IMPACT ON YIELD OF WIREWORM (COLEOPTERA: ELATERIDAE) POPULATIONS IN FLORIDA SUGARCANE AT PLANTING

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ABSTRACT

Twelve commercial sugarcane fields were sampled to determine the effect of soil insecticide application for wireworm control at planting. No significant differences in yield were found between plots with and without soil insecticide application in any of the 12 fields. However, commercial growers at planting did apply soil insecticides for wireworm control to the rest of the field outside the plots in 50% of these fields. In addition, whole field transect samples taken in different fields showed a wide range of wireworm population densities at sugarcane planting. Taken together, these data show that soil insecticides are often not necessary for wireworm control at sugarcane planting in Florida and currently Florida sugarcane growers are applying these insecticides unnecessarily in many cases.

INTRODUCTION

The Everglades Agricultural Area (EAA) is a highly productive agricultural area located in southern Florida. The histosol soils of the EAA, commonly called muck soils, were formed over a 4,400 year period from partially decomposed remains of hydrophytic (water loving) vegetation that accumulated under anaerobic wetland conditions resulting in highly organic soils (Rice et al. 2005). The EAA is bordered by sandy soils with extremely low organic matter. Sugarcane, vegetables, rice, and sod are the predominant crops grown on muck soils. These crops and citrus and pasture occur on sandy soils.

Wireworms in Florida are primarily a pest in newly planted sugarcane where the larvae attack the underground portions of the plant by feeding on the buds and root primordia during germination and on shoots and roots after germination. Although the insects are also found at higher densities in older ratoon sugarcane, they are rarely considered a pest in ratoon sugarcane because the sugarcane plants are large and well established. Of the different wireworm species found in Florida sugarcane, *Melanotus communis* Gyllenhal is the most important pest. Hall (1985) noted that *M. communis* damaged sugarcane by feeding on root primordia, buds, and roots as well as directly on the stem of young plants. Hall (1990) later reported that tillering during the growing season compensated for early stand losses due to wireworm damage. Seasonal flight activity of *M. communis* was greatest during May and June with 88% of the annual total adult catch during this period (Cherry & Hall 1986). Cherry(2007) reported that in Florida sugarcane fields, wireworms were significantly less abundant in summer than other seasons and these wireworms were also significantly smaller at this time. Cherry & Stansly

(2008) noted that species composition of wireworms varied with soil type in Florida sugarcane fields.

Florida sugarcane growers generally use a soil insecticide at planting as protection against potential wireworm damage. The value of using soil insecticides at planting to increase sugarcane yield has been shown by Samol and Johnson (1973) and Coale and Sosa (1991). However, in the latter study, wireworm populations were very low in two of three fields tested and the authors concluded that sugarcane yield response to soil insecticides was highly variable in Florida sugarcane fields. More recently, Cherry and Stansly (2008) showed high inter-field variability in wireworm densities in ratoon sugarcane fields in Florida. The latter data suggest that some sugarcane fields with low wireworm densities could be planted without a soil insecticide if sampling methodology existed to determine this. Our objective was to measure wireworm populations at sugarcane planting and compare these to sugarcane yield with and without soil insecticide application. These data are thought essential to better understand the necessity of soil insecticide application for wireworm control in Florida sugarcane.

MATERIALS AND METHODS

INSECTICIDE TESTS - Experimental plots were located in 12 commercial sugarcane fields in different areas of southern Florida. Fields were sampled on muck and sandy soils since sugarcane soil insect pests such as wireworms (Cherry and Stansly 2008) and grubs (Stansly et al. 1994) have been shown to be different in the two soil types in Florida sugarcane. Agronomic and soil features of these fields are given in Table 1. Eight plots were located in each field in a 2 x 4 pattern (2 treatments x 4 replications). Each plot was 10 m long by 4 rows wide (6 m) with a 2 m border between plots. All fields were thoroughly disced several times before planting which is normal practice.

Wireworms were sampled after the final discing and right before planting because we believe this to be the best time to decide if soil insecticides are necessary at planting. Four soil samples were taken in each plot from random locations. Each soil sample was 50 x 50 x 30 cm and was examined visually on a table for 20 min by one person or 10 min by two persons. Wireworms were put into alcohol for later identification. A t-test (SAS 2008) was conducted to determine mean differences in wireworms between plots with and without soil insecticide application in each field.

