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Rodents cause extensive damage to sugarcane (Saccharum spp. hybrids) in southern Florida (Samol 1972). Losses have been estimated as high as $235/ha (Lefebvre et al. 1978). Cotton rats (Sigmodon hispidus) and roof rats (Rattus rattus) are responsible for most of the damage (Holler et al. 1981). In-field treatment is required for effective reduction of rat populations because of the distribution and restricted movement patterns of rats within fields (Lefebvre et al. 1985a). Zinc phosphide (2%) baits are the only rodenticide baits registered for in-field use in Florida sugarcane. A preliminary test of in-crop aerial application of ZP Rodent Bait AG[3] (Bell Laboratories, Inc., Madison, Wis.) in Florida showed poor results in reducing roof rat populations; only 7 of 40 (18%) radio-collared rats in 2 treated fields died whereas none of 38 radio-collared rats in 2 control fields died (Lefebvre et al. 1985b). Furthermore, no significant difference in pre- and post-treatment trapping success between treatment and control fields was observed. Donovan (1986) reported that numbers of cotton rats trapped in fields treated with this bait differed from those trapped in untreated fields; however, degree of efficacy was not discussed.

Our study was conducted to obtain preliminary data on the effectiveness of ZP Rodent Bait AG in reducing cotton rat populations in Florida sugarcane. The study also provided information on the rate of disappearance of the bait following application.

METHODS

We selected 4 sugarcane fields (7.3-ha; 366 X 183 m) at the Okeelanta Division, Gulf and Western Food Products, Inc., Palm Beach County, for study in October 1985 based on results of trapping field edges for 2 nights with 24 Haguruma (Japanese) wire mesh live traps. We selected fields where 4-5 rats/field were captured. Two fields were randomly chosen for treatment with the zinc phosphide bait and 2 were untreated. Four 366-m transects, 37 m apart, were cut through the length of each sugarcane field and 22 live trapping stations (88/field) were located on each transect at 15-m intervals. We trapped from 17-22 October 1985; captured rats were individually marked in each ear with numbered metal tags and released at the capture location. All captures for individual rats were recorded by date and number. The zinc phosphide bait was applied aerially (at the registered rate of 5.6 kg/ha) on 22 October 1985 to the 2 fields selected for treatment and to an adjacent buffer area (180 m wide) except where fields were bordered by a barrier to rat movement (i.e., road or large canal). We trapped again from 28 October 1985 to 3 November 1985 using procedures identical to those of the pre-treatment trapping.

Efficacy of the Z.P. bait was based on reduction of cotton rat populations

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as reflected by trapping data. We analyzed trapping data by Program CAPTURE (Otis et al. 1978) to obtain population estimates. Total number of individuals captured pre- and post-treatment in each field were compared by 2-way analysis of variance (PROC GLM; SAS Institute 1988).

To determine the rate of bait disappearance, we established bait stations at the first trap site on each transect in the 2 treated fields. At each station, immediately after treatment, we placed 10 pellets in a rodent proof wire-mesh cage, and 10 unprotected pellets on the ground. Bait at these stations was monitored daily for 5 days to determine rate of disappearance. A rain gauge at each field was checked daily to determine precipitation.

RESULTS

Fewer rats were trapped during the post- than pre-treatment period in both treatment fields, despite the fact that the number of rats captured in each untreated field increased between pre- and post-treatment periods (Table 1). Treated fields showed an average reduction of 81% while control fields had a mean increase of 66%. The control vs treatment and the pre- vs post-treatment responses approached significance ($\underline{F} = 6.59$; 1 df; $\underline{P} = 0.0622$; and $\underline{F} = 6.00$; 1 df; $\underline{P} = 0.0705$ respectively). The interaction between the 2 effects was highly significant ($\underline{F} = 38.22$; 1 df; $\underline{P} < 0.0035$) indicating that pre-to post-treatment changes on treated fields differed from those observed on untreated fields.

Population estimates could not be used in evaluating efficacy. Program CAPTURE provided estimates for all 8 trapping periods; however, only one was considered to be valid (Control Field 1, pre-treatment). Others were considered invalid because they were derived from a model without an estimator, or failed the tests for goodness of fit or closure.

Protected and unprotected bait placed at stations disappeared rapidly (Table 2). By the first day after treatment only 4 (2 protected; 2 unprotected) stations had pellets remaining and by the fifth day after treatment bait was gone from all stations. Fire ants (<u>Solenopsis invicta</u>) were observed feeding on bait at several of the stations where bait remained on the first and second day after placement.

Table 1. Number of cotton rats captured in 6 days (17-22 October 1985) of pre-treatment and 6 days (28 October - 3 November 1985) of post-treatment livetrapping in south Florida sugarcane fields with and without zinc phosphide rodenticide application.

	No. Cotton Rats Captured		
Field	Pre-treatment	Post-treatment	Difference (%)
Treatment 1	50	14	-36 (-72)
Treatment 2	42	4	-38 (-90)
Total	92	18	$\bar{x}$ = -37 (-81)
Control 1	34	51	+17 (+67)
Control 2	27	42	+15 (+64)
Total	61	96	$\bar{x}$ = +16 (+66)

Table 2. Rate of disappearance of protected and unprotected zinc phosphide bait particles at 4 bait stations (10 pellets/station) in each of 2 Florida sugarcane fields, October 1985.

