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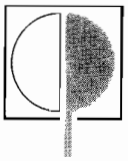

Evaluation of a methyl anthranilate formulation for reducing bird damage to blueberries

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We evaluated the bird repellency of ReJeX-iT® AG-36 which contains the active ingredient methyl anthranilate (MA). In a 14-day field trial in Michigan, MA applied at 16.1 kg ha^{-1} did not reduce bird damage overall, but did appear to offer some protection from 3 to 10 days post-treatment. After 10 days, however, bird damage more than doubled. In Florida, we applied MA at a rate of 32 kg ha^{-1} and then presented the fruit to individually caged cedar waxwings (*Bombycilla cedrorum*). Berry consumption did not differ between treatment and control groups, but consumption of berries 72 h post-spray exceeded that of 24 h post-spray.

Keywords: Bird repellent; crop damage; methyl anthranilate; blueberries; ReJeX-iT®

Migratory birds cause substantial damage to ripening fruit crops in the United States (Crase *et al.*, 1976; Mott and Stone, 1973). In 1989, growers, researchers and extension specialists estimated that 10% of the nationwide blueberry crop was damaged by birds (Avery, Nelson and Cone, 1992). When extrapolated to the 1989 US blueberry production (158 million pounds at $0.50 lb^{-1}), birds caused an estimated loss of $8.5 million.

The loss of Mesurol® (Avery *et al.*, 1993; Tobin and Dolbeer, 1987), a non-lethal means to manage bird depredations in blueberries and other fruit crops (Dolbeer, Avery and Tobin, 1994), and the limited effectiveness of other control methods (Strik, 1990; Tobin *et al.*, 1988) have stimulated efforts to develop chemical repellents that are effective, economical and safe. Methyl anthranilate (MA) is a food flavouring approved for human consumption by the Food and Drug Administration that has been found to be offensive to birds in some contexts (Cummings, Otis and Davis, 1992; Mason *et al.*, 1991). An initial aviary test application of 0.5% (g/g) MA presented to individually caged cedar waxwings reduced blueberry consumption 75% (Avery, Decker and Nelms, 1992). Later, however, flight pen evaluations of MA applications (9–18 kg ha^{-1}) proved ineffective against European starlings (*Sturnus vulgaris*) and cedar waxwings (Avery, 1992). Nevertheless, Askham (1992) reported that a 0.25% (v/v) solution of MA combined with a molecular binding compound substantially reduced bird damage on two varieties of blueberries.

In this study, we evaluated a new MA formulation for its effectiveness in protecting blueberries from bird damage. At this time, the demand for improved safe and effective bird control materials for use on fruit crops makes continued testing and evaluation of candidate materials particularly important.

Methods

Michigan, 1992

Near Fennville, Michigan, we located three blueberry sites (0.16, 0.21 and 0.25 ha) that had histories of bird damage. All sites were planted with blueberry cultivars (Jersey and Bluecrop) of similar ripening periods. Sites were at least 10 km apart, and each site was divided into two units of equal size separated by at least 100 m. One unit was assigned randomly as a control plot and the other as treated. We applied MA (ReJeX-iT® AG-36, PMC Specialties Group, Cincinnati, OH, USA) 14 days before first commercial harvest at a rate of 16.1 kg ha^{-1}. This formulation of ReJeX-iT AG-36, which was diluted 100:1 in water prior to spraying, contained 21.8% (v/v) MA and included an ultra-violet screen to inhibit photodegradation.

On the day of treatment, we prepared an aqueous solution of the repellent and the units designated as treated were sprayed with an FMC® 1029 airblast sprayer calibrated to deliver 561 l ha^{-1}. Prior to

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spraying, we randomly selected 40 blueberry bushes within each test unit (Avery *et al.*, 1993). We marked the base of these bushes with flagging tape and recorded bird damage 1, 3, 5, 7, 10 and 14 days post-treatment. On each sample bush, a randomly selected limb identified with a numbered tag and having 2–38 blueberries was used to assess damage. The number of unripe, ripe and damaged berries were recorded for each assessment period.

Data were analysed as a 2-factor factorial experiment in each block (site) of a randomized block design. Bird damage was expressed as a percentage of ripe berries available that were eaten by birds. Availability was defined as the sum of: (1) the berries taken by birds; and (2) the ripe berries present 14 days post-spray when the final counts were made. We assumed droppage was negligible.

