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The effectiveness of monofilament line, reflective tape, beach-balls and pyrotechnics (propane cannons and shotgun scare shells) in reducing damage to citrus by great-tailed grackles was tested in the lower Rio Grande Valley of southern Texas. Results indicate that these treatments can produce reduction in damage. Whether the treatments are economically advisable for a grower depends on the history of grackle damage to the grove and grove size. Only large amounts of damage in large groves justify costs associated with implementation of these methods.

INTRODUCTION

The great-tailed grackle uisca 1 s mexicanus) is a serious pest to the citrus industry of south Texas (Hobbs and Leon 1988). As part of a multi-prong approach to develop techniques to reduce damage to citrus we evaluated a number of non-lethal methods that had been developed for protecting other agricultural crops.

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Techniques we evaluated were monofilament line, reflective tape (Tobin et al. 1988, Dolbeer et al. 1986), eye spot balloons (Mott 1985, Shirota et al. 1983) and pyrotechnics (Conover 1984). These techniques were evaluated in a series of experiments from 1987 through 1989.

METHODS

In the spring of 1987, 30 groves of 0.4-ha each were selected to test the effects of reflective tape, monofilament tape, and pyrotechnics (propane cannons and shotgun scare shells) on damage by grackles to citrus fruit. Nine groves (3 replications at 3 different intensities) were used to test each technique, and 3 groves served as untreated plots. Groves were placed into groups of 10 based on their proximity to one another and randomly assigned to the 10 possible treatments. Additionally, all reflective tape and monofilament groves (excluding 1 3-m monofilament grove) had individual control groves located adjacent to them.

Fluorescent yellow monofilament fishing line (9-kg test) was strung in a grid pattern at 1 of 3 different spas (3-m, 7-m, and 11-m) over 9 groves (3 spacings, 3 groves each). Reflective tape was suspended in rows parallel to tree rows at one of 3 spacings (3-m, 5-m, and 7-m) over 3 groves each. Both the monofilament and scare tape were strung approximately 1-m above the canopy, supported by rows of poles with 1 pole every 30-m. The poles were steel electrical conduit (EMT), 3-m long and 1.3-cm in diameter inserted into a 3-m section of Schedule 40 PVC pipe, 1.9cm in diameter driven 15-cm into the ground. The height of the poles was adjusted for each grove by sliding the EMT section within the PVC section to the desired height, and securing it by drilling a hole through the EMT just above the PVC and inserting a nail. Each pole was supported by guylines running to 3 wooden stakes. Poles, stakes, and guylines were all located within the dripline of the trees so as not to interfere with normal grove operations.

In the monofilament groves, Size 24 nylon twine was run from top to top of the poles around the perimeter of the grove, and also across the tops of each row of poles within the grove. In the groves treated with reflective tape, nylon twine was run only across the tops of each row of poles within the grove. The monofilament and reflective tape were then connected to the nylon twine at the desired spacing. Monofilament was attached directly to the twine. Reflective tape was wrapped around wooden dowels, which were then attached to the nylon twine with duct tape.

Propane cannons (Margo Supplies Ltd., Calgary, Canada) were placed in 9 groves of 0.4-ha each in 1987. The cannons are metal tubes roughly 1-m in length that stand about 1-m off the ground on a tripod. They are connected to a 10-kg propane tank. A timed, electronic spark ignites a small amount of propane at pre-set intervals producing a loud, "thunderclap" sound of 80-120 decibels. Three different treatments were applied: 1) 3 groves had single detonation cannons placed in one corner of the grove and pointed toward the diagonally facing corner, 2) 3 groves received 1 multi-detonation cannon on rotomats (cannon placed on 360 degree rotating platform) placed in the center of the grove, and 3) 3 groves had both a multi-detonation and a single detonation cannon placed as described in Treatments 1# and #2 supplemented by firing of "Shot Tell scare shells (Reed Joseph International Co., Greenville, Mississippi) over the treated grove 4 times daily. These scare shells are fired from a 12 gauge shotgun. They explode with a very loud noise at about 50-m down range. Cannons in alt treatment groves were turned on in the morning shortly after daylight and off in the evenings before nightfall. These treatments were applied daily from 1 June - 1 September 1987.

In the spring of 1988, two additional series of nonlethal experiments were initiated. Results from the 1987 monofilament experiments indicated that 3-m spacing did reduce damage but was not cost effective because damage levels in the treated goves were not high enough to justify the treatment. Three citrus groves with histories of high damage levels have been selected to revaluate monofilament line placed at 3-m intervals. Control areas were set up adjacent to the treatment plots within the same groves. Two of the groves had been used as control groves in the 1987 monofilament study allowing for temporal comparsion between years. Method for hanging the line was similar to the 1987 study.

Preliminary tests with eyespot balloons (Avery et al. 1988) indicate that this procedure might be effective, especially in urban areas where noisy or lethal techniques might not be accepted Four groves were chosen for treatment using eyespot balloons. It was determined that commercial eyespot balloons would be cost prohibitive, so beach-balls, 51 cm in diameter, were used. The balls were placed at the end of guyed poles extending 1 m above the canopy in selected groves at densities of 1 beach-ball /10 trees(3 groves) and 1 beach-ball/4 trees (1 gove). For 3 goves, the beach-balls were painted white with 3 large black irises and bright red pupils, and in 1 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 adjacent to the treatment area.

