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California fig producers annually incur serious economic losses from bird damage to their early maturing Black Mission fig crop. During the 1976 growing season, the avian repellent methiocarb was tested to determine its effectiveness in reducing bird damage to figs. A number of problems developed in those trials which made the results difficult to interpret. With what was learned in the 1976 trials, a more intensive study was planned with cooperation between the Fresno County Department of Agriculture, California Fig Institute, University of California at Davis, California State Department of Food and Agriculture, United States Fish and Wildlife Service, and individual fig producers for the 1977 growing season. This paper is a report on the findings of the 1977 field trials.

METHODS AND MATERIALS

The trial was conducted in Fresno County at four test sites of first crop Black Mission figs. Each test site was two acres (98 trees) divided equally into a reference (control) and treatment plot. The treatment plots were sprayed with methiocarb (4-(Methylthio) -3, 5-xy|y| methylcarbamate) at the rate of four pounds active ingredient per acre. The methiocarb, a wettable powder, was mixed with 400 gallons of water and applied at the rate of 400 gallons per acre using an air blast sprayer pulled by a tractor.

The trees were sprayed just prior to the onset of bird damage. As the fig matures, it increases in size and begins to darken. When the fig turns a dark purple, the birds begin to damage the fruit. All test sites were sprayed on the same day even though the percentage of figs showing color break varied between the sites. Site 2 had the greatest percentage of dark fruit, approximately 10 to 15%. There was also some bird damage to fruit before spraying. Site 3 and Site 4 were showing similar stages of crop maturity with about 5-10% of the fruit darkening. No bird damage was noted before spraying at either Site 3 or 4. Site 1 had less than 5% of the fruit darkening, and also no bird damage was noted.

The relative number of birds in each test plot was estimated by walking through each reference and treatment plot and counting the numbers of birds flushed. These counts were made twice a week in the mornings. The order in which the sites and plots were counted was altered each time to prevent biases due to count time or starting point.

Evolution of damage was studied in Sites 2 and 3. These sites were selected because of the expected yield and homogenous nature of the plots. Eight trees were randomly selected in each treatment and reference plot. Random assignment of which area of the tree was to be studied was made (i.e., N, S, E, or W and top or bottom). Limbs with the proper number of fruit (10 in Site 2 and 15 in Site 3) were marked. Twice a week the marked limbs were examined to determine the amount of mature fruit and the percentage of fruit damaged.

Damage assessments were made by gathering the fruit from one quarter of the area under each of 12 randomly chosen trees in each plot. The quarter area sampled was rotated 90° at each successive tree. The fig samples were collected as close to harvest

as practical. The samples were bagged and taken into the lab, where the figs were assessed for bird damage.

Other information or samples were gathered at each test site. Searches were made for dead or affected birds, observations were made on feeding patterns, and unusual sightings such as animal tracks or non-target species in the orchard were recorded. Figs were gathered during the study to be used in residue analysis. Samples were sent to Morse Laboratories in Sacramento and the California Department of Food and Agriculture for residue analysis.

Industry-wide damage assessments were made for the first crop of Black Mission figs, and second crop Black Missions, Calimyrna, Adriatic, Kadota and Conadria figs. For the first crop of Black Mission figs, the samples were collected and assessed for damage in the orchards in four counties just prior to harvest. For all other crops, figs were sampled for bird damage at the dry yards in Fresno County. Random samples were taken from field boxes and off-on dry trays.

RESULTS

The bird counts for each test plot indicated that the repellent methiocarb had little or no effect in reducing the bird numbers in the treated areas. As expected, the birds counted most often were the house finch *(Carpodacus mexicanus)* and the starling *(Sturnus vulgaris).* Robin *(Turdus migratoris),* scrub jay (*Aphelocoma coerulescenis),* Brewer's blackbird *(Euphagus cyanocephalus)* and mourning dove *(Zenaidura macroura)* were also counted frequently. Each of the four test sites had a different percentage of bird species causing damage. The bird count data indicated that the number of birds increased as more of the figs ripened.

The evolution of damage data supported the bird pressure data in that there was no difference between the evolution of damage in the treatment and reference plots. In Site 2 the onset of bird damage in the sample trees occurred when approximately 30% of the figs were ripe. The percent of figs damaged by birds increased as the percent of ripe figs increased. By the last sample date of July 4, 1977, all of the figs on the sample limbs had ripened; and in the treatment plot the birds had damaged 46% of the figs, compared to 34% damage in the reference plot. In Site 3 the bird damage to figs had not occurred until approximately 88% of the figs on the marked limbs had ripened. By July 4, 1977, the damage level was 11% and 14% in the treatment and reference plots, respectively.

The information concerning the final damage assessments was gathered in only three of the test sites (2, 3, and 4). Site 1 had such a low yield (because of heavy pruning) that the owner disked and irrigated before we were able to gather our samples. The percent damage figures for the other sites are shown in Table 1. Three 100 fig samples were taken from figs collected in each plot. These samples were given to the Dried Fig Advisory Board to be examined for bird and insect damage. Table 2 contains this data. There appears to be no effect of the level of fig damage due to the treatment with methiocarb.

Searches for dead or affected birds turned up no evidence that methiocarb seriously affected either target or non-target species. As for unusual sightings, Table 3 is a list of mammals that were in the orchard at various times during the study. Table 4 is a list of birds sighted in one or more of the test sites. This table also indicates which of the species sighted damaged figs and/or nested in the orchards.

