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# SURVEY OF *HELIOTHIS* SPP. LARVAE FOUND ON FLORIDA BEGGARWEED AND POSTHARVEST TOBACCO IN FLORIDA

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ABSTRACT

*Heliothis* spp. larvae were collected from pre- and postharvest tobacco and Florida Beggarweed, *Desmodium tortuosum*. Five distinct adult *H. virescens* peaks were determined from pheromone-baited cone traps, but only 4 larval *Heliothis* spp. peaks followed them. The late July larval

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population was much lower than expected on tobacco and beggarweed, suggesting the existence of another alternate host. Maximum densities on beggarweed were 37 and 18 larvae/sweep sample (10 sweeps) in 1978 and 1979, respectively. The ratio of *H. virescens*: *H. zea* increased from 0.2:1.0 in July to over 20.0:1.0 by season's end. *Cardiochiles nigriceps* parasitized 44.5% of *H. virescens* larvae from postharvest tobacco, and 9.2% from beggarweed. *Archytas marmoratus* parasitized 2.9% of the *Heliothis* larvae collected from postharvest tobacco, but 20.0% of those from beggarweed.

RESUMEN

Se colectaron las larvas de *Heliothis* spp. de tabaco de pre-y post-cosecha y de pega-pega, *Desmodium tortuosum.* Se determinaron cinco picos de los adultos de *H. virescens* con trampas cónicas de feromona, pero los siguieron solo 4 picos de larvas de *Heliothis* spp. La población en los fines de julio fue mucho más bajo que lo que se esperaba sobre el tabaco y la pega-pega, lo cual hecho sugiere la existencia de otra planta hospedera alternativa. Las densidades maximas sobre la pega-pega fueron de 37 y 18 larvas/muesta de red (10 pasadas de la red) en 1978 y 1979, respectivamente. La razón de *H. virescens: H. zea* se aumentó desde 0.2:1.0 en julio hasta más de 20.0:1.0 hacía el fin de la temporada. *Cardiochiles nigriceps* infestó 44.5% de las larvas de *H. virescens* de tabaco de post-cosecha, y 9.2% de las de pega-pega. *Archytas marmoratus* infesto 2.9% de las larvas de *Heliothis* colectadas de post-cosecha, pero 20% de las de pega-pega.

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Larvae of the tobacco budworm (TBW), *Heliothis virescens* (F.) and the corn earworm (CEW), *H. zea* (Boddie) (Lepidoptera:Noctuidae), feed on a large number of cultivated crops and weed species (Barber 1937, Lincoln 1972, Roach 1975). Female moths of both species discriminate among plants and lay more eggs on some hosts, preference being influenced by morphological characteristics and chemical stimuli from the plants (Callahan 1957, Deutsch 1968, Widstrom et al. 1979). Within an agroecosystem, oviposition by a *Heliothis* species during a season shifts from host to host depending on the availability and phenological states of individual hosts (Snow and Brazzel 1965). These "adaptive host plant shifts" (Freeman et al. 1967) are distinctive for each geographical area with its particular cropping system and alternate host complex (Chamberlin and Tenhet 1926a, Barber 1937, Neunzig 1963, Graham et al. 1972, Roach 1975). Yearly differences in magnitudes of insect populations, weather conditions, cropping patterns, postharvest practices, and coincidental timing of plant phenologies may alter the observed importance of a particular plant species. The effects of associated predators and parasites of *Heliothis* spp. also vary geographically, seasonally, and among host plants (Ridgway and Lingren 1972, Roach et al. 1979).

While there have been many reports of *Heliothis* spp. larvae developing on wild hosts, there have been few attempts to quantify the importance of weed species on the population dynamics of TBW and CEW. This is not due to a lack of appreciation for the role of alternate hosts in these insects' life cycles, but due rather to difficulties in conducting quantitative research (Lincoln 1972). Weeds seldom occur in spatially or phenologically uniform stands, making estimations of the absolute quantity of plant material per unit area difficult. Weeds accepted as food by *Heliothis* spp. occur in several families with considerable morphological variation, and these plants are typically mixed with other host and nonhost species. These factors coupled with inherent nonuniformities in CEW and TBW distributions further complicate sampling procedures (Roach 1975, Stinner et al. 1979).

