ORGANIC MULCH AS A FACTOR IN THE NYMPHAL HABITAT OF *MYNDUS CRUDUS* (HEMIPTERA: AUCHENORRHYNCHA: CIXIIDAE)

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ABSTRACT

Certain types of organic mulches spread on the ground in a palm planting with St. Augustine grass, *Stenotaphrum secundatum*, ground cover enhanced the habitat for the nymphal development of *Myndus crudus* Van Duzee, as measured by the greater numbers of adults emerging from mulched areas compared with controls. Plots mulched with chopped and shredded coconut fronds had greater numbers of *M. crudus* than controls. Higher numbers of *M. crudus* emerged from plots with pine bark mulch than from control plots. There were no significant differences in mean numbers of adults captured in plots with eucalyptus and pine bark mulch. The least numbers of adults emerged from plots mulched with pine bark nuggets. *Myndus crudus* nymphs were never in the open but always beneath pieces of mulch. The benefit of mulches to the insects appears to be that of providing shelter.

Key Words: *Myndus*, Cixiidae, Fulgoroidea, palm, lethal yellowing, cultural control

RESUMEN

Ciertas clases de cobertura orgánica dispersada sobre el suelo en un plantío de palmeras con pasto de San Agustín, *Stenotaphrum secundatum*, mejoraron el habitat para el desarrollo de las ninfas de *Myndus crudus Van Duzee*, como fue estimado por el mayor número de adultos emergidos de estas áreas en comparación con testigos. Parcelas con frondas de cocotero picadas y ralladas tenían números mayores de estos insectos que los testigos. Un mayor número de *M. crudus* emergió de parcelas con cáscara de pino picada en comparación con los testigos. El promedio de adultos capturados en parcelas con cobertura de eucalipto y de cáscara de pino no difirió significativamente. Las ninfas de *M. crudus* nunca estuvieron al descubierto, sino siempre debajo de los fragmentos de cobertura. El beneficio de las coberturas orgánicas para *M. crudus* parece ser el de proveer abrigo.

Myndus crudus Van Duzee (Hemiptera: Auchenorrhyncha: Cixiidae), a widely distributed planthopper in the American tropics (Howard et al. 1984, Kramer 1979, Villanueva Barradas 1991), is a vector of lethal yellowing of palms (Howard 1987, Howard et al. 1983). Lethal yellowing is a fast-spreading, destructive disease associated with a phytoplasma to which at least 35 species of Palmae are susceptible, including the economically important coconut palm, *Cocos nucifera* L., and date palm, *Phoenix dactylifera* L. The disease has long been known in western islands of the West Indies, from where it apparently invaded Florida (U.S.A.) and Mexico (Howard 1983, Howard et al. 1984, Villanueva Barradas 1991). It has recently spread to Belize and Honduras (Ashburner et al. 1996). Thus far, there is no evidence implicating any insect species other than *M. crudus* as a potential vector of lethal yellowing.

The nymphs of *M. crudus* develop at or just under soil level on grasses or sedges, and the adults feed on palms (Howard & Villanueva-Barradas 1994, Eden-Green 1978). At least 37 species of grasses (Graminae) and 4 species of sedges (Cyperaceae) have been reported as nymphal hosts of *M. crudus* (Carrillo Ramirez & Piña Razo 1990, Howard 1989, Howard 1990a, Howard 1990b, Piña Quijano 1993, Tsai & Kirsch 1978, Villanueva B. et al. 1987, Zenner de Polania & Lopez A. 1977). When rearing *M. crudus*, Eden-Green (1978) observed that the nymphs were often hidden beneath pieces of coconut fiber. Therefore, we decided to determine whether coconut fiber and similar materials spread on soil among nymphal hosts would improve the habitat for *M. crudus* nymphs, as estimated by the numbers of emerging adults.

MATERIALS AND METHODS

The study was conducted at the Fort Lauderdale Research & Education Center in a 0.6 ha grove of 100 coconut palms and other susceptible species of palms. St. Augustine grass, *Stenotaphrum secundatum* (Walt.) Kuntze, a preferred host of *M. crudus* (Howard 1990b), was the predominant ground cover. Plots (2 × 2 m) selected at random were not mowed or otherwise disturbed during each experiment.

