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Several techniques were tested to reduce the damage caused by great-tailed grackles to citrus in the lower Rio Grande Valley of southern Texas: monofilament line, eyespot balloons, pyrotechnics, and grackle nest removal. Ten species were found nesting in the treated groves, but only the mourning dove, white-winged dove, and great-tailed grackle in significant numbers. Nesting success was not reduced significantly by any treatment but observations indicate that cannon treatments are likely to have a negative impact on overall nesting success for several species.

INTRODUCTION

Mature citrus groves provide suitable nesting habitat for great-tailed grackles in the lower Rio Grand Valley of southern Texas. Densities > 20 nests/ha were found in 20% of the groves examined during our study. Typically, these groves contain large trees and an ample water supply (irrigation ditches). Also they are usually located near fallow fields that provide a source of Lepidoptera larvae for hatchlings. High nesting densities of grackles are directly correlated with high damage rates to citrus fruit in the groves (Rappole et al. 1989, this volume). Therefore, several control techniques have been tested to reduce the number of grackles nesting in groves with high nesting densities.

In addition to grackles, several other avian species nest in citrus groves including the economically valuable white-winged dove n i siatica). This species is estimated to bring 20 million dollars annually to the Rio Grande Valley economy during the 2 weekend/yr hunting season in September (George 1985). In this study, we surveyed citrus to identify what species other than grackles nest in the groves, and we assessed the possible effects of various grackle control techniques on the nesting success of these birds.

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METHODS

Citrus groves were selected at random from a pool of available groves in 1987 to test the effects of reflective tape (scare tape), monofilament line, and pyrotechnics (propane cannons and shotgun scare shells) on damage by grackles to citrus fruit. Nine groves (3 replications at 3 different intensities) 0.4-ha in size were used to test each technique. Groves with monofilament and reflective tape were split into 0.4-ha treatment and control sections.

In 1988, we re-tested techniques that appeared to show some promise in reducing grackle damage to citrus fruit from our 1987 work; and we tested a new technique, eyespot balloons. In testing these techniques, groves known to have had high grackle nesting densities were used, rather than a random sample as in 1987.

Fluorescent yellow monofilament fishing line (20-1b test) was string in a grid pattern at 1 of 3 spacings (3, 7, and 11-m). The scare tape was used at spacings of 3, 5, and 7-m. Details of these methods are presented in Tipton et al. (1989, this volume). All treatments were put in place during the first 2 weeks of June, 1987 and continued until August 1987.

The pyrotechnics were used in 3 different configurations: 1) 1 single detonation cannon/0.4-ha firing once every 2-5 minutes throughout daylight hours, 2) 1 double detonation cannon/0.4-ha firing every 2-5-min during the day, and 3) 1 double detonation cannon/0.4-ha firing every 2-5-min supplemented with fining of "Shot Tell" scare shells (12-ga shotgun shells that fire an explosive charge roughly 50-m down range) discharged 4 times/day over the grove.

Six additional groves were selected for treatment with cannons alone (2 double detonation propane cannons/0.4-ha) in groves that were known to have high whitewing nesting densities. Treatments were begun during the first 2 weeks of June, 1987 and continued through July 1987. Only whitewing nests were recorded and tracked in these groves.

Monofilament was tested again during the summer of 1988 when it was installed in early April in 3 groves of 0.4-ha each at a 3-m density using procedures described in Tipton et al. (1989, this volume).

Beach-balls, 51-can in diameter, were placed in 4 groves during the 1988 season to reduce damage to citrus fruit. These balls were placed at the end of guyed poles extending 1-m above the canopy in selected groves in March, 1988 at a density of 1 beach-ball/10 trees. For 3 groves, the beach-balls were painted white with a large black iis and bright red pupil, and in one grove the beach-balls were used as purchased (i.e. multicolored - red, blue, green, yellow). Each 0.4-ha treated area was paired with a 0.4-ha control area.

In addition to these passive treatments, we instituted a grackle nest removal treatment 1 in 2 groves from March - June 1988. The groves were 0.3 and 0.8-ha in size. In each grove, all grackle nests were removed by pulling them down using a long pole with a hooked end on a bi-weekly basis.