The purpose of this study was to investigate the population dynamics of *Heliothis* spp. in tobacco fields and adjacent weedy areas in Alachua County, Florida. Because of the long frost-free period in North Florida, the total growing season extends well beyond the period of tobacco production. *Heliothis* spp. females emerging before tobacco transplanting or after harvest seek other hosts for oviposition. The primary early-season weed hosts for *Heliothis* spp. in the Florida-Georgia tobacco belt are toadflax, *Linaria canadensis* (F.) Dumont, and Carolina cranesbill, *Geranium carolinianum* L. (Barber 1937, Snow et al. 1966). Florida beggarweed, *Desmodium tortuosum* (Swartz) de Candolle, is the dominant late-season host plant (Chamberlin and Tenhet 1926a, Snow and Burton 1967), and smooth meadow-beauty, *Rhexia alifanus* Walter, is an important mid-season weed host of *Heliothis* spp. larvae (Barber 1937). Physical descriptions, distributions, and blooming periods of these plants may be found in Small (1933), Radford et al. (1968), and Duncan and Foote (1975). Tobacco, corn, and soybeans are the most common cultivated crops attacked by TBW and CEW in the study area.

## Materials and Methods

This study was conducted during 1978-1979 in 11 tobacco fields and 16 weedy locations on 6 farms in Alachua County, FL. This is an area of diverse agricultural, forest, and residential lands. We leased and managed one 12-ha farm, which was used for our control plots in 1979. No insecticides were used on 750 tobacco plants (ca. 0.07 ha), 350 transplanted *D. tortuosum* plants (ca. 0.03 ha) or around weedy field borders. Management of the 5 privately owned farms was left to the discretion of individual growers who employed a variety of insecticidal and cultural practices. These fields ranged in size from ca. 3 to over 12 ha.

During the tobacco growing period, 25 or 50 plants were checked for *Heliothis* spp. larvae at 5 locations within each field. Four fields each year were sampled twice weekly. In all but 2 postharvest fields, 5 plots of 25 tobacco plants were checked weekly, and all larvae were collected. When only completely harvested stalks remained, the plants were cut near ground level in the plots to allow regrowth. In 2 fields that were disked following harvest and had widely scattered regrowth, permanent plots could not be established. In these fields, 25 plants were chosen randomly from 5 areas each week. After sampling, these plants were destroyed.

Beggarweed was sampled with a 38-cm-diam. sweep net. Each sweep sample consisted of 10 sweeps of ca. 120-180°C arc. All sweeping was done by the senior author. Depending on the size of the weed patch and the relative *Heliothis* population size, 10, 20, or more samples were taken twice weekly.

All *Heliothis* spp. larvae collected in the field were reared on pinto bean artificial diet (Burton 1969) in 30-ml cups at ca. 25°C. Because of the large number of larvae collected, species determinations were not made until individuals pupated. Parasitism rates were determined by rearing pupae or adults from *Heliothis* spp. larvae on diet. Dead larvae were not dissected to determine parasitism or disease organisms. Pupae from late-season collections were examined for retention of larval eyespots (Phillips and Newsom 1966) to determine if they had entered diapause.

Cone traps (Hartstack et al. 1979) constructed of screen wire mesh and baited with Virelure [(*Z*)-11-hexadecenal:(*Z*)-9-tetradecenal16:1] were used to monitor male TBW activity in all fields. In postharvest tobacco fields and beggarweed patches, 4-8 traps were maintained and checked twice weekly. Pheromone dispensers (Hercon® laminates containing 10 mg pheromone) were changed monthly.

## Results

During 1978 and 1979, 4184 *Heliothis* larvae were collected from *D. tortuosum* and postharvest tobacco (Table 1). Mortality was high after larvae were placed on artificial diet. Parasites reared from collected larvae accounted for 10.0% mortality, while disease, injury during handling, unsuccessful parasite development, and other unknown causes accounted for 66.6% mortality (Table 1). The remaining 23.4% of larvae collected became adult moths.

There were differences in crop and weed patch sizes and insect populations between farms. *Heliothis* spp. larvae were abundant in some fields, while collections were small in others. During the growing season, farmers often destroyed weeds after only a few sampling dates. Of particular importance to this study were the various postharvest practices. Each of the following was used on at least one of the study fields: 1) field abandoned until next season; 2) tobacco stalks mowed, but weeds along field edges and hedge rows left; 3) field completely mowed one or more times before winter; 4) field mowed and disked; and 5) cattle allowed to graze after one of the previous practices. A grower may employ one or more of these procedures over a postharvest season.

