CONTROLLING GREAT-TAILED GRACKLE DAMAGE TO CITRUS IN THE LOWER RIO GRANDE VALLEY, TEXAS

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Abstract: Great-tailed grackle (*Quiscalus mexicanus*) damage to citrus is a serious concern to producers in the lower Rio Grande Valley of Texas. Damage caused by grackles pecking fruit is initiated by breeding colonies in the spring on immature fruit and extends through the fall and winter on ripening fruit. The most significant damage occurs during the post-breeding period of July through September when neither the currently registered DRC-1339-treated dog food bait nor frightening strategies are effective. Observations by Texas Wildlife Services personnel suggested that watermelon was highly attractive to grackles during the period when dog food baits are poorly accepted. Two control strategies using watermelon to bait large cage traps and to formulate DRC-1339 baits were evaluated in cage and field trials during a 2-year research project. This paper reports on the development and preliminary evaluations of a unique trap design and the 0.1% DRC-1339-treated watermelon bait. Summer field trials in citrus groves were conducted to evaluate the effectiveness and safety of trapping and DRC-1339 baiting. Results of preliminary evaluations clearly demonstrated the utility of these methods for controlling grackles. Although the effectiveness of these methods for controlling grackle damage in citrus groves was less conclusive, no measurable hazards to non-target wildlife were documented. With suggested modifications, both methods may provide a viable means to reduce grackle damage to citrus during a period when other alternative methods are ineffective.

Key Words: cage trap, citrus damage, DRC-1339/watermelon bait, Great-tailed grackle, *Quiscalus mexicanus*, Texas

Proc. East. Wildl. Damage Manage. Conf. 8:158-172

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Great-tailed grackle (*Quiscalus mexicanus*) populations are associated with locally severe damage to citrus fruits (e.g., grapefruit, oranges) in the lower Rio Grande Valley of Texas (Hobbs and Leon 1987). Damage occurs when grackles peck at the fruit, which leaves either holes or external blemishes. Damage commences in the spring when breeding grackle colonies nest in citrus groves and extends through the fall and winter as fruits ripen. Resident birds and their offspring are presumed responsible for most damage problems, given that most damage occurs before fall migration. In 1987, grackle damage to grapefruit alone exceeded $2.2 million, with average losses of $295/ha (Johnson et al. 1989). In addition, estimates of damage from grackles to row and truck crops in this intensively farmed region exceed $4 million annually (J. Hobbs, Texas Wildlife Services, pers. commun.). Grackle predation on the eggs and young of resident bird species, such as the white-winged dove (*Zenaida asiatica*), also is a documented problem (Blankenship 1966).

Although frightening techniques help reduce damage to citrus during the late fall and winter, site tenacity by grackles makes these techniques less effective during the post-breeding period of July through September (Rappole et al. 1989), when the greatest amount of damage appears to occur (Johnson et al. 1989). The difficulty in frightening grackles from groves during the summer (Rappole et al. 1989) and the limited movements of these birds during this period

(Rappole et al. 1989) suggest that population reduction may be a practical and biologically sound damage management strategy.

DRC-1339-treated dog food has been used in some situations to reduce grackle populations (Tipton et al. 1989). However, past experience of USDA/APHIS/Wildlife Services (WS) field personnel suggested that this bait was accepted poorly during summer months. Observations by WS personnel in Texas indicated that watermelon was highly attractive to grackles during this period when dog food baits were not accepted. Watermelon potentially could be used to attract grackles to traps or to formulate a new DRC-1339-treated bait.

The objectives of our research were to (1) identify or develop a suitable trap design for capturing grackles, (2) investigate and develop a DRC-1339 treated watermelon bait, and (3) evaluate the potential effectiveness of each for reducing grackle damage to citrus during the summer months.

Numerous people assisted and supported this cooperative research effort, including the following present or past employees with the National Wildlife Research Center (NWRC) or the Texas WS program: Bob Beech, Jesus Cerda, Martin Mendoza, Ray Ramos, David Reinhold, Ricky Sramek, Patrick Smith, and David Trevino. We thank the late Jerry Roberts and the Analytical Chemistry personnel at the NWRC for their assistance in formulation and analytical studies. We especially thank Ray Prewett of Texas Citrus Mutual and the Texas citrus producers for their continued support during this project. Mark Tobin provided helpful comments on an earlier draft of this manuscript. This research partially was funded under cooperative Service agreement #12-34-74-0245-TF with Texas Citrus Mutual.

METHODS

Cage Trap Development and Evaluation

Three large (2.4 x 2.4 x 1.5 m) cage traps were assembled from 4 (2.4 x 1.5 m) side and 2 (2.4 x 1.2 m) top panels that were constructed from 2.5 x 5 cm welded wire fencing stapled onto 5 x 5 cm framing lumber. Traps were assembled by fastening panels together with plastic cable ties. Once assembled, each trap was supplied with dog food and cracked corn in rubber pans, water in a poultry waterer, a rubber pan bird bath, and roosting perches. A (2.4 x 1.2 m) plywood sheet was fastened to the roof panel to provide shade. Three trap designs were used, including a modified Australian Crow Trap (MAC) that used a crow ladder entrance with a 11.4 cm spacing between rungs (Zajanc and Cummings 1965), a modified blackbird decoy trap (DECOY) that incorporated enlarged entrance holes (NWRC Files, Ft Collins, CO), and a Bob-type pigeon cage trap (BOB) that had 2 (33 x 86 cm) bob entrances (Clark 1975). Based on our observations of grackle behavior during a 1-week trial exposure period to each trap design, we modified each of the traps before proceeding with a replicated evaluation of trap designs. Modifications made to the MAC and DECOY traps included the addition of 2 (15 x 15 cm) ground entrances, similar to those recommended for MAC traps when attempting to capture crows (Zajanc and Cummings 1965). The BOB trap was modified by including a wide funnel entrance (FUNNEL) of our own design (Figure 1). The funnel device tapered from a 86 x 33 cm opening to a 15 x 15 cm opening and projected into the trap about 60 cm. A 33 x 91 cm guide fence was positioned outside the center of the entrance opening to direct grackles into the funnel.