Damage was assessed in the 1987 studies by selecting 10 randomly selected trees/grove before initial fruit harvest in the fall of 1987. All fruits on the sample trees were classified as undamaged or damaged by birds. Damaged fruit was further graded using a modified USDA grading scale for grapefruits (Johnson et al. 1989). Grades 1-3 represent fresh (<25% of fruit damaged by birds), juice fruit (>25% of fruit damaged by birds) and unusable fruit, respectively.

For the evaluation of control procedures used in 1988 groves were chosen that had a known history of high damage or were part of our damage assessment program for 1987. Damage was assessed for 1988 experiments by randomly selecting 15 trees/grove and evaluating damage on a monthly basis starting in June. Procedures and time intervals were as followed is 1987 (Johnson et al 1989).

RESULTS AND DISCUSSION

Reflective tape was considered an impractical method for use in reducing grackle damage to citrus in the Rio Grande Valley. As a result of the high daily winds (> 25 km/h) during the test period, the scare tape was consistently breaking at connection points or becoming entangled in the trees and breaking at the point of entanglement. The majority of the tape did not stay suspended for longer than 2 weeks before replacement was necessary.

In an effort to try to develop an attachment technique that would increase the suspension life of the tape, tests were conducted in Kingsville with many attachment methods. All of the tested attachment methods failed to keep the tape suspended for longer than 25 weeks. After tests with different methods failed to yield a satisfactory attachment, evaluation of reflective tape was ended.

Results from tests of the effectiveness of pyrotechnics in reducing grackle damage to citrus proved inconclusive. Although there were no significant differences between the various levels of intensity or between treated and untreated groves, it was not possible to determine if differences in damage levels between treatment and control groves and between treatments were due to treatment or location differences.

Monofilament groves in the 1987 treatments had less damage than the mean damage of the 3 test plots. Damage was 0.37, 0.86, and 2.7% lower in the 7, 3, and 11-m groves, respectively, thus indicating that the 11-m spacing afforded the most protection. When treatments are compared to their individual controls ("nextdoor-neighbor" comparisons), however, the results are very different (table 1). We feel that comparisons with individual controls more accurately measure the effectiveness of the technique because damage tends to be site-specific and differences in damage may be due to location and not treatment. In these

Table 1. -Effects of monofilament on damage rates to citrus fits in October 1987.

	Mw Damage % in October	
Grow	**Treatment**	CO"
Block 1		
$-M	**3.48**	**7.27**
7-n	**4.22**	**7.84**
11-m	**0.58**	**0.68**
Block 2		
3-m	**3.71**	**15.85**
7-m	**5.88**	**13.94**
11-m	**2.81**	**8,05**
Block 3		
3-m	**2.07**	
7-m	**0.70**	**3.04**
11-m	**0.59**	**0.88**

comparisons treatments reduced bird damage an average of 1.95, 4.68, and 8.02% for the 11, 7, and 3-m spacings, respectively.

Monofilament groves for the 1988 treatments had lower damage levels (table 2) for all groves and all months. Since all 3 groves used 3-m spacing, data were combined and a paired t-test was run to compare treated vs untreated groves. The resulting p value was 0.249.

The eye-spot groves in the 1988 treatments also had less damage (table 3). Data for all groves was combined for the analysis. Results from a paired t-test was (p= 0.0535).

Table 2. –Effects of monofiament on damage rates to citrus fruits in 1988.

		Mean Damage % by Month			
Grove	All		Aug	Sep	Oct
Val Verde - T 1		1. 7	4 . 3	3 . 0	3 . 5
Val Verde - C2		3 . 0	5 . 4	4. 8	4 . 4
Anderson - T	0 . 9		3. 0	2 .1	2 . 9
Anderson - C	1. 0		4. 2	4 .1	3. 3
Van Meter - T		0 . 8	2 . 0	1 . 8	2. 1
Van Meter - C		3 . 8	5 .1	5 . 3	5 . 9

1 T = Treatment (monofilament) .

Table 3 . -Effects of eyespot balloons on damage rates to citrus fruits.

	Mean damage % by Month			
Grove	Jul	Aug	Sep	Oct
Segrado _T1	0.2	1.9	1.2	1.8
Segrado _C2	0.9	2.2	3.4	2.8
Dillon - T	2 . 9	7 . 4	5 . 2	7.2
Dillon - C	8.1	12.4	10.1	8.2
Romain Site i - T	2 .0		4.8	3.0 3.0
Romain Site 1 - C	8 . 8	9 . 8	8. 8	8. 8
Romain Sits 2 - T	2 . 2	8 . 9	3. 7	4 . 8
Romain Site 2 - C	6 . 6		9 . 8	6. 8 8. 8

1T = Treatment (eyespot balloons) . 2C = Control (no eyespot balloons) .

CONCLUSIONS

Grackle damage appears highly variable from 1 site to the next so tests need to be conducted which take this variability into account. '

Reflective scare tape is not a viable technique for reducing grackle damage to citrus due to prevailing winds in south Texas. Pyrotechnics are not effective when used a the only method of reducing damage. Propane cannons and scare shells can be used effectively in the fall and early winter when birds are moving from grove to grove on a daily basis. Pyrotechnics are also effective if reinforced with live ammunition. Monofilament line and eyespot balloons all hold some promise in terms of damage reduction. Every grove in which these techniques were used showed lower damage levels than untreated groves. Damage levels in groves in 1988 was in general was lower than in 1987. This reduced damage level and the small sample size could have contributed to the lack of statistical significance.

Cost benefit analysis is presently being conducted to determine if these techniques would be cost effective. Preliminary results indicate damage levels must be very high to justify the use of monofilament line.

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