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BIRD PROBLEMS IN CALIFORNIA PISTACHIO PRODUCTION

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ABSTRACT: In 1984 studies were initiated to identify the bird species causing damage to pistachio nuts, quantify the losses, and explore possible methods for alleviating bird losses. The first year's field observations were made to identify and determine the level of activity of the various depredating bird species in the orchard. Field samples of nuts were collected to assess the levels of damage occurring in representative orchards. A mail survey of all commercial pistachio growers in California was conducted to determine which bird species growers believed were the cause of nut losses, the extent of damage they have experienced and what, if any, bird control methods they have used.

The objective of the second year was to further evaluate production losses due to crows and scrub jays. During the damage season, evaluation of various types of baits for crows and scrub jays was made in several pistachio orchards. Finally, with most growers reporting the use of shooting to frighten and disperse the birds from the orchard, an initial effort to evaluate shooting as a control method was made.

INTRODUCTION

From 1975 to 1984, the number of bearing acres of pistachios in California increased over 50-fold, from 600 to 31,900 acres. During this time, reported bird losses to this crop increased dramatically throughout the state. Birds have been reported to cause damage to pistachios as well as other nut crops (e.g., almonds and walnuts) in the past but information on actual losses is limited.

As an effort to better understand the impact of birds on pistachio production in California, a study was initiated with the support of the California Pistachio Commission. The objectives of the 2-year study was to determine the bird species damaging pistachios, attempt to quantify the losses, evaluate current control methods and, to a limited degree, propose and test new control methods (Salmon et al. 1986). This paper presents a portion of the results from field work conducted in orchards with histories of bird damage and a mail survey of all commercial pistachio growers in California.

NATURE OF THE PROBLEM

From field observations, survey results, and information in the literature, it is clear that the primary pest birds of pistachios are all in the bird family of Corvidae (Simpson 1972). The raven (*Corvus corax*), crow (*Corvus brachyrhynchos*), scrub jay (*Aphelocoma coerulescens*), and magpie (*Pica nuttalli*) are all pests in pistachios, feeding on nuts in the tree from the time the first nuts ripen until they are harvested (a 6 to 8-week period in late summer). In addition to corvids, blackbirds (*Euphagus* spp.) and European starlings (*Sturnus vulgaris*) are found in pistachio orchards. It appears that both blackbirds and starlings are feeding primarily on insects, and only occasionally on pistachio nuts that have been knocked from the trees. However, this needs further study. House finches also frequent orchards, but like the blackbirds and starlings, are believed to be of minor importance as pests. From survey results and field observations we found the distribution of orchards with damage from each bird species fit the known geographic distribution of the birds within California (Grenfell and Laudenslayer 1983).

For those pistachios growers responding to our statewide survey, production losses due to ravens, crows, scrub jays, magpies, blackbirds, and starlings during the 1984 growing season were estimated to be slightly less than $2 million (Salmon et al. 1986). This represents about 4% of the gross income for the growers reporting bird damage. Survey reported losses by all pest birds in 1984 averaged $27.68 per acre with a range from $0.05 to $1,086.00 (based on a pistachio nut value of $.98/lb). From follow-up detailed damage assessments made by us in orchards with crow damage, the losses ranged from $40 to $121 per acre (Table 1). For scrub jays the per-acre losses based on field damage assessments ranged from $64 to $205 (Table 2).

Pistachio losses due to birds were reported in 18 counties in California. These 18 counties account for 98% of the pistachio production in California. Growers responding to the statewide survey were questioned about their perception of whether the level of bird damage to pistachios was changing as the years passed. It appears that for the major bird pests of pistachios, most growers feel the problems are becoming more severe (Table 3).

Table 1. Average number of crows per acre and the amount of crow damage to three pistachio orchards in Tulare County, 1985.

Orchard	Average number of crows/acre	Pounds of nuts eaten/acre	Pounds of good nuts knocked down/acre	Total pounds nuts lost/acre
1	3.1	23.25	18	41.25
2[a]	4.7	36.2	43.8	80
3[b]	9.4	93.5	30.5	124

[a] Three gas cannons in the orchard (1 cannon/4.5 acres)
[b] One gas cannon in the orchard (1 cannon/4 acres)

Table 2. Average number of scrub jay flights per hour per acre and the amount of scrub jay damage in two pistachio orchards in Tulare County, 1985.

