February 1989

The Use of DMA to Reduce Robin Depredation on Cherries

Leonard R. Askham
Washington State University Pullman, WA

John K. Fellman
University of Idaho, Moscow, ID

The Use of DMA to Reduce Robin Depredation on Cherries'

Leonard R. Askham and John K. Fellman2

The use of a biorational *pesticide, Dimethyl* Anthrantlate (DMA), was investigated for possible use as a robin repellant in an Eastern Washington Research orchard. Applied in low concentrations (2, 4, and 8% with surfactant), robin **depredation was** reduced an average of 75%. A double-blind taste test showed no

INTRODUCTION

Each year, the state of Washington produces about 58,000 tons of the fresh sweet cherries, or 60% in the United States. Prices for this crop during the last five years have ranged from a low of $689 to a high of $1,030 per ton ($864 five year average). These revenues account for approximately $44.9 million of the states' total agricultural income (Schotzko, 1989; U.S.D.A., N.D.).

As with most soft fruit crops, *cherries are* prone to bird depredation. In most areas damage is primarily caused by robins (Turdus migrarorius), common grackles (Quiscalus quiscula) and starlings sturnus vulgaris) (Guarino, 1972) although other species have been known to feed upon the crop at various times. Until recently, the problem was resolved by spraying the ripening crop with methiocarb (a chemical repellent containing 4-[methylthio]-3,5-xylyl Nmethylcarbamate) shortly before harvest. In the initial studies, depredation on the cherries, after the material was applied was significantly reduced ($p>0.001$) between treatment and controls. Random samples in sweet cherries showed that the controls received about 5 times as much damage as the treated trees (36% vs. 7%). With sour cherries, over 50% of the fruit was damaged in the control plots while only 20% was damaged in the treated plots.

In 1988, methiocarb (Measurol tm) was withdrawn from the United States market by the manufacturer at the request of the Environmental Protection Agency (EPA) because concentrations of chemical residues found in the ripe fruit exceeded standards established by the federal government. With this material removed from the market, few, if any effective repellent materials and methods remain available to the grower. Unless a viable alternative is found, millions of dollars in lost revenues will be incurred by the producers.

With the depredation of a monoculture by a protected species (such as robins) a non-toxic biodegradable compound with little or no discernable residual taste to the ultimate consumer must be found to replace the banned repellent. One possible alternative is dimethyl anthranilate (N-methyl methyl anthranilate). Dimethyl anthranilate (DMA) is a colorless to pale yellow liquid with a concord *grape-like odor* that is derived from methylation of methyl anthranilate or esterification of N-methyl anthranilic acid. It has a specific gravity of 1.132 to 1.138, is soluble in 3 or more volumes of 80% alcohol, benzol benzoate, diethyl phthalate, fixed oils, mineral oils and volatile oils (Arctander, 1969). As a naturally-occurring compound, it meets established criteria as a biorational pesticide pursuant to the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) (Federal Regisister, 1979).

DMA, long used as a food and drug flavoring additive, has been found to be an effective taste repellant when applied to different food sources in concentrated doses. In a series of tests conducted by Mason and Arzt (N.D.), caged starlings fed progressively less on treated lipophyllic starch treated with DMA as the concentrations were increased from 0.4 to 1.6%. In another series of tests, Mason, et al (1985) found that "DMA substantially reduced consumption ($P=0.05$)" during the treatment periods and suggested that the material "might be used as a feed additive to reduce bird depredation without primary or secondary hazards to non-target animals."(p. 636) with concentrations as low as 0.2%. Mason and Bean (1987), however, found that 2% concentrations were necessary to repel Mallard ducks *(Anas platynchos)* and Ring-necked pheasants *(Phasianus colchicus).*

1. Associate Research Scientist and Associate Professor Vertebrate Pest Management Cooperative Extension Department of Horticulture and Landscape *Architecture Washington* State University Pullman, WA. 99164-6414

2. Assistant Professor and Postharvest Physiologist, Department of Plant, Soil and Entomological Sciences, University of Idaho, Moscow, ID. 83843.

