EFFECT OF TIME OF BAIT EXPOSURE ON NUMBER OF WIREWORMS (COLEOPTERA: ELATERIDAE) FOUND AT BAITS

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In Florida, the Everglades Agricultural Area (EAA) encompasses 260,000 hectares (650,000 acres) of the upper Everglades extending from Lake Okeechobee south about 50 km. Most of the soils in the EAA are organic (Histosols) generally containing 85% or more organic matter by weight (Snyder et al. 1978). The area is intensively farmed, with sugarcane and winter vegetables being the principal crops.

Wireworms are ubiquitous soil insect pests of most of these crops and soil insecticides are frequently applied at planting for wireworm control. Cherry (1993) showed

that rolled oats was a simple, attractive bait that could be used for sampling *Melanotus communis* (Gyllenhal) and *Conoderus* sp. wireworms in the organic soils of the EAA. In that study, baits were left in fallow fields for 14 d. However, the effect of time of bait exposure on wireworm numbers found at baits was not determined. Moreover, the effect of time of bait exposure on wireworm numbers found at baits has received little attention in general. Toba & Turner (1983) reported on tests in Washington State in which wireworm baits were left in fields for one, two, or three weeks. Results were variable with significant differences in wireworm numbers, primarily *Ctenicera pruinina* (Horn), at baits with different time exposures in some tests and not in other tests. Seal et al. (1992) reported on the effect of the postemergence period of bait exposure on wireworm numbers in Georgia. Baits removed one week after emergence contained significantly more wireworms than similar baits removed 2 and 3 weeks after emergence in fields dominated by *Conoderus scissus* Schaeffer and *C. amplicollis* (Gyllenhal). In a field dominated by *C. rudis* (Brown), more wireworms were found following increased exposure of the bait. The objective of our study was to determine the effect of time of bait exposure on numbers of wireworms found at baits under the field conditions of the EAA.

All tests were conducted on Histosols at the Everglades Research and Education Center at Belle Glade, Florida. Tests were conducted in 10 fallow fields which had been disked following sugarcane. Fields were surveyed by digging to determine the presence of wireworms before tests were conducted. Each bait consisted of 200 g of rolled oats placed in a plastic bag. Four baits plus two controls (= no bait) were in each replication in a 3×2 pattern with baits and controls 5 m apart. Ten replications were used in each field with replications being 10 m apart. A randomized complete block design was used for placement of the baits and controls. Holes were dug 15 cm deep, each bait poured from its plastic bag into the hole, a flag placed through the bait to mark for recovery, and the bait covered with soil. At the time of bait placement in the field, one unbaited control sample from each replication was dug-up to represent 0 days after bait placement. Thereafter, one bait in each replication was dug-up at 7-day intervals up to 28 days after bait placement in the field. The second unbaited control sample was also dug-up at 28 days. By comparing the two control samples (0 vs. 28 d), it was possible to determine if wireworm population density changed in the plots during the tests. If the wireworm population density did not change in the plots, this would indicate that wireworm populations at baits were due to wireworm attraction to baits over time and not changes in population levels in the plots over time. Baits were recovered by digging-up the bait and adjacent soil in a $25 \times 25 \times 20$ cm deep sample and placing the sample in a bucket. Samples were stored in a laboratory at about 23°C. Each sample was visually examined for wireworms for 30 min in the laboratory. Wireworms were then stored in alcohol and later identified by microscopic examination. *M. communis* (Gyllenhal) was identified using the key of Riley & Keaster (1979). *Conoderus* sp. was identified by J. B. Heppner at the Florida Division of Plant Industry, Gainesville. Other wireworm species were less than 10% of total wireworms found at baits and were not identified. Ten tests were conducted in 10 different fields from October, 1992 to September, 1993.

Since greater than 90% of the wireworms found at food baits were either *Conoderus* sp. or *M. communis*, statistical analysis was restricted to these two groups. A paired t-test analysis was conducted to determine if wireworm numbers were significantly different in the controls in any of the 10 fields at 0 d versus 28 d. The main objective of our tests was to determine the overall response of wireworms to baits over time. Hence, data from the 10 fields were pooled for regression analysis. Initially, the total number of wireworms at baits was plotted against time (0, 7, 14, 21, 28 d). Visual

TABLE 1. REGRESSION RESULTS FROM THE ESTIMATED EQUATIONS.[a]

Item	Equation	
	M. communis	*Conoderus* sp.
Intercept	-0.11	16.21
X	6.65[b] (0.46)	-4.24 (9.70)
X^2	-0.15[c] (0.02)	1.08 (0.88)
X^3	—	-0.03 (0.02)
R^2	0.99	0.92
C.V.	5.96	38.97

[a]Figures in parentheses are the standard errors of the estimated coefficients.
[b]Statistically significant at P<0.005.
[c]Statistically significant at P<0.01.

observation indicated a quadratic function for *M. communis* and a cubic function for *Conoderus* sp. Thereafter, these models were used for the two wireworm groups using the General Linear Models Procedure (SAS 1990). The quadratic equation for *M. communis* was:

$Y = a_o + a_1 X_i + a_2 X^2 i$; where
Y = Total number of wireworms at baits
X_i = Days baits left in field
i = 0, 7, 14, 21, and 28 days
a_o, a_1, and a_2 = the intercept, linear term, and the quadratic term, respectively.