After wireworm sampling, plots were furrowed and cane seedpieces placed in furrows by growers as part of preparing the whole field for planting. A randomized block design with 4 replications was used to determine plots with soil insecticide application in each field. The soil insecticide used was Thimet 20G (AI = 20% phorate) placed in a 30 cm band over the seedpieces at 22.3 kg/ha (19.5 lbs/acre) which is a common practice and rate used by Florida sugarcane growers. In 6 of the 12 fields, Thimet for wireworm control was also applied by growers to the rest of the field outside the plots (Table 1). This application was based on the growers' policy of using Thimet for wireworm control in those fields to maximize sugarcane yield.

Tiller counts were made in all rows of plots approximately 60 days after planting. Stalk counts were made in the middle 2 rows in each 4 row plot in August. A stalk here is defined as a stalk at least 4 ft. high at the top visible dewlap (collar). These counts are considered future harvestable stalks and used to predict eventual sugarcane yield.

Approximately one year after planting and shortly before the commercial harvest of each field, cane stalks were harvested from plots to estimate final yield. Ten stalks were randomly selected for harvest from the two center rows in each plot. These 20 stalks were then bundled together and taken to the Everglades Research and Educational Center where stalk weight and % sucrose were determined. These latter data in conjunction with earlier stalk counts were used to estimate metric tons of sugar per hectare yield. Tiller counts, stalk counts, and final sugar yield were analyzed by t-test for differences in plots with and without insecticide application for each field.

WIREWORM SURVEY - Ten of the 12 fields in the previous study had sugarcane planted after sugarcane (successively planted). However, Florida sugarcane may also be planted after other crops such as rice or vegetables and also after fallow periods of dry fallow or wet fallow (flooded). Hence, 10 additional fields (7 muck, 3 sand) were surveyed to gain insight into expected wireworm populations after different cropping systems. Sampling was again conducted after the last discing and before furrow for cane planting. Samples were taken on a straight line transect located diagonally across each field. Sampling started about 25 m into the field to avoid possible edge effect. Thereafter, 25 samples were taken evenly spaced along the transect across the whole field. Each sample was 30 x 30 x 30 cm of moist soil dug-up with a shovel. In rare cases where the soil was very dry, the top dry soil was scraped off first. The soil was then examined in the field for 2 minutes by one person and wireworms counted. The transect sampling provided a quicker and easier method to gain insight into wireworm populations in the fields than bait samples which take longer (Cherry & Alvarez 1995) or absolute density samples which are more labor intensive.

RESULTS AND DISCUSSION

INSECTICIDE TESTS - In 11 of the 12 fields (Table 2), there was no significant difference in wireworm numbers between plots with and without Thimet in each field. Hall (1990) noted that wireworm populations in Florida sugarcane generally appear to be randomly or uniformly dispersed in cane fields at planting, at least in localized areas. This general lack of statistical differences between plots in fields does suggest that the wireworms were fairly uniformly distributed among the plots.

Tiller counts performed early in the season in plots with and without Thimet application showed a trend among the 12 fields (Table 3). In 11 of the 12 fields, tiller counts were higher in the Thimet applied plots being significantly higher in 4 of the fields. Reasons for the higher tiller counts are not known since wireworms or other arthropods were not sampled at this time. Although applied for wireworm control, Thimet is a general insecticide-acaricide with contact, systemic, and fumigant activity and hence may be controlling arthropods other than wireworms. Moreover, Thimet is a phytostimulant (Thomson 2001) which may have resulted in increased tiller counts.

In contrast to tiller counts, there were no significant differences in millable stalk counts performed in the summer between plots with and without Thimet application in any of the 12 fields (Table 4). These data show that sugarcane plants compensated over time for earlier differences in tiller counts. Similarly, Hall (1990) reported that tillering during the growing season compensated for early stand losses due to wireworm damage in Florida sugarcane. Our data and the Hall study are in accord with Dillewijn's observation (1952) that in general cane fields have a large capacity for compensation to early losses due to various types of damage. This compensatory growth is greatest in young cane where many surplus shoots are ready to take the place of dying ones and the compensating ability decreases as the crop grows older.

