CONTINUED STUDIES OF INSECT POPULATION DYNAMICS IN CRIMSON CLOVER AND REFUGIA / COTTON SYSTEMS. PART II: PITFALL TRAP SAMPLING

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Abstract

Linear and transect pitfall traps were used to monitor and compare the seasonal abundance of epigeal (ground-dwelling) arthropods in three cotton fields in Dooly and Tift county, in the Coastal Plain region of south Georgia. In Dooly county linear pitfall traps were placed in a 20 ha conservation-tilled (Crimson clover) field and in a nearby 20 ha conventional-tilled (fallow) field. In Tift county linear pitfall traps were also placed in a 10 ha conventional-tilled field interspersed with six permanent 3-row refugia strips comprised of Crimson clover and annual weeds. Pitfall traps were also placed in two transects across the Tift county field. Arthropod taxa commonly captured at all three study sites included two species of Collembola, *Bourletiella hortensis* (Sminthuridae) and *Podura aquatica* (Poduridae), the striped earwig *Labidura riparia*, fire ants, *Solenopsis invicta*, twenty Carabid species and seven Staphylinid species. Other abundant epigeal arthropods included Wolf spiders (Pardosa) and Thomisids, and one species of centipede, nr. *Lithobius forficatus*. The Anthicid (ant-like beetle), *Notoxus monodon*, two Cicindelids (tiger beetles), *Megacephala carolina* and *Cicindela nr. sexguttata*, and one unidentified Pedilid were also captured, but at low levels.

In Dooly county, 1994-95 seasonal densities of Collembola and *L. riparia* in the conventional-tilled clover field were significantly higher than densities in the conservation-tilled fallow field. Densities of spiders and centipedes were significantly higher in the clover field. Wolf spiders (genus *Pardosa*), and Thomisids were the predominant spider species collected in the traps. *S. invicta* and Carabid densities were numerically, but not significantly, higher in the clover field. Staphylinid densities were not significantly different.

In Tift county, seasonal densities of Collembola and *L. riparia* captured in the linear traps were also significantly higher in the conventional-tilled cotton strips. *S. invicta*, Carabid, spider and centipede densities were all significantly higher in the refugia strips. Staphylinid densities were not significantly different. Densities of spiders and Carabid beetles captured in the transect traps were significantly higher in the cotton strips lying between or immediately adjacent to the refugia strips. The overall density and distribution of epigeal beneficials in the Tift county field, even within the cotton strips most distant from the refugia strips, remained high throughout the 1995 season.

Introduction

Part II summarizes the results of pitfall trapping in the second year of an ongoing study, first reported in the 1995 Beltwide Proceedings (Haney et al., 1995). The study is designed to 1) Identify and quantify the beneficial arthropods found in various conservation- vs. conventional-tilled cotton systems, 2) Evaluate the benefits of cover crops and refugia strips, and 3) Quantify the biological and economic benefits of reduced pesticide use. There are three main approaches to habitat conservation, enhancement of beneficial predator populations, and promotion of sustainability in agriculture, including 1) Conservation (reduced) tillage, 2) Management of refugia that provide alternate habitats and/or overwintering sites for beneficial arthropods (Reichert and Lockley, 1984; Nyffeler et al., 1992), and 3) Reduction of pesticide use. The number of empirical studies concerning the biodynamics of epigeal (ground-dwelling) arthropods occurring in various cotton tillage systems in Georgia (and the Southeast) remains somewhat limited. Relatively little is known about the role played in cotton by the two species of Collembola collected in this study, except that they are mycophagous, and they may be an important early season food source for spiders. The interactions between fire ants, *S. invicta*, and the striped earwig, *L. riparia* (Pallus), are not well documented in Georgia cotton. Evidence from studies conducted in other cotton-producing states indicates that both species prey voraciously on a wide variety of cotton pests, especially lepidopteran species. *Solenopsis* plays a complex, somewhat contradictory role in cotton, acting in many cases as an effective predator, while also preying on or inhibiting some beneficial species, such as *L. riparia* and Coccinellids. Fortunately, the beneficial complex in cotton is quite diverse, and the overall net effect of *Solenopsis* in cotton appears to be positive (Brinkley et al., 1991). Carabid beetles exhibit a wide variety of habitat and feeding preferences. Both adults and larvae are generally highly beneficial, playing a dominant role in the epigeal community. The twenty species captured during the last two seasons often comprised eighty percent or more of the specimens trapped each week. We have little empirical knowledge of the contributing role played by the other genera of predatory beetles collected in this study (e.g., *Anthicidae* and *Cicindelidae*). Finally, although spiders are recognized as major predators in widely diverse agro-ecosystems around the world, there are still aspects of their contribution to cotton pest management that remain unclear.