According to pheromone trap catches, there were 5 adult male TBW peaks during each year (Fig. 1). They were during late-April, early-June, mid-July, late-Aug. or early-Sept., and early-Oct. The small values early in the 1978 season are due to very high trap densities (22 traps/ha) in 2 of the fields. After harvest in 1978 and during all of 1979, trap densities were 0.7-1.5 trap/ha for all fields.

During 1978, 4 distinct peak collections of *Heliothis* spp. larvae were made from tobacco; 2 peaks (late-April, mid-June) were from preharvest and 2 (early-Sept., early-Oct.) from postharvest plants (Fig. 2). The data for 1979 were far less distinct, but were in general agreement with the previous year's collections. Maximum larval counts from individual preharvest tobacco fields were 0.57 larvae/plant (15 June 1979) and 0.32 larvae/plant (3 May 1979). The largest individual field collections from tobacco regrowth were 0.54 larvae/plant (6 September 1978) and 0.23 larvae/plant (21 September 1979).

Nearly an equal number of CEW and TBW adults were reared from postharvest tobacco (Table 1), but these data are not truly reflective of the CEW:TBW ratio because of selected parasitism by *Cardiochiles nigriceps* (Viereck) (Hymenoptera:Braconidae) on *H. virescens* (Lewis et al. 1967). Other parasite species reared from *Heliothis* larvae are not so specific. After adjusting for *C. nigriceps* parasitism, the ratio of *H. virescens* to *H. zea* became ca. 5:3.

TABLE 1. TOTAL NUMBER OF *Heliothis* SPP. ADULTS AND PARASITES REARED FROM LARVAL COLLECTIONS FROM FLORIDA BEGGARWEED AND POSTHARVEST TOBACCO OVER 2 SEASONS IN ALACHUA CO., FL.

| Host plant | Total larvae collected | Dead larvae[1] | Pupae and adults | | Parasites | | Other[2] |
|---|---|---|---|---|---|---|---|
| | | | *H. zea* | *H. virescens* | *C. nigriceps* | *A. marmoratus* | |
| | | | 1978 | | | | |
| Postharvest tobacco | 247 | 150 | 31 | 36 | 23 | 4 | 3 |
| *Desmodium tortuosum* | 1740 | 1240 | 99 | 278 | 33 | 83 | 7 |
| | | | 1979 | | | | |
| Postharvest tobacco | 430 | 251 | 65 | 50 | 46 | 4 | 14 |
| *Desmodium tortuosum* | 1767 | 1145 | 103 | 317 | 27 | 141 | 34 |
| Total | 4184 | 2786 | 298 | 681 | 129 | 232 | 58 |

[1]No species determinations.
[2]Primarily *Eucelatoria rubentis* (Coq.), *Netelia sayi* (Cushman), *Apanteles marginiventris* (Cresson).