	Mean Pellets Remaining	
Days After Placement	Protected Stations	Unprotected Stations
1	2.9	3.6
2	2.5	3.6
3	1.3	1.3
4	1.3	1.3
5	trace	trace

DISCUSSION AND CONCLUSIONS

This preliminary test indicates that ZP Rodent Bait AG is efficacious in reducing cotton rat populations in Florida sugarcane fields. The fact that increased numbers of rats were trapped in the untreated fields during the post-treatment period whereas reductions were obtained in the treated fields adds credence to this conclusion. The increase in rats captured in untreated fields may not be entirely due to a population increase. Layne (1974) found that probability of capture was higher for cotton rats that had been previously captured, especially on day 1 of his trapping periods. The same behavioral response would have been expected in the treated fields. Lefebvre et al. (1978) showed that consumption of other foods by cotton rats surviving zinc phosphide bait acceptance tests was not reduced, thus, rats in our treated fields should still have accepted bait in traps post-treatment.

The results of this study are in contrast to those of Lefebvre et al. (1985b), which indicated that ZP Rodent Bait AG failed to reduce roof rat populations. Differential efficacy could result in a shift in the relative abundance of the two species in Florida sugarcane. We have, in fact, observed a general reduction in abundance of cotton rats with a concomitant increase in roof rat abundance since our work began in 1973. This subjective observation is based on extensive trapping during a 12-year period. Failure to combine use of this bait with an effective control program for roof rats may result in increased sugarcane losses to that species.

Although the results of this study indicate that ZP Rodent Bait AG will reduce cotton rat populations, a more extensive test involving multiple treatments during the sugarcane growth cycle and using numerous fields is needed. The positive results of our study support the initiation of this intensive and expensive undertaking. Such a test should include determination of bait and application costs as well as actual damage reduction so that cost:benefit analysis may be conducted. Lefebvre et al. (1978) have shown that such a test would require between 20 and 62 experimental units (fields), due to the variability in rodent damage among sugarcane fields, to detect a 50% damage reduction with 90 to 95% confidence 70 to 95% of the time.

The rapid disappearance of bait from both protected and unprotected stations seemed to be due primarily to fire ants. Bait concentrated at stations may have been more susceptible to this loss than bait dispersed by aerial application. Bait particles from aerial application were still present in the fields after 5 days. Consideration should be given to the potential for this type of loss in any use of rodenticide baits at bait stations. Rain was not a factor during this study as measurable precipitation did not occur until the fifth day after bait application

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LITERATURE CITED

Donovan, W. C. 1986. Efficacy of aerial application of a 2 percent zinc phosphide bait on cotton rats (Sigmodon hispidus) in Florida sugar cane. (Abstract). Sugar y Azucar. 81:39.

Holler, N. R., L. W. Lefebvre, and D. G. Decker. 1981. Ecology and control of rodent depredations to Florida sugarcane. Proc. Inter-American sugar cane seminar: Insect and rodent pests--1981. 2:183-188.

Layne, J. N. 1974. Ecology of small mammals in flatwoods habitat in north-central Florida, with emphasis on the cotton rat (Sigmodon hispidus). Am. Mus. Novit. 2544. New York, N.Y. 48pp.

Lefebvre, L. W., N. R. Holler, and D. C. Yang. 1978. Assessment of rat damage to Florida sugarcane in 1975. Proc. Am. Soc. Sugar Cane Technol. 7:75-80.

Lefebvre, L. W., D. L. Otis, and N. R. Holler. 1982. Comparison of open and closed models for cotton rat population estimates. J. Wildl. Manage. 46:156-163.

Lefebvre, L. W., C. R. Ingram, and M.G. Decker. 1985a. Comparative effectiveness of full-field and field-edge bait applications in delivering bait to roof rats in Florida sugarcane fields. J. Amer. Soc. Sugar Cane Tech. 5:64-68.

Lefebvre, L. W., N. R. Holler, and D. G. Decker. 1985b. Efficacy of aerial application of a 2% zinc phosphide bait on roof rats in sugarcane. Wildl. Soc. Bull. 13:324-327.

Lefebvre, L. W., N. R. Holler, D. G. Decker and N. J. Shafer. 1978. Assessment of zinc phosphide-treated-bait acceptance by cotton, black, and Florida water rats and determination of acute oral toxicity of zinc phosphide to these species. Proc. Amer. Soc. Sugar Cane Technol. 7:81-85.

Otis, D. L., K. P. Burnham, G. C. White, and D. R. Anderson. 1978. Statistical inference from capture data on closed animal populations. Wildl. Monogr. 62. 135pp.

Samol, H. H. 1972. Rat damage to sugarcane in Florida. Proc. Int. Soc. Sugar Cane Technol. 14:575-580.

SAS Institute Inc. 1988. SAS Users guide:statistics. Release 6.03 Edition. SAS Inst. Inc., Cary, N.C. 1028 pp.