The cubic equation for *Conoderus* sp. was:

$Y = a_o + a_1 X_i + a_2 X^2 i + a_3 X^3 i$; where
a^3 = the cubic term; all other terms were previously explained.

A t-test analysis showed no significant difference (P=0.05) in mean numbers of *Conoderus* sp. or *M. communis* at 0 vs 28 d in unbaited samples in any of the 10 fields. These data indicate that wireworms at baits over time were due to bait attraction and not changes in population densities during the tests.

Regression results from the estimated equations are shown in Table 1. The equation for *M. communis* is highly predictive of the actual observed wireworm distribution over time (Fig. 1). Both linear (X) and quadratic (X^2) terms are highly significant statistically; furthermore, the coefficient of determination is a high 0.9954 and the coefficient of variation is a low 5.96. None of the coefficients from the equation for *Conoderus* sp. are statistically significant. However, the equation is very close to the actual distribution of wireworms in the fields (Fig. 2), as shown by the high coefficient of determination (0.9196), but not by the coefficient of variation (39). Both equations show that time of bait exposure was a strong predictor of wireworm numbers found at rolled oats baits.

Currently, soil insecticides are frequently applied for wireworm control when various crops are planted in the EAA. In many cases, soil insecticides are not needed since wireworm populations are too low to cause economic damage (Cherry et al. 1993). However, few growers sample for wireworms since this procedure is difficult due to digging, sorting through soil, and low numbers of wireworms normally found. Cherry (1993) and this study have shown that rolled oats baits are attractive to wire-

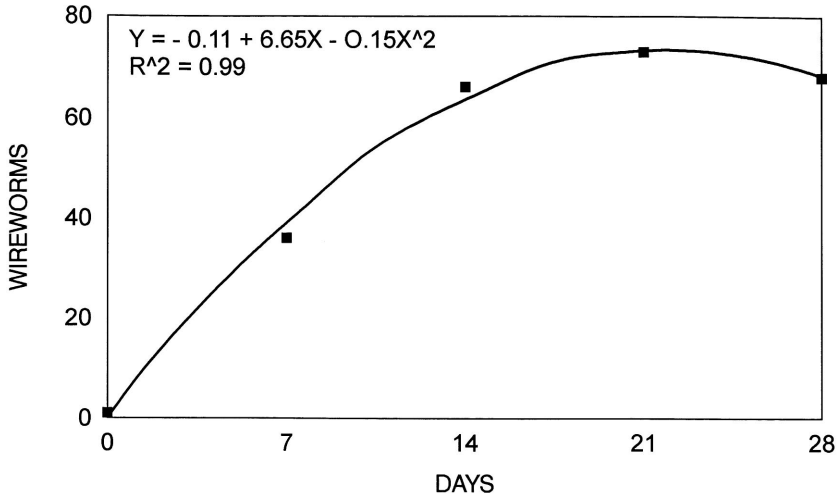

Figure 1. Regression equation for *M. communis*. Y = the total number of wireworms at baits and X = the duration of bait exposure in days.

worms in the EAA and that the time of bait exposure affects the number of wireworms found at baits. These latter two studies provide basic data for using rolled oats baits as a sampling tool to determine the necessity of applying insecticides for wireworm control when planting various crops in the EAA.

Florida Agricultural Journal Series No. R-04466.

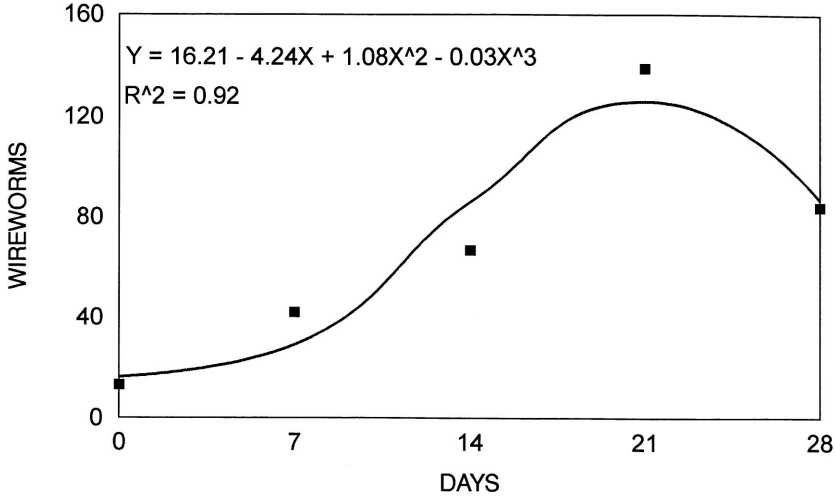

Figure 2. Regression equation for *Conoderus* sp. Y = the total number of wireworms at baits and X = the duration of bait exposure in days.

SUMMARY

Our data show that the duration of exposure of rolled oats baits is important in determining the numbers of wireworms found at baits under field conditions. Wireworms of both *Conoderus* sp. and *M. communis* were found in increasing numbers from 0 to 21 days and then declined in number at 28 days.

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