Industry-wide damage assessment pointed out that the fig industry loses significant amounts of figs due to bird damage. Table 5 shows the percentage of bird-damaged figs in Fresno, Madera, Merced and Kern Counties along with a weighted industry-wide figure. Table 6 contains information on the industry-wide losses in later crops of figs including Black Mission, Calimyrna, Adriatic, Kadota and Conadria varieties. The damage estimates, average yield figures for 1971 through 1975, and market value of the figs were used to calculate a dollar loss from bird damaged figs to the industry, (Table 7). It is estimated that the fig industry lost over one-half of a million dollars due to bird damage during the 1977 season.

RESIDUE ANALYSIS

Residue analysis indicated that methiocarb residues on the figs declined rapidly. In test Sites 2, 3 and 4 the residue found on the fig after treatment was 11.9, 11.9 and 8.02 parts per million, respectively. By four days after treatment the residues were 3.28, 3.20 and 4.76 parts per million for Sites 2, 3, and 4, respectively. Just prior to harvest, approximately four weeks after treatment, the residues were, 30 parts per million for Sites 1, 3, and 4, and 0.23 parts per million for Site 2.

CONCLUSIONS

The starling, house finch (linnet), and scrub jay cause most of the damage, while the robin, Brewer's blackbird, and western kingbird do occasional damage. One rodent species, the ground squirrel, was observed eating figs. Other species such as raccoon, skunk, coyote, and deer are suspected of eating ripe figs.

The repellent methiocarb applied at the rate of 4 pounds of active ingredients per acre did not result in any measurable difference in bird or insect damage between the treatment and control plots (Tables 1 and 2). Bird damage to the first crop of Black Mission figs was significant. Damage levels as high as 70% were recorded.

Understanding the way birds damage figs suggests why methiocarb may not be effective in reducing bird damage. By piercing (starling and kingbird) or tearing away (house finch, robin and blackbird) of the skin, the bird is exposed to little or no repellent. The bird can then eat the meat of the fig without any ill effect. Surface repellents of any type may be ineffective in reducing bird damage to figs.

AVAILABLE BIRD CONTROL TECHNIQUES

Several techniques are available to the fig producers to help reduce the bird damage to figs. An integrated approach similar to that used in vineyards and other orchard crops will provide the best results. Since several species are involved in fig damage, a control program must be designed that will be effective on all species. A typical program would be one which includes trapping and acoustical repellents for control of the starling, along with the use of toxic baits and trapping for house finch control. This type of program would have to be planned in advance and be in operation before damage began to occur. In fact, house finch control can be conducted year around, since it is primarily a resident bird contributing to the fig damage. There is no easy or "automated" bird control technique that has proven to be effective.

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TABLE 1. Percentage of figs damaged by birds.

	Treatment Plot	Control Plot
Site 2 N. Liddel Ranch	59%	70%
Site 3 Jura Farms Ranch	51	31
Site 4 J. Liddel Ranch	30	32
Mean Percent Damage	47	44

Table 2. Percent of figs with bird damage and percent of figs with insect damage, DFA inspection.

	Type of Damage	Treatment Plot	Control Plot
Site 2 N. Liddell Ranch	Bird Damage	80%	73%
	Insect Damage	1	2
Site 3 Jura Farms Ranch	Bird Damage	56	25
	Insect Damage	0	2
Site 4 J. Liddell Ranch	Bird Damage	19	22
	Insect Damage	2	3

Table 3. Mammals in orchards at some time during this study.

Species	Sign
Ground Squirrel *Citellus beecheyi*	visual observation
Raccoon *Procyon lotor*	tracks
Skunk *Mephitis mephitis*	tracks
Coyote *Canis latrans*	tracks and visual observation
Mule Deer *Odocoileus hemionus*	tracks

Table 4. Birds sighted in one or more of the orchards during the study.

	Damaging Figs	Nesting
House Finch *Carpodacus mexicanus*	X	X
Starling *Sturnus vulgaris*	X	
Robin *Turdus migratorius*	X	X
Scrub Jay *Aphelocoma coerulescens*	X	
Brewer's blackbird *Euphagus cyanocephalus*	X	
Western Kingbird *Tyrannus verticalis*	X	
Mourning Dove *Zenaidura macroura*		X
Mockingbird *Mimus polyglottos*		
Western Tanager *Piranga ludoviciana*		
Killdeer *Charadrius vociferus*		
Quail *Lophortyx californicus*		
Bullock's Oriole *Icterus bullockii*		
Horned Lark *Eremophila alpestris*		
Blackheaded Grosbeak *Pheucticus melanocephalus*		X
Bay-breasted Warbler *Dendroica Castanea*		
Hummingbird Stellula calliope		X

Table 5. Percentage of figs damaged by birds in Fresno, Madera, Merced and Kern Counties, and a weighted industry-wide loss percentage.

County	Acres Sampled	Percent Bird Damage
Fresno	46	13%
Madera	34	25%
Merced	32	61%
Kern	32	36%
Industry-wide	144	32%

Table 6. Industry-wide losses to bird damage for different varieties of figs

Variety	Percent Damage
First Crop Black Mission	32%
Second Crop Black Mission	3%
Calimyrna	5%
Adriatic	1%
Kadota	3%
Conadria	6%

Table 7. Industry-wide dollar loss due to bird damage.

Variety	Tons Lost	Cost
First Crop Black Mission	84	42,000
Second Crop Black Mission	11	44,660
Calimyrna	242	389,300
Adriatic	52	33,800
Kadota	32	22,400
Conadria	42	27,300
Total		$569,460