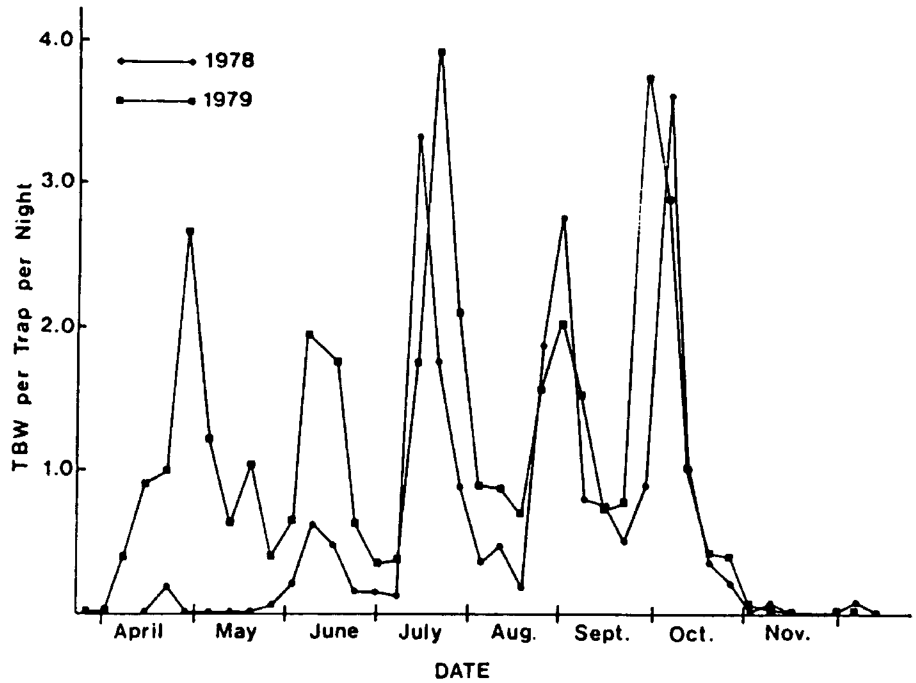


Fig. 1. Average weekly numbers of adult *Heliothis virescens* males (TBW) collected per cone-type trap baited with Virelure during 1978 (6 fields) and 1979 (7 fields) in Alachua Co., FL.

Larval *Heliothis* populations on beggarweed were more or less concurrent with those on postharvest tobacco. Sampling peaks were observed during Julian weeks 36 and 40 (early-Sept., early-Oct.) 1978, and weeks 35 and 43 (early-Sept., mid-Oct) 1979 (Fig. 3). The highest numbers of *Heliothis* larvae in any field were collected from *D. tortuosum* on 1 September 1978 (37.4 larvae/sweep sample) and 22 October 1979 (18.3 larvae/sweep sample). There was considerable variation between fields on the dates of maximum larval collections from beggarweed. The peaks for individual fields ranged over a 3-week span.

A field adjacent to the control field had a large stand of toadflax in 1979. During April a maximum of 5.4 *Heliothis* spp. larvae/sweep sample collected from this weed. Two-thirds of the larvae collected were TBW, and over 90% of these were parasitized by *C. nigriceps.*

*Archytas marmoratus* (Townsend) (Diptera: Trachinidae) and *C. nigriceps* were the most abundant parasites reared from *Heliothis* spp. larvae. *Netelia sayi* (Cushman) (Hymenoptera:Ichneumonidae), *Apanteles marginiventris* (Cresson) (Hymenoptera:Braconidae), and *Eucelatoria rubentis* (Coq.) (Diptera:Tachinidae) were found in lesser numbers. The ichneumonids *Hyposoter annulipes* (Cr.), *Pristomerus spinator* (F.), and *Mesochorus discitergus* (Say) and the tachinid *Lespesia aletiae* Riley were also collected.

*Cardiochiles nigriceps* were reared from *H. virescens* larvae from all host plants, and they were found from April-October. During the tobacco production season parasitism ranged 24-62%. Over both years 44.5% of all