Final yield data was very consistent in that there were no significant differences in yield (metric tons sucrose/ha) between plots with and without Thimet application in any of the 12 fields (Table 5). These data are consistent with stalk count data taken in August (Table 4). However, like stalk count data, the final yield data show that early tiller counts (Table 3) were not good predictors of final yield. As noted earlier, later plant tillering may compensate for early tiller differences. In general, yields were higher in plots on muck than sand. This is consistent with the general trend that in Florida sugarcane, yields are generally higher in muck soils than sandy soils.

WIREWORM SURVEY - Transect samples taken at sugarcane planting showed a wide range of wireworm population densities present in fields (Table 6). No wireworms were found in the two fields which had received controlled flooding being a fallow flood and flooded rice. This is not surprising since there is much research published on controlled flooding to kill soil insects in southern Florida agricultural fields. The effect of flooding on wireworm populations was reported in Genung (1970) in fallow fields and Cherry and Powell (1993) in flooded rice fields in Florida.

In summary, 12 commercial sugarcane fields were sampled to determine the effect of soil insecticide application for wireworm control at planting. No significant differences in yield were found between plots with and without soil insecticide application in any of the 12 fields. However, commercial growers at planting did apply soil insecticides for wireworm control to the rest of the field outside of the plots in 50% of these fields (Table 1). In addition, whole field transect samples taken in other fields showed a wide range of wireworm population densities at sugarcane planting. Taken together, these data show that soil insecticides are not always necessary for wireworm control at sugarcane planting and currently Florida sugarcane growers are applying these insecticides unnecessarily in many cases. This situation exists because currently there is no economic threshold for wireworms at planting in Florida sugarcane. Hall (1985) did report on the effect of different levels of wireworm populations on damage to newly planted cane, but an economic threshold was not determined. Future research will be directed towards this need.

CONCLUSIONS

Our data show that soil insecticides are often not necessary for wireworm control at sugarcane planting in Florida and currently Florida sugarcane growers are applying these insecticides unnecessarily in many cases.

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Table 1. Agronomic features of sugarcane fields located in muck and sandy soils.

	Muck		
Field	Pre-plant	Date planted	Thimet applied[1]
1	Dry fallow	11-12-2005	No
2	Sugarcane	11-30-2005	Yes
3	Sugarcane	12-14-2005	Yes
4	Flood (50 day)	11-10-2006	No
5	Sugarcane	12-19-2006	Yes
6	Sugarcane	12-28-2006	Yes
	Sand		
Field	Pre-plant	Date planted	Thimet applied[1]
1	Sugarcane	11-11-2005	Yes
2	Sugarcane	12-7-2005	Yes
3	Sugarcane	9-24-2005	No
4	Sugarcane	9-26-2006	No
5	Sugarcane	2-13-2007	No
6	Sugarcane	2-16-2007	No

[1] Growers applied Thimet 20G at planting at 22.3 kg/ha (19.5 lbs/acre) in whole field outside of plots based on growers policy.

Table 2. Wireworm populations in plots in sugarcane fields located in muck and sandy soils.

	Muck Soil samples[1]		Sandy Soil samples[1]	
Field	- Thimet	+ Thimet	- Thimet	+ Thimet
1	0.6 ± 0.6 A	0.4 ± 0.5 A	0.2 ± 0.1 A	0.2 ± 0.1 A
2	0.8 ± 0.7 A	0.4 ± 0.7 A	0.9 ± 0.1 A	0.6 ± 0.7 A
3	0.6 ± 0.9 A	0.5 ± 0.9 A	3.1 ± 0.4 A	3.0 ± 0.3 A
4	0.2 ± 0.4 A	0.3 ± 0.5 A	1.0 ± 0.3 A	0.2 ± 0.1 B
5	0.4 ± 0.8 A	0.3 ± 0.7 A	1.1 ± 0.4 A	1.1 ± 1.0 A
6	0.3 ± 0.6 A	0.4 ± 0.5 A	2.9 ± 0.6 A	2.6 ± 0.6 A

[1] Mean ± SD wireworms/sample. Means ± SD in row followed by same letter show no significant difference (t-test, alpha = 0.05) between means.