During spring 1993, we evaluated the 3 modified trap designs at 2 livestock feeding sites: the McAllen High School Farm, near McAllen, Texas, and the Tres Corales Ranch, Hidalgo County, Texas. To replicate these trials further, we repeated our evaluation at the latter site during spring 1994. To compare the relative effectiveness of these traps in capturing grackles, we positioned the 3 traps < 5 m apart at each site to reduce position bias on trap results. To reduce trap shyness, open traps were pre-baited with dog food and watermelon for up to 2 weeks. In addition, traps were pre-baited over weekends and other times when they were secured open and not tended. We baited traps with equal amounts of bread, watermelon, and dog food. Following the initial pre-baiting period, trapping at the McAllen High School Farm extended from 17 March to 25 March. Traps at the Tres Corales

ranch were tested from 14 April to 19 May 1993 and again from 4 April to 15 April 1994. During these periods, traps were serviced daily, except for weekends, when they were not operated. Any grackles captured during trapping were removed daily and either marked and released or disposed of by euthanasia. All non-target animals were released unharmed from traps.

We recorded the number of grackles and non-target species trapped daily for each trap design. In addition, we estimated the number of grackles present within 100 m of the traps daily. We ranked grackle capture rates (number captured/day) among trap designs from each site or year and analyzed these data using a Kruskal-Wallis analysis. A Tukey's test was used to separate differences among means. No attempt was made to analyze capture rates of non-target species.

During summer 1993, we re-evaluated traps of the design that was most effective during the spring 1993 trials. Traps were deployed at 4 citrus groves (2-4 ha in size) located in eastern Hidalgo County. Sites were selected based on their past experience with grackle damage and on our observation of grackle presence and fruit damage during an inspection conducted in August. To assume independence among grackle populations, the citrus groves we selected (Anderson Estate, Freeloma, Rio Farms, B&B Enterprises) all were separated by $\geq$5 km.

At the edge of each grove, we deployed 1 trap baited with pieces of cut watermelon. Traps were pre-baited for approximately 1 week before initiating trapping. To restrict predators, we initially installed a multi-strand electric fence around the perimeter of each trap. We later removed these fences and operated the traps only during daylight hours. Traps were operated for approximately 1 month (11 August 1993 to either 8 or 10 September 1993) and rendered between 21 and 25 actual trapping days at each site.

To assess grackle and non-target species activity at each grove, we counted the number of grackles and non-target birds seen in the immediate vicinity of these groves twice weekly during the trapping period. Groves were visited sequentially at about the same time each day from 0830 to 1130 h.

DRC-1339/Watermelon Bait Development and Testing

Initial development of the DRC-1339 watermelon formulation required examination of methods to effectively disperse the chemical in the watermelon. We found that chopping and homogenizing the pulp was the most practical method. This involved inserting an impeller (~2.5 cm) connected to a stainless steel shaft (~20 cm long) and mounted in an electric drill into a halved watermelon and chopping the pulp using an up and down motion for about 2 minutes. DRC-1339 was added to the homogenized watermelon mixture and blended for an additional minute using the impeller until the DRC-1339 appeared to be distributed evenly.

To evaluate the utility of the formulation and formulation procedure, we examined the dispersion of the DRC-1339 chemical within the watermelon formulation and its degradation under simulated field conditions. The first objective involved analyzing samples of treated watermelons for DRC-1339 content. The second objective involved chemical analyses of treated watermelons after 4 h and 8 h in a lighted environmental chamber maintained at 90^0F.

Following formulation testing, we conducted preliminary trials to evaluate acceptance by and mortality of grackles exposed to 0.1% wt/wt DRC-1339 as delivered in our watermelon bait. Groups of 4 to 8 grackles were transported to a 2.4 x 2.4 x 1.5-m holding pen outside the WS storage facility near McAllen and supplied with perches, shade, and rations of dog food, cracked corn, and water. On the first day of the trial, untreated watermelon pulp was presented to penned birds for 4 h. We observed grackle behavior for 20-30 min after initial presentation to see if they would consume watermelon. We observed grackles from about 6 m away using a parked vehicle as a blind. After this exposure, we removed the watermelon from the pen and assessed watermelon consumption. Procedures during the second day of the trial were identical to the first, except that DRC-1339 was formulated into watermelon halves at 0.1% wt/wt of

watermelon pulp using technical DRC-1339 previously assayed for active ingredient. After exposure to treated watermelon, we kept these grackles in captivity for an additional 3 days to assess mortality.

In 1995, an additional cage trial was conducted to assess the acceptance of an enhanced treated bait by grackles. A water soluble watermelon flavoring (Robert Koch Industries, Denver, CO) was added to the treated bait to help mask the odor of the DRC-1339. This cage trial was conducted similar to those previously run and used DRC-1339 treated watermelons with and without the 0.2% flavoring added to a 1 kg sample. Each 1-kg sample was presented to 8 grackles that had been pre-baited for 1 day with untreated watermelon. We estimated the amount of consumption of each sample the following morning and all birds were observed for 3 days after exposure to assess mortality.

DRC-1339/Watermelon Field Trials

Bait formulation—Current 24C label directions for bait formulation stipulate that we remove 10 pounds (4.5 kg) of watermelon pulp from the rind and place it in a large bowl. We then broke the pulp into small pieces by hand to facilitate chopping by the rotating impeller blade, used in an up and down motion for 2 minutes. We added 4.5 grams of technical DRC-1339 to this pulp/juice mixture and distributed the chemical evenly by stirring it with the rotating impeller blade for an additional minute.

Study sites—Field trials were initiated in 1994 and continued in a similar manner in 1995. In July of both years, 6 grapefruit groves with a history of severe grackle damage were selected from within eastern Hidalgo County. To assure independence among grackle populations, all groves were spaced $\geq$5 km apart. During each year, 3 of the 6 groves were selected randomly to receive DRC-1339-treated watermelon baiting; the other 3 sites served as untreated controls.