Orchard	Average number of jay flights/ac/hr	In-tree damage pounds/acre	Carry-out damage pounds/acre	Total nuts lost pounds/acre
1	101	65	154	209
2	31	18	47	65

Table 3. Grower response to whether bird problems in their orchards are changing, 1984.

	Perceived change				
Bird	Increasing	Decreasing	Remaining the same	Not sure	No answer
Raven	9	0	2	3	0
Crow	39	2	23	6	3
Scrub jay	28	2	14	4	1
Magpie	7	0	6	2	1
Blackbird/ Starling	15	2	14	14	9

Currently, as determined from the survey results and field observations, most growers with bird problems use control methods designed to frighten and disperse birds from the orchard. The number of growers undertaking control of each pest bird species and growers perception of the level of effectiveness of each control technique are provided in Table 4. Shooting to scare and disperse is the most frequently used control method regardless of the target species. For all methods, the perceived level of control was highly variable. This illustrates the need for examining more closely the methods and how they are implemented.

IMPACT OF BIRD SPECIES

Ravens were estimated to cause the greatest amount of damage to pistachios in California (Table 5). Geographically most of this damage occurred in the very southern region of pistachio production in California, primarily in Kern and Tulare Counties. A typical damage pattern by ravens is very localized, often in small areas of the orchard with limited human activity. Flocks of 25 to 500 or more ravens will enter orchards and knock pistachios from the tree, then fly to the ground to open and eat the pistachio nut.

Ravens are migratory nongame birds and are protected by federal law. At the present time there are no avicides registered for use on ravens in California. Control methods available to pistachio growers are frightening devices such as shooting, gas cannons, and Av-Alarm. If a pistachio grower wants to kill ravens by shooting, a federal depredation permit is required.

Table 4. Percent of growers indicating the perceived effectiveness of control methods they used for each bird species damaging pistachios, 1984.

Technique		None	Level of control: Slight	Moderate	Excellent
RAVEN					
Shooting	(N= 8)	12	25	25	38
Gas cannon	(N= 7)	14	57	0	29
Av-Alarm	(N= 3)	67	0	0	33
Hawk kite	(N= 1)	100	0	0	0
CROW					
Shooting	(N=47)	11	36	47	6
Gas cannon	(N=25)	16	28	40	16
Av-Alarm	(N= 7)	57	0	14	29
Hawk kite	(N= 5)	80	20	0	0
SCRUB JAY					
Shooting	(N=29)	0	58	41	1
Gas cannon	(N=14)	36	36	28	0
Av-Alarm	(N= 7)	43	43	14	0
Hawk kite	(N= 5)	80	20	0	0
MAGPIE					
Shooting	(N= 9)	11	45	33	11
Gas cannon	(N= 4)	25	25	50	0
Av-Alarm	(N= 1)	0	0	100	0
BLACKBIRD/STARLING					
Shooting	(N=18)	6	55	33	6
Gas cannon	(N=10)	10	50	30	10
Av-Alarm	(N= 4)	50	50	0	0
Hawk kite	(N= 4)	75	25	0	0

Crows cause damage to pistachios throughout the pistachio-growing areas of California (Table 5). Pistachio losses from crows occur in two ways: first by eating pistachios, and second by knocking additional nuts to the ground when landing in and taking off from pistachio trees. Since pistachios are harvested by catching the nuts as they are shaken from the tree, any nuts on the ground are lost. As with ravens, crows cause heavy damage to only a small percent of the trees in an orchard (Figure 1). Flocks as large as 250 crows normally enter orchards in areas most distant from human activity and where visibility of surrounding areas can be maintained. As with early reports of crow damage in almonds (Emlen 1937), crows enter pistachio orchards on an irregular basis throughout the day. Without disturbance crows will feed on nuts in and under the trees they are taken from. If disturbances are likely (e.g., periodic firing of gas cannons) crows will often remove nuts, and then fly a short distance from the orchard to open and eat the nuts.

Crows are a game bird under California Fish and Game regulations. Growers are allowed to shoot crows out of season without a state or federal permit if they are causing or about to cause damage to pistachios. Even though avicides such as Avitrol are federally registered for use in controlling crows in a variety of crops, California Fish and Game code prohibits the use of avicides on game birds.

