LEPIDOPTEROUS PESTS OF COTTON AND THEIR PARASITOIDS IN A DOUBLE-CROPPING ENVIRONMENT

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ABSTRACT

Seasonal populations of *Spodoptera frugiperda, S. exigua, S. eridania, Heliothis virescens, Helicoverpa zea, Pseudoplusia includens*, and their parasitoids, were monitored on late-season cotton in northcentral Florida in 1992. The cotton was planted as a second crop, following corn, in one field and as a first crop in a second field in which cotton has not been grown for many years. At least twelve species of parasitoids emerged from lepidopterous larvae collected from the cotton plants. The most common parasitoids were *Cotesia marginiventris, Meteorus autographae, Cardiochiles nigriceps, Netelia sayi*, and *Copidosoma truncatellum*. The native parasitoid that showed the most potential as a biological control agent was *C. marginiventris*, because it attacks a broad range of pests including the *Heliothis*/*Helicoverpa* complex, *Spodoptera* spp., and *Pseudoplusia includens*.

This article is from *Florida Entomologist Online*, Vol. 77, No. 3 (1994).
FEO is available from the Florida Center for Library Automation gopher (sally.fcla.ufl.edu)
and is identical to *Florida Entomologist (An International Journal for the Americas).*
FEO is prepared by E. O. Painter Printing Co., P.O. Box 877, DeLeon Springs, FL. 32130.

Key Words: Cotton, *Heliothis*/*Helicoverpa*, *Spodoptera*, parasitoids

RESUMEN

Las poblaciones estacionales de *Spodoptera frugipereda*, *S. exigua*, *S. eridania*, *Heliothis virescens*, *Helicoverpa zea*, *Pseudoplusia includens*, y sus parasitoides, fueron muestreadas periodicamente en algodón tardío en la region noroccidental de Florida en 1992. El algodón fue plantado en un campo como segundo cultivo, despues de maíz, y en otra area donde no se había sembrado algodón durante muchos años. Al menos doce especies de parasitoides emergieron de las larvas de lepidopteros colectadas de las plantas de algodón. Los parasitoides mas comunes fueron *Cotesia marginiventris*, *Meteorus autographae*, *Cardiochiles nigriceps*, *Netelia sayi*, y *Copidosoma trucatellum*. El parasitoide nativo que mostró el mayor potencial como agente de control biologico fué *C. marginiventris*, porque ataca un amplio rango de plagas, incluyendo el complejo *Heliothis*/*Spodoptera*, *Spodoptera* spp., y *Pseudoplusia includens*.

Cotton had not been grown commercially in northcentral Florida for over 50 years until a 60-ha field was planted following an early corn crop in Gilchrist County in 1991. This crop was successful and more acreage was planted in 1992. Because cotton had not been planted in this area for many years and particularly because it was planted as a second crop in a double-cropping environment, we chose to monitor populations of cotton pests and their parasitoids in cotton in 1992. Information on the parasitoids was needed to define the natural populations and to determine their potential value in integrated pest management programs.

MATERIALS AND METHODS

The cooperating grower planted cotton in a 18-ha dryland field on June 6 as the first crop of the year and in a nearby 152-ha irrigated field July 11-18 following an early corn crop that was harvested for silage. Two cotton varieties, Delta Pine 90 and HS 46, were planted in each of the two fields, which were separated by a highway and tree line. Information on insect pest infestations and damage levels was provided to the grower who applied conventional insecticide treatments at his discretion. Approximately 52% of the insecticide applications involved synthetic pyrethroids. Other pesticide groups applied included carbamates, chlorinated bicyclic sulfites, organophosphates, and *Bacillus thuringiensis*. The dryland cotton received 12 applications of pesticide, and 10 applications were made in the irrigated field. Although some irrigation was used, it was not a major factor that influenced the outcome of the study because rainfall was sufficient throughout the growing season.

Cotton plants (stems, leaves, squares, blooms, and bolls) were checked for damage and lepidopterous eggs and larvae were counted twice weekly in each of the 2 varieties at 6 preselected locations in the dryland field and at 12 locations in the irrigated field (25 randomly selected plants per location). Different plants were checked on each sample date. The eggs and larvae were collected by hand, returned to the laboratory, and reared individually in 33-ml plastic cups on artificial diet (Guy et al. 1985) for emergence of adults or adult parasitoids. Larval and egg collections were made from June 30 through October 16 in the dryland cotton. The larval and egg collections in the irrigated field began on July 21 and continued through November 20. Parasitization levels were determined throughout the season based on the emergence of moths

or parasitoids from collected eggs and larvae. Identification of pest and parasitoid species was verified by comparison with preserved specimens.