Treatments—Treatment sites were pre-baited with untreated chopped watermelon for 1 to 3 days. The slurry mix was placed in bowls made from halved and excavated watermelons, which were situated in areas of the grove where grackles were observed to congregate. In 1994, 3 bowls, each containing 1 kg of chopped watermelon, were placed daily on elevated platforms and another 3 bowls were placed on the ground spaced approximately 30 m apart. In 1995, 5 bowls, each containing 1 kg of chopped watermelon, were placed exclusively on raised platforms located throughout the grove to facilitate baiting during irrigation. To enhance acceptance of treated bait in 1995, bowls were covered with a 2.5-cm cross section slice of watermelon (Watermelon Slice Lid), which was laid on its side and held in place with tooth picks.

Groves were baited during the last week of July in both years. Freshly prepared 0.1% DRC-1339-treated chopped watermelon was distributed at sunrise daily for 1 or 2 days, in bowls containing either 0.5 or 1 kg of treated watermelon. Treatment bowls were placed only at locations where more than negligible pre-bait consumption had occurred previously or high grackle use was noted. Treated bait was exposed only during the daylight hours for a minimum of 8 h daily.

Between 2 August and 17 August 1995, 4 additional groves (Buce, Chilson, Loop, Vealds Valley) were baited with DRC-1339/watermelon or a combination of DRC-1339/watermelon and DRC-1339/dog food. A process of 1 day of pre-baiting followed by 1 day of baiting was used, and all bowls were positioned on the ground. Overall, 2 to 4 kg of treated watermelon were applied at all 4 sites, and 0.9 to 1.4 kg of 1% treated dog food also was applied at the Buce and Chilson Grove sites, respectively.

Bait consumption—The contents of each watermelon bowl were weighed at the beginning and end of each day and consumption was estimated by subtracting the final weight from the initial weight. Weight loss due to evaporation was assessed daily by placing a bowl with an equal amount of chopped watermelon outside under a welded wire enclosure that prevented consumption by grackles and other animals. The proportion of weight loss from this enclosed bowl was subtracted from that of exposed bowls to estimate watermelon consumption by grackles.

Grackle populations—Grackle populations in the immediate vicinity of both treated and control groves were estimated visually as birds were flushed from groves by observers driving the perimeter of each grove. Populations were sampled 3 times daily starting 3 days before treatment and ending 3 days after the end of treatment. The 3 daily sampling periods were from 0700 to 1100 h, 1100 to 1500 h and from 1500 to 1900 h. Once sampling times for each period were selected, groves were visited at approximately the same times each day. In addition, groves were visited weekly at these selected times and grackle populations were estimated beginning 7 days after treatment and ending about the end of August.

Damage assessment—In 1995, we assessed grackle damage in the 2 treated and 2 control groves by examining all fruit on 15 trees in each grove for the presence or absence of grackle damage (Johnson et al. 1989). We selected the first tree at random; subsequent trees were selected systematically based on a tree-count interval determined by dividing the estimated number of trees in the grove by 15. Percent damage was calculated based on the total number of fruits damaged divided by the total number of fruits examined. Starting in September, or approximately 40 days after initial treatment, we conducted a second damage assessment, using procedures identical to those used in the first assessment and involving the same trees previously sampled. Differences in the percent of fruits damaged between the first and second assessment were assumed to represent the percent of damage sustained following treatment.

Non-target hazards—We used 3 methods to assess potential hazards to non-target animals, primarily birds. These involved pre- and post-treatment censuses, pre-bait and bait exposure observations, and dead animal searches. Non-target censuses were conducted at both treated and control groves 3 days immediately before treatment and 3 days immediately after treatment ended. Censuses were conducted along two 500-m transects, one inside the grove and the other in an adjacent habitat. Censuses were conducted between 0700 and 1100 h, and each grove was censused about the same time each day.

Pre-bait and bait exposure observations were conducted at treated sites 3 times/day during days of pre-baiting and baiting. These consisted of 30 min observations of all DRC-1339-treated watermelon bowls from a selected observation point located >30 m away. Using binoculars or a spotting scope, we recorded the number and species of birds and other animals observed consuming treated or untreated watermelon every 5 min.

Dead animal searches were conducted at treated sites between 1500 and 1900 h on all baiting days. We used the same transects established for non-target censuses as our search areas.

RESULTS

Cage Traps

Initial observations of the unmodified traps suggested that grackles generally were wary of the traps, but were likely to approach a trap by landing nearby and walking up to it rather than landing on it. Thus, ground entrances seemed necessary to optimize trap success. In addition, we sensed that modifications were needed on the Bob trap because grackles were reluctant to push the bobs to enter this trap.

During 8 trapping days at the McAllen High School Farm site, 5, 8, and 67 grackles, respectively, were caught in the MAC, DECOY, and FUNNEL traps, which translate to capture rates of 0.6, 1.0, and 8.4 grackles/day for these traps. The total number of grackles trapped exceeded the average daily grackle population observed at this site, estimated at 62.5 birds during the trapping period. At the Tres Corales ranch, trapping was conducted from 14 April to 19 May, but, because grackle populations dropped to only 25 birds after 10 May (from an average population of 122 grackles previously in the area), only 18 trapping days were considered. The number of grackles caught during these 18 trapping days was 2, 6, and 29 birds, respectively, for MAC, DECOY, and FUNNEL traps. Capture rates (0.1, 0.3, and 1.6 grackles/day) at this site were lower for all trap designs, and appeared to be affected by raccoon activity around traps during part of the trapping period. During 10 trapping days in April 1994, 44, 24, and 74 grackles, respectively, were

captured at Tres Corales with MAC, DECOY, and FUNNEL traps (capture rates: 4.4, 2.4, and 7.4 grackles/day, respectively). Higher capture rates at this site in 1994 may have be due to a larger grackle population, which averaged 272.5 grackles observed during the trapping period, and the lack of predators. We noted higher capture success for DECOY and MAC traps that were positioned under tree limbs, where grackles commonly dropped down onto the traps from perching positions on these limbs.