Scrub jays also cause damage to pistachios in all areas of the state. Unlike crows and ravens, jays tend to feed throughout the orchard. By harvest, most trees in orchards where scrub jays are feeding will have suffered damage (Figure 1). Even when entering the orchard from a preferred habitat (e.g., along one side adjoining a citrus orchard), scrub jays will usually disperse throughout the pistachio orchard to feed. Pistachio losses to scrub jays occur from either opening and feeding on pistachio nuts in the tree or by carrying the nuts outside the orchard to eat or cache them.

Based on our survey results, growers estimated their losses from scrub jays to be slightly less than $50,000 during the 1984 season (Table 5) with the average loss amounting to $3.41 per acre. From actual damage assessment made in pistachio orchards in Tulare County in 1985, the losses averaged $150.00 per acre. Pistachio growers may underestimate their losses from scrub jays because the damage is distributed at low levels over most of the bearing trees in the orchard. This makes it difficult to assess or quantify the actual losses. Also, we found that over 65% of pistachios lost to scrub jays are those carried away to be eaten or cached outside the orchard, leaving few clues or little evidence of damage.

Scrub jays are also protected by federal regulations and in most states can only be controlled after obtaining a federal depredation permit. An exemption exists in the states of Washington and Oregon where nut growers can shoot scrub jays if they are causing or about to cause damage to their nut crops. No avicides are registered for controlling scrub jays. Growers report that bird control techniques presently used were less effective on scrub jays than other pest species (Table 4). In other words, frightening or scaring methods as currently used are relatively ineffective for this species.

Table 5. Pistachio damage (losses) by different bird species segregated by the portion of the state's growing area (e.g., districts) where the losses occur as reported by growers on the statewide survey, 1984.

District	Number of surveys returned	Percent reporting damage	Acres affected	Average reported loss ($/ac)	Estimated dollar loss
RAVEN					
Northern	19	5	200	12.19	2,439
Central	34	0	0	0	0
Southern	39	33	9,848	92.34	909,364
TOTAL		15	10,048	90.74	911,803
CROW					
Northern	19	79	578	6.24	3,711
Central	34	91	10,401	1.82	18,921
Southern	39	69	6,689	115.61	773,320
TOTAL		79	17,668	45.05	795,952
SCRUB JAY					
Northern	19	79	361	1.15	415
Central	34	44	7,743	2.37	18,351
Southern	39	49	6,159	4.84	29,814
TOTAL		53	14,263	3.41	48,580
MAGPIE					
Northern	19	74	599	47.44	28,417
Central	34	6	62	0.56	35
Southern	39	0	0	0	0
TOTAL		17	661	43.04	28,452
BLACKBIRD/STARLING					
Northern	19	63	547	2.21	1,209
Central	34	65	8,819	1.28	11,288
Southern	39	51	9,123	0.96	8,758
TOTAL		59	18,489	1.15	21,255
UNKNOWN BIRD					
Northern	19	21	203	1.42	288
Central	34	15	50	1.71	85
Southern	39	5	3,865	0.05	193
TOTAL		12	4,118	0.14	566

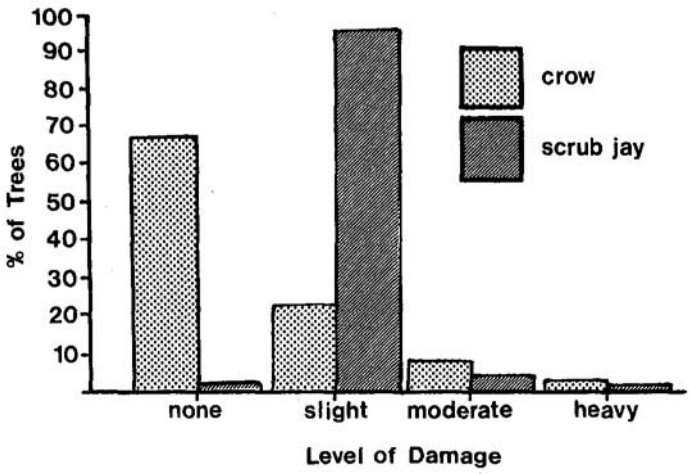

Figure 1. Percentage of trees with different levels of damage caused by crows or scrub jays in pistachio orchards in Tulare County, California, 1985.

