The number of viable lettuce seedling remaining were recorded each day. Throughout the preconditioning and test period horned larks were offered water *ad libitum*. Immediately following the aviary test, all horned larks were weighed, banded, and released.

Analysis of data for each treatment was conducted separately. An analysis of variance (ANOVA) with repeated measures over days was used to determine if there was a treatment effect (SAS Institute Inc., Cary, NC). Only the final day of each preconditioning period was used in the analysis. Significance was set at $P < 0.05$.

RESULTS

Cage Test

Experiment 1: Overall, horned larks consumed significantly less clay-coated lettuce seed ($F_{31,238}=52.00$, $P<0.01$). Mean consumption of feed mix during the preconditioning period was 3.3 g/bird. During the test period horned larks consumed a mean of 4.8 and 0.2 g/bird of feed mix and clay-coated lettuce seed, respectively (Figure 1). Mean consumption of feed mix during the preconditioning period was significantly less than the test period ($F_{1,238}=149.43$, $P<0.01$). Mean consumption of feed mix was greater than clay-coated seed ($F_{1,238}=1413.09$, $P<0.01$). Mean weight loss of horned larks during the test period averaged 3.4%.

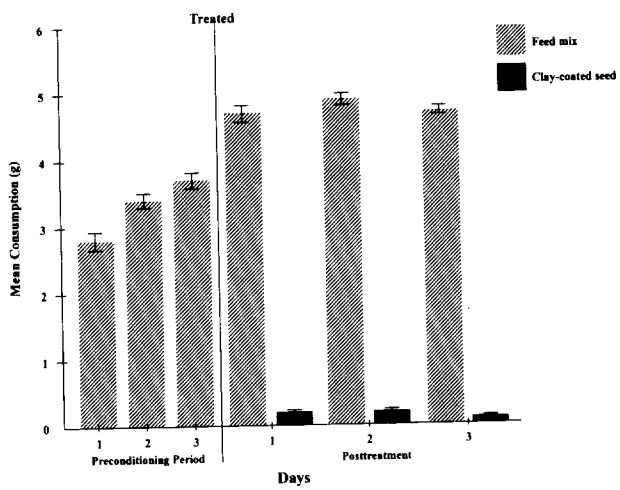

Figure 1. Experiment 1: Horned lark consumption of untreated clay-coated lettuce seed in a choice test. Capped vertical lines represent standard errors.

Experiment 2: There were no significant differences in mean consumption of untreated clay-coated lettuce seed or treated clay-coated lettuce seed ($F_{4,85}=2.04$; $P=0.09$). Mean consumption of untreated clay-coated lettuce seed was 2.2 g/bird or treated with 1% ReJeX-iT® AG-145

(a.i.), 1% Mesurol® (a.i.), 1% lime, and 1% activated charcoal was 1.4, 1.1, 0.9, and 0.7 g/bird, respectively. Mean weight loss of horned larks during the test period averaged about 28%.

Aviary Test

Mesurol® significantly reduced horned lark consumption of lettuce seedlings ($F_{1,20}$= 603.46, P<0.01). Overall consumption of lettuce seedlings treated with Mesurol® was <0.1 seedlings per horned lark on day 4 of the test. ReJeX-iT® AG-145 and lime also reduce horned lark consumption of lettuce seedlings ($F_{1,20}$= 68.55, P<0.01) and ($F_{1,20}$= 27.06, P<0.01), respectively. On day 4 of the test, horned larks consumed 0.5 ReJeX-iT® AG-145 treated lettuce seedlings per bird, where as they consumed about six lime treated lettuce seedlings per bird (Figures 2 and 3).

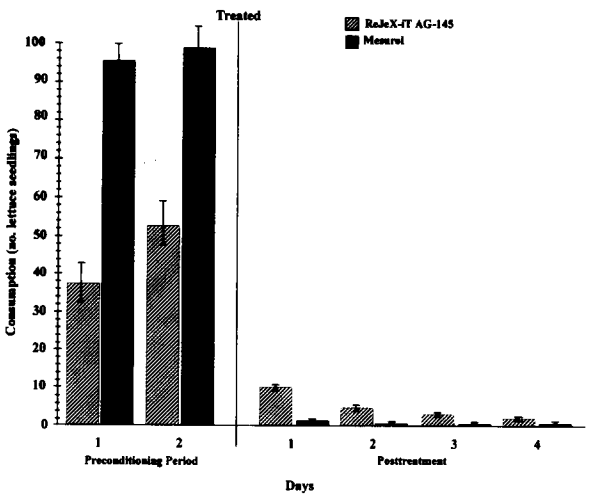

Figure 2. Horned lark consumption of lettuce seedlings sprayed with Mesurol® at 4 kg/ha and ReJeX-iT® AG-145 at 64 kg/ha. Capped vertical lines represent standard errors.