In the first experiment, which was initiated February 1994, a mulch was obtained by passing coconut palm fronds through a mechanical brush chipper. This material consisted of fine shredded fragments and larger pieces of variable size between 2-5 cm in width and 5-10 cm in length. The material was spread on each of 6 plots (0.05 m^3/plot) and raked lightly so that it settled on soil and allowed the grass blades to emerge. Six similar plots where fiber was not spread were selected as controls.

In May 1994, traps were used to sample adults emerging from the plots. Traps consisted of 60 × 60 × 50 cm plywood boxes. Polypropylene funnels of 5 cm dia and 0.5 cm mouth were fitted over an opening at the center of the top of each box. Transparent plastic test tubes (2.1 × 10 cm) were placed over the funnel mouths. Adults that emerged from the plants attempted to exit through the funnel opening and thus were captured in the tubes and counted.

Emergence traps were placed simultaneously in the center of each of 6 plots with coconut fiber and 6 control plots. Just prior to placing a trap, the grass was agitated vigorously for several minutes to repel any adult Auchenorrhynchous insects from the sample area. Additionally, any adults captured in traps during the first 24 hours were removed and not counted in samples. The traps then remained in place for 1 week, after which the numbers of male and female *M. crudus* captured in emergence vials were determined.

In the second experiment, initiated February 1995, the effect of the following materials on the nymphal habitat for *M. crudus* were tested: (1) pine nuggets, (2) pine bark mulch (Hyponex Corporation, Marysville, Ohio), (3) cypress mulch (Greenleaf Products, Inc., Haines City, Florida) and (4) eucalyptus mulch (AACTION Nursery Products, Inc., Fort Myers, Florida). The length and width of 10 of the larger fragments were determined for each type of material. The materials were spread as in the first experiment in 6 plots per material, with 6 control plots.

Adult *M. crudus* emerging from plots were sampled during June - July, 1995. In each plot, an emergence trap was placed successively for 4 days each in the NE, NW, SW, and SE quadrants, and *M. crudus* female and male adults captured were counted.

Plots were closely examined for *M. crudus* nymphs for 2 hours on the afternoon of October 12, 1995. Grass stolons were carefully parted to examine soil surfaces of about 400 cm^2 at a time, and mulch fragments were lifted to examine the soil surface beneath them.

Data of the experiment with coconut fiber were analyzed by Student's *t*-test and of the experiment with several types of mulch with Analysis of Variance and the Waller-Duncan Bayesian *k*-ratio *t*-test (SAS Institute 1985).

RESULTS

A mean of 4.16 (SEM = 1.74) adults were captured in emergence traps from plots mulched with coconut fiber, compared to 0.17 (SEM = 0.17) adults from control plots ($P \leq 0.05$, t = 2.29). The total of 25 adults captured from mulched plots included 18 males and 7 females.

In the second experiment, the numbers of *M. crudus* adults captured varied among mulch types ($F = 4.08$, df 4, 115, $P < 0.05$)(Table 1). More adults were captured in plots with pine bark mulch than from plots with cypress mulch, pine bark nuggets or the control plots. The highest numbers of *M. crudus* resulted from plots with pine bark mulch and eucalyptus mulch. Similar numbers of *M. crudus* resulted in plots with cypress mulch, pine bark nuggets and the control plots.

There were differences between mulch types in lengths of pieces (F = 13.5, df 3, 36, $P < 0.0001$). Based on the length and width of the largest pieces, pine bark nuggets was the coarsest of the materials in the second experiment, followed by pine bark mulch, eucalyptus mulch, and cypress mulch (Table 2). Pine bark nuggets consisted of large pieces of bark with almost no fine material. All the other materials consisted of about equal volumes of large pieces and fine fibrous material.

During the 2-hour examination of plots on October 12, a total of only 10 *M. crudus* nymphs were observed. All were beneath fragments of mulch. Nymphs occurred singly or in groups of up to three.

TABLE 1. MEAN NUMBERS OF *M. CRUDUS* ADULTS CAPTURED IN EMERGENCE TRAPS IN PLOTS WITH DIFFERENT TYPES OF MULCH.