Of all the corvids, growers estimated magpies did the least amount of total damage to pistachios statewide (Table 5). However, based on the estimated per acre losses to specific growers reporting damage from magpies ($43/acre), magpies are a very significant pest. Magpie damage occurs in pistachio growing-areas north of Madera County.

In California, magpies can be controlled without a permit when causing or about to cause crop damage. No avicides are currently registered for magpie control, leaving only shooting or other frightening methods as means of protecting crops.

Blackbirds and starlings were reported by growers responding to the survey as causing damage to pistachios (Table 5). Our field observations confirm that blackbirds and occasionally starlings are found feeding in pistachio orchards. Pistachio nut losses due to blackbirds and starlings are probably not important to pistachio growers since both species appear to spend most of the time in the orchard feeding on insects. Most pistachio nuts eaten are those already on the ground. No blackbirds or starlings were observed removing pistachios from trees.

Blackbirds can be controlled without a permit when damaging or about to damage the crop. Starlings are not protected by either state or federal regulations. For both species avicides are registered for use but adequate bait acceptance and their nomadic behavior limit the effectiveness of these toxicants in many situations.

House finch was listed by several growers under the category of "other" birds damaging pistachios. Field observations confirm that house finches are frequent visitors to pistachio orchards, but they spend most of their time taking food from the orchard floor. With their heavy bill, house finches can probably shell and eat mature nuts when the shells have begun to split open, but this is unlikely to occur in sufficient quantity to become a serious problem. Control methods, such as strychnine-treated bait in feeding troughs and trapping, could be effectively used in pistachio orchards. It should be noted that where trials were run to evaluate potential baits for scrub jay control, the pistachio nut baits were readily taken from the "v" troughs by house finches, indicating bait acceptance would not be a problem as it was with crows and scrub jays.

POTENTIAL METHODS FOR PREDICTING BIRD-RELATED PRODUCT LOSSES

Not surprisingly, the statewide survey of commercial pistachio growers revealed that some of the growers had difficulty in quantifying their losses to birds. More important, growers had no good means of estimating their potential losses for the current growing season, thus making it difficult to select the most appropriate control options based on cost and potential benefits to be derived. In most cases, the need for bird control is established from past history.

During the 1984 and 1985 growing seasons, field studies and damage assessments in a number of orchards allowed us to quantify both the nut losses and the average number of scrub jays or crows using the orchard during the period that damage occurred. Using linear regressions to analyze the data (Dixon 1983), it was found that a significant correlation (r=0.993) existed between the average number of crows found in the pistachio orchard and the estimated damage that occurred by the end of the season (Figure 2). Likewise, data gathered from orchards with scrub jay damage showed a significant correlation (r=0.999) between bird activity and damage (Figure 3).

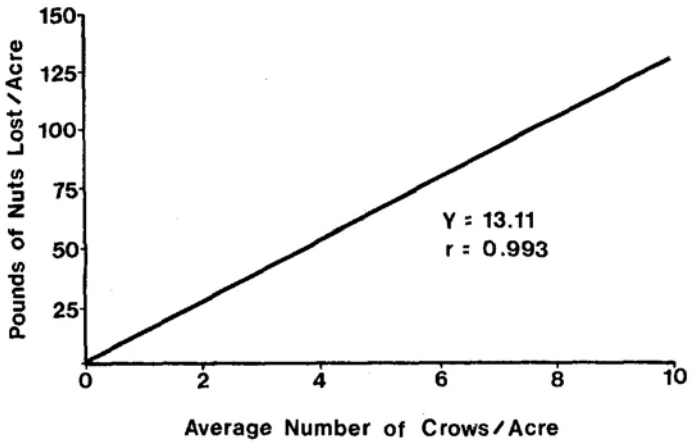

Figure 2. Correlation between the average number of crows per acre and the estimated level of nut loss at harvest based on bird counts and damage assessments made in pistachio orchards in 1984 and 1985.

Assuming these bird damage estimation models based on bird numbers can be further validated over several seasons, they may prove useful to growers in determining whether control of scrub jays or crows would be necessary or cost-effective for that growing season. Combining estimated loss figures from the above and models with cost/benefit models described by Dolbeer (1981) and Gorenzel et al. (1986), pistachio growers would be able to choose control methods that would give them the best economic return.