Results and Discussion

The insect surveys and the emergence of adults from eggs and larvae collected from the late-season cotton enabled us to monitor field populations (Fig. 1-3) of the following pest species: fall armyworm (FAW), *Spodoptera frugiperda* (J.E. Smith); beet armyworm (BAW), *S. exigua* (Hübner); southern armyworm (SAW), *S. eridania* (Cramer); tobacco budworm (TBW), *Heliothis virescens* (F.); corn earworm (CEW), *Helicoverpa zea* (Boddie); and soybean looper (SBL), *Pseudoplusia includens* (Walker).

Prior to September 1, the predominant pest species in the dryland cotton, as indicated by the number of adults that emerged from collected larvae and eggs, was FAW (Figures 2A and 3A, respectively). Parasitoids could have been a major factor in preventing the emergence of adults from the TBW and CEW larvae found on the cotton plants (Figure 1B), because 50 to 100% of the field-collected TBW and CEW larvae were parasitized during August. Also during August, 65 to 75% of SBL larvae were parasitized (Fig. 1C), whereas less than 40% of the FAW and BAW larvae were parasitized (Figure 1A). Parasitism of FAW and BAW larvae increased rapidly, reaching 100% during the first week of September. At this time SBL became the most common pest (Figures 1C and 2B) until the cotton matured. However, very few SBL eggs were found on the cotton plants in either field, and no parasitoids emerged from any of the field-collected lepidopteran eggs. Predation of larvae and eggs by beneficial insects was not assessed.

The predominant pest species in the later-planted cotton in the irrigated field was TBW, as indicated by adult emergence from larval and egg collections (Fig. 2D and 3D), until outnumbered by FAW in late August (Fig. 2C and 3C). Subsequently, BAW larvae predominated in September. As in the dryland cotton, parasitoids apparently prevented a substantial number of TBW and CEW larvae from reaching the adult stage. Parasitization of TBW and CEW larvae peaked at 80% during the first week of September and again at almost 70% during the first week of October (Fig. 1E). Parasitization of FAW and BAW larvae did not exceed 50% throughout the season (Fig. 1D).

SBL larval populations in the irrigated cotton increased in mid-September and peaked two weeks later (Fig. 1F and 2D). Parasitism levels of the SBL larvae ranged from 20 to 50% during September and October. More FAW than BAW eggs were collected from cotton plants during October (Fig. 3C), but by late October more BAW adults emerged from the field-collected larvae than any other pest species (Fig. 2C).

No SAW larvae were found in either field, but some SAW egg masses were collected from plants in the irrigated field in late October (Fig. 3C). Differences between the larval and egg collection data likely result from protection of the eggs and small larvae in the laboratory from insecticide applications, predators, parasitoids, heavy rains, and other environmental hazards. Most of the field-collected larvae of each pest species were half-grown or smaller.

At least 12 species of parasitoids emerged from the lepidopterous larvae collected from the cotton plants. These included the following Hymenoptera: *Cardiochiles nigriceps* (Viereck) [Braconidae], *Chelonus insularis* Cresson [Braconidae], *Copidosoma truncatellum* (Dalman) [Encyrtidae], *Cotesia marginiventris* (Cresson) [Braconidae], *Meteorus autographae* Muesebeck [Braconidae], *Netelia sayi* (Cushman) [Ichneumonidae], *Ophion* sp. [Ichneumonidae], and *Pristomerus spinator* (F.) [Ichneu-