With this information, a series of trials were established to test differing concentrations of pure (98.7%) DMA on various soft fruit crops. The objectives of the first trials were to: 1) determine if DMA, when applied to soft fruit, would deter birds from consuming a significant quantities of the crop. 2) test whether the consumer could taste the difference **between treated** and non-treated fruit, and 3) analyze the harvested crop for detectable residues.

MATERIALS & METHODS

Pen Trials

To determine if DMA, when applied in reduced concentrations to soft fruit, would repel birds from the crop, a series of trials using caged birds and ripe grapes was established. In the caged trials, 120 starlings were placed in a 20 X 60 X10 foot wire screened outside aviary for 7 days for pre-trial conditioning. Because fresh cherries were not available when the trials were started, chenin blanc and cabernet grapes and applies were placed in 10 X 14 X 2 inch white enamel pans inside the aviary between 8 and 9 A.M. each day. Cooked french fried potatoes were placed in the same type of trays at noon and left for the remainder of the day. Any residue food sources were removed the following morning and the process repeated. Water was provided, ad lib, during the entire period for all trials.

To establish the effective application rate of DMA on small fruit, two groups of twenty starlings were randomly selected from the pool, placed in two identical aviaries, as described above, and preconditioned for an additional two days. The same feeding reqime and conditions as established for the larger population were continued, except that all food was removed at dusk. Each morning between 8 and 9 A.M. pre-weighed samples of grapes dipped in formulations of either 20, 40 or 80 ml of DMA and 3 ml of 95% ETOH and distilled water (2, 4 or 896, 1 liter solutions) were placed in the white enameled baking pans, paired with non-treated samples, and left for the remainder of the day for 5 consecutive days. Throughout the trails, additional pans of pre-weighed untreated samples were placed in screened enclosures outside of the pens to establish desiccation rates. At noon, 2.5 kg of cooked french fried potatoes were placed in two enameled pans and left in the cages. At 5 P.M. all food was removed from the aviaries, inspected, weighed and recorded.

Field Trials

The following spring, two mature Van cherry trees were treated with 40 ml of DMA and 13 ml of Regulaid (as a surfactant) per 1000 ml fresh water. The amount was doubled for one additional tree. Approximately 1.5 liters of test material was placed on each tree with a Solo (tm) back pack air blast mist sprayer. None was placed on three trees which served as controls for the experiment. The remainder of the orchard was treated with Measurol.

The trees were monitored each day for color change, phytotoxcicity and predation. Immediately prior to and for fourteen days after treatment two, 24 inch branches were cut from the outside of each tree (between the tree rows), 6 feet from the orchard floor. Fruit from each branch was divided into one of three categories, whole and unmarked, partially eaten or marked, or missing. Marking was defined as any blemish that might have been caused by birds feeding on the fruit (excluding cracking). Missing fruit was defined as the presence of a whole green stem, without a desiccated flowering head at the pedestal, where a ripening fruit was borne. Torn remnants of a fruit were often found on these pedestals. The fruit from each category was then counted, recorded, removed from the branch, sealed in double plastic bags, and stored at -40°C until processed.

Taste Trials

Before freezing, 6 oz. sub-samples were selected from each of the treatment groups for taste analysis. Three plates, each containing six fresh cherries from each treatment group, were placed in front of six tasters, three of whom had been informed about the experiment. All were asked to rate each group for sweetness, flavor, and note any abnormal taste.

Residue Analysis

Representative samples of treated cherries were frozen for later extraction and analysis. Cherries were thawed, blended with distilled water, and clarified by centrifugation at 80 g's (500 rpm) for 1 min. Supernatants were filtered, brought to constant volume and stored at -40°C until analyzed.

Initial studies were undertaken with thawed aqueous solutions using purge-and trap cryofocusing injection into a fused-silica open tubular gas chromatograph (FSOT/GC). Despite its apparent volatility, DMA condensed on the glass surfaces of the injection apparatus, forcing the abandonment of this direct procedure. Aqueous samples were then extracted with acidified hexane. The concentrated organic phase was injected into a Hewlett-Packard 5890A Gas chromatograph equipped with a flameionization detector and a model 3396A digital integrator. Chromatographic separation was performed on a 30mx0.32mm I.D. DB-1 FSOT column (J&W Scientific, Rancho Cordova CA) held under the following conditions:

- initial temperature 145°C
- temperature immediately increased 20°C/min to a final temperature of 280°C and held for 2 min.