In each of the treated groves, every citrus tree within the grove was given a number (there are roughly 200 trees in a 0.4-ha grove). Each tree within the grove was checked weekly for grackle nests and for the nests of non-target species from 25 June - 15 August, 1987 and from 28 April - 17 June, 1988. For each nest located, the species, date, tree number, and status (number of eggs and/or young, age of young) was recorded, and the tree was marked with a strip of red engineers tape. All nests were re-visite< and their status recorded weekly until the young fledged or they were destroyed by predators. The number of eggs laid was compared with the number of young fledged to obtain a percent hatching success for each treatment.

Only the mourning dove Zenai macroura) nested in sufficient densities to allow statistical comparison of the effects of treatments on nesting success for most of the treatments. Analyses compared mean percent fledging success (total young fledged/total eggs laid) for each set of treatments monofilament reflective tape, eyespot balloons) with paired control groves using a paired t test. The fledging success in nest removal and pyrotechnic groves was compared with that of control groves from the monofilament, reflective tape and eyespot groves for their respective years using a 2 sample t test.

White-winged doves nested in low densities within the randomly selected groves, but were found in good densities in a few non-randomly selected groves, which were used in testing the effects of cannons on whitewing nesting success. The control groves used for comparison with these treated groves were surveyed by Texas Parks and Wildlife Department as reported by Waggerman (1988). A 2 sample t test was used to compare treatment versus control nesting success.

RESULTS AND DISCUSSION

Thiry-six 0.4-ha groves (14.4-ha) were examined for nests in 1987 out of the 48 total groves in the experimental design (excluding the whitewing groves). The remaining groves were missed due to a variety of problems including heavy rainfall, flooding for irrigation, jet-spraying with pesticides, and high winds causing collapse of reflective tape treatments. A total of 14 groves (5.9-ha) was examined for nests in 1988, 12 groves of 0.4-ha each, and 2 odd-size groves of 03 and 0.8-ha respectively.

Ten species of birds were found nesting in treatment and control groves during 1987 and 1988 (table 1), 5 in 1987 and 10 in 1988. Mourning doves were the most numerous species in the groves, and were relatively evenly distributed as well, occurring in 30 of 42 groves examined in 1987 and 14 of 14 groves in 1988. Clearly, citrus is a very important component of mourning dove reproduction in the Rio Grande Valley, providing nesting habitat for an estimated 50,000-300,000 pairs. The lower nesting pair density estimates (1987) given in table 1 are probably more accurate as they are based on densities in groves that were randomly selected rather than on groves known to have high grackle nesting densities, as the 1988 samples were.

Table 1: -Total nests and nest densities for species found in citrus groves treated to reduce grackle damage during the 1987 and 1988 breeding seasons. t

Total Nests ZNests/ha (x1,000)	'Est. pop.
Species	19871988 1987 1988 1987 1988
White-winged Dove	5
40.30.7 3.5	8.2
Zxnaida asiatica	
Mourning Dove	77
105 53	17.8
623 209.0	
n i macroura	
Inca Dove	1
30.10.5 1.2	5.9
Columbine inca	
Common Ground-Dove 0	3
0.0 OS	0.0
5.9	
Columbine passerine	
White-tipped Dove	2
3 0.1 0.5	1.2
5.9	
Leptotila verreauxi	
Yellow-billed Cuckoo	2
3 0.1 OS	1.2
5.9	
Cog=s anericanus	
Common Pauraque	0
3 0.0 0.5	0.0
5.9	
Nvctidromus albicollis	
Northern Mockingbird 0	1
0.0 0.2	0.0
2.4	
Mimus P&P-lottos	
Long-billed Thrasher	0
2 0.0 0.3	0.0
3.5	
Toxostoma Jon longirostre OStrC	
Great-tailed Grackle	41

'Excludes 1987 whitewing groves.

ZA total of 16.8-ha (42 groves of 0.4-ha each) was examined in 1987 and 5.9-ha (14 groves of 0.4-ha each) in 1988.

3Total pairs of birds nesting in citrus based on estimated citrus acreage of 11,760-ha for the entire lower Rio Grande Valley.