EVALUATION OF POTENTIAL BIRD CONTROL METHODS

The research team considered several methods for possible evaluation for the control of birds damaging pistachios. Factors used in the consideration of potential control methods were selectivity, economics, ease of application, and the chance for success.

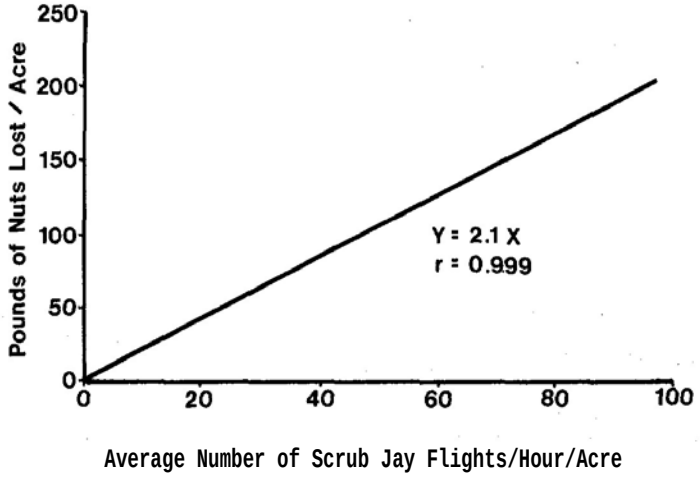

Figure 3. Correlation between the average number of scrub jay flights per hour per acre and the estimated level of nut loss at harvest based on bird counts and damage assessments made in pistachio orchards in 1984 and 1985.

Effective chemical repellents would be valuable in reducing bird losses to pistachios. Since birds damaging pistachios remove the hull and shell before actually consuming the pistachio, we wondered whether enough repellent would be ingested by the birds to have any effect. After talking with pistachio growers who had tried various repellents and considering the factors outlined by Tobin and Crabb (1985), we decided not to test repellents during this study.

Poor results with the use of hawk kites were reported by pistachio growers using this method. Due to little or no documentation on the effectiveness of other visual repellents, such as metallic streamers, flagging, and owl and hawk decoys in orchard crops and vineyards, no effort was made to evaluate these techniques. Recent work by Conover (1985) using predator decoys may have some application in bird control in pistachio orchards. However, Howard et al. (1985) had little success with raptor perches and stationary raptor models in vineyards.

Sound repellents such as the gas cannons, Av-Alarm, and recorded distress calls were not tested to any extent. Survey results indicated that both gas cannons and Av-Alarm units were used by many growers with varying results. In Tulare County various attempts at using sound to repel scrub jays from pistachio orchards had not produced encouraging results (Simpson 1972).

Trapping birds has been used as a control method for house finches and starlings. Scrub jays, magpies, ravens, and blackbirds are considerably more difficult to trap. Considering the difficulty in trapping some of the common pest birds of pistachios, and the amount of labor involved in effective trapping programs, it was decided not to field test trapping as a bird control method at this time.

Chemical frightening agents such as Avitrol and lethal avicides such as Starlicide were considered to have good potential for the control of scrub jays. Avitrol has been effective in controlling crows in pecans (Wilson 1972) and work by Simpson (1972) had indicated some success in luring scrub jays to feed on Starlicide-treated bait from bait troughs after pistachio harvest. Using methods described by Simpson (1972) and Wilson (1972), tests were conducted during the 1985 growing season to evaluate the attractiveness of various kinds of baits to crows and scrub jays. Bait-evaluation tests were conducted in orchards with moderate-to-heavy damage by either scrub jays or crows. Table 6 lists the delivery methods and baits tested on the two species. In all cases the baits and delivery methods failed to attract the birds feeding in the pistachio orchards. To be effective, a relatively high percentage of the offending birds must eat the bait. Thus highly attractive baits and an acceptable method of bait delivery are necessary.

