N O T E

Effect of Tillage Practices on Soil Insect Pests of Florida Sugarcane[1]

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Sugarcane (*Saccharum* sp.) is a major agricultural crop in Florida and is planted by vegetative methods in 15–30-cm-deep furrows. Land preparation for sugarcane planting in Florida normally involves at least three or four disk passes followed by furrow preparation. Growers also cultivate between rows during the first few months of growth to reduce compaction and increase tillering. Reduced tillage or no tillage may play an important role in reducing soil erosion (Gebhardt et al. 1985, Science 230: 625–630), production costs (Al-Kaisi and Yin 2004, Soil Till. Res. 78: 91–101), and consumption of fossil fuels (Phillips et al. 1980, Science 208: 1108–1113). However, reduced or no-tillage practices may affect soil insect pests by altering soil microclimate, altering occurrence of weeds that may be alternate hosts, and/or increasing direct arthropod mortality via crushing, desiccation, or exposure to predators such as birds.

Three major groups of insects have been described as pests of sugarcane production in Florida. Wireworms (Coleoptera: Elateridae) were the first soil insect pests reported causing significant damage in Florida sugarcane (Bregger et al. 1959, Proc. Soil Crop Sci. Soc. Fla. 19: 287–294). Hall (1988, Fla. Entomol. 71: 138–150) listed 12 species of wireworms in the crop. Several studies have shown that the corn wireworm, *Melanotus communis* (Gyllenhal), is clearly the dominant species of economic concern. White grubs (Coleoptera: Scarabaeidae) also cause significant damage in Florida sugarcane. Gordon and Anderson (1981, Fla. Entomol. 64: 119–138) first reported significant grub damage to the crop in 1971. They identified six species associated with the crop; three species, especially *Tomarus subtropicus* (Blatchley), caused economic damage. The sugarcane root weevil, *Diaprepes abbreviatus* (L.) (Coleoptera: Curculionidae), was reported as an economic pest in 2010 by Cherry et al. (2011, Fla. Entomol. 94: 1063–1065). The

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study reported here was conducted to determine the effects of no tillage, minimum tillage, and conventional tillage on soil insect pests of Florida sugarcane.

A field experiment was established at the Everglades Research and Education Center (N 26°39′, W 80°38′; 3–4 m elevation), Belle Glade, FL, in January 2013 with different tillage practices (no tillage, minimum tillage, and conventional tillage) and three commercial sugarcane varieties, CP 88-1762 (Tai et al. 1997, Crop Sci. 37: 1388), CP 89-2143 (Glaz et al. 2000, Crop Sci. 40: 577), and CP 00-1101 (Gilbert et al. 2008, J. Plant Reg. 2: 95–101). After second ratoon harvest in December 2015, the field was planted again in January 2016 with same tillage treatments assigned to the same plots to continue this trial for second crop cycle. The soil at the experimental site was Histosol and the soil series was Lauderhill soil (euic, hyperthermic, Lithic Haplosaprist), which represents the large area (78%) of muck soils under sugarcane cultivation in southern Florida. The experimental design was split-plot with tillage level as whole plot and variety as subplot. The whole plots (tillage) were 45 m long and 6 rows (9 m) wide, and the subplots (variety) were 10 m long and 4 rows (6 m) wide with 5-m separations between subplots.

In plant cane, tillage treatments were both preplanting and postplanting. The preplanting tillage was performed with John Deere disc harrows (Model 425 offset disk; Deere and Co., Moline, IL) at 10–15 cm depth to prepare the field for planting, and postplanting tillage was light interrow cultivation with tines (custom made for 2–4-cm-deep scratching of soil) to break soil compactness and improve tillering. The preplanting tillage treatments were no tillage (no pass with disc harrow), minimum tillage (one pass with disc harrow), and conventional tillage (three passes with disc harrow). The tillage treatments were followed by furrowing to create 15–20-cm-deep furrows for planting. Postplanting tillage was conducted only in minimum and conventional tillage with one interrow cultivation at 45 d after planting (DAP) with tines in minimum tillage and two interrow cultivations (one with discs at 45 DAP, and the other with tines at 70 DAP) in conventional tillage. The postplanting tillage treatments were repeated in ratoon cane at 15 d after harvest (DAH) in minimum tillage and 15 and 62 DAH in conventional tillage.

Mature sugarcane is a very difficult crop in which to sample insects, and Florida sugarcane may be 3 to 4 m high before harvest. Therefore, sampling was conducted after harvest for easy access. All sampling was conducted during the 2-mo period of March and April 2019 (after $>$5 yr under same tillage treatments) to reduce the possibility of seasonal variation in soil insect populations in Florida sugarcane, such as wireworms (Cherry 2007, Fla. Entomol. 90: 426–430). Sugarcane plants (stools) were sampled because most soil-dwelling pests of Florida sugarcane aggregate under sugarcane stools (Cherry 1984, J. Econ. Entomol. 42: 556–557; Cherry 2007). Two samples were taken from each plot. One sample was taken from a sugarcane stool randomly selected from the two inner rows of sugarcane of the four-row plot. One sample was randomly selected from between the two inner rows of sugarcane. Each sample consisted of a soil sample ($40 \times 40 \times 20$ cm deep) dug around and under a sugarcane stool or from soil between the rows of sugarcane. Each sample was examined for 10 min by two people. All stages of soil insect pests present were collected and returned to a laboratory for identification and counting.