Although capture rates for each trap design varied among sites and years, ranked capture rates among traps per site differed significantly ($P=0.0110$). The FUNNEL trap achieved consistently higher capture rates and differed ($P<0.05$) from both the MAC and DECOY traps. Ranked capture rates did not differ ($P>0.05$) between the MAC and DECOY trap designs.

The trapping success of FUNNEL traps used in citrus groves was considerably lower compared to earlier results. At Rio Farm, only 23 grackles were trapped during 25 trap days (trap success rate=0.92 grackles/trap/day), where the average population of grackles observed within the vicinity of this grove was >200 during the trapping period. At Freeloma, only 16 grackles were captured during 21 trap days (0.76 grackles/trap/day), but the mean population here was estimated at only 7.1 grackles during the trapping period. No grackles were trapped at Anderson Estate or B&B Enterprises during 22 and 21 trap days, respectively. We observed very few grackles at either of these groves.

DRC-1339/Watermelon Bait Development and Testing

Our preliminary formulation method (using the impeller blade for 2 minutes) was effective in chopping the melon into small pieces. Neither the size of the impeller blade nor time spent chopping produced much difference in the uniformity of the bait matrix, except for reducing the pulp almost to all juice. Pulp pieces made with the existing procedure ranged from approximately 1 g to 20 g, with a mean of approximately 8 g. DRC-1339-treated watermelon baits formulated at NWRC in an identical manner had a mean concentration of 0.098% (CV=7.8%) immediately after formulating. However, baits placed in an environmental chamber and exposed to simulated field conditions (90°F for 4 and 8 hours) had mean chemical concentrations of 0.066% (CV=0.63%) and 0.058% (CV=1.4%), respectively.

The formulation procedure was simple and practical to perform under field conditions, but we found that initial crushing of larger pieces by hand was necessary to obtain uniform pulp texture. During the cage trials, grackles that fed on both treated and untreated watermelons perched on the edge of the rind and consumed pieces of pulp that floated in the pulp/juice matrix. In the first trial, only 3 of 8 grackles ate from either the untreated or treated watermelon and 3 died. In the next 2 trials, which involved 6 and 4 grackles, all consumed treated watermelon and all 10 died. In a subsequent cage trial, grackles were repelled by 0.1% DRC-1339 treated watermelon with 0.2% watermelon flavoring. Eight caged grackles consumed approximately 160 g of treated watermelon without flavoring, but consumed only a negligible amount of the flavored melon. Consistent with previous trials, all 8 birds died within 24 hours after exposure.

DRC-1339/Watermelon Field Trials

Bait application, grackle use, and consumption—At the 3 groves selected for treatment during 1994 (Thompson-East, Thompson-West, Rio Farm-East), pre-bait acceptance appeared adequate after 2 days of pre-baiting. However, differential evaporation and consumption by bees confounded an accurate assessment of consumption by birds. Treated groves were baited either for 1 day (Thompson-East and Thompson-West) or 2 days (Rio Farm-East), where 1.5 or 3.0 kg of DRC-1339-treated watermelon was available per day, respectively. Post-treatment weights-of remaining treated watermelon indicated that birds did consume the product. Observations of the watermelon bowls conducted as part of our non-target evaluations (see below) provided a useful index to grackles' use of the watermelon. During 9 hours of pre-treatment observations during 1994, we recorded 435 grackles (48.3 grackles/hour) at the 3 pre-baited sites, whereas, during actual treatment, we

observed 87 grackles (14.5 grackles/hour) at the treated bait during 6 hours of observation. Although grackles' use of bowls positioned on the ground was, on average, almost 1.5 times that of those on platforms, we detected no significant difference (P=0.51) in use between bowls placed on the ground vs. those on platforms.

Puncture marks made by grackles through the watermelon slice lids, as used during 1995, provided a better index to how grackles responded to bowl placement. However, after pre-baiting the Anderson, B&B Airport, and Cray for 3 days, only Anderson demonstrated adequate pre-bait consumption to warrant baiting. Use of watermelon pre-baits positioned on platforms during 1995 was only 3.4 grackles/hour of observation. At B&B Airport and Cray, our observations suggested that grackles spent only a small part of the day in the grove, thus limiting the time available to find and consume watermelon. A fourth grove (Steward) later was selected, pre-baited, and treated by WS personnel. Five and 6 kg/day of treated bait, respectively, were applied during 2 days of baiting at Anderson and Steward.

Grackle Populations—Variability of grackle populations over time (Figures 2 and 3) may have masked changes in populations due to treatment. Grackle populations varied not only among days, but also within a day. Populations in untreated groves varied among morning, mid-day, and late afternoon censuses (P=0.0001), where morning counts consistently were higher (P=0.05) than the other 2 counts.

Our analysis of grackle population response to treatment involved 4 treatment groves (3 treated in 1994, 1 in 1995) and 4 control groves (3 used in 1994, 1 in 1995). Data from other treatment groves used in 1995 were incomplete and not used in our analyses. Ranked grackle populations 3 days before and 3 days after treatment did not differ (P=0.1482) between treated and control groves. However, grackle populations increased at 3 of 4 control groves and decreased by 37% - 85% at the 4 treated groves (Figures 2 and 3). We suspect the increase in grackle populations at control groves was associated with irrigation operations during post-treatment. Irrigation may have masked more dramatic treatment effects at the 3 groves that were treated during 1994. The Anderson grove (irrigated) showed an 85% reduction in grackle populations in response to treatment in 1995. Similarly, the Steward grove and other groves baited only with watermelon showed a 50-80% reduction in grackle populations immediately after treatment (Table 1). At 2 groves (Buce and Chilson), large pre-treatment grackle populations were reduced by at least 90% when 1% dog food baits were combined with watermelon baiting (Table 1).