Mulch material	Mean[1] number of *M. crudus* adults captured ± Standard Deviation
Pine bark mulch	3.04 ± 3.20 a
Eucalyptus mulch	2.00 ± 2.48 ab
Cypress mulch	1.71 ± 1.97 b
Control	1.08 ± 1.41 b
Pine bark nuggets	0.75 ± 1.03 b

[1]Means within a column followed by the same letter are not significantly different ($P < 0.05$, least significant difference.)

DISCUSSION

The higher numbers of adult *M. crudus* emerging in plots with certain types of organic mulches probably reflects higher numbers of nymphs in these plots. It is not known whether this was due to (1) preference of these microhabitats by ovipositing females, (2) movement of nymphs into plots from adjacent areas, or (3) a greater rate of survival in plots. In any case, the fragments benefit the nymphs of this species by providing shelter.

Possibly, organic mulches may also benefit nymphs indirectly by improving the soil, thus the quality of host plants. The principal benefit to plants of wood mulches is in improving water retention of the soil, thus increasing the availability of water and reducing the rate of leaching of nutrients. The nitrogen content of wood mulch is generally about 0.09% and release of nutrients due to decomposition is extremely slow (Anon. 1994). Release of nutrients from decomposing organic mulch may be important to plants over long periods, but probably would have been insignificant during the period of this experiment.

Based on evidence from the first experiment, that coconut frond mulch enhanced the ground habitat for *M. crudus* development, we expected that any organic mulch would have similar effects. However, other materials differed in this respect. Fewer *M. crudus* adults developed to adult in the coarsest (pine bark nuggets) and finest (cypress mulch) materials than in the materials of intermediate sizes. Whether these dif-

TABLE 2. MEAN WIDTHS AND LENGTHS OF FRAGMENTS (EXCLUDING FINE FIBER) OF DIFFERENT MULCH TYPES TESTED FOR ENHANCEMENT OF *M. CRUDUS* NYMPHAL HABITAT.

Mulch type	Mean width ± SD[1]	Mean length ± SD
Pine nuggets	3.190 ± 1.15 a	6.1 ± 2.22 a
Pine bark mulch	1.620 ± 0.69 b	5.5 ± 1.28 a
Eucalyptus mulch	0.950 ± 0.62 c	3.4 ± 1.07 b
Cypress mulch	0.840 ± 0.31 c	2.4 ± 1.02 b

[1]Means within a column followed by the same letter are not significantly different ($P < 0.05$, least significant difference.)

ferences in production of the insects were related to the obvious differences in mulch texture, or to volatile substances in the materials, decomposition rates, or other factors is not known. Of the materials tested in the second experiment, pine bark nuggets were ranked lowest in productivity of *M. crudus*. Fine fibrous material, which pine bark nuggets lacked, may be important in enhancing the ground habitat for *M. crudus* nymphs.

The results of this study are applicable to enhancing *M. crudus* populations in lethal yellowing research areas including field trial areas for testing palms for lethal yellowing-resistance. In attempting to subject palms to adequate testing, efforts are made to enhance disease pressure, which is presumably partly dependent on the levels of vector populations (Howard & Harrison 1997). Populations of *M. crudus* may be increased by spreading organic debris among their nymphal host plants to provide shelter. Coconut palm fiber was found to be suitable for this and can be derived from palms on and near the testing site. This technique could be combined with that of maintaining a ground cover of preferred nymphal host plants of this insect (Carrillo Ramirez & Piña Razo 1990, Howard 1989, Howard 1990a, Howard 1990b, Piña Quijano 1993, Tsai & Kirsch 1978, Villanueva B. et al. 1987, Zenner de Polania & Lopez 1977).

On the other hand, elimination of organic debris in palm plantings to reduce the suitability of the habitat for development of *M. crudus* would probably not be a practical management method for lethal yellowing. Continual removal of organic debris from coconut plantations would be prohibitively costly. Additionally, the role of organic debris in improving the water-holding capacity of soil and in slowly releasing nutrients is regarded as beneficial to palms.

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