Florida, 1993

The study site at Gainesville, Florida was a 3.2-ha field of early-ripening highbush blueberries visited daily by hundreds of cedar waxwings. We selected a 0.2-ha portion of the field to be sprayed and designated a similar part of the field as an unsprayed control. In each plot, we then erected bird-proof exclosures around eight bushes that still had substantial numbers of berries.

On 18 May, we applied 38 l of formulated MA to the 0.2-ha treatment plot. This formulation (ReJeX-iT AG-36) contained 14.5% (v/v) MA and we diluted it 20:1 with water prior to application with an airblast sprayer. This produced an application of 32 kg ha^{-1}. We chose this application rate because it was approximately twice that used in our Michigan trial where we did obtain some indication of short-term repellency (see Results).

One day later, on 19 May, we picked berries from the protected bushes in the sprayed and unsprayed areas and brought them to our Florida Field Station where we presented them to 36 individually caged cedar waxwings that had been captured 2 weeks earlier at the study site.

We randomly assigned birds to one of four groups. Three groups received sprayed berries, the other group received unsprayed berries. We intended to examine the effect of reinforcement schedules on the birds' response to MA-treated berries. Thus, one treatment group was to receive MA-sprayed berries 1, 3, 5, 7, 9 and 11 days post-spray; another group was scheduled for days 1, 3, 7 and 11; and the third group was to receive MA-treated berries 1, 3 and 11 days post-spray.

One day post-spray, we gave each bird 15 berries plus 25 g of alternative food (Kaytee Exact®, Kaytee Products, Chilton, WI, USA) which they had been eating while in captivity. After 1 h, we recorded the number of berries in each cup and in spillage pans beneath each cage, and we weighed the alternative food. We repeated this procedure 2 days later. Then the birds were banded and released. We used repeated measure analyses of variance to assess consumption of berries and alternative food among groups and between post-spray periods.

Results

Michigan, 1992

At the time of treatment, an average of 11 and 15% of the blueberries were ripe in the untreated and treated units, respectively. At the conclusion of the test, 60 and 73% of the blueberries were ripe, respectively. Bird damage during the 14-day trial was 27% on the untreated units and 31% on the treated units. Bird damage did not differ ($p > 0.05$) between unsprayed blueberries and those sprayed with MA, regardless of days after treatment or site (*Figure 1*). Nevertheless, bird damage appeared to be reduced on treated units 3–10 days post-treatment (*Figure 1*). Damage during this period totalled 45 and 24% on the untreated and treated units, respectively. Following day 10, however, damage more than doubled on all sites.

Florida, 1993

The four groups of captive cedar waxwings did not differ ($p > 0.05$) in berry consumption. Across all groups, more berries were eaten ($p \leq 0.001$) 72 h post-spray ($\bar{x} = 14.1$ berries per bird, s.e. = 0.3) than during the initial presentation, 24 h post-spray ($\bar{x} = 11.7$ berries per bird, s.e. = 0.5). There was no interaction ($p > 0.05$) between group and trial (*Figure 2*).