Grackle populations that remained weeks after treatment may or may not have been influenced by treatment. An analysis of variance of the slope of grackle population trends over the month following treatment showed no significant difference (P=0.282) between treated and control groves. However, populations at treated sites appeared to remain low at least 2 weeks after treatment, whereas grackle populations at control groves during the same period consistently exceeded pre-treatment levels (Figures 2 and 3).

Citrus Damage—During 1995, damage assessments conducted at 2 treated and 2 control test sites at the time of treatment and again ~40 days later suggest that DRC-1339/watermelon baiting reduced grackle damage. Damage recorded at the 2 treated groves was slightly less than estimated initially, whereas control groves experienced slightly greater damage ($\underline{t}$=-4.357, df=2, $\underline{P}$=0.0488) (Table 2). We suspect that much of the damage occurred prior to treatment in late July and the small decreases in assessed damage between assessments may represent the degree of error in our assessment methodology.

Non-target Hazard Evaluations—The 3 methods we used to assess non-target hazards associated with DRC-1339/watermelon baiting all revealed no evidence of significant non-target hazards. Our surveys of non-target populations 3 days before and 3 days after treatment found 25 species of birds and 2 species of rabbits present within the test groves. However, of these 27 species, only mourning doves (*Zenaida macroura*) were present in sufficient numbers to allow analysis. Changes in mourning dove populations before and after treatment did not

differ (F=0.23; df=1,6; P=0.65) between treated and control groves. During 1994, mourning dove populations increased immediately after treatment in all but 1 treated grove and in all control groves, whereas, during 1995, dove populations decreased slightly over the same period (Table 3). However, only several of these within-grove changes were significant (Table 3). We suspect that the changes in dove numbers, like those of grackles, were related to irrigation operations at these groves.

One cottontail rabbit (*Sylvilagus floridanus*) was observed feeding at a watermelon bowl during 54 hours of observation at 65 watermelon bowls (includes both pre-baiting and baiting periods). In contrast, 681 grackles fed at these bowls during this same period.

We found no carcasses of non-target species during 3.8 hours of searching within and adjacent to treated groves during each day of treatment. However, we found 6 dead grackles at Steward after baiting during 1995.

DISCUSSION

Our results suggest that the large funnel entrance cage trap of our own design was most successful in capturing great-tailed grackles. This is consistent with previous observations (West and Brunton 1967) that suggest that ground entrance traps, such as the Chachalaca trap, are more effective than the MAC trap. The large entrance and guide fence features of this trap facilitate entry by grackles that normally approach a trap by walking up to and around them. The use of a large, tapering entrance has been reported previously and was recommended as the best way to capture black-billed magpies (*Pica pica*) (Clark 1975). The tapering of the entrance also reduces escapes by grackles and precludes larger birds and mammals from entering. Although measuring escape rates was not a stated objective of this study, we noted that very few grackles escaped from this trap.

Several factors may account for the reduced capture success of the FUNNEL trap during summer in citrus groves. Low or inconsistent number of grackles in the proximity of these traps probably was paramount. Few birds were trapped at most sites because few birds were present on days we trapped. We suspect the electric fences we installed around the traps initially may have reduced trap success. At Anderson Estate, grackles rapidly consumed watermelon during pre-baiting, but appeared to avoid the trap completely after the electric fence was installed. This avoidance persisted after the electric fence was removed. Following the removal of these fences, we ran traps only during daylight hours to limit the effects of predation. This also reduced the length of the trapping day to <11 hours, and traps were not operated during early morning hours just after sunrise when grackles are most active.

Efficacy of 0.1% DRC-1339 treated watermelon in our cage trials was consistent with toxicity data of DRC-1339 to great-tailed grackles. Using cage trials, West and Brunton (1967) calculated an MLD_{100} for DRC-1339 to great-tailed grackles at 1.8 mg/kg. Using an average weight of 200 gm for a male grackle, then a single 1 gm piece of 0.1% bait should be lethal (approximately 1 MLD_{100}) even when allowing for some degradation of the chemical. However, the rapid degradation of chemical content we observed in these baits necessitated that fresh baits be prepared daily.

Temporal variation of grackle numbers in citrus groves provided information about the effective timing of such treatments. Based on times when grackles are most abundant in groves, treatment probably should be applied early in the morning when groves are being irrigated. Our field efficacy tests suggest that DRC-1339-treated watermelon may reduce grackle populations in citrus groves during the summer and have no measurable effects on non-target populations. Although extensive use by grackles may have limited our ability to accurately assess impacts on non-target species, we believe our tests indicated that watermelon baits should be placed on elevated platforms or on the ground along the edge of groves to limit exposure of non-target species to the treatment. More recent records of DRC-1339/watermelon baits during 1996 and 1997 control operations at 15 groves in the Rio Grande Valley (Wildlife Services Files, McAllen, TX) further demonstrate the efficacy of this

formulation. About 1-2 liters of this formulation used for 1 day reduced grackle populations in citrus groves from 75-100% ($\bar{X}$ =89.6%) within a week after treatment compared to pre-treatment populations that ranged from 20-275 birds.

By reducing grackle populations in citrus groves, one also presumably reduces the amount of damage they caused to ripening fruit. In the cases where we measured damage, this appeared to be true. The apparent reduction of damage in these groves over time may have been an artifact of damage assessment error rather than a treatment effect. However, it also suggests that no appreciable new damage occurred after baiting, which was in contrast to the measurable damage that occurred at our 2 control groves.

MANAGEMENT IMPLICATIONS

Watermelon appears to be effective as a trap bait and a DRC-1339-treated bait used to reduce summer grackle populations associated with citrus damage, without detectable hazard to non-target species. This has critical importance to efforts to reduce citrus damage because previous studies indicate that most damage by grackles occurs during summer (Johnson et al. 1989) and alternative methods are not effective at this time (Rappole et al. 1989).