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Materials and Methods

All of the Dooly and Tift county pitfall samples were taken in the same fields reported in **Part I**, and all of the planting dates, procedures, plot designs, treatment dates, etc., are the same as reported in **Part I**.

In Dooly county, ten 480 ml (16 oz) uncovered Solo® cup pitfall traps containing rock salt as a preservative (Clark, 1992) were each placed 50 m apart in the same linear row in the approximate middle of both fields. Traps were maintained from February 15 through September 22, 1995. In Tift county, five pitfall traps were placed ca. 100 m apart in row 44 and again in row 153, for a total of ten traps. Rows 44 and 153 were the center rows within the center refugia strips of Group 1 and 2 (refer to **Part I** for a complete description of the field). The same procedure was also followed in rows 93 and 201 of the regular cotton strips. This design allowed the linear trap lines in the refugia vs. cotton strips to be as widely separated from one another as possible while still placing them well away from the field margins. In addition, two sets of 12 pitfall traps were set out in a perpendicular transect across the field to monitor density and dispersal of beneficials from the refugia strips into the cotton strips. One trap was placed in the middle row of each cotton strip; a total of eight traps were placed in each of the three types of plots. The first set of traps were placed ca. 100 m from the west end of the field; the second set of traps were placed ca. 100 m from the opposite (east) end of the field, with ca. 200 m separating the two sets. The linear traps were maintained from April 14 through September 25, while the transect traps were maintained from July 27 through September 25, 1995.

Pitfall Trap Design

Each trap was placed inside a protective sleeve made from a No. 12 steel can with the top and bottom lids cut out. The metal sleeves provided protection, a margin for drainage space, and support to the plastic traps. Each trap cup was also equipped with a pair of drains made by melting two 10 mm holes in opposite sides of the cup with a glue gun, then covering them, from the outside, with a 20 mm-square piece of fine-mesh organdy cloth that was well secured with the glue gun. The two holes were placed ca. 40 mm from the top of the cup. The drainage holes worked extremely well; virtually none of the traps overflowed in any of the three fields, even during periods of heavy rainfall, during the entire season. Each site was marked by a 2 m stake tied with colored flagging ribbon to help facilitate location from a distance. Traps were changed weekly; each cup was removed from its protective sleeve, covered with a clear plastic lid and placed in a polyethylene carrying tray for transport to the lab, where the contents were separated and washed with tap water through fine organdy screens, then stored in labeled vials containing 70% ethyl alcohol. Arthropods were counted by species using a binocular microscope before being pooled into major taxonomic groups. All data sets were analyzed for seasonal significant variance (ANOVA; $p = 0.05$), using weekly pooled means.

Results and Discussion

Dooly County

Linear Pitfall Traps

Seasonal densities of each arthropod group captured in the Dooly county conservation- vs. conventional-tilled fields in 1995 are presented together with the 1994 results in the same graphic format reported in Haney et al., (1995).

Early spring Collembola densities in the fallow field were significantly higher ($p = 0.04$) than densities of Collembola in the conservation field. It is still unclear why Collembola densities were consistently higher in the cultivated fallow field than in fields with a cover crop or refugia. The pooled seasonal population densities of both Collembola species are summarized in **Figure 1**.