Table 3. Tiller counts[1] in plots in sugarcane fields located in muck and sandy soils.

	Muck[2]		Sand[2]	
Field	-Thimet	+ Thimet	- Thimet	+ Thimet
1	49.2 ± 12.2 A	59.4 ± 14.2 B	69.7 ± 3.6 A	73.0 ± 4.3 A
2	46.4 ± 8.8 A	59.1 ± 11.1 B	91.7 ± 3.8 A	92.9 ± 3.4 A
3	45.8 ± 13.1 A	51.6 ± 14.8 A	46.3 ± 3.5 A	58.4 ± 3.8 B
4	48.9 ± 14.3 A	53.5 ± 9.4 A	122.6 ± 7.1 A	131.1 ± 10.7 A
5	27.6 ± 6.7 A	39.1 ± 5.1 B	63.5 ± 12.0 A	75.3 ± 16.2 A
6	62.8 ± 11.6 A	65.3 ± 22.3 A	71.5 ± 17.0 A	46.1 ± 11.0 A

[1] Tillers/10 m row.

[2] Means ± SD in row followed by same letter show no significant difference (t-test, alpha = 0.05) between means.

Table 4. Stalk counts[1] in plots in sugarcane fields located in muck and sandy soils.

	Muck[2]		Sand[2]	
Field	-Thimet	+ Thimet	- Thimet	+ Thimet
1	129.4 ± 17.1 A	132.3 ± 9.4 A	125.8 ± 3.1 A	127.8 ± 3.3 A
2	100.8 ± 20.0 A	91.3 ± 19.4 A	76.0 ± 3.3 A	80.4 ± 3.9 A
3	95.0 ± 18.7 A	107.5 ± 23.2 A	66.0 ± 3.1 A	73.0 ± 3.7 A
4	117.3 ± 8.8 A	108.8 ± 35.6 A	96.1 ± 3.2 A	97.2 ± 3.4 A
5	106.5 ± 13.2 A	101.8 ± 10.6 A	57.9 ± 7.8 A	64.4 ± 10.4 A
6	110.3 ± 20.0 A	104.0 ± 20.2 A	49.8 ± 14.8 A	55.3 ± 9.6 A

[1] Stalks/10 m row.

[2] Means ± SD in row followed by same letter show no significant difference (t-test, alpha = 0.05) between means.

Table 5. Yield[1] in plots in sugarcane fields located in muck and sandy soils.

	Muck[2]		Sand[2]	
Field	-Thimet	+ Thimet	- Thimet	+ Thimet
1	15.4 ± 1.7 A	15.5 ± 2.2 A	12.8 ± 1.5 A	11.4 ± 0.6 A
2	10.6 ± 3.4 A	9.3 ± 2.9 A	11.3 ± 0.5 A	12.1 ± 1.0 A
3	13.7 ± 0.5 A	15.3 ± 1.9 A	12.8 ± 1.4 A	14.5 ± 1.4 A
4	14.4 ± 1.2 A	13.2 ± 0.9 A	9.5 ± 0.34 A	9.2 ± 0.2 A
5	14.9 ± 2.9 A	13.1 ± 0.8 A	4.1 ± 0.82 A	5.4 ± 1.4 A
6	11.7 ± 1.1 A	11.4 ± 1.0 A	4.7 ± 1.67 A	4.8 ± 1.7 A

[1] Metric tons sucrose/ha.
[2] Means ± SD in row followed by same letter show no significant difference (t-test, alpha = 0.05) between means.

Table 6. Wireworms in transects across fields at sugarcane planting.

Pre-plant[1]	Soil type	Wireworms[2]	Insecticide[3]
Fallow flood	muck	0	-
Flooded rice	muck	0	-
Dry fallow	sand	0	+
Sugarcane	muck	1	+
Dry fallow	muck	2	+
Vegetables	sand	2	-
Vegetable	sand	4	+
Dry fallow	muck	7	+
Sugarcane	muck	11	+
Sugarcane	muck	36	+

[1] Previous crop or cultural practice before planting sugarcane.
[2] Total number of wireworms in 25 samples in transect.
[3] Based on grower policy, soil insecticide applied (+)or not (-) for wireworm control when field planted.