Trapping likely will not remove grackles from the population as rapidly as toxic baiting does, but it supplements baiting and should be considered part of an integrated control program. An advantage of trapping is that it can be conducted by growers, whereas, under the current 24C registration, DRC-1339 baiting can be conducted only by WS personnel. Small portable traps might be more practical for growers to place within or move about in the grove than the large traps we utilized. We suggest that the entrance dimensions for these smaller traps must be the same as those of the larger traps, and food, water, and shade must be provided to grackles or any non-target species that might enter the trap. Traps should be pre-baited and the doors left open for several days (or until evidence that watermelon bait is being consumed). Traps should be set at sunrise to correspond with peak grackle activity in groves and checked before dark to prevent predation. Trapping during periods of irrigation also will increase trap success because grackles are more numerous in groves at these times.

A number of factors need to be considered when using DRC-1339-treated watermelon. First, the DRC-1339 treated watermelon bait quickly degrades in response to heat and light. It should be used immediately after preparation, especially at sunrise to correspond with peak grackle activity and lower temperatures. We also recommend using watermelon slice lids to shade the treated bait and help retard degradation. Lids appeared to increase acceptance by grackles and helped limit access to the treated bait by non-target birds. Regarding potential non-target hazards, DRC-1339-treated watermelon is not as selective in controlling grackles as the previously registered DRC-1339-treated dog food bait. Therefore, watermelon should be used only when the latter bait is ineffective. We have no conclusive evidence that placing bait on the ground or on platforms affected its effectiveness or safety, so both options should be evaluated by the applicator. Although ground placement sometimes may be preferable, the timing of baiting with respect to irrigation efforts suggests that the use of platforms may be more effective and logical.

Although not the panacea for controlling grackle damage to citrus, removal of post-breeding grackles from citrus groves with traps or DRC-1339/watermelon baits can provide additional methods to control citrus damage during a period when alternative methods typically are ineffective.

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Table 1. Counts of great-tailed grackles (*Quiscalus mexicanus*) in citrus groves 1-day before (PRE-COUNT) and approximately 1 week after (POST-COUNT) 1 or 2 days of treatment with 0.1% DRC-1339-treated watermelon alone (WATERMELON ONLY) or in combination with 1% DRC-1339-treated dog food (WATERMELON + DOG FOOD) by Texas Animal Damage Control personnel in August 1995.

		NUMBER OF GREAT-TAILED GRACKLES		
GROVE	TREATMENT	PRE-COUNT	POST-COUNT	% REDUCTION
STEWARD**	WATERMELON ONLY	50	20	60
LOOP FARMS	WATERMELON ONLY	30	15	50
VEALDS VALLEY	WATERMELON ONLY	75	15	80
BUCE	WATERMELON & DOG FOOD	500	30	94
CHILSON	WATERMELON & DOG FOOD	200	20	90

** 2 consecutive days of baiting

Table 2. Changes in percent of estimated great-tailed grackle (*Quiscalus mexicanus*) damage to citrus in Hidalgo County, Texas, as assessed during the last week of July (immediately following treatment) and on 6 or 7 September 1995 at 2 treated and 2 control groves following treatment with 0.1% DRC-1339-treated watermelon.

	JULY DAMAGE (%)	SEPTEMBER DAMAGE (%)	CHANGE IN DAMAGE (%)
TREATED GROVES			
ANDERSON	4.8	4.3	-0.5
STEWARD	4.1	2.5	-1.6
CONTROL GROVES			
RIO FARM-EAST	1.0	2.3	+1.3
THOMPSON	14.0	15.7	+1.7

Table 3. Mean number of mourning doves (*Zenaida macroura*) observed in or adjacent to treated and control citrus groves in Hidalgo County, Texas, during 3 consecutive days before and after treatment with 0.1% DRC-1339-treated watermelon during July 1994 and July 1995.

	PRE-TREATMENT $\bar{X}$ ± S.E.	POST-TREATMENT $\bar{X}$ ± S.E	% CHANGE
TREATED GROVES			
ANDERSON (1995)	21.67 ± 1.66	13.33 ± 1.33	-38.6 **
RIO FARM-EAST (1994)	9.67 ± 4.70	4.33 ± 1.45	-55.2
THOMPSON-EAST (1994)	14.33 ± 4.37	23.67 ± 0.67	+65.2**
THOMPSON-DW (1994)*	38.00 ± 17.0	65.00 ± 9.0	+71.1
CONTROL GROVES			
RIO FARM-EAST (1995)	5.33 ± 1.45	3.67 ± 2.03	–31.1
RIO FARM-WEST (1994)	36.0 ± 4.04	51.0 ± 9.07	+41.7**
STEWARD (1994)	21.0 ± 3.51	25.67 ± 4.25	+22.2
STEWARD-HARGILL (1994)	9.33 ± 1.76	20.0 ± 10.60	+89.3