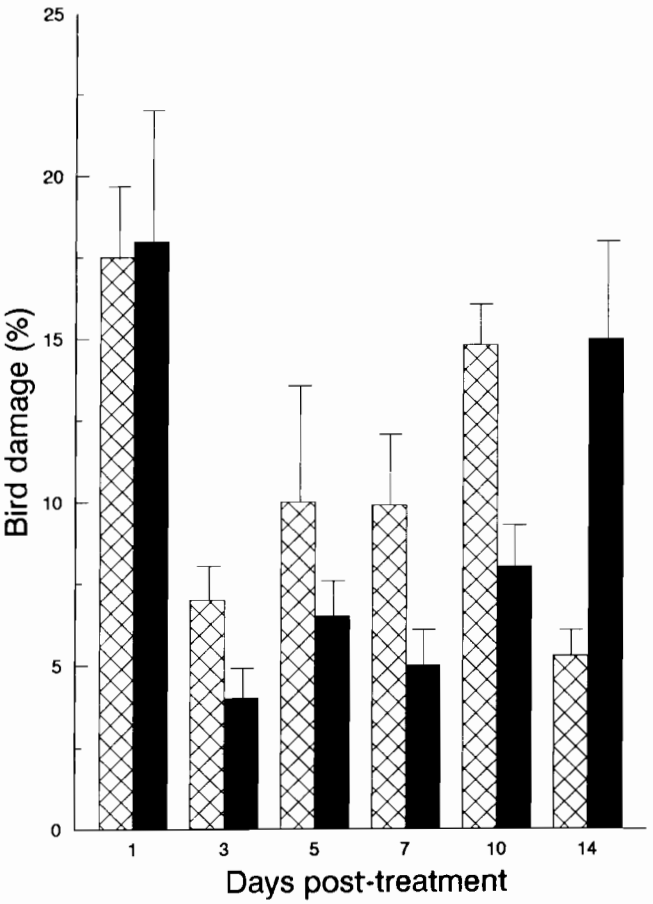

Figure 1. Bird damage to untreated blueberries (cross-hatch) and blueberries treated with methyl anthranilate (ReJeX-iT® AG-36) (solid) at 16.1 kg ha^{-1} during July and August 1992 near Fennville, Michigan. Damage estimates are based on the number of available ripe blueberries. Capped bars indicate 1 s.e.

Consumption of alternative food did not vary ($p > 0.05$) among groups or between 24 and 72 h post-spray.

Discussion

In these trials, we did not obtain satisfactory bird repellency in blueberries with the ReJeX-iT AG-36 formulation of MA. In Michigan, this could have been due to the timing of the application. We applied MA 14 days before the initial harvest, after birds had already been depredating the sites. We reasoned that had the repellent been applied just prior to the onset of damage, bird use could have been more effectively countered (Askham, 1992).

We addressed this in 1993 by testing captive birds with berries sprayed in the field at double the MA rate used in Michigan. But even on their initial encounter, 24 h post-spray, captive cedar waxwings ate just as many MA-treated berries as unsprayed berries. Thus, the cage trial suggested that even if the first berries encountered by depredating birds are MA-treated, birds will still consume them.

Methyl anthranilate is very susceptible to aerobic microbial degradation (L. Clark, unpubl. results) which could have reduced residues and thus contributed to the lack of efficacy in both trials. We did not measure MA residues on the berries, but pesticide exposure models assume that a 1.12 kg ha^{-1} application results in a maximum residue on fruit of 7 mg kg^{-1} 24 h post-spray (Hoerger and Kenaga, 1972). Extrapolating to our MA application of 32 kg ha^{-1} gives a maximum expected MA residue of 200 mg kg^{-1}. This is well below the estimated 0.5% (g/g), or 5000 mg kg^{-1}, treatment level of MA that was repellent to cedar waxwings in cage trials (Avery *et al.*, 1992a).

Additional field research is needed to determine MA residues on blueberries at various rates of application with different types of spray equipment. If the residue model of Hoerger and Kenaga (1972) is accurate, and if residues close to 5000 mg MA kg^{-1} are needed to deter birds, then it may be very difficult to apply sufficient MA to protect fruit from bird damage.

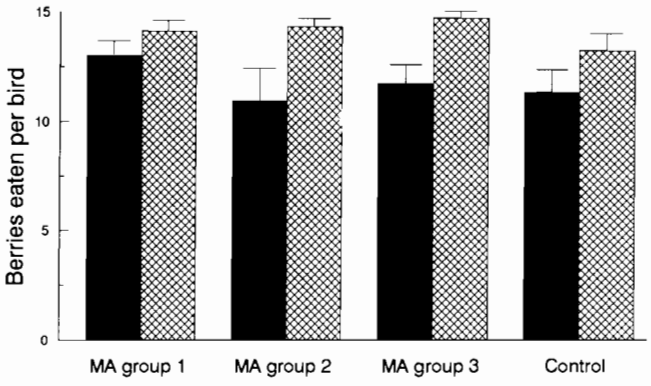

Figure 2. Mean consumption of blueberries by individually caged cedar waxwings, 24 h (solid) and 72 h (cross-hatch) after field application of methyl anthranilate (32 kg MA ha^{-1}). Each bird received 15 berries during the 1-h trials. The MA groups received berries picked from the sprayed plot while the control group received unsprayed berries

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