The most abundant soil insect pest in plots was clearly the corn wireworm, *M. communis*, comprising 95% of all soil insect pests collected. Hence, statistical

Table 1. Mean ± SD of *Melanotus communis* in response to tillage method in three sugarcane varieties (Belle Glade, FL).*

	Mean ± SD	Range
Conventional tillage		
CP 00-1101	12.3 ± 12.1 a	3–30
CP 88-1762	7.3 ± 6.7 a	1–20
CP 89-2143	8.8 ± 6.1 a	2–18
Minimal tillage		
CP 00-1101	8.5 ± 6.3 a	2–18
CP 88-1762	7.5 ± 8.8 a	2–25
CP 89-2143	11.3 ± 8.6 a	2–27
No tillage		
CP 00-1101	6.7 ± 3.8 a	4–14
CP 88-1762	8.7 ± 7.6 a	2–23
CP 89-2143	7.8 ± 6.0 a	1–17

* Means followed by the same letter are not significantly different (alpha = 0.05) using the least significant difference test.

analysis was restricted to *M. communis* (Table 1) because too few insects of other soil pests were found for meaningful statistical analysis. This wireworm has been the dominant wireworm species of economic importance in Florida sugarcane both historically and in recent surveys (Cherry et al. 2017, J. Entomol. Sci. 52: 169–176). The majority (80%) of the *M. communis* were found under sugarcane plants rather than between rows of sugarcane. The aggregation of these wireworms beneath sugarcane plants is consistent with results of Cherry (2007). Of the *M. communis* life stages found, 80% were larvae (wireworms), 10% pupae, and 10% adults. The 20% pupae and adults are the leading edge of the *M. communis* unimodal flight, which primarily occurs during May and June (Hall and Cherry. 1993. Fla. Entomol. 76: 155–160). Other wireworms found were larvae of *Conoderus* spp. and *Glyphonyx bimarginatus* Schaeffer, which are common, but not abundant, in Florida sugarcane fields (Cherry et al. 2017).

The only white grub of economic importance found in the plots was *Cyclocephala parallela* Casey with only 15 found in all plots. This species is an occasional pest of Florida sugarcane. Interestingly, the white grub *T. subtropicus* was not found in the plots. This species was once the major grub pest in Florida sugarcane but has greatly declined for reasons not totally understood, as discussed by Cherry et al. (2017). *Diaprepes abbreviatus* was not found in the plots. This insect was first reported as a pest of Florida sugarcane in 2010 (Cherry et al. 2011), but has remained at low population levels since that observation (Cherry et al. 2017).

There is very little research, including Florida studies, on host plant resistance of sugarcane to wireworm attack. Hall (1990, Fla. Entomol. 73: 298–302) speculated that there may be differences in rates of emergence and tillering due to variability among Florida sugarcane genotypes. While Hall (2003, J. Am. Soc. Sugarcane Technol. 23: 8–19) later examined bud position and shoot emergence of eight sugarcane genotypes in an evaluation of insecticides for wireworm control, no statistical comparisons were presented between genotypes. More recently, Larsen et al. (2013, J. Pest Sci. 86: 91–98) reported on sugarcane varietal susceptibility to *M. communis*. Several genotypes were able to produce acceptable stands in wireworm-infested trays by emerging quickly and producing many tillers. In this study, there were no significant differences in wireworms among the three varieties tested within any of the three tillage practices (Table 1). These data show that the varieties were not a significant factor in affecting wireworm populations over the duration of this study. Although we found no significant response of wireworms to the varieties tested, we believe that the study of host plant resistance of sugarcane to wireworms warrants further research. Florida sugarcane frequently compensates for early wireworm damage resulting in no yield loss when harvested approximately 1 yr later. Hence, plant resistance would not have to be high to produce sugarcane yield without soil insecticides in many cases. There is a paucity of data on the subject and a potential for further research on sugarcane host-plant resistance against wireworms.

Conservation tillage refers to reduced-tillage or no-tillage practices. Insects have shown highly variable population responses to these practices. Stinner and House (1990, Ann. Rev. Entomol. 35: 299–318) surveyed 45 studies related to the subject. They reported that 28% of the species and their damage increased with conservation tillage, 29% showed no significant influence of tillage, and 43% decreased with conservation tillage. Even within a single crop, insect responses to tillage practices can be highly variable. For example, Del Pozo-Vadivia (2017, J. Econ. Entomol. 110: 168–176) reported that many examples show how tillage practices influence insect population dynamics in soybeans with examples of positive, negative, and neutral effects. Studies with soil insect pests also have shown variable outcomes. When conservation tillage systems were first introduced, it was postulated a priori that there would be an accompanying increase in pest severity, especially with soil-inhabiting insects (Stinner and House 1990). This is consistent with Edwards and Thompson (1978, J. Appl. Ecol. 15: 789–795), who reported that wireworms increased in cereal crops with conservation tillage. In contrast, other soil insect pests have decreased with conservation tillage. Hammond (1997, Crop Prot. 16: 221–225) reported that seedcorn maggot, *Delia platura* Meigen, populations were less with conservation tillage. Damage by the corn rootworm, *Diabrotica balteata* LeConte, has been shown to be less in no-tillage corn than in plowed fields although other studies have shown corn rootworm not significantly affected by tillage treatments (Stinner and House 1990). Our study is consistent with these latter studies in that none of the three tillage treatments had significant effects on wireworm populations in any of the three varieties (Table 1).

Reducing or eliminating the number of cultivations to minimum tillage or no tillage improved ratoon yields with no effect on overall yields compared to conventional tillage in a typical 3-yr crop cycle in Florida (Sandhu et al. 2018, Agron. J. 111:1516–1523). Furthermore, the current study showed no significant tillage effects on wireworm populations. Therefore, without any negative effects on yields and change in wireworm populations, switching from conventional tillage to no or minimum tillage may help growers in lowering the production cost with additional benefit of soil conservation.