* ONLY 2 PRE-TREATMENT AND 2 POST-TREATMENT CENSUSES WERE CONDUCTED AT THIS GROVE

** INDICATES SIGNIFICANT ($P < 0.05$) CHANGES BASED ON T TEST OF MEANS

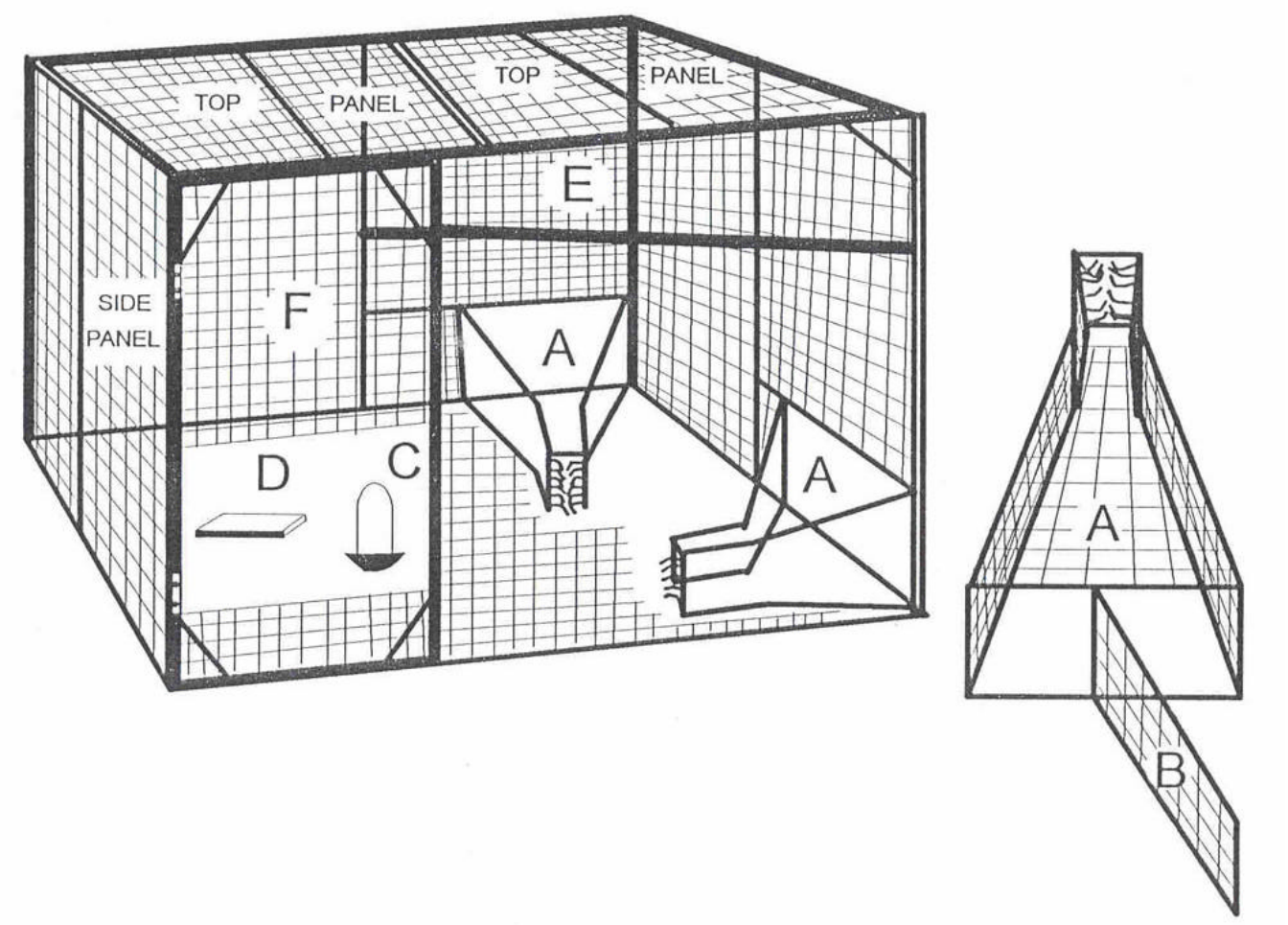

Figure 1. A 6-panel (4 [2.4 x 1.5 m] side panels and 2 [2.4 x 1.2 m] top panels) great-tailed grackle (*Quiscalus mexicanus*) cage trap that features a large (86 x 33 cm) funnel entrance (A), the opening of which tapers to 15 x 15 cm, and a 33 x 91 cm guide fence (B). A poultry waterer (C), food tray (D), and perch (E) are provided to sustain grackles or other captured birds. A (0.8 x 1.4 m) hinged door (F) on the front side panel allows access for servicing. Hot weather options not shown include a (2.4 x 1.2 m) plywood sheet fastened to the roof panel to provide shade and an 11-L rubber pan filled with water for a bird bath.