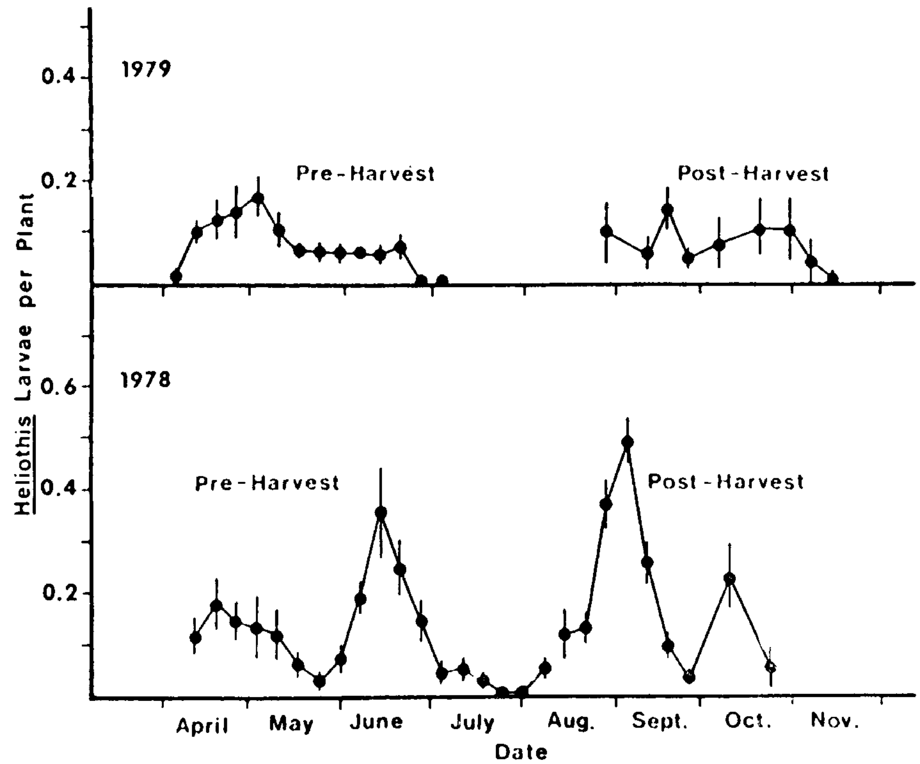


Fig. 2. Average weekly numbers of *Heliothis* spp. larvae collected from tobacco during 1978 and 1979 from 11 fields in Alachua Co., FL. Vertical lines indicate 95% confidence intervals around the means.

TBW larvae collected from postharvest tobacco were parasitized by *C. nigriceps*. In contrast, only 9.2% of all TBW from beggarweed were parasitized by this species (Table 1).

Very few (2.9%) *Heliothis* spp. larvae from postharvest tobacco were parasitized by the late-season *A. marmoratus*. On the other hand, an average of 20% of the *Heliothis* spp. larvae from beggarweed over the 2 seasons were parasitized by these flies.

The percentage of TBW of both *Heliothis* spp. collected on beggarweed increased dramatically in late August, until only a few CEW were found by season's end. Over both years 76.4% of *Heliothis* larvae collected from beggarweed and 61.8% collected from postharvest tobacco were TBW. Most diapausing TBW larvae were produced from beggarweed late in the season (Fig. 4).

## Discussion

Alternate weed hosts play an important role in the population dynamics of *Heliothis* spp. in the southeastern United States. Tobacco transplanting commences in April, but they are a poor host until the seedlings become established. In general, *Heliothis* spp. larvae prefer plants in the flowering or fruiting stage (Johnson et al. 1975, Neunzig 1963, Parsons 1940). Toadflax blooms from March to May, and is the primary early-season host of

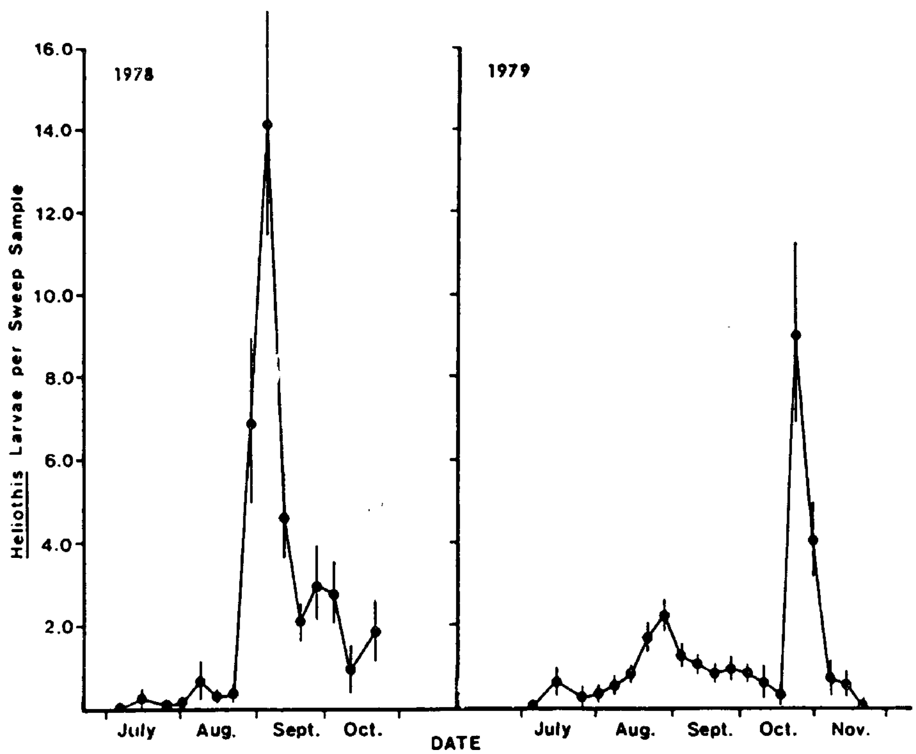


Fig. 3. Average weekly numbers of *Heliothis* spp. larvae collected per sweep sample of 10 sweeps from Florida beggarweed, *Desmodium tortuosum,* during 1978 and 1979 from 16 locations in Alachua Co., FL. Vertical lines indicate 95% confidence intervals around the means.