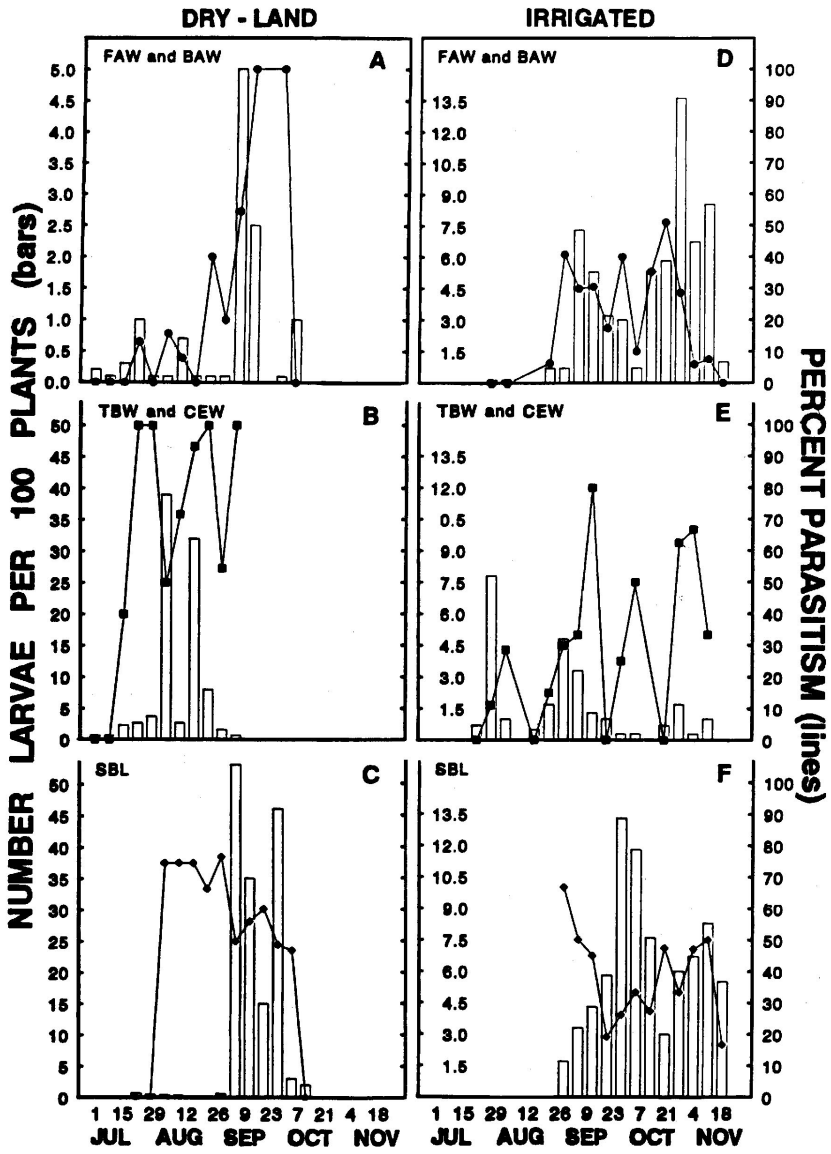

Fig. 1. Number of *Spodoptera* (FAW and BAW), *Heliothis/Helicoverpa* (TBW and CEW), and *P. includens* (SBL) counted per 100 cotton plants and percentage parasitism of field-collected larvae in each field.

monidae]. Four species of Diptera, all Tachinidae, were identified: *Archytas marmoratus* (Townsend), *Eucelatoria rubentis* (Coquillett), *Lespesia archippivora* (Riley), and *Winthemia rufopicta* (Bigot).

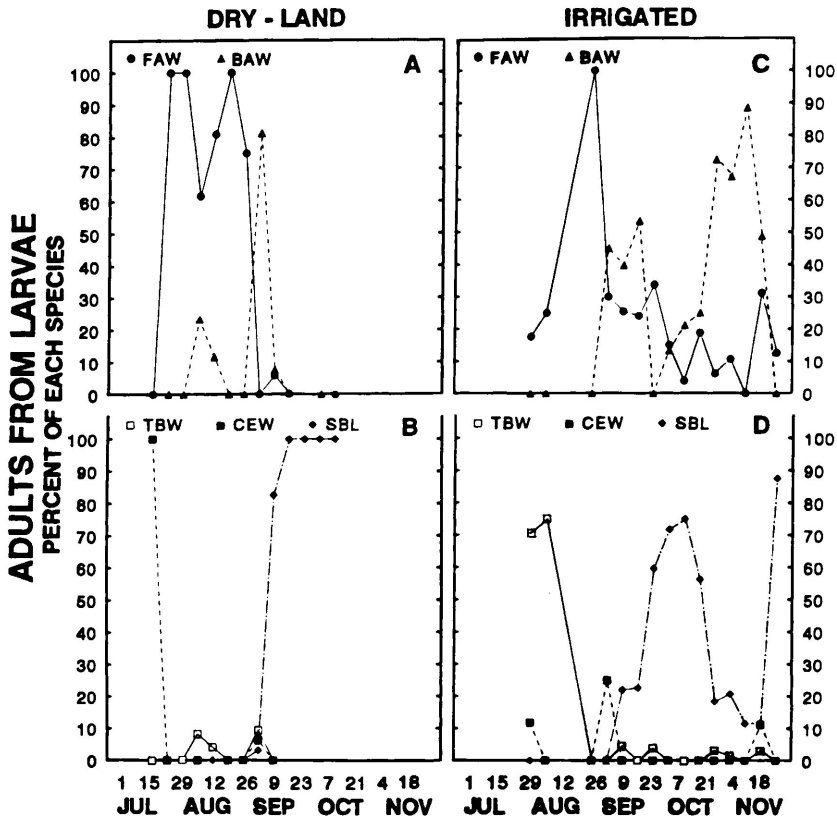

Fig. 2. Percent of each pest species as determined by emergence of adults from larvae collected from cotton plants in each field (FAW = fall armyworm; BAW = beet armyworm; TBW = tobacco budworm; CEW = corn earworm; SBL = soybean looper).