Shooting, primarily to frighten and disperse birds, was the most common bird control method used by pistachio growers regardless of the bird species they were attempting to control. With this widespread use of shooting, initial studies were conducted during the 1985 damage season to determine how growers were conducting shooting programs, and to determine if other shooting regimes might prove more effective in reducing bird damage in pistachio orchards. Growers with several orchards often employ roving shooters who move from orchard to orchard, shooting a short time in each orchard before moving to another. From our observations, this method seemed of little or limited value since the birds quickly learned to avoid the shooters and resumed normal feeding activity within a few minutes after the shooters left. Another technique used by some shooters was to pick sites where the movement of the birds in and out of the orchard was the greatest and then sit partially covered by vegetation to shoot birds flying within range. Observations on other sides of the orchard found that the bird activity in the orchard remained constant in areas out of range of the shooter.

A method of putting a single shooter into the orchard on foot for a 20 to 30-minute period, six to eight times a day was tested for 2 days in a Tulare County pistachio orchard with heavy scrub jay

Table 6. Baits and methods of delivery tested for acceptance by crows and scrub jays in pistachio orchards, 1985.

Bird	Delivery method	Type of bait	Acceptance
Crow			
	Ground baiting	Whole kernal corn	poor
	Ground baiting	Chopped pistachios	poor
	Ground baiting	Chopped walnuts	poor
	Ground baiting	Chopped pecans	poor
	Suet block	Ground meat	poor
Scrub Jay			
	"V" bait trough	Chopped pistachios	poor[a]
	"V" bait trough	Fresh whole pistachios	poor
	"V" bait trough	Chopped walnuts	poor
	"V" bait trough	Chopped pecans	poor
	"V" bait trough	Dog food	poor
	Suet block	Ground meat	poor
	Suet block	Canned dog food	poor

[a]Some acceptance of the bait by scrub jay early in the summer before pistachio hull slip.

activity. From this initial test it took, on the average, 45 minutes for the level of scrub jay activity to return to normal after the shooting stopped. For the 65 to 75 minutes, from the onset of shooting to the return to preshooting activity levels, the overall bird activity was about 40% of the expected level (Figure 4).

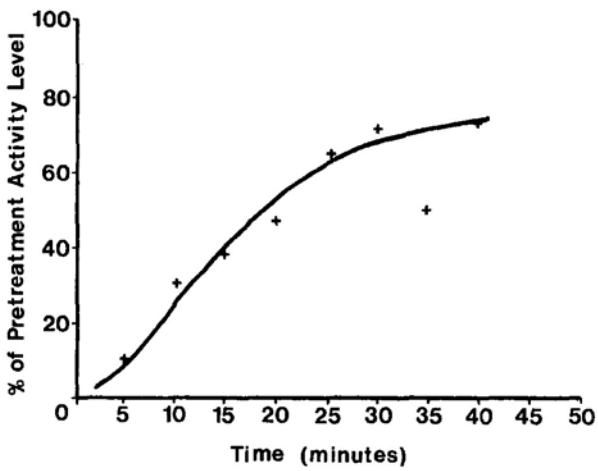

Figure 4. The average number of flights per hour, expressed in percent of pretreatment activity levels, of scrub jays in a pistachio orchard after shooting a shot gun four to six times within the orchard during a 20 to 30 minute period.

After 4 days of relatively intense shooting pressure, the relative number of scrub jay flights returned to levels in excess of the preshooting levels of activity after a single day without shooting. This indicates that even with shooters present in an orchard frequently and on a daily basis, to control scrub jays shooting may need to be continued during the 6 to 8-week damage period.

CONCLUSIONS

In the relatively short period of time that pistachios have been grown commercially in California, a number of birds species have adapted to using the crop as a food source. The most important pest birds of pistachios are the corvids, including raven, crow, scrub jay, and magpie.

Industrywide, the losses are relatively low considering the total state production but, as with other pest bird problems, damage is not distributed evenly or equally among the growers. Field damage assessments made in 1984 and 1985 revealed losses in excess of $200.00 per acre; however, some growers surveyed reported losses in excess of $1000.00 per acre.

At the present time growers attempting any form of control rely on methods that frighten or disperse the birds from the orchard. Regardless of the offending bird species, shooting followed by gas cannons, Av-Alarm and hawk kites are the most commonly used bird control techniques in pistachio orchards. Experimental use of chemical repellents have met with poor success and, without a suitable luring bait, an effective avicide bait seems unlikely.

The common perception among pistachio growers reporting bird damage is that the problem is becoming more serious with time. Further research is needed to attempt to develop both lethal and nonlethal control methods that can be used in a cost-effective manner by those growers sustaining heavy production losses due to bird depredation.

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