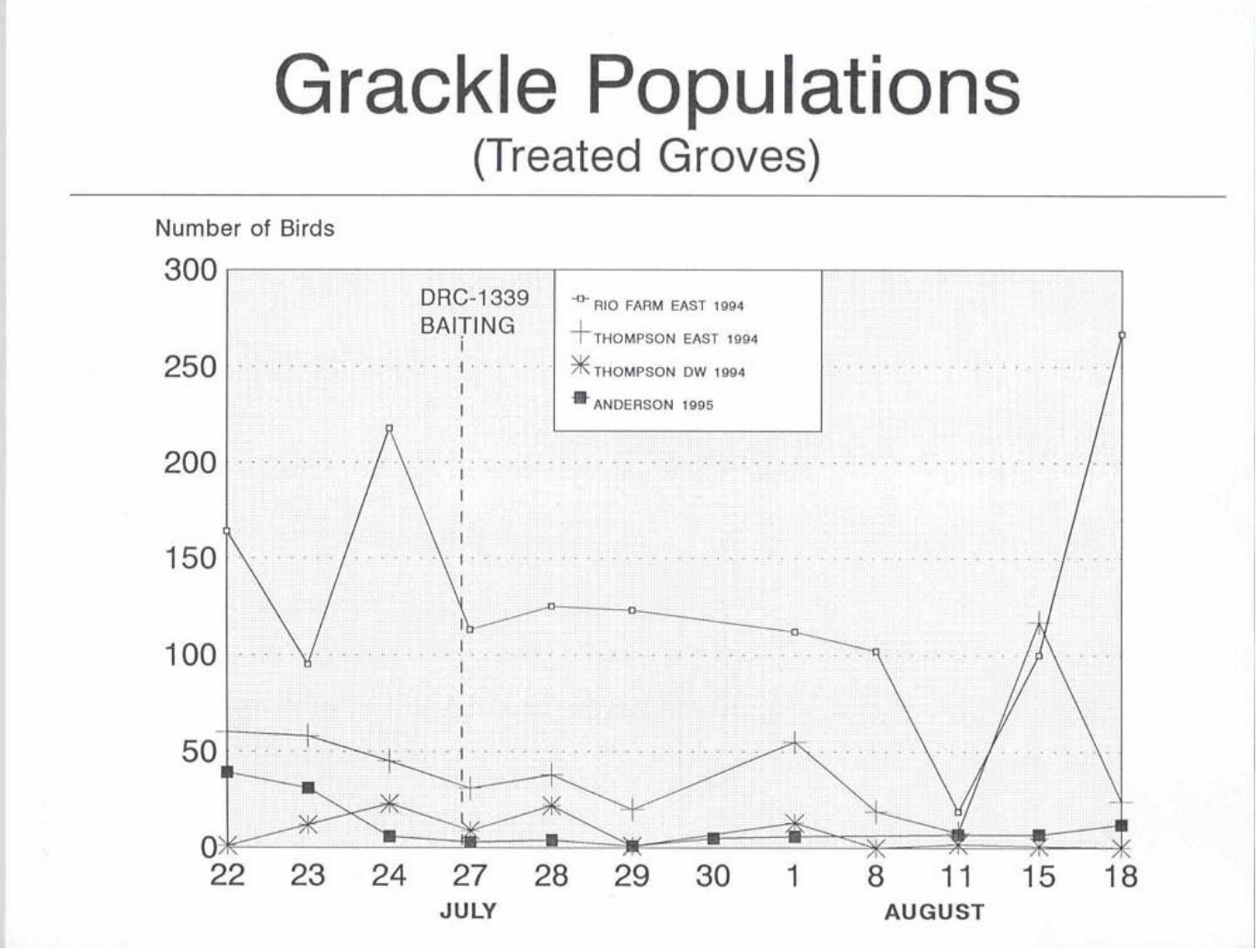

Figure 2. Mean daily population census counts of great-tailed grackle (*Quiscalus mexicanus*) at 4 citrus groves in Hidalgo County, Texas, conducted 3 consecutive days before treatment, then daily (for 3 days) and weekly (for 5 weeks) following treatment with 0.1% DRC-1339-treated watermelon during July 1994 and July 1995.

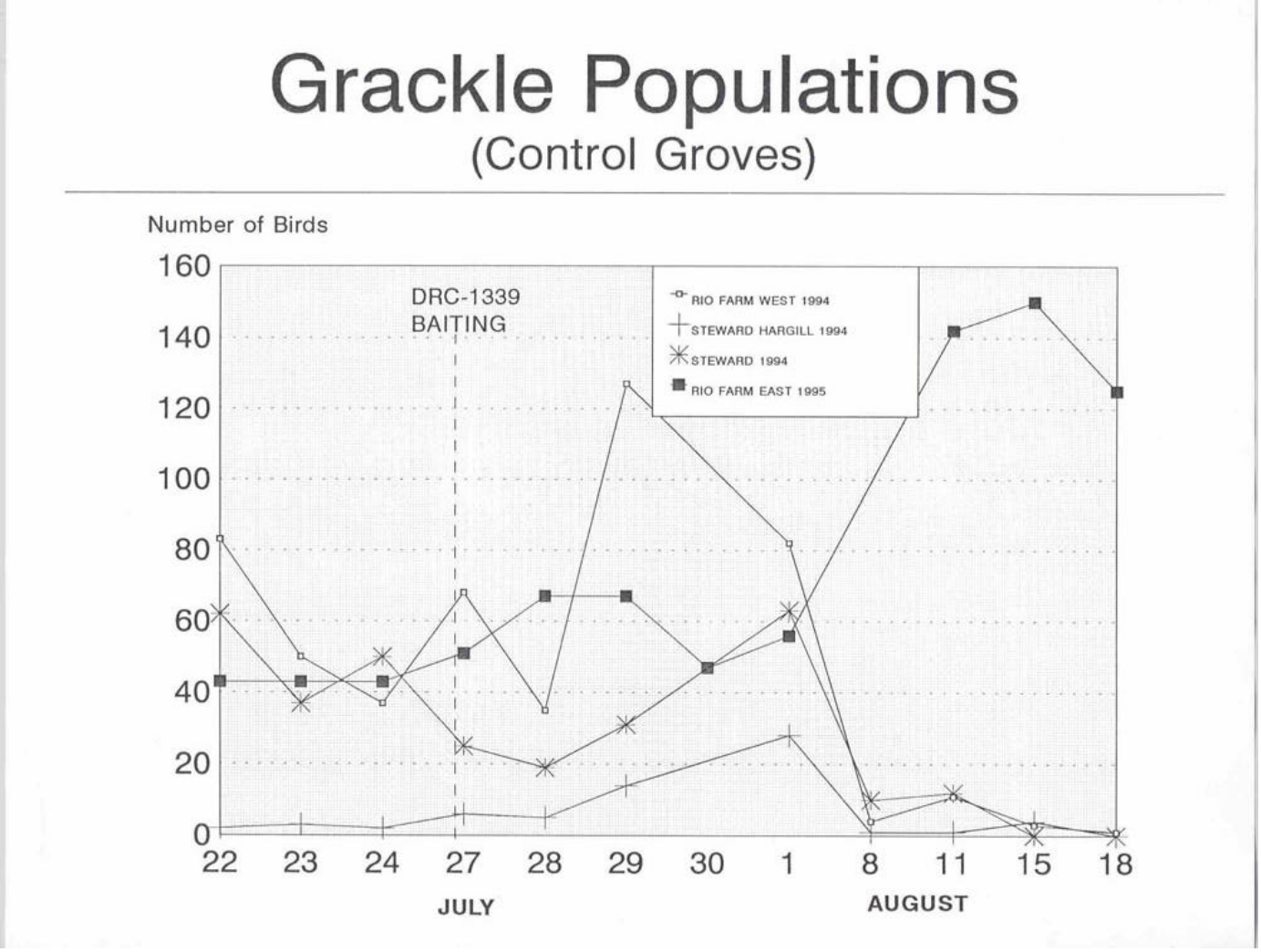

Figure 3. Mean daily great-tailed grackle (*Quiscalus mexicanus*) population estimates at 5 control (untreated) citrus groves in Hidalgo County, Texas for 3 consecutive days before treatment and at daily (for 3 days) and then weekly (for 5 weeks) intervals following treatment with 0.1% DRC-1339-treated watermelon in July of 1994 and 1995.