Split injection was performed with an inlet split ratio of 60:1 at a helium carrier gas velocity of 37cm/sec. DMA eluted at 256°C with a retention time of approximately 5.6 min. under these conditions. Putative indentification of DMA was by co-elution of standards.

Studies are currently underway to ascertain the difference, if any, between purge-and trap and extraction/direct injection methods.

RESULTS

Pen Trials

Wine grape consumption by the starlings was considerably less when treated with DMA (Fig. 1). The 2% solution reduced feeding approximately 29 to 59%. The 4% solution reduced consumption approximately 46 to 61% while the 8 % solution decreased consumption 94 to 95%. There was no dessication of untreated grapes outside the aviaries.

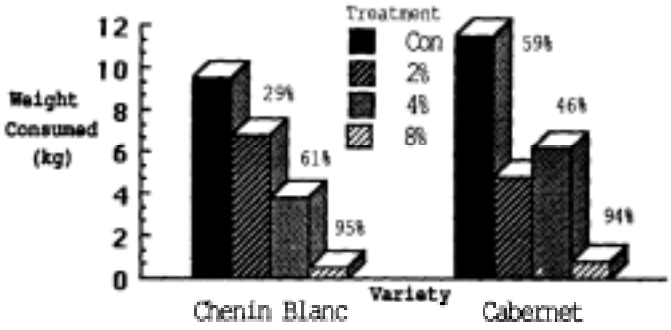

Figure 1. Consumption (kg) of Chenin Blanc and Cabernet Wine Grapes Treated With Three Concentrations of DMA During Choice Feeding Trials with Starlings

Prior to treatment, 9.8% of the fresh fruit on all of the trees in the experiment had either been damaged, eaten or removed by robins (Fig. 2). After treatment, depredation on the fruit on the control trees had increased to 14.9% but had decreased to 6.4 and 3.5% respectively for the 4 and 8% treated samples. None of the trees treated with the 4% solution exhibited any signs of discoloration, cracking or phytotoxcicity (Fig. 2). However, the tree treated with the 8% solution the leaves, stems, branches. and fruit were severely burned and discolored where they had been drenched during application. The remainder appeared to be normal.

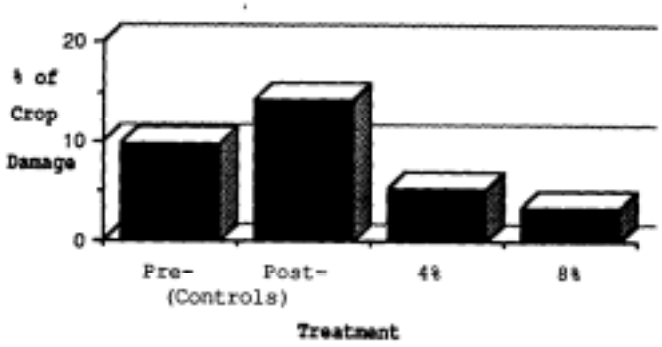

Figure 2. Bird Damage to Sweet Cherries Before and After Treatments with DMA

Taste Trials

No taste differences between treatment grou were noted by the panel. All stated that the first cherry tried was the sweetest, the second less so, and the remainder about the same. None reported any abnormal flavor differences, particularly those that had been informed of what to look for prior to the study.

Residue Analysis

Representative chromatograms of a sweet cherry extract and an extract fortified with a known amount of DMA are depicted in figures 3 and 4.. No DMA was detected in the fruit treated with the 4% and 8% solutions The data for both samples were the same (Fig. 3). Figure 5 depicts the effect of fortification with 1 ppm.

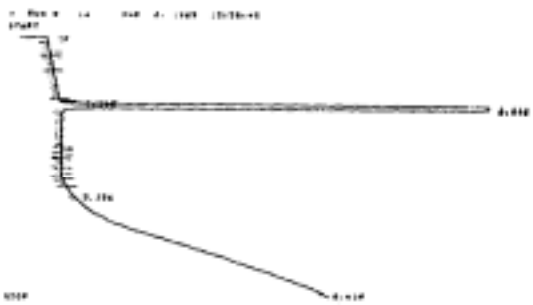

Figure 3. FSOT/GC of extracts from Van Cherries treated with 4 & 8% solutions of DMA. (Arrow indicates position of authentid materials for each sample. Major peak indicates solvent presence)

Figure 4. FSOT/GC of Fig 3 fortified with 1 ppm DMA.