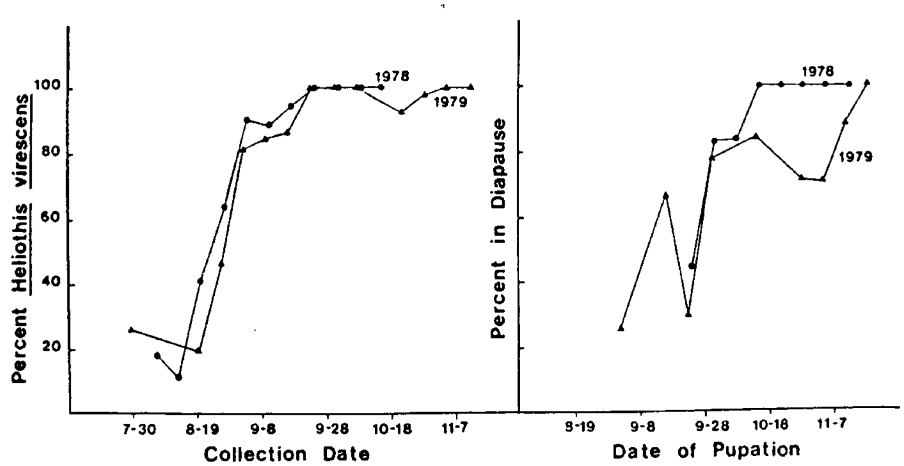


Fig. 4. Percentage *Heliothis virescens* of all *Heliothis* spp. larvae collected from *Desmodium tortuosum,* and the percentage of *H. virescens* pupae collected from *D. tortuosum* entering diapause in Alachua Co., FL.

both CEW and TBW in Florida, eastern Georgia, eastern South Carolina, and eastern North Carolina (Chamberlin and Tenhet 1926a, Barber 1937, Neunzig 1963, Roach 1975). Toadflax was the only weed found in the spring in Alachua County in sufficient quantities to be considered an important host plant. A few widespread *G. carolinianum* plants were found, but no *Heliothis* spp. larvae were collected from them.

Fall hosts are equally important to the survival of these species. A large diapausing population is needed to insure sufficient numbers surviving the winter season. Florida beggarweed is by far the most important late-season host in North Florida and southeastern Georgia (Chamberlin and Tenhet 1926a, Barber 1937, Snow and Burton 1967), but it is less important further north, and is only a minor host in eastern North Carolina (Neunzig 1963). Most diapausing TBW in this study were collected from *D. tortuosum.*

The practice of using *D. tortuosum* as a forage crop dates back many years. Barber (1937) described beggarweed as a crop sometimes cultivated for hay. Conversations with Alachua County farmers revealed that grazing in old tobacco or corn fields and along roadsides has been common for many years. Therefore, growers are often reluctant to destroy beggarweed stands. After cultivation, mowing, or heavy grazing, *D. tortuosum* may regrow and produce new flowers and seeds. Since these cultural practices are performed at different times, plants of all phenological stages may be found at any time from July to October. Often weeds in different stages of growth are found in the proximity of an old field. This provides a more continuous food source for *Heliothis* than would occur naturally. Old *D. tortuosum* plants put on some new leaves after dropping their seeds. *Heliothis* spp. larvae were also collected from these small, tender leaves.

Chamberlin and Tenhet (1926a) delineated 5 *H. virescens* larval peaks in North Florida. They felt that the first 2 (late-May, late-June) were produced primarily from tobacco, the middle peak (early-August) from tobacco and Florida beggarweed, and the final 2 peaks (mid-Sept. and early-Oct.) from beggarweed. They observed no appreciable discontinuity in the food supply as beggarweed matured about harvest time.