1995 seasonal densities of *L. riparia* in the conventionally-tilled field were significantly higher ($p \leq 0.001$) than *L. riparia* densities in the conservation-tilled field, just as they were in 1994, although overall densities of *L. riparia* were significantly lower in 1995 than in 1994 ($p \leq 0.001$; **Figure 2**.). This relative 'decline' may have been due to extended periods of drought experienced during the 1995 season.

Between-field densities of *Solenopsis* were not significantly different in 1995 ($p = 0.34$), and densities were numerically lower than in 1994, again perhaps due to extended periods of drought (**Figure 3**).

Between-field densities of Carabids in 1995 were not significantly different at any time during the season ($p = 0.46$), although one small peak occurred in the conservation-tilled field in mid-April (**Figure 4**). Staphylinid densities in both fields were significantly higher than densities in 1994, but between-field Staphylinid densities were not significantly different ($p = 0.49$; **Figure 5**). Other predatory beetles commonly trapped in 1995 include *N. monodon*, an unidentified Pedilid, and two Cicindelids, *Megacephala carolina* and *Cicindela nr. sexguttata*. Between-plot densities of these three groups were not significantly different ($p = 0.81, 0.10, 0.88$).

Seasonal densities of spiders in the conservation-tilled field were significantly higher ($p \leq 0.001$) than densities in the conventional-tilled field, just as in 1994 (**Figure 6**). Two species of wolf spiders, *Pardosa milvina* and *P. pauxilla*, along with at least two Thomisid species were the most commonly collected specimens in 1995, comprising fifty and forty-five percent of the total spiders captured, respectively. The Striped lynx spider, *Oxyopes salticus*, comprised just two percent of the total specimens captured, while species from an assortment of other genera comprised the remaining three percent. A portrait of the seasonal distribution of the two dominant spider taxa is provided in

Figure 7. Finally, the 1995 seasonal phenology of the centipede, nr. *Lithobius forficatus*, was also similar to 1994, with significantly higher densities in the conservation-tilled field ($p \leq 0.001$) and peak activity occurring in the spring (March through May) in both fields (**Figure 8**).

Tift County
Linear Pitfall Traps

Early spring population densities of Collembola were numerically higher in the cotton strips than in the refugia strips, but they were not significantly different ($p = 0.27$). Seasonal phenology was quite similar to the Collembola phenology observed in the Dooly county conservation- vs. conventional-tilled fields in 1994 and 1995 (**Figure 9**). Seasonal densities of *L. riparia*, RIFA and Carabid beetles are represented in **Figure 10-12**. The phenology of all three groups in Tift county was similar to seasonal phenology observed in the 1994 and 1995 Dooly county fields. Densities of *L. riparia* were significantly higher ($p = 0.01$) in the cultivated cotton strips 'conventional-tilled' than in the refugia strips 'conservation-tilled', while densities of *S. invicta* and the Carabids were both significantly higher ($p \leq 0.001$) in the refugia strips. It is clear that *L. riparia and S. invicta* cannot coexist in the the same locality. Both are important predators of lepidopterous larvae and pupae, but *L. riparia* densities are always significantly reduced when *S. invicta* is present. Staphylinid densities in the refugia vs. cotton strips were not significantly different ($p = 0.40$; **Figure 13**). Other predatory beetles captured in the Tift county pitfall traps included *N. monodon*, the same Pedilid as in Dooly county, and two Cicindelids, *M. carolina* and *C. nr. sexguttata*. As in Dooly county, seasonal densities of *N. monodon* were significantly higher in the cultivated cotton strips than in the refugia strips ($p = 0.03$), but there were no significant differences in seasonal densities in the other two taxa ($p = 0.67$ and 0.60).

Spider populations were significantly higher ($p = 0.01$) in the refugia strips than in the cotton strips (**Figure 14**), just as in the Dooly county clover vs. fallow fields. *Pardosa milvina* and *P. pauxilla*, and two Thomisid species comprised sixty-eight and twenty-two percent of the total specimens captured, respectively. *Oxyopes salticus* comprised the remaining ten percent of the captured specimens. A graphic portrait representing the seasonal distribution of these three dominant spider taxa is presented in **Figure 15**.