DISCUSSION

The use of low concentrations of DMA to reduce bird depredation on cherries appears to be a viable alternative to using methiocarb as a chemical repellant. While the trials were limited, each indicated that the chemical properties of the tested material were well within established tolerances.

During the pen trials, feeding on the grapes treated with 4 & 8% solutions was significantly

reduced over those that has been treated with 1 & 2% or not treated at all. After the pans of fruit had been placed in the aviaries and the researcher had left the area, starlings would immediately fly to each of the treatment sites. When untreated samples had been placed in each pan, the birds would devour as many grapes as possible at one time unless frightened or forced from the site. When samples treated with 4 and 8% solutions were placed, in the pan the birds would pick one grape from a cluster, spit it out, look at the remaining grapes and then fly to another pan where other birds were freely feeding.

None of the concentrations discouraged the starlings from feeding on the apples. Feeding was accomplished by first pecking a hole in the outer layer of the fruit and then removing the pulp and seeds. When finished, each apple had been hollowed out until only the skin, stem and a 1 in. hole remained. These observations indicate that the targeted bird must be able to remove an entire fruit from the stem to receive the full taste of the repellancy compound. Where small amounts of the treated area are removed, when the fruit is pecked, the concentrations tasted or ingested do not appear to be significant enough to cause a taste aversion.

In the field trials, the feeding on non-treated cherries increased a little over 30%. Feeding on treated cherries decreased 62 to 76% respectively for the 4 & 8% treatments.

The taste test showed that there were no discernable taste differences between the treated and the untreated fruit. None of the people (including those who knew that some of the fruit had been treated with DMA) who participated in the trials were able to detect any adverse flavoring from the DMA.

Initial residue studies suggest little retention of DMA inside sweet cherries harvested 2 weeks after orchard treatment. More detailed residue studies are currently underway. One possibility is the sampling methodology precluding analysis of skin residue. It is likely that DMA does not penetrate the surface of sweet cherries. In light of the apparent dissipation of DMA residues coupled with the chemical's long standing history as a safe flavor additive, further studies of DMA as a Measuroltm replacement may foster the implementation of a lower-input, low impact vertebrate control strategy for sweet cherries.

Literature Cited

Arctander, S. (1969) Perfume and Flavor Chemicals (Aroma Chemicals) II Self Published. Montclair, N.J.

Bean, N.J. and J.R. Mason (1987) Dimethyl Anthranilate Repellency to Mallard Ducks *(Anus platyrhynchos)* and Ring-necked Pheasants *(Phasianus colchicus).* Mimeo. 12 PP.

Federal Register (1979) Regulation of "Biorational" Pesticides; Policy Statement and Notice of Availability of Background Document. May 14. Vol. 44(94):28091-93.

Guarino, J.L. (1972) Methiocarb, A Chemical Bird Repellent: A Review of its Effectiveness on Crops. In: Marsh, R.E. (Ed.) Fifth Vert. Pest. Conf. Proc. Fresno, Ca. March 7-8. pp. 108-111.

Mason, J.R. and A.H. Arzt. (N.D.) Evaluation of Dimethyl Anthranilate as a Nontoxic Starling Repellent for Feedlot Settings. Monell Chemical Senses Center, 3500 Market St., Phil. PA 19104.

Mason, J.R., J.F. Glahn, R.A. Dolbeer and R.F. Reidinger (1985) Field Evaluation of Dimethyl Anthranilate as a Bird Repellent Livestock Feed Additive. J. Wildl. Man. 49(3):636-642.

Schotzko, R.T. (1989) Demand for Washington Fresh Sweet Cherries. College of Ag. & Home Econ., Wa. State Univ. Res. Bul. XB 1007

U.S.DA. Marketing Washington Apricots, Cherries, Nectarines, Peaches and Prunes. 1986 Crop. Federal-State Market News Serv. Ag. Marketing Serv., Fruit and Veg. Div. Market News Branch. Yakima, Wa. Various issues.