Average parasitism of FAW and BAW combined was 23% in each field although the average numbers of larvae counted per week were almost 5 times greater in the irrigated field than in the dryland cotton. The number of FAW and BAW larvae per 100 plants averaged 0.7 ± 0.3 (June 30-October 16) in the dryland cotton and 3.4 ± 0.9 (July 21-November 20) in the irrigated cotton that followed an early corn crop. Most of the parasitoids that emerged from the FAW and BAW larvae were *C. marginiventris*. This species made up 66% and 83%, respectively, of the parasitoids that emerged from larvae collected in the dryland and irrigated fields. The second most common parasitoid in each field was *M. autographae* (10 and 15% of the parasitism in the dryland and irrigated fields, respectively).

Parasitism of the TBW and CEW larvae combined averaged 65% per week throughout the season in the dryland cotton but only 29% in the later-planted irrigated cotton. Also, the TBW and CEW larval population was almost 4 times greater in the dryland cotton [5.9($\bar{x}$) ± 2.9(SEM) larvae per 100 plants] than in the irrigated field (1.5 ± 0.5 larvae per 100 plants).

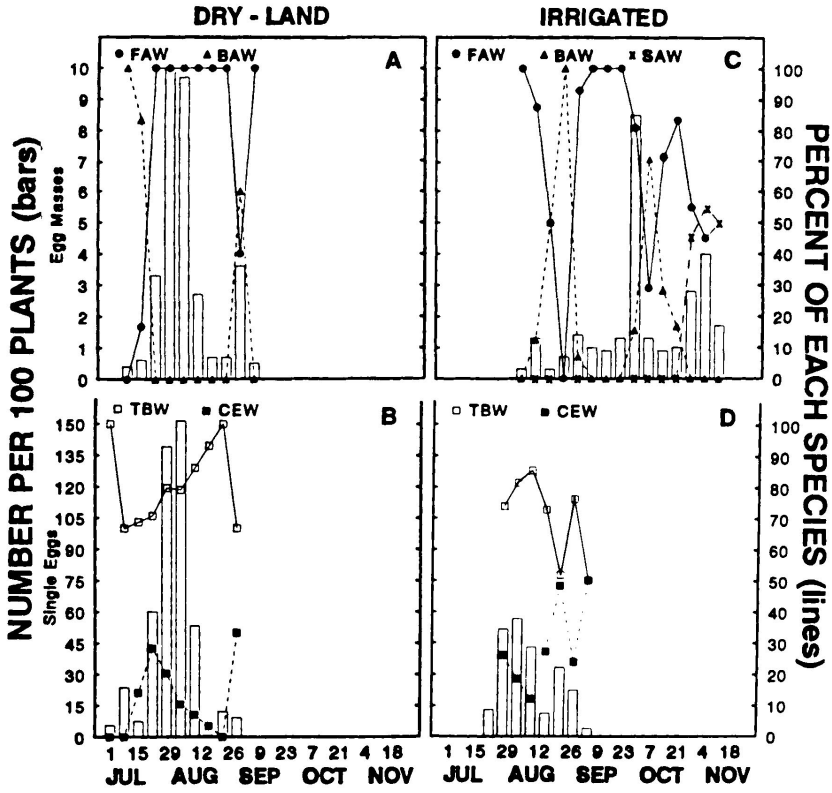

Fig. 3. Number of *Spodoptera* (FAW, BAW, anf SAW) egg masses and *Heliothis/Helicoverpa* (TBW and CEW) eggs counted per 100 cotton plants and percent of each species as determined by emergence of adults from egg collections in each field (FAW = fall armyworm; BAW = beet armyworm; SAW = southern armyworm; TBW = tobacco budworm; CEW = corn earworm).