Densities of the centipede, nr. *Lithobius forficatus*, were significantly higher in the refugia strips than densities in the cotton strips ($p = 0.04$; **Figure 16**).

Tift County
Transect Pitfall Traps

All the groups discussed in the Linear Pitfall section were captured in the transect pitfall traps, but only the two dominant epigeal taxa, spiders and Carabids, were monitored in this experiment. Traps located in the Full-influence strips captured significantly higher numbers of spiders ($p = 0.01$) and Carabids ($p = 0.02$) during the season than traps in the Low-influence strips. Seasonal densities of spiders in the Partial- versus Low-influence strips were not significantly different ($p = 0.27$), but seasonal densities of Carabids in the Partial- versus Low-influence strips were significantly higher ($p = 0.01$; **Figure 17** and **18**). Spider and Carabid seasonal densities in Full- versus Partial-influence strips were not significantly different ($p = 0.81$ for spiders; 0.16 for Carabids). Seasonal distribution across the field of both taxa followed a sine-wave pattern, just as with the spiders, *Geocoris*, and Coccinellids in the whole plant samples (**Figure 19**; also see **Part I, Figure 20**). Also, there was a steady influx of Carabid beetles into the Partial-influence cotton strip lying immediately adjacent to the 20 row tobacco strip on the north side of the field. Presumably, the Carabids were preying on larvae and pupae of *Heliothis virescens*, which was abundant in the tobacco, then were captured in the pitfall traps as they ventured into the nearby cotton strip.

Conclusion

In Dooly county, the conservation-tilled field was a more favorable environment for dominant epigeal beneficial taxa than the conventional-tilled field. In Tift county, results from our first year of using refugia strips to enhance the density and distribution of beneficials in cotton were informative and encouraging. There is a clear correlation between the refugia strips and significantly higher densities of spiders and Carabid beetles, the two dominant epigeal taxa, in the cotton strips. Also, the overall density and distribution of epigeal beneficials in the Tift county field, even within the cotton strips most distant from the refugia strips, remained very high throughout the 1995 season, presumably because of migration from the refugia. In 1996 we will consider ways to manage the plant composition of the refugia strips to further encourage increased densities and dispersal of beneficials into the cotton.

Acknowledgments

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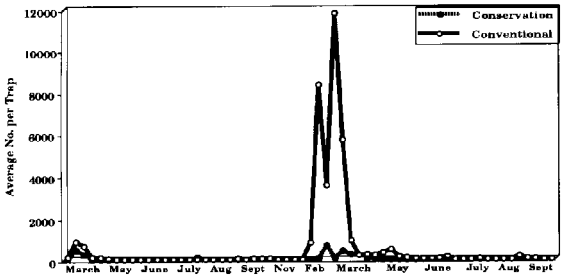

Fig. 1: 1994-95 Dooly Co. Pitfall Trap COLLEMBOLA Densities in Conservation vs. Conventional Tilled Cotton

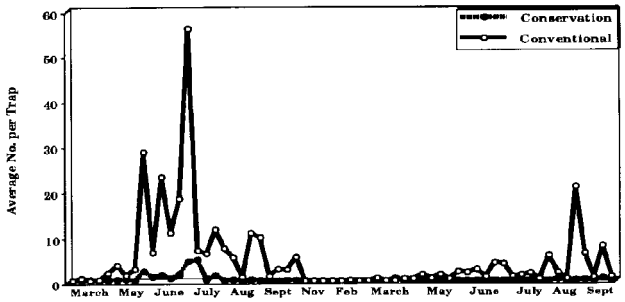

Fig. 2: 1994-95 Dooly Co. Pitfall Trap LABIDURA Densities in Conservation vs. Conventional Tilled Cotton

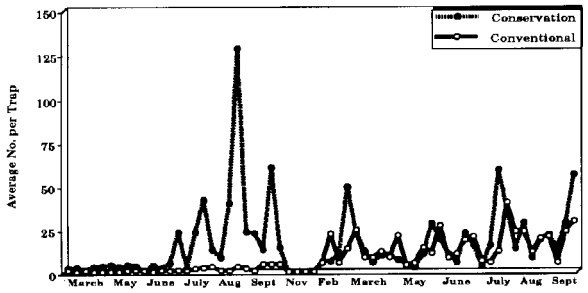

Fig. 3: 1994-95 Dooly Co. Pitfall Trap SOLENOPSIS Densities in Conservation vs. Conventional Tilled Cotton