Nesting densities for white-winged doves were far below expected values. Texas Parks and Wildlife Department conducts spring counts based on numbers of calling birds which are then used to estimate breeding population sizes in citrus and chaparral habitats (Rappole and Waggerman 1986). The estimates of nesting densities in citrus were 4.5 pairs/ha for 1987 and 5.1 pairs/ha in

1988 (Waggerman 1988), different by a factor of 10 from our estimates. It should be noted that our groves were located in the east and central portions of the Valley, and that there are groves in the northwest portion where nesting densities are as high as 50 pairs/ha. However, the number and area of these groves is a small percentage of the total 11,760-ha of citrus in the Valley, making us worry that whitewing numbers are currently being over-estimated by a considerable amount. Accurate estimates of whitewing numbers are critical for establishment of proper bag limits for the hunting season.

Reflective tape treatments appeared to have no effect on nesting success for mourning doves (table 2). This result conforms with field observations in which we observed mourning doves and grackles entering groves treated with the tape without any apparent reaction to tape presence. In addition, the tape on these groves was often down because it breaks easily in the strong southeasterly winds (26-32-km/h) that prevail throughout the summer in the Valley.

Table 2: -Mourning dove nesting success (%) for 1988 in groves with monofilament eyespot balloons, or nest destruction as compared with control groves.

Treatment	Number of groves	Total eggs laid	Mean % nest success	Standard Deviation
Nest destruction	2	43	27.5	233
monofilament	3	33	633	32.1
monofilament control	3	34	53.0	12.7
Eyespot	3	38	47.0	12.1
Eyespot	3	27	62.0	

Results from the eyespot and monofilament treatments similarly produced no significant reduction in nesting success in mourning doves (tables 2 and 3). Field obseravations were consistent with this result, as we observed no avoidance behavior toward the fishing line or beach balls by birds entering or leaving the groves. However, a great-horned owl I(*Bubo virginianus* was killed in a collision with one of the monofilament lines.

The lack of any statistically significant reduction in nesting success by the pyrotechnic treatments for whitewings (table 4) and mourning doves (tables 2 and 3) was surprising to us. The effect of the cannons on birds nesting in cannon-treated groves was obvious to the observer, causing the incubating or brooding bird to fly off the nest in many cases, particularly for those located within 50-m of the cannon. The high variance and small size of the samples are the probable explanation for the lack of a statistically significant result. The effects of pyrotechnic techniques on nesting success of non-target species should receive further study if these are to be considered for widespread use.

A similar situation occurred with the statistical evaluation of the effects of grackle nest removal on non-target species. Only 2 groves received this treatment, Nonmacher and Signez, and the statistical analysis showed no significant reduction in nesting success as compared with controls. The Nonmacher grove was 0.8 ha in size. This grove had moderate grackle densities, and mourning dove nesting success was 45.4%. The Signez grove was 0.3-ha and only 2 of 21 eggs laid produced fledged young (9.5%). Grackle density in Signez was very high, despite the removal of their nests, and the effect of the personnel pulling nests down was to frighten incubating or brooding birds of non-target species off from their nests exposing the contents to grackle predation.

Table 3: -Mourning dove nesting success (%) for 1987 in groves with monofilament reflective scare tape, or pyrotechnics as compared with control groves.

Treatment	Number of groves	Total eggs laid	Mean % nest success	Standard Deviation
Monofilament	8	20	21.4	35.6
Monofilament control	8	16	40.3	41.6
Reflective tape	9	15	31.4	40.9
Reflective tape	9	3	20.8	35.4

Table 4: -Whitewing nesting success (%) for 1987 in citrus groves containing propane cannons.

Treatment	Number of groves	Total eggs laid	Mean %nest success	Standard Deviation
Cannons	6	100	28.5	19.4
Control	3	109	40.0	15.9

CONCLUSIONS

Citrus provides important nesting habitat for at least 10 species of birds native to the lower Rio Grande Valley of Texas. Refelective scare tape, monofilament, and eyespot balloon treatments placed in the groves do not appear to have negative effects on nesting densities of these species. Propane cannons and bi-weekly destruction of grackle nests may have negative effects, and need to be tested further if their use is expanded for protecting groves from grackles. Populations of white-winged doves nesting in citrus appear to be seriously over-estimated by procedures currently used by Texas Parks and Wildlife Department. Further work should be done to develop accurate techniques for assessing breeding population size of this important game species.

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