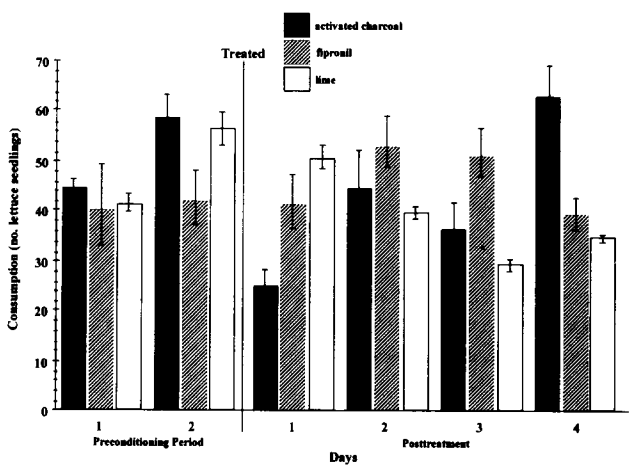

Figure 3. Horned lark consumption of lettuce seedlings sprayed with activated charcoal at 32 kg/ha, fipronil at 4 kg/ha and lime at 32 kg/ha. Capped vertical lines represent standard errors.

Activated charcoal or fipronil did not reduce consumption of lettuce seedlings by horned larks ($F_{1,20}$= 2.96, P=0.10 and $F_{1,20}$= 0.36, P=0.55), respectively. On day 1 of the test, activated charcoal significantly reduced lettuce seedling consumption by horned larks. However, horned lark consumption of treated lettuce seedlings was slightly greater than preconditioning levels by day 4 of the test (Figure 3). Horned lark consumption of fipronil treated seedlings remained relatively constant throughout the test period (Figure 3). Lettuce seedlings phytoxicity was not observed from any chemical used in this test.

DISCUSSION

Cage tests indicated that current procedures of clay-coated lettuce seed prior to planting has a significant effect on reducing lettuce seed loss by horned larks. Limited consumption of the clay-coated lettuce seed was attributed to the difficulty horned larks had cracking the coating and extracting the seed. Dolbeer and Ickes (1994) showed that blackbirds consumed less rice seed that was coated with Portland cement or plaster (50% g/g). Daneke and Decker et al. (1988) also showed that coating rice seeds with clay and starches reduced bird damage. Both summarized that handling time made coated-seeds less attractive to birds. When only clay-coated lettuce seed was offered to horned larks (Experiment 2) birds lost significant body weight. Since the clay-coating can be thinned or thickened in the coating process it is suggested maximum thickness that will still allow emergence of seedlings be applied to lettuce seed that is planted in areas of high bird damage.

The aviary test indicated that Mesurol®, ReJeX-iT® AG-145, and lime significantly reduced horned lark damage to lettuce seedlings. Even though lime showed statistically that horned lark damage to lettuce seedlings was reduced, it was only a 50% reduction. Results of Mesurol® and ReJeX-iT® AG-145 are consistent with other studies where both reduced bird damage to seeds, grapes, cherries, and grass (Fuller et al. 1984; Guarino 1972; Dolbeer et al. 1974; Mason and Clark 1995; Cummings et al. 1995). Activated charcoal has been shown to be repellent to birds in the laboratory (Mason and Clark 1994) and in the field (Mason and Clark 1995). However, this test showed that at a rate six times higher than used for Canada geese and starlings, it was not effective in reducing horned lark damage to lettuce seedlings. Explanations why activated charcoal was ineffective might be due to horned larks being unresponsive to its texture, abrasive or osmotic effects (Mason and Clark 1994). Fipronil did not deter horned larks. It appears that the poor results might be attributed to the low concentration.

Mesurol®, ReJeX-iT® AG-145, and lime are registered with the Environmental Protection Agency. Uses as bird repellent on seedlings (lettuce, tomato, etc.) are warranted. The cost for a field application using our rates would be $160/ha for Mesurol®, $190/ha for ReJeX-iT® AG-145 and $3/ha for lime. The low cost of lime makes it very attractive as a bird repellent. Large-scale field evaluations for each chemical are warranted.

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