Data from this study support the conclusions of Chamberlin and Tenhet (1926a), except that only 4 distinct *Heliothis* spp. larval peaks were encountered. Few *Heliothis* spp. larvae were collected from tobacco or *D. tortuosum* in late-July to early-August (Fig. 2, 3). This is normally the height of the tobacco harvest and there is little food available on mature, topped, and suckered plants. Also, there is little mature beggarweed at this time. Snow and Burton (1967) did find one *H. virescens* peak on *D. tortuosum* near Tifton, GA on 11 August 1965.

The possibility of an additional weed host cannot be ruled out, but none was found. The meadow-beauties, *Rhexia alifanus* and *R. mariana* L., were reported as important mid-season hosts of *Heliothis* spp. in Georgia and South Carolina (Barber 1937, Roach 1975). These plants are found in moist pineland and bogs (Duncan and Foote 1975) which were not sampled in our study.

Parasitism rates by *C. nigriceps* were higher for larvae collected from tobacco than from *D. tortuosum.* Chamberlin and Tenhet (1926b) reported similar findings. *C. nigriceps* females are attracted to tobacco in the absence of host insects (Vinson 1975). However, we did not observe these parasites in the vicinity of beggarweed in the absence of *Heliothis* spp. infestations.

The opposite situation exists with *A. marmoratus.* Here parasitism rates among larvae collected from *D. tortuosum* were much higher than those from tobacco. *A. marmoratus* parasitizes a number of host species from several host plants (Hughes 1975), and levels of parasitism are often different on various cultivated crops (Hughes and Rabb 1976). Female flies are stimulated to larviposit by *Heliothis* spp. frass and larvae (Nettles and Burks 1976). Differences in the rates of parasitism by flies on larvae from tobacco and beggarweed may have been due to increased larviposition on beggarweed where *Heliothis* spp. levels were higher. However, the possible attraction of gravid flies to beggarweed itself cannot be ruled out.

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# MITES ATTACKING CASSAVA IN SOUTHERN FLORIDA: DAMAGE DESCRIPTIONS AND DENSITY ESTIMATE METHODS

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ABSTRACT

*Mononychellus caribbeanae* (McGregor), *Tetranychus urticae* Koch, and *Panonychus citri* (McGregor), were collected from cassava leaves. *Mononychellus caribbeanae* was observed mainly on the upper leaves, with a virus-like pattern damage. *Tetranychus urticae* and *P. citri* were observed on the lower leaves. Stippling and leaf browning were the damage symptoms for these species. The number of mites attacking the plant was correlated with a visual damage rating. Three times more damage was obtained from *M. caribbeanae* than from *T. urticae* and *T. citri*. Distribution of the mite species on 3 areas of the leaf was assessed. The use of a relative sampling method estimated ca. 63% of the total population per leaf.

RESUMEN

*Monoychellus caribbeanae* (McGregor), *Tetranychus urticae* Koch, y *Panonychus citri* (McGregor) se colectaron de hojas de yuca. *Mononychellus caribbeanae* se observó principalmente sobre las hojas superiores las cuales tenían daños parecidos como los causados por virus. *Tetranychus urticae* y *P. citri* se observaron sobre las hojas inferiores. El punteado y el tostarse de las hojas fueron las síntomas de los daños de estas especies. Se correlacionaron el número de ácaros que atacaban la planta con una clasificación visual de los daños. *Mononychellus caribbeanae* hizo 3 veces mas daños que *T. urticae* y *T. citri*. Se determinó la difusión de las especies de ácaros sobre 3 areas de la hoja. Por el uso de un método de tomar muestras se estimó cerca de 63% de la población total por hoja.

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Three phytophagous mite species, the cassava mite, *Mononychellus caribbeanae* (Mc Gregor), the two spotted spider mite, *Tetranychus urticae* Koch, and the citrus red mite, *Panonychus citrus* (McGregor), damage cassava foliage in southern Florida (Pena and Waddill, 1982). Differences in the response of the host to these mites are marked. In addition, spatial differences in species distribution occur (Rodriguez, 1978). We report here the mites damage distribution and seasonal pattern on cassava plants during 1979-80, and determine a relationship between a relative sampling method with an absolute mite population on the leaves.