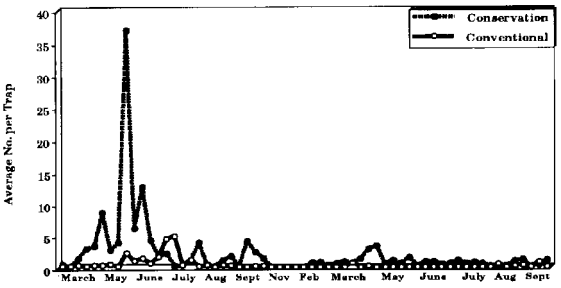

Fig. 4: 1994-95 Dooly Co. Pitfall Trap CARABID Densities in Conservation vs. Conventional Tilled Cotton

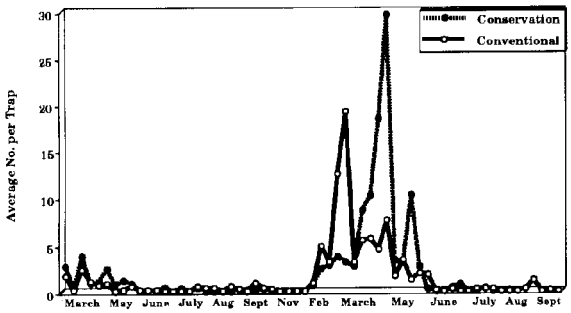

Fig. 5: 1994-95 Dooly Co. Pitfall Trap STAPHYLINID Densities in Conservation vs. Conventional Tilled Cotton

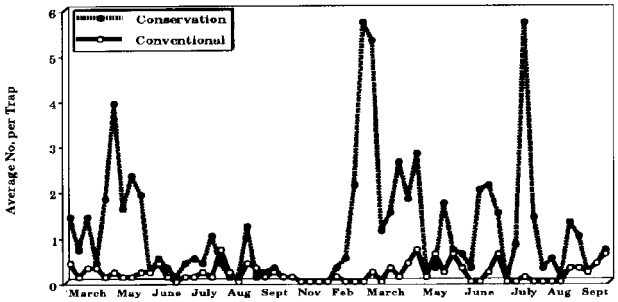

Fig. 6: 1994-95 Dooly Co. Pitfall Trap SPIDER Densities in Conservation vs. Conventional Tilled Cotton

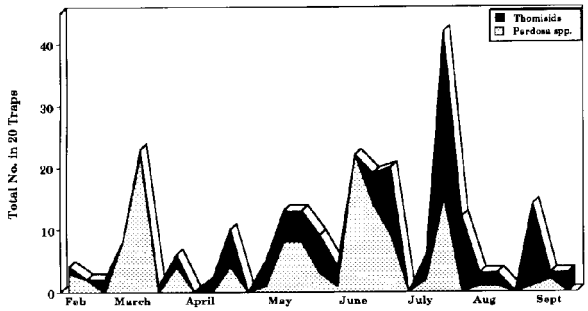

Figure 7: 1995 Dooly Co. Pitfall Trap SPIDER Species Composition

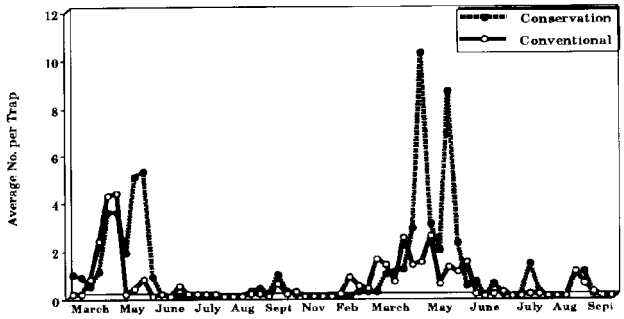

Fig. 8: 1994-95 Dooly Co. Pitfall Trap CENTIPEDE Densities in Conservation vs. Conventional Tilled Cotton

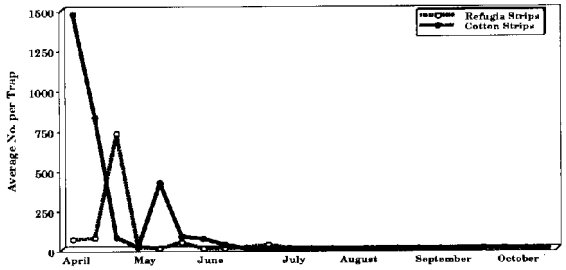

Figure 9: 1995 Tift Co. Pitfall Trap COLLEMBOLA Densities in Refugia vs. Cotton Strips

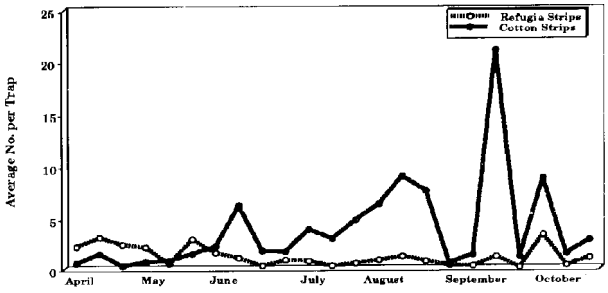

Figure 10: 1995 Tift Co. Pitfall Trap LABIDURA Densities in Refugia vs. Cotton Strips

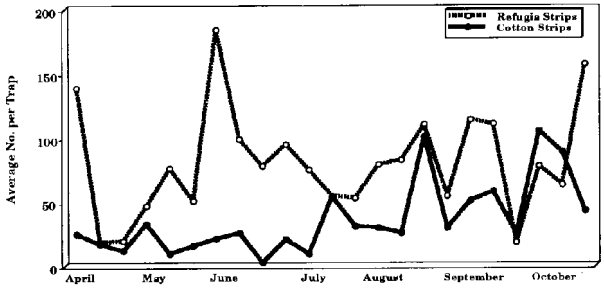

Figure 11: 1995 Tift Co. Pitfall Trap SOLENOPSIS Densities in Refugia vs. Cotton Strips

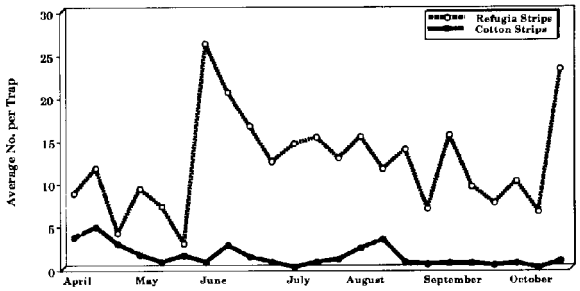

Figure 12: 1995 Tift Co. Pitfall Trap CARABID Densities in Refugia vs. Cotton Strips

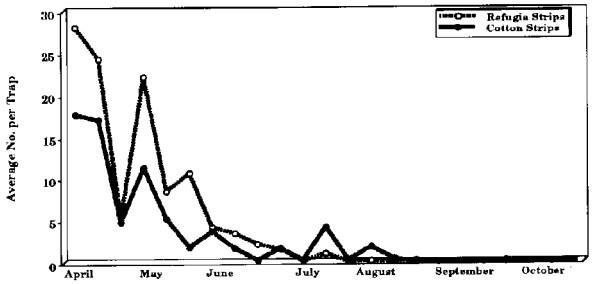

Figure 13: 1995 Tift Co. Pitfall Trap STAPHYLINID Densities in Refugia vs. Cotton Strips

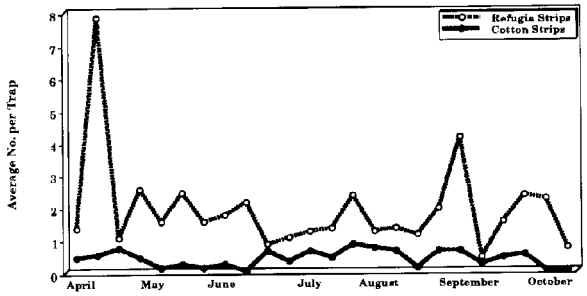

Figure 14: 1995 Tift Co. Pitfall Trap SPIDER Densities in Refugia vs. Cotton Strips

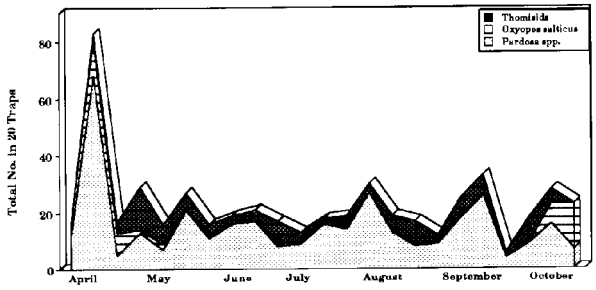

Figure 15: 1995 Tift County Pitfall Trap SPIDER Species Composition

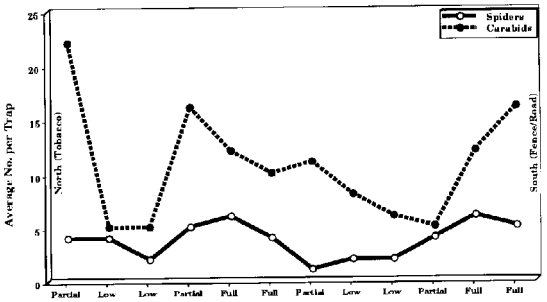

Figure 19: 1995 Tift County Transect Pitfall Trap Overall Seasonal Distribution of SPIDERS and CARABIDS in Full vs. Partial vs. Low Influence Cotton Strips

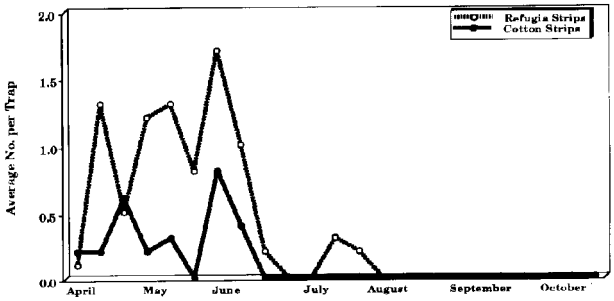

Figure 16: 1995 Tift Co. Pitfall Trap CENTIPEDE Densities in Refugia vs. Cotton Strips

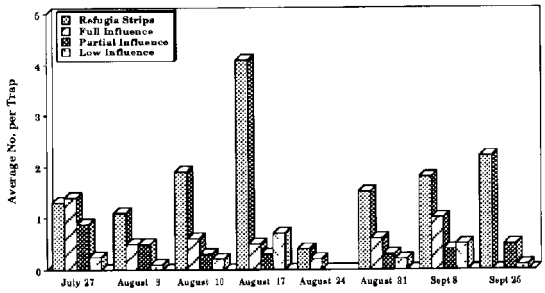

Figure 17: 1995 Tift County Transect Pitfall Trap SPIDER Densities

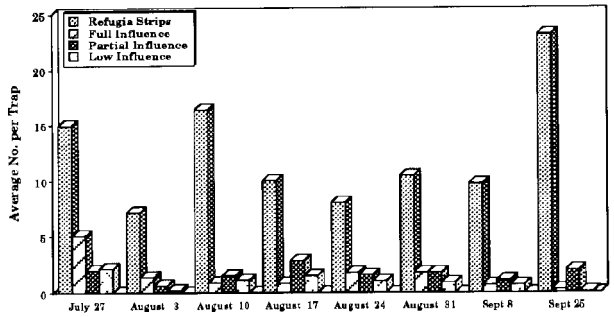

Figure 18: 1995 Tift County Transect Pitfall Trap CARABID Densities