Almost one-half (48%) of the parasitoids that emerged from the TBW and CEW collected from plants in the irrigated field were *C. marginiventris*, which was also the predominant parasitoid species emerging from FAW and BAW larvae from both fields. Only 23% of the parasitoids that emerged from TBW and CEW larvae in the dryland cotton were *C. marginiventris*. The most common parasitoid that emerged from the TBW and CEW larvae from the dryland field was *N. sayi*, comprising 47% of the total parasitoids that emerged from these species. *N. sayi* made up 20% of all parasitoids from TBW and CEW larvae collected in the irrigated field.

Another important parasitoid that emerged from the collections of TBW and CEW larvae was *C. nigriceps*. Although TBW and CEW were not identified to species before emergence of adults, *C. nigriceps* is restricted to TBW (Marsh 1978). This parasitoid made up about 25% of the total parasitoid species that emerged from larvae collected from cotton in each field. In a previous 3-year study in an adjoining county, *C. nigriceps* was the predominant parasitoid species reared from TBW larvae collected from tobacco (Tingle & Mitchell 1982). *N. sayi*, which was the most prevalent parasitoid of

TBW in postharvest tobacco (Tingle & Mitchell 1982), also emerged from TBW larvae collected from cotton in the present study.

The weekly average percentage parasitism of SBL larvae collected from cotton during the season was 49% in the dryland field and 39% in the irrigated field. The average number of SBL larvae counted per 100 plants per week was [9.9($\bar{x}$) ± 4.6(SEM)] in the dry-land cotton and 4.2 ± 1.0 in the irrigated field. Although *C. marginiventris* emerged from 58% of the parasitized SBL larvae collected in the irrigated field, 92% of parasitized SBL in the earlier planted cotton contained *C. truncatellum*. This species also emerged from 32% of the parasitized SBL larvae collected from cotton in the irrigated field.

C. truncatellum, a polyembryonic egg-larval parasitoid of several insect pests, has a high reproductive potential and has been reported as the most prevalent parasitoid of SBL (Burleigh 1971). However, this parasitoid may not be a promising candidate in an integrated control program for SBL because Hunter & Stoner (1975) found that SBL larvae parasitized by this species consumed 35% more food than unparasitized larvae. The increased food consumption of parasitized larvae could outweigh benefits resulting from reduced SBL populations.

C. marginiventris, however, has potential as a biological control agent because it attacks a broad range of lepidopterous pests such as the *Heliothis* / *Helicoverpa* group, *Spodoptera* spp., and *Pseudoplusia includens*. This parasitoid frequently causes high mortality among these pests (e.g., Tingle et al. 1978; McCutcheon & Turnipseed 1981, Pair et al. 1982, 1986). Ashley (1979) reported that *C. marginiventris* is one of the most frequently recovered parasitoids from FAW larval collections. It is an important natural enemy of FAW because it parasitizes first- and second-instar larvae that die when they reach the fourth instar (Ashley et al. 1982).

Growers in northcentral Florida are experimenting with various crops and production schemes in an attempt to increase profitability on existing acreage. The concept of producing a cash crop such as cotton following a crop of silage corn has received attention and appears promising. Of particular concern to growers pursuing this practice has been the mix of insect pests encountered in cotton planted so late in the growing season, and also how the pest complex might be exacerbated by the early (i.e., first) crop of corn.

This study indicates that the species of lepidopterous pests in dryland (early season) and irrigated (late season, 2nd crop) cotton were virtually the same as was the parasitoid complex associated with these pests. Although several species of parasitoids were recorded, *C. marginiventris* was the most prevalent and had the largest impact because of its propensity to attack a broad range of pests including the *Heliothis*/*Helicoverpa* complex, *Spodoptera* spp., and *Pseudoplusia includens*.

The data presented here suggest that parasitoids in general, and *C. marginiventris* in particular, could play a major role in control of most lepidopterous pests on cotton. Pest control strategies should foster the preservation of these and other natural enemies via the selection and judicious use of pesticides that have minimal impact on the natural enemies complex and, where possible, provide suitable habitats in and around cotton fields to encourage parasitoid development and survival.

ACKNOWLEDGMENTS

We gratefully acknowledge the technical assistance of W. Copeland, J. Leach, J. Rye, R. Navasero-Ward, F. Adams, C. Green, and R. Hemphill of this laboratory. Also, we thank J.R. Ruberson (Dept. Entomol., Coastal Exp. Stn., Tifton, GA) and personnel of the Division of plant Industry (DPI), Fla. Dept. of Agric., Gainesville, FL, for

providing preserved specimens to aid in identification of parasitoids. Mention of a proprietary product does not constitute an endorsement or